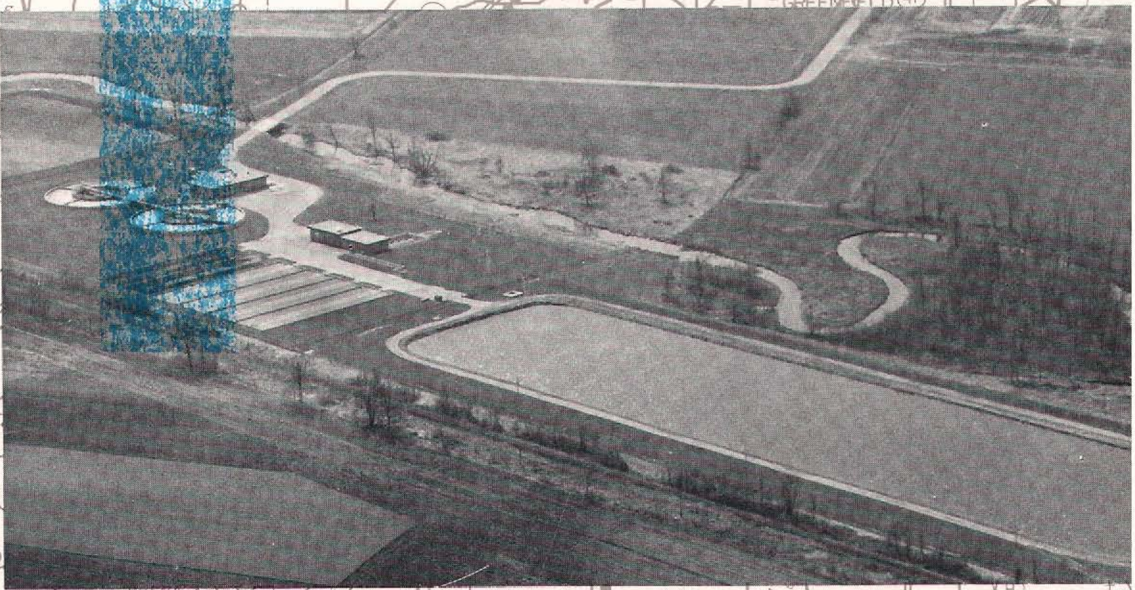
PLANNING REPORT NO. 30

A REGIONAL WATER QUALITY MANAGEMENT PLAN FOR SOUTHEASTERN WISCONSIN -- 2000



volume one

INVENTORY FINDINGS

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Special acknowledgement is due Robert P. Biebel, P.E., SEWRPC Senior Engineer; David B. Kendziorski, SEWRPC Water Quality Analyst; and Thomas C. Sweet, SEWRPC Water Quality Management Data Coordinator, for their contributions to this report.

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Volume One

INVENTORY FINDINGS

Prepared by the

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The preparation of this report was financed in part through a planning grant from the U. S. Environmental Protection Agency in cooperation with the Wisconsin Department of Natural Resources under the provisions of Section 208 of the Federal Water Pollution Control Act.

September 1978

Inside Region	$10.00
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STATEMENT OF THE CHAIRMAN

Pursuant to the provisions of Section 208 of the Federal Water Pollution Control Act, the Southeastern Wisconsin Regional Planning Commission on July 1, 1975, undertook an areawide water quality management planning program. The objectives of this program were: to determine the current state of stream and lake water quality conditions within the seven-county Region; to compare these conditions against established water use objectives and supporting water quality standards; to the extent necessary, to explore alternative means of meeting those objectives and standards through the abatement of both point and diffuse sources of water pollution; and to recommend the most cost-effective means of meeting the established objectives and standards over time. In addition to considering the means for abating both point and diffuse sources of water pollution, the program was to consider the best means for the management of the residual sludges that may be expected to result from recommended wastewater treatment facilities. Moreover, the program was to integrate land use and air quality management planning with the water quality management planning, thus assuring a comprehensive, as well as areawide, approach to the national goal of achieving "fishable and swimmable" waters.

The findings and recommendations of the planning program are presented in a three-volume planning report. This, the first volume, presents a summary of the findings of the many inventories required to provide the factual basis for the planning work. More specifically, these inventories provide data on the man-made and natural features of the Region as they relate to water quality conditions; on the existing and historical level of water quality within the Region; on the existing sources of water pollution; and on the legal and financial structures affecting water quality management. Set within the context of the Commission's comprehensive, areawide planning program, these inventory data provide the basis for sound analysis of the water pollution problems of the Region and thereby permit the planning, design, and construction of water pollution abatement facilities and the institution of land management practices needed to meet agreed-upon water use objectives to proceed on a sound basis throughout the Region.

The alternative means for abating water pollution within the Region and achieving the national objective of "swimmable and fishable" waters and the best means available from among these alternatives, together with effective means for their implementation, will be set forth in two succeeding volumes of this report.

Careful review and study of the entire report by all responsible public officials and by interested citizens is urged, for the findings and recommendations of the areawide water quality management planning program may be expected to have a far-reaching impact on the cost of providing certain municipal facilities and services, as well as on the overall quality of life within the Region.

Respectfully submitted,

George C. Berteau,
Chairman

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Chapter I

INTRODUCTION

PURPOSE AND USE OF THE REGIONAL WATER QUALITY MANAGEMENT PLAN

This report presents a plan to abate and prevent water pollution in the lakes and streams of southeastern Wisconsin up to the year 2000. The sources of pollution, the disposal or use of the solids removed from wastewaters, and the management responsibility all are addressed. This document thus is intended to provide information for use in water pollution abatement and prevention decision-making at the local, state, and federal levels of government. This comprehensive water quality management plan considers technical aspects of the abatement of each major source of pollution in the Region, the economic and financial factors related to such abatement, and the social and political considerations involved in implementation of this plan.

The areawide water quality planning and management program for southeastern Wisconsin is the third major planning program to be undertaken by the Southeastern Wisconsin Regional Planning Commission for the purpose of preparing an important element of a long-range comprehensive plan for the physical development of the seven-county Planning Region. Because the program is an integral part of a broader regional planning program, an understanding is required of the need for and objectives of regional planning and the manner in which these needs and objectives are being met in the Region. For a complete understanding of the areawide water quality planning and management program for southeastern Wisconsin, its findings, and its recommendations, these considerations are discussed below.

NEED FOR REGIONAL PLANNING

The need for regional planning is prompted by certain important social and economic changes which, while national phenomena, have far-reaching impacts on the problems facing local government. These changes include: widespread urbanization; increasing agricultural and industrial productivity; increased income levels and more leisure time; generation of mass recreational needs and pursuits; increasingly intensive use and consumption of natural resources; development of extensive electric power and communications networks; and development of limited access highway systems and mass automotive transportation.

Under the impact of these changes, entire regions such as southeastern Wisconsin are becoming mixed rural-urban areas. This, in turn, is creating new and intensified areawide development problems of an unprecedented scale and complexity. Rural as well as urban citizens must increasingly concern themselves with these problems or face irreparable damage to their land and water resources and a decline in the overall quality of their lives.

The areawide problems which prompt the regional planning effort in southeastern Wisconsin all arise from the character of the urbanization occurring within the Region. These areawide problems include, among others, inadequate drainage and mounting flood damages; underdeveloped sewerage and inadequate sewage disposal facilities; impairment of water supply; increasing water pollution; deterioration and destruction of the natural resource base; rapidly increasing demand for outdoor recreation and for park and open space reservation; inadequate transportation facilities; and, underlying all of the foregoing problems, rapidly changing and unplanned land use development. These problems all are truly regional in scope since they transcend the boundaries of any one municipality and can only be resolved within the context of a comprehensive regional planning effort involving, on a cooperative basis, all levels of government concerned.

THE REGIONAL PLANNING COMMISSION

The Southeastern Wisconsin Regional Planning Commission (SEWRPC) represents an attempt to provide the necessary areawide planning services for one of the large urbanizing regions of the nation. The Commission was organized in August 1960, after almost a decade of public deliberation, under the provisions of Section 66.945 of the Wisconsin Statutes to serve and assist the local, state, and federal units of government to plan for the orderly and economical development of southeastern Wisconsin. The role of the Commission is entirely advisory; and participation by local units of government in the work of the Commission is on a voluntary, cooperative basis. The Commission is composed of 21 citizen members who serve without pay, three from each of the seven counties that comprise the Region: Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, and Waukesha.

The powers, duties, and functions of the Commission and the qualifications of the Commissioners are set forth in the state enabling legislation. The Commission is authorized to employ experts and a staff as necessary for the execution of its responsibilities. Basic funds to support Commission operations are provided by the member counties, the budget being apportioned among the several counties on the basis of relative equalized valuation. The Commission is authorized to request and accept aid in any form from all levels and agencies of government for the purpose of accomplishing its objectives and is authorized to deal directly with the state and federal governments for this purpose. The Commission, its committee structure, and its staff organization, together with its relationship to the constituent counties, are shown in Figure 1.

THE REGIONAL PLANNING CONCEPT IN SOUTHEASTERN WISCONSIN

Regional planning, as conceived by the Commission, is not a substitute for, but a supplement to, local, state, and federal planning efforts. Its purpose is to aid the various levels and units of government in finding solutions to areawide developmental and environmental problems which cannot be properly resolved within the framework of a single municipality or a single county. As such, regional planning has three principal functions:

> Inventory—the collection, analysis, and dissemination of basic planning and engineering data on a uniform, areawide basis so that the various levels and agencies of government and private investors operating within the Region can better make decisions about community development.
>
> Plan Design—the preparation of a framework of long-range plans for the physical development of the Region, these plans being limited to those functional elements having areawide significance. To this end the Commission is charged by law with the function and duty of "making and adopting a master plan for the physical development of the Region." The permissible scope and content of this plan, as outlined in the enabling legislation, extend to all phases of regional development, implicitly emphasizing, however, the preparation of alternative spatial designs for the use of land and for the supporting transportation and utility facilities.
>
> Plan Implementation—promotion of plan implementation through the provision of a center for the coordination of the many planning and plan implementation activities carried on by the various levels and agencies of government operating within the Region.

The work of the Commission therefore is visualized as a continuing planning process providing information for resource management and physical development decision making by public and private agencies and for the preparation of plans and plan implementation programs at the local, state, and federal levels of government. This work emphasizes close cooperation between the government agencies and private enterprise responsible for the development and maintenance of land uses within the Region and for the design, construction, and maintenance of their supporting public works facilities. Commission programs are all carried out within the context of a continuing planning program which provides for the periodic reevaluation of the plans produced, as well as for the extension of planning information and advice necessary to convert the plans into action programs at the local, regional, state, and federal levels.

THE REGION

The Southeastern Wisconsin Planning Region is shown on Map 1, and is composed of seven counties having a total area of 2,689 square miles excluding Lake Michigan. Together these seven counties comprise about 5 percent of the total area of the State of Wisconsin. About 40 percent of the state population, however, resides within these seven counties, which contain three of the seven and one-half standard metropolitan statistical areas in the State. The Region contains approximately one-half of all the tangible wealth in the State as measured by equalized valuation and represents the greatest wealth-producing area of the State with about 38 percent of the state labor force being employed within the Region. The Region contributes about twice as much in state taxes as it receives in state aids; contains 154 local units of government, exclusive of school and other special purpose districts; and encompasses all or parts of 12 major natural watersheds. The Region has been subject to rapid population growth and urbanization and, in the period from 1960 to 1975, accounted for about 34 percent of the total population increase of the entire State.

The Region is well located for continued growth and development. It is bounded on the east by Lake Michigan, with an ample supply of fresh water for domestic and industrial uses, and is part of a major international shipping and transportation network. The Region is bounded on the south by the heavily populated northeastern Illinois metropolitan region, and to the west and north by the fertile agricultural lands and desirable recreational areas of the remainder of the State of Wisconsin. Many of the most important industrial areas and heaviest population concentrations in the Midwest lie within a 250-mile radius of the Region, and over 33 million people live within this radius.

COMMISSION WORK PROGRAMS

Initial Work Program

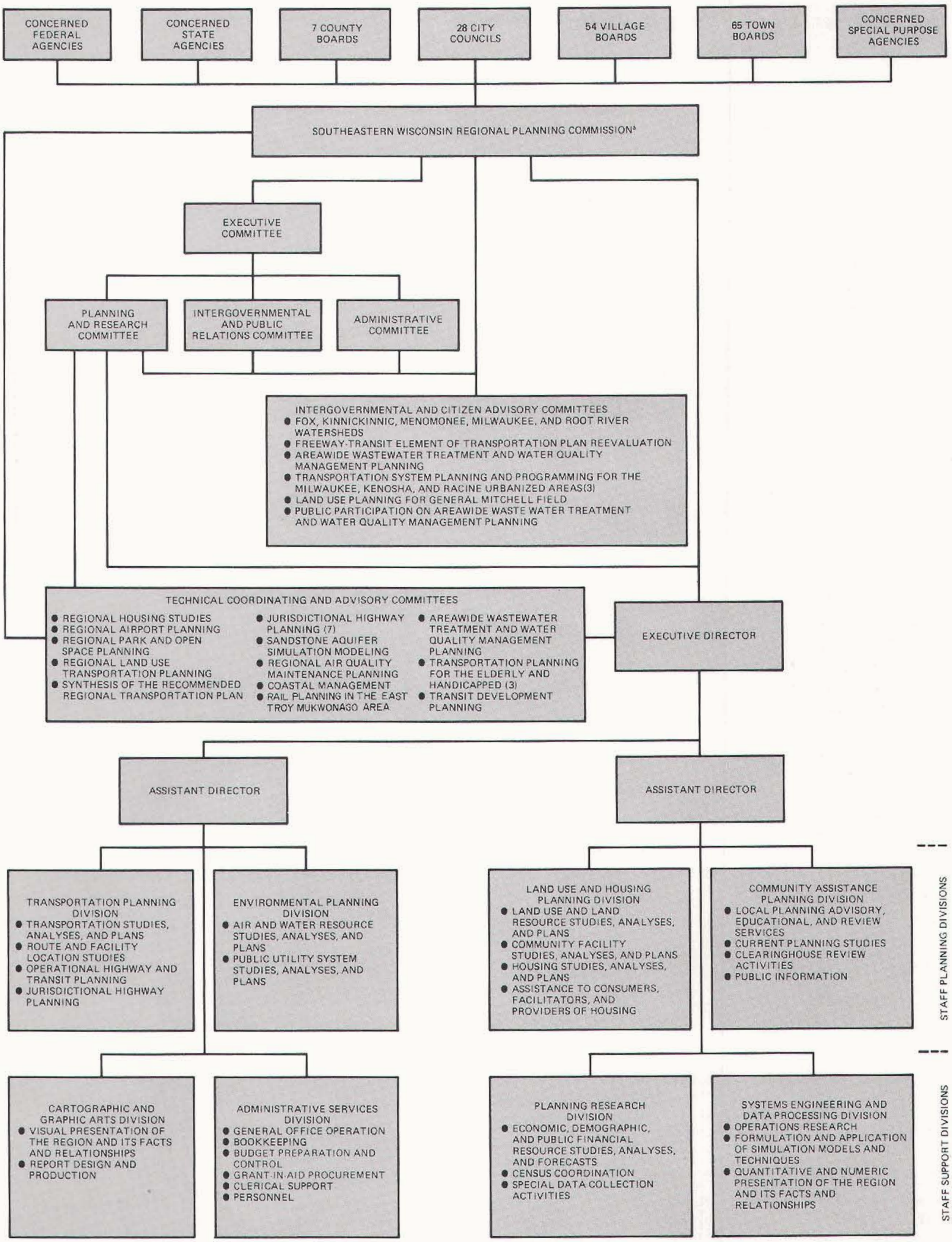
The initial work program of the Commission was directed entirely toward basic data collection. It included six basic regional planning studies which were initiated in July 1961 and completed by July 1963: a statistical program and data processing study, a base mapping program, an economic base and structure study, a population study, a natural resources inventory, and a public utilities study.

All of these initial studies provided fundamental planning and engineering data for regional planning and were documented in six published planning reports. None of these studies involved the preparation of plans, but they provided a valuable point of departure for all subsequent Commission work, including the areawide water quality planning and management program.

The Commission since its establishment in 1960, has recognized the critical importance of maintaining comprehensive, accurate, and current inventory data for the preparation of regional plan elements. In a series of planning programs, the Commission has maintained

Figure 1

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION: ORGANIZATIONAL STRUCTURE

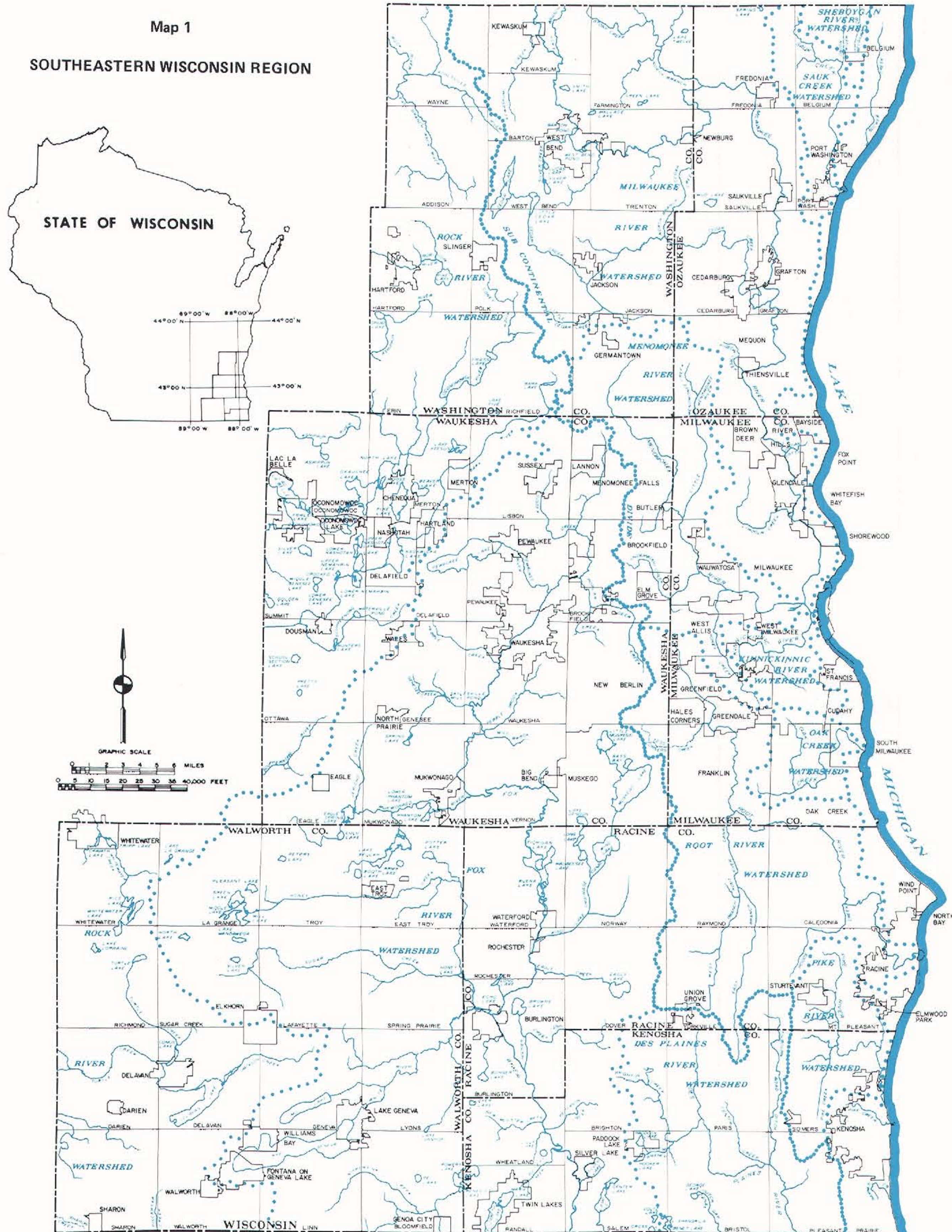


[a]THE COMMISSION IS COMPOSED OF 21 CITIZEN MEMBERS, THREE FROM EACH COUNTY, WHO SERVE WITHOUT PAY.

Source: SEWRPC.

Map 1

SOUTHEASTERN WISCONSIN REGION



The seven-county Southeastern Wisconsin Region encompasses an area of about 2,689 square miles, or about 5 percent of the total area of the State of Wisconsin. About 40 percent of the state's population, however, resides in these seven southeastern counties. The Region employs about 40 percent of the state's labor force and contains about 42 percent of all the tangible wealth in the state as measured by equalized assessed property valuation. The Region has been subject to rapid population growth and urbanization, and from 1960 to 1975 accounted for about 40 percent of the total population increase of the state.

Source: SEWRPC.

carefully organized and interrelated sets of data related to water resources and other topics; most of this data has been documented in summary fashion in Commission reports. These reports have presented data on the size, spatial distribution, and characteristics of the population of the Region; on the kinds and spatial distribution of the economic activities—including the industrial structure—that support the regional population; on the amount, type, intensity, and spatial distribution of the various land uses; on the location, capacity, and service areas of the various public utility systems that support the land use pattern; and on the natural resource base including the climate, air, physiography, geology, soils, mineral and organic resources, surface water resources and associated shorelands and floodlands, groundwater resources and associated recharge areas, woodlands, wetlands, fish and wildlife habitat areas, sites with scenic, scientific, historical or recreational value, and prime agricultural areas. The following sections briefly describe those work programs that relate most directly to the areawide water quality management planning program.

Land Use-Transportation Study

The first major work program undertaken by the Commission actually directed toward long-range plan preparation was a regional land use-transportation study, initiated in January 1963 and completed in December 1966. This program produced two key elements of a comprehensive physical development plan for the Region: a land use plan and a transportation (highways and transit) plan. The findings and recommendations of the regional land use-transportation study have been published in the three-volume SEWRPC Planning Report No. 7, The Regional Land Use-Transportation Study.

The regional land use and transportation plans were formally adopted by the Commission in December 1966. In March 1967 these plans were certified to the local units of government within the Region and to various state and federal agencies concerned with the physical development of the Region. All seven county boards adopted the recommended transportation plan in 1967. All but the Ozaukee County Board adopted the recommended regional land use plan in 1967. Since then, the plan has been adopted or endorsed by the governing bodies of 11 of the 28 cities, 13 of the 54 villages, and 14 of the 65 towns within the Region. These plans have also been adopted or endorsed by numerous agencies of government since 1967, including the Federal Highway Administration, the former State Highway Commission of Wisconsin, and the Milwaukee County Expressway and Transportation Commission.

The regional land use-transportation study has provided many important inputs to other regional planning programs in general, and to water quality planning programs in particular. For example, the regional sanitary sewerage system plan recommendations for southeastern Wisconsin, especially those recommendations on public sanitary sewer service areas, are inextricably related to the rural-to-urban land use conversion recommendations and natural resource protection measures set forth in the adopted regional land use plan. At the same time, subregional planning programs, as exemplified by comprehensive watershed plans, are intended to build upon and refine the regional land use plan. For example, these watershed plans include refinements of land use plan environmental corridor delineations, with those refinements being based on supplemental, detailed natural resource base data—woodlands, wetlands, wildlife habitat, floodlands—acquired under the watershed planning programs.

Prior to synthesis of the regional land use plan, the Commission conducted an intensive inventory of the Region's natural resource base and man-made features. Key portions of this inventory information are updated and refined under a continuing regional land use-transportation study. This data base has been invaluable to the preparation of other plans. Inventories maintained current under the continuing regional land use-transportation planning program that are useful in water quality planning efforts include those dealing with water quality, streamflow, soils, water supply systems, sanitary sewerage systems, land use, population, commercial-industrial activity, and planning law. Particularly important among these work elements for water quality management are the detailed operational soil survey of the Region documented in SEWRPC Planning Report No. 8, Soils of Southeastern Wisconsin, and the regional stream water quality inventory documented in SEWRPC Technical Report No. 4, Water Quality and Flow of Streams in Southeastern Wisconsin, both completed in 1966 and maintained current since then.

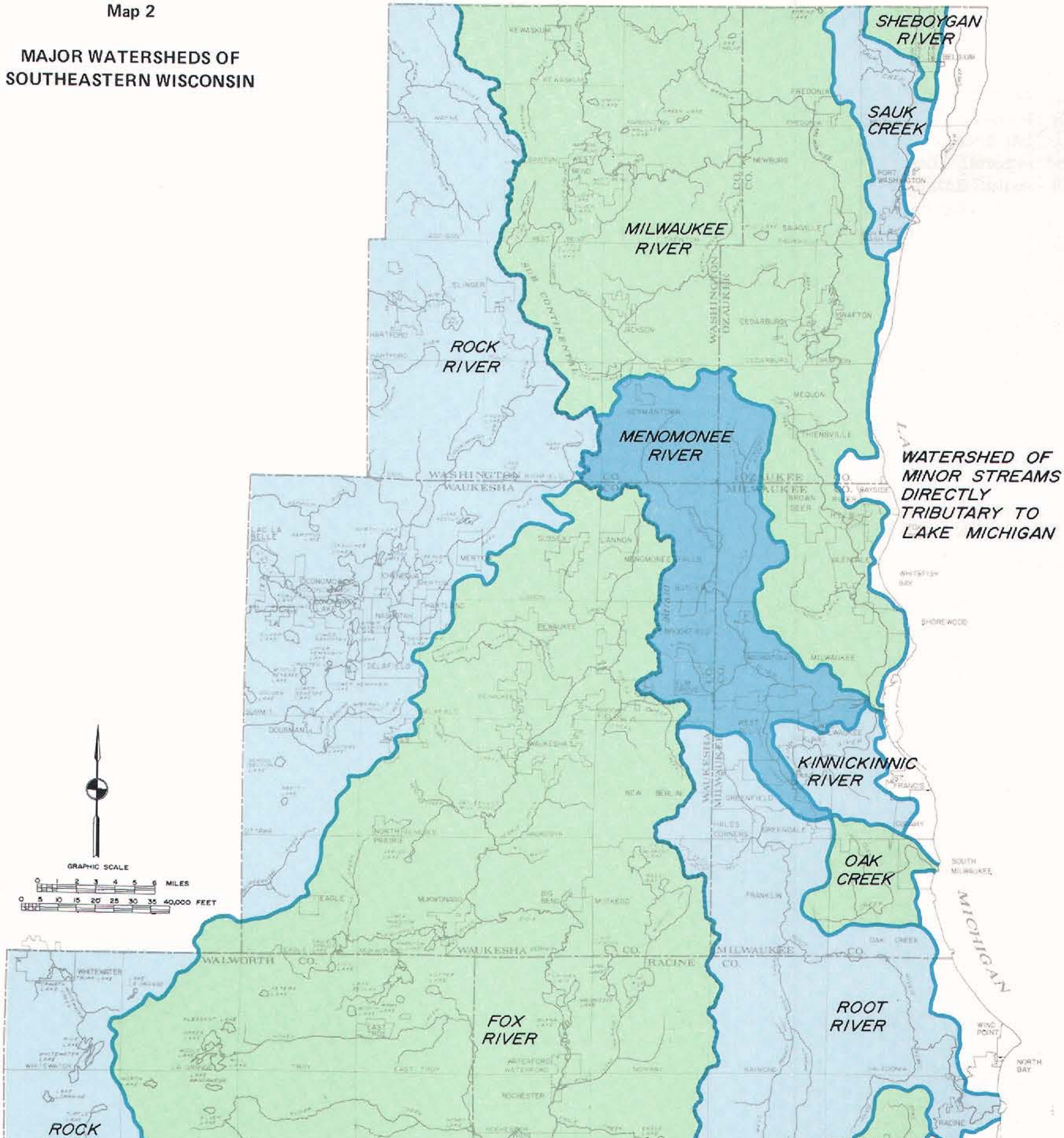
Comprehensive Watershed Studies

The Commission very early recognized the serious character and importance of water resources problems in the Region, including flooding and water pollution. The natural watershed was selected by the Commission as the basic geographic unit for water and water-related resources planning. There are 11 such major natural watersheds within the Region (see Map 2) and a twelfth which includes drainage areas tributary to small streams draining directly to Lake Michigan. Comprehensive watershed plans have been completed for the Root, Fox, Milwaukee, and Menomonee River watershed, which together comprise 63 percent of the total area of the Region. In addition, the Commission had under preparation a comprehensive plan for the Kinnickinnic River watershed, which comprises an additional 1 percent of the area of the Region.

The basic purpose of the watershed planning programs, as developed within the context of the overall regional planning program, is to permit public evaluation and choice among alternative water resource development policies and plans and to provide for the coordination of local, state, and federal water resource management programs within the Region. The specific objectives of the watershed planning programs include abatement of flood damage; protection of floodlands from incompatible development; abatement of water pollution and the protection of water supply; preservation of

Map 2

MAJOR WATERSHEDS OF SOUTHEASTERN WISCONSIN



A subcontinental divide traverses the Southeastern Wisconsin Region. That part of the Region lying east of this divide is tributary to the Great Lakes-St. Lawrence River drainage system, while that part of the Region lying west of this divide is tributary to the Mississippi River drainage system. This subcontinental divide has certain important implications for water resources planning and management, since major diversions of water across this divide are restricted by law and interstate and international compacts. The generally dendritic surface water drainage pattern of the Region, which is the result of the glacial land forms and features, divides the Region into 11 individual watersheds, three of which—the Des Plaines, Fox, and Rock River watersheds—lie west of the subcontinental divide. In addition to the 11 watersheds, there are numerous small catchment areas along the Lake Michigan shoreline that drain directly to the lake, which areas together may be considered to comprise a twelfth watershed.

Source: SEWRPC.

land for parks and open space; preservation of woodlands, wetlands, wildlife habitat, and prime agricultural lands; promotion of the wise and judicious use of the Region's limited land and water resources; refinement and adjustment of the regional land use plan; and achievement of a more complete integration of land and water resource planning.

Root River: The Root River watershed study was the first comprehensive watershed planning program and the second major work program directed toward preparation of long-range development plans to be undertaken by the Commission. This study was initiated in July 1964 and completed in July 1966. The findings and recommendations were published in SEWRPC Planning Report No. 9, A Comprehensive Plan for the Root River Watershed, and in supporting SEWRPC Technical Report No. 2, Water Law in Southeastern Wisconsin. The comprehensive watershed plan documented in the planning report contains specific recommendations for the abatement of the flooding, water quality, and related land use and natural resource conservation problems in this 197 square mile watershed. The Commission adopted the comprehensive plan for the Root River watershed on September 22, 1966. As of January 1, 1977, the recommended plan has been formally adopted by the Milwaukee and Racine County Boards of Supervisors; by the Metropolitan Sewerage Commission of the County of Milwaukee and the Sewerage Commission of the City of Milwaukee; by the Common Councils of three of the eight cities; and by the Town Board of one of the seven towns within the watershed.

On February 5, 1971, the Root River watershed plan was certified by the Wisconsin Department of Natural Resources to the U. S. Environmental Protection Agency as the state-approved water quality management plan for the Root River basin, and on September 14, 1971, the U. S. Environmental Protection Agency approved the plan for use by state and federal agencies in the review and award of federal grants-in-aid for sewerage facility construction. Substantial progress has been made toward implementing this plan, as documented in the Commission series of annual reports.

Fox River: The Fox River watershed study was the second comprehensive watershed planning program and the third major work program directed toward the preparation of long-range development plans to be undertaken by the Commission. This study was initiated in November 1965 and completed in February 1970. The findings and recommendations were published in SEWRPC Planning Report No. 12, A Comprehensive Plan for the Fox River Watershed, Volume One, Inventory Findings and Forecasts, and Volume Two, Alternative Plans and Recommended Plan. The plan contains recommendations for the abatement of the flooding, water quality, water supply, recreation, and related land use and natural resource conservation problems of this watershed. The study also produced special lake use reports for 45 of the 46 major lakes of the watershed.

The Fox River watershed study differed from the Root River watershed study in that it was not conducted for an entire watershed, but only for the headwater portion of the Fox River basin. The attention of the Commission was focused primarily on the 942 square miles of the watershed lying in Wisconsin, but the Commission remained cognizant of the relationship of this headwater area to the 1,640 square mile portion of the Fox River watershed located in Illinois.

The Commission adopted the comprehensive plan for the Fox River watershed on June 4, 1970. As of January 1, 1977, the Fox River watershed plan had been formally adopted by the Kenosha, Milwaukee, Racine, Walworth, and Waukesha County Boards of Supervisors; by the Common Councils of four of the nine cities; by the Village Boards of five of the 19 villages; and by the Town Boards of four of the 36 towns in the watershed. The plan also has been formally endorsed or acknowledged by the U. S. Department of Housing and Urban Development; the U. S. Department of Agriculture, Soil Conservation Service; the U. S. Department of Transportation, Federal Highway Administration; the U. S. Department of the Interior, Geological Survey; and the Wisconsin Department of Transportation.

On June 11, 1971, the Wisconsin Natural Resources Board approved the comprehensive Fox River watershed plan and on July 21, 1971, certified the plan to the U. S. Environmental Protection Agency as the interim basin plan for the Fox River basin in Wisconsin. In reviewing the plan, the Environmental Protection Agency indicated that before formal federal approval as a fully approved basin plan, two issues relating to the timetable for plan implementation should be addressed, one dealing with the nutrient removal requirements in the plan and the other with implementation of the proposed areawide sewerage system in the upper watershed.

In response to this request by the Environmental Protection Agency, the Wisconsin Department of Natural Resources, the Regional Planning Commission, and the concerned local units of government prepared a specific plan implementation schedule that included timely phosphorus removal recommendations for the entire watershed and a recommendation that the plan be amended to include two major sewage treatment plants to serve the upper watershed area instead of the single plant originally recommended. On September 13, 1973, the Commission took formal action to amend the Fox River watershed plan to include the two-sewage-treatment-plant alternative in lieu of the one-sewage-treatment-plant alternative for the upper watershed area in the adopted plan. The amendment further included, as part of the adopted plan, the Revised Implementation Schedule for Meeting Water Quality Objectives and Waste Treatment Requirements for the Fox-Illinois River Watershed, published in August 1973 by the Wisconsin Department of Natural Resources. On January 9, 1974, the Wisconsin Natural Resources Board certified the plan amendment to the Environmental Protection Agency, and on April 5, 1974, that agency gave full approval to the Fox River comprehensive plan as the water quality management plan for the Fox River basin. Progress toward implementation of the amended plan is documented in the Commission series of annual reports.

Milwaukee River: The Milwaukee River watershed study was the third comprehensive watershed planning program undertaken by the Commission and the fourth major work program directed toward preparation of a long-range physical development plan. The study was initiated in October 1967 and was completed in October 1971. The findings and recommendations were published in SEWRPC Planning Report No. 13, A Comprehensive Plan for the Milwaukee River Watershed, Volume One, Inventory Findings and Forecasts, and Volume Two, Alternative Plans and Recommended Plan. Like the plan for the Fox River watershed, the plan for the Milwaukee River watershed contains recommendations for the abatement of the flooding, water quality, water supply, recreation, and related land and other natural resource conservation problems of this important watershed. The study also produced special lake use reports for all of the 21 major lakes of the watershed. Of particular importance to the Section 208 water quality planning and management program are the recommendations contained in the plan for the abatement of water pollution from combined sewer overflows in the entire Milwaukee metropolitan area.

The Milwaukee River watershed study differed from the Root and Fox River watersheds in that a significant portion—about 38 percent—of the headwater area of the 694 square mile watershed is located outside and north of the seven-county Region. It was evident to all concerned that the entire watershed should be included in any comprehensive planning program. This meant including in the study the considerable portions of the watershed lying outside of the Region in Fond du Lac and Sheboygan Counties, as well as the very small area of the watershed lying in Dodge County. Fond du Lac and Sheboygan Counties accordingly were requested to join in the work of the watershed committee established by the Commission, and their consent and participation marked the first time that neighboring counties formally and actively participated in a Commission planning program.

The comprehensive Milwaukee River watershed plan was formally adopted by the Commission in March 1972. As of January 1, 1977, the plan had been formally adopted by the Milwaukee, Ozaukee, Sheboygan, and Washington County Boards of Supervisors; by the Common Council of the City of Milwaukee; by the Common Councils of one of five cities in the watershed, by the Village Boards of three of the 18 villages in the watershed; by the Town Board of one of 22 towns within the watershed; by the Sewerage Commission of the City of Milwaukee and the Metropolitan Sewerage Commission of the County of Milwaukee; by the City of Milwaukee Board of Harbor Commissioners; and by the Milwaukee County Park Commission. The watershed plan has also been formally endorsed or acknowledged by such important state and federal agencies as the Wisconsin Board of Soil and Water Conservation Districts; the Wisconsin Board of Health and Social Services; the Wisconsin Department of Transportation; the U. S. Department of Agriculture, Soil Conservation Service and Farmers Home Administration; the U. S. Department of Housing and Urban Development; the U. S. Department of the Interior, Geological Survey and Bureau of Outdoor Recreation; and the U. S. Department of Transportation, Federal Highway Administration.

The Wisconsin Natural Resources Board on July 26, 1972, approved the Milwaukee River watershed plan, and on August 3, 1972, certified the plan to the U. S. Environmental Protection Agency as the approved water quality management plan for the basin. On March 19, 1973, the latter agency approved the plan, noting that it "is certainly without equal in the State of Wisconsin with respect to comprehensiveness and quality of planning."[1] Thus the Milwaukee River watershed plan currently stands as an approved basin plan being utilized by the state and federal agencies in support of the review and award of federal grants-in-aid for sewerage and water quality control facility construction.

Menomonee River: The Menomonee River watershed study was the fourth comprehensive watershed planning program to be undertaken by the Commission. Work on the Menomonee River watershed study was initiated in March 1972 and was completed in October 1976, resulting in the publication of SEWRPC Planning Report No. 26, A Comprehensive Plan for the Menomonee River. Like the other watershed plans, this plan contains recommendations for the abatement of flooding, land and other natural resource conservation, and park and related open space development. The water quality management element of this plan serves as an integral part of and a prototype for the areawide water quality plan for the Region, including in particular recommendations on the abatement of pollution from both urban and rural nonpoint sources. The comprehensive Menomonee River watershed plan was formally adopted by the Commission on January 20, 1977, and transmitted for local adoption and implementation. As of June 1, 1977, the plan had been formally adopted by Washington County.

Kinnickinnic River: A comprehensive planning program for the Kinnickinnic River watershed was initiated in 1976, and is being conducted concurrently with and in full coordination with the areawide water quality management planning program. The two programs complement each other, particularly on the determination of water quality conditions along the Kinnickinnic River and its tributaries and the resolution of pollution problems within the watershed.

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[1] *Letter from Francis T. Mayo, Regional Administrator, U. S. Environmental Protection Agency, to L. P. Voight, Secretary, Wisconsin Department of Natural Resources, dated March 19, 1973.*

Regional Sanitary Sewerage System Planning Program

Recognizing the importance of sanitary sewerage to regional development, the Commission in 1969 initiated a regional sanitary sewerage system planning program. This program was completed in May 1974 with the formal adoption of the plan by the Commission and publication of SEWRPC Planning Report No. 16, A Regional Sanitary Sewerage System Plan for Southeastern Wisconsin. The regional sanitary sewerage system plan was initially envisioned as a plan to provide recommendations for the ultimate urban service areas to be considered in the extension of major trunk sewers in the urbanizing areas of the Region in order to meet planning requirements set forth in the 1960's by the U. S. Department of Housing and Urban Development. During the plan preparation period, however, as the federal and state governments began to take a more active interest in water quality management planning, the plan evolved—at the behest of the advisory committee—into a broader effort to identify the size, type, and location of all waste treatment works necessary to serve the Region to the year 1990, together with the level of treatment required to meet established water use objectives. As such, the plan attempted in part to satisfy evolving federal planning guidelines for waste water planning, although it was recognized in the plan that not all of the rapidly evolving federal guidelines, and in particular not all of the Section 208 planning requirements, could be met through the regional sanitary sewerage system planning effort.

The regional sanitary sewerage system plan produced under the study is composed of four major elements: recommended sanitary sewer service areas, recommended sewage treatment facilities, recommended trunk sewers, and recommendations for the abatement of combined sewer overflows. The plan recommends that centralized sanitary sewer service be extended to a total of 670 square miles, or about 25 percent of the total area of the Region. The plan also recommends that sewage treatment be provided through a total of 52 public facilities and that, in order to meet the established water use objectives and supporting water quality standards, 41 of the 52 facilities provide an advanced level of treatment. Twenty-two existing public sewage treatment facilities and 29 existing private sewage treatment facilities would be abandoned upon full implementation of the plan. The plan further recommends the general alignment and approximate size of those intercommunity trunk sewers required to extend trunk sewer service from the recommended treatment plants into the recommended sewer service areas, as well as to permit the relocation of certain sewage treatment facilities and the abandonment of other sewage treatment facilities. As for the abatement of pollution from combined sewer overflows, the plan recommends proceeding with implementation of the Milwaukee River watershed plan recommendation to conduct a preliminary engineering study, including further consideration of the construction of a combination deep tunnel mined storage/flowthrough treatment system to collect, convey, and adequately treat all combined sewer overflows in Milwaukee County. In the Kenosha and Racine areas, the plan recommends that definitive recommendations on which of the remaining combined sewer areas should be separated and which should receive specialized sewage treatment facilities be held in abeyance until the completion of the combined sewer overflow research and demonstration studies in those communities. Finally, the plan includes several auxiliary recommendations, including recommendations for the mounting of clear water elimination efforts; the elimination of nearly 600 known points of sewage flow relief in the Region; the full metering of all sewage flows, including bypassed flows; the undertaking of special studies for sludge handling, disposal, or recycling; and the conduct of a continuing water quality monitoring program.

The regional sanitary sewerage system plan was formally adopted by the Commission on May 13, 1974. As of January 1, 1977, it had been formally adopted by the County Boards of Milwaukee, Walworth, and Washington Counties; the Common Councils of four of the 28 cities in the Region including the City of Milwaukee; the Village Boards of 11 of the 54 villages within the Region; and by the governing boards of the Allenton Sanitary District, the Delavan Lake Sanitary District, the Sewerage Commission of the City of Milwaukee, and the Metropolitan Sewerage Commission of the County of Milwaukee. In addition, the plan has been reviewed and endorsed by the Wisconsin Departments of Administration and Local Affairs and Development and by the U. S. Department of Agriculture, Farmers Home Administration; the U. S. Department of the Interior, Geological Survey; and the U. S. Department of the Army, Corps of Engineers. Finally, on March 6, 1975, the Wisconsin Department of Natural Resources advised the Commission that the regional sanitary sewerage system plan would be certified to the U. S. Environmental Protection Agency as an interim plan for guidance in administration of federal construction grants until completion of the areawide water quality management program authorized under Section 208 of the 1972 Amendments to the Federal Water Pollution Control Act. Subsequently, on December 14, 1977, the plan was formally certified by the Secretary of the Wisconsin Department of Natural Resources to the Regional Administrator, Region V, U. S. Environmental Planning Agency as the interim point source element of the areawide water quality management plan.

Coastal Zone Management

Since 1975 the Commission also has been involved, in cooperation with the Wisconsin Office of State Planning and Energy, in developing a coastal zone management planning program for the shoreline of Lake Michigan within southeastern Wisconsin. To date, the Commission has participated actively in the public review and discussion of coastal management problems, as well as in the provision of technical data for program development, and anticipates that a technical planning and management program may be undertaken in 1978 to address such problems as water quality, public access, natural areas of protection, port development, and shoreline erosion along the Lake Michigan shoreline within southeastern Wisconsin.

Community Assistance Program

The Commission also conducts a community assistance program which is essential not only to the wide dissemination of data assembled under the regional planning program but also to the further understanding and implementation of adopted regional and subregional plan elements. Toward this end, the Commission community assistance program has included the preparation of local planning guides and model land use control ordinances; sponsorship of planning conferences and workshops; publication of a bimonthly newsletter; the extension of functional guidance and advice on local as well as regional developmental and environmental problems to communities upon request; and the provision of project planning services and resident staff services at cost to local units of government, also upon request.

Of particular importance to the areawide water quality management planning program are the following types of community assistance activities:

1. The preparation of land use control ordinances designed at least in part to abate water pollution. Recent efforts toward this end are the City of Muskego Subdivision Control Ordinance, which includes specific provisions aimed at ensuring consideration of erosion control and sedimentation as part of the subdivision development process, and the Walworth County Zoning and Shoreland Zoning Ordinances, both of which contain numerous provisions for regulation of both urban and rural activities to reduce undesirable runoff and concomitant surface water pollution.

2. The preparation of municipal ordinances designed to prohibit the introduction of undesirable matter into sanitary sewerage systems, including ordinances prohibiting the introduction of groundwater from sump pump systems into sanitary sewerage systems.

3. The conduct of conferences and meetings concerning water quality management. The most recent example of this type of community assistance effort was the Regional Conference on Sanitary Sewerage System User and Industrial Waste Treatment Recovery Charges held by the Commission on July 18, 1974.

4. The conduct of special water quantity and quality studies for local units of government upon request. Recent examples of this type of effort include the drainage and water level control plan for the Rochester-Waterford-Wind Lake areas of the Lower Fox River watershed, as documented in SEWRPC Community Assistance Planning Report No. 5, and the floodland information report prepared for the City of Hartford, as documented in SEWRPC Community Assistance Planning Report No. 4.

5. The preparation of detailed land use plans for numerous neighborhoods and civil towns within the Region.

Planning Guides

The Commission has established a series of local planning guides that are intended to constitute manuals of local planning practice and, as such, to improve the overall quality of planning within the Region and promote sound community development properly coordinated on a regionwide basis. The guides discuss the planning principles involved in the particular subject matter, contain examples of good planning practice, and provide the local elected officials and technicians with model ordinances and forms to assist them in their everyday planning efforts.

To date, six such guides have been published by the Commission: a Land Development Guide (1963); an Official Mapping Guide (1964); a Zoning Guide (1964); an Organization of Planning Agencies (1964); a Floodland and Shoreland Development Guide (1968); and a Soils Development Guide (1969). The latter two guides have particularly important implications for water pollution control and water quality management efforts throughout the Region because the planning and plan implementation principles discussed deal directly with the need to properly adjust urban land use development to the natural resource base and to regulate both rural and urban development to minimize adverse impacts on water quality.

Air Quality Maintenance Planning

In 1973, during Commission reevaluation of regional land use and transportation plans, the need to consider the details of the impacts of regional plans on ambient air quality became apparent. In addition, new federal requirements led to the proposal that the seven-county Southeastern Wisconsin Region Intrastate Air Quality Control Region also be designated an Air Quality Maintenance Area. These events led to the 1974 development of a comprehensive regional air quality planning program. The major elements of the regional air quality maintenance planning program for southeastern Wisconsin were set forth in the Regional Air Quality Maintenance Planning Program Prospectus published in July 1974. This program is currently underway and is funded in part by the U. S. Environmental Protection Agency and in part by the Wisconsin Departments of Natural Resources and Transportation. Since the Commission has been given and has assumed the responsibility for regional air quality maintenance planning as well as areawide water quality management planning, these two programs have been fully coordinated, utilizing common demographic, economic, land use, and transportation data. Those elements of the regional air quality maintenance planning program that relate to water quality are fully integrated into the areawide water quality management planning program, inclusive of the levels of air pollutants contributing materials to the land and water surfaces of the Region as forecast under the regional air quality maintenance plan.

Other Regional and Subregional Planning Programs

Six additional regional planning programs have been conducted by the Commission.[2] The regional planning program for parks, outdoor recreation, and related open spaces was completed in 1977 and provides important information on recreational water use in the Region. The regional airport system plan was completed in 1975, the regional housing study in 1975, and the regional library system plan in 1974.

The Commission also has completed more detailed urban development plans for certain subareas of the Region, including the Kenosha and Racine Urban Planning Districts. Of particular importance to the areawide water quality management planning program are those recommendations in these plans which directly relate to land use development; to storm water retention and drainage; and to sanitary sewage conveyance and treatment. The comprehensive plan for the Kenosha Urban Planning District was adopted by the Regional Planning Commission on June 1, 1972, and was adopted by the City of Kenosha on October 16, 1972. The comprehensive plan for the Racine Urban Planning District was adopted by the Regional Planning Commission on June 5, 1975.

AREAWIDE WATER QUALITY MANAGEMENT PLANNING PROGRAM

Section 208 of the 1972 Amendments to the Federal Water Pollution Control Act (P.L. 92-500) provides for the development and implementation of areawide water quality management planning programs across the nation. In response to this Congressional Act, and in accordance with its statutory areawide planning responsibilities and the findings and recommendations of its previous water quality planning efforts, the Southeastern Wisconsin Regional Planning Commission adopted a resolution on May 13, 1974, requesting the Governor of the State of Wisconsin to officially designate the seven-county southeastern Region as an areawide water quality management planning area and the Southeastern Wisconsin Regional Planning Commission as the official planning agency for that area. These requests were presented in accordance with the procedural requirements set forth in Section 208 of the Act, and substantiating information relating to the planning area and planning agency designations can be found in a document prepared by the Commission in the spring of 1974.[3]

Study Objectives

The primary objective of the areawide water quality management planning program for southeastern Wisconsin, as set forth in the approved study design,[4] is to prepare and adopt an areawide water quality management plan providing for the abatement and prevention of water pollution in the lakes and streams of the Region to the year 2000. In addition, the plan is intended to include specific recommendations for the designation of management agencies. More specifically, the objectives of the planning program are to:

1. Provide for full integration of Commission regional water quality management planning with regional land use planning.
2. Provide for the conduct of a refined areawide water quality and quantity monitoring and modeling program.
3. Prepare an areawide point source pollution abatement plan element through revision and refinement, as may be found necessary, of the previously prepared and adopted comprehensive watershed and regional sanitary sewerage system plans.
4. Prepare an areawide nonpoint source pollution abatement plan element, extending previous Commission watershed planning efforts.
5. Prepare a practical areawide sludge management systems plan element.
6. Prepare a practical areawide water quality management plan element for the continuous streams and major lakes of the Region.
7. Conduct subarea facilities planning for municipal wastewater conveyance and treatment facilities anticipated to be constructed within a five-year period following completion of the Section 208 plan (this objective to be achieved through separate Section 201 funding).
8. Provide for the establishment of a continuing areawide water quality planning and management program for southeastern Wisconsin.

Relationship to Areas Served by Combined Storm and Sanitary Sewers, the Lake Michigan Estuaries, Lake Michigan, and Groundwater Quality

The achievement of these objectives is limited to the geographic area of the study. The approved study design for the areawide water quality management planning program indicated that the initial work effort could not include the identification, evaluation, and development of proposals for the resolution of water quality problems

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[2] *For more detailed descriptions of these planning programs, see SEWRPC Planning Report No. 10, A Comprehensive Plan for the Kenosha Planning District; SEWRPC Planning Report No. 14, A Comprehensive Plan for the Racine Urban Planning District; SEWRPC Planning Report No. 19, A Library Facilities and Services Plan for Southeastern Wisconsin; SEWRPC Planning Report No. 20, A Regional Housing Plan for Southeastern Wisconsin; SEWRPC Planning Report No. 21, A Regional Airport System Plan for Southeastern Wisconsin; and SEWRPC Planning Report No. 27, A Regional Park and Open Space Plan for Southeastern Wisconsin (in printing).*

[3] *See "Substantiating Information for Area and Planning Agency Designation Under Section 208 of the Federal Water Pollution Control Act Amendments, 1972," SEWRPC and Wisconsin Departments of Natural Resources and Administration, May 1974.*

[4] *See Study Design for the Areawide Water Quality Planning and Management Program for Southeastern Wisconsin: 1975-1977, SEWRPC, July 1975.*

in the combined sewer overflow areas or in Lake Michigan itself. In its previous work efforts the Commission had completed the systems level analyses of the combined sewer overflow problems in the Milwaukee River watershed and identified the most cost-effective solutions to those problems. The Commission recommended that, as the next step toward the abatement of combined sewer overflows in the Milwaukee, Kenosha, and Racine combined sewer service areas, detailed facilities plans for the combined sewer overflow abatement facilities should be developed. These facility plans are to comprise an integral element of the areawide water quality management plan.

The recreational, aesthetic, economic, and water supply benefits of Lake Michigan are among the most important assets of the Region and are vital to the continued well being of its residents. However, the technical and institutional complexities of managing this Lake are beyond the scope of the initial areawide water quality management planning effort. Indeed, certain wide ranging scientific studies prerequisite to this task are just now being conducted by the International Joint Commission. The Regional Planning Commission has concluded that any sound analysis of water quality problems in Lake Michigan must address the allowable pollutant loading levels within not only the portions of Lake Michigan which form the eastern border of the Southeastern Wisconsin Region but in the entire body of water, together with its tributary drainage area. The necessary studies are clearly beyond the geographic and fiscal limits of Commission abilities. Consequently, the Commission can only assist an appropriate lead agency, such as the Great Lakes Basin Commission, in any comprehensive planning effort for Lake Michigan as a whole.

The Commission has observed that those reaches of the Kinnickinnic, Menomonee, and Milwaukee Rivers which lie within and downstream of the combined sewer overflow area function as estuaries of Lake Michigan. As such, those reaches are highly complex in their hydrology and hydraulics, exhibiting not only thermal and chemical density currents and backwater effects from Lake Michigan, but also the mechanical effects of ship traffic in the inner harbor and the estuary-like effects of Lake Michigan itself. Accordingly, a study of these areas which carry the waste from the combined sewer areas and which serve as complex elements of both the river systems and the Lake, are considered to be beyond the scope of the initial areawide water quality management planning effort. The Commission believes that the harbor-estuary area ultimately must be studied to the same level of detail as the tributary streams have been to identify the actions needed to enhance or maintain water quality conditions. Similar study may be appropriate in the harbors at Kenosha, Racine, and Port Washington. In order to conduct suitable analyses, certain information will be required—such as current and anticipated pollutant transport rates and water quality conditions in the tributary streams—which has been obtained during the conduct of the areawide water quality planning and management program. The harbor-estuary study, as such, is proposed, however, to be accomplished under the continuing areawide water quality management planning effort. Once the inland lakes and streams and the intervening estuary areas have been examined for their roles in pollutant contribution, transport, storage and release, the Commission will be prepared to contribute to a sound study of the human effects upon and the control measures required to protect and enhance the water quality of Lake Michigan itself. To this end, the initial study does include recommendations for actions anticipating such a work effort.

Similarly, the Commission determined that groundwater quality problems within the Region could only be addressed to a limited degree under the initial areawide water quality planning program. More specifically, previous Commission work efforts related to groundwater quality and quantity, groundwater recharge areas, and some additional data on groundwater pollution potential would be incorporated in this study. It should be noted that groundwater is an integral element of the hydrologic system by which water pollutants are moved through the environment, and that the protection of groundwater quality is vital to the continued well-being of the Region and its potential for further development. Conceptually, the consideration of groundwater problems in this initial work effort of the areawide water quality planning program was to be limited to those aspects which interact with surface water quality conditions. It is particularly important to note the Commission's continuing interest in these water resources management and planning problems, and the expectation of the Commission that at some future time the technical and financial resources necessary to address these problems in full detail will become available.

Relationship to Other Concurrent Studies in the Region

In addition to the areawide water quality management planning program conducted by the Commission, two other important water resources-related studies involving the Commission were underway within the Region during the study period. These research efforts included the pilot watershed study of the Menomonee River watershed conducted by the International Joint Commission and the Washington County Sediment and Erosion Control Project being conducted by the Washington County Soil and Water Conservation District and the State Board of Soil and Water Conservation Districts in cooperation with the University of Wisconsin. The Commission is involved as a project participant in both of these studies, which are essentially of a research nature.

Menomonee River Pilot Watershed Study: In April 1972 the governments of Canada and the United States signed a Great Lakes Water Quality Agreement and requested that the International Joint Commission (IJC)[5] investigate pollution of the Great Lakes from various land use activities. The IJC then established the Great Lakes Water Quality Board to carry out the provisions of the Great Lakes Water Quality Agreement. The Board, in turn, created an international reference group on Great Lakes pollution from land use activities for the purpose of carrying out detailed studies relating to the effect of land use on water quality.

Included in the detailed studies of the reference group[6] is a series of intensive studies of a small number of watersheds within the Great Lakes basin. These watersheds were carefully selected to permit extrapolation of the data and findings of the studies to the entire Great Lakes basin and to relate water quality degradation found at river mouths to specific land uses in the tributary areas. The Menomonee River watershed in the Southeastern Wisconsin Region was selected as one of the seven watersheds to be studied, with particular emphasis upon the impact of urban land uses on Great Lakes water quality. Work on the Menomonee River pilot watershed study was initiated in 1973 and is scheduled for completion in early 1978.

The principal objectives of the Menomonee River pilot watershed study were:

1. To determine the levels and quantities of major and trace pollutants, including but not limited to nutrients, pesticides, and sediments reaching and moving in stream systems tributary to the Great Lakes.

2. To identify the sources and evaluate the behavior of pollutants from an urban complex, with particular emphasis on the potential impact of residential, commercial, and industrial land use development, including supporting utility and transportation facilities, and of construction activities associated with rapid urbanization on stream water quality.

3. To develop the predictive capability necessary to facilitate extension of the findings of the Menomonee River pilot watershed study to other urban settings, leading to an eventual goal of permitting the accurate estimation of pollutant inputs from urban sources for the entire Great Lakes basin.

The Menomonee River pilot watershed study is a research endeavor of both national and international importance, and thus afforded the Commission staff an opportunity to participate in a sophisticated technical project, staffed with experienced research personnel. The project was a joint endeavor between the Wisconsin Department of Natural Resources; the University of Wisconsin System, Water Resources Center; and the Regional Planning Commission. The Commission staff contribution to the conduct of the study included project management, data provision, and systems analysis. Although the Menomonee River watershed pilot study was not scheduled for completion until 1978, some of the preliminary findings of the research effort and assistance of the project personnel were very helpful in the areawide water quality management planning program.

The objectives of the Menomonee River pilot watershed study—as noted, primarily a research endeavor—differ markedly in content, methodology, and scope from the Commission Menomonee River watershed study, the latter being intended to provide specific recommendations for the solution of existing flooding, pollution, and related land use problems within the watershed and the prevention of future problems.

Washington County Sediment and Erosion Control Project: In another research effort funded by the U. S. Environmental Protection Agency, the Commission is participating with the Wisconsin State Board of Soil and Water Conservation Districts, the Washington County Board of Supervisors, and the Washington County Soil and Water Conservation District in the conduct of a sediment and erosion control study. The Federal Water Pollution Control Act Amendments of 1972 focused attention on certain diffuse, or nonpoint, pollution sources, including sediments. This legislation encouraged evaluation of the sources and extent of sediment and related pollution associated with both agricultural and urban lands. Examination of the legal, economic, and other aspects of the implementation of erosion and sediment control methodology also was called for in the legislation.

In response to the provisions of the 1972 Amendments, a demonstration project was initiated in Washington County in July 1974 under the leadership of the Wisconsin State Board of Soil and Water Conservation Districts and the University of Wisconsin. Although more commonly known as the Washington County Project, the formal name of this demonstration study is "Development and Implementation of a Sediment Control Ordinance: Institutional Arrangements Necessary for Implementation of Control Methodology on Urban and

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[5] *The IJC, established in 1912 under provisions of the 1909 Canada-U. S. Boundary Waters Treaty, is composed of six members, including three Canadian and three U. S. representatives. The IJC has two major responsibilities. The first is to approve or reject all proposals involving the utilization, obstruction, or diversion of surface waters on either side of the Canada-U. S. boundary. IJC actions or proposals are final. The second reponsibility is to investigate and make recommendations concerning special projects and problems in response to requests—formally referred to as references—received from either or both governments. IJC actions with respect to references, which have dealt with a variety of topics including air and water pollution, are not binding on either of the two governments. For a detailed discussion of the IJC, refer to: A Proposal for Improving the Management of the Great Lakes of the United States and Canada, Technical Report No. 62, Water Resources and Marine Sciences Center, Ithaca, New York, January 1973.*

[6] *Detailed Study Plan to Assess Great Lakes Pollution from Land Use Activities, submitted to the Great Lakes Water Quality Board, International Joint Commission, by the International Reference Group on Pollution of the Great Lakes from Land Use Activities, March 1974, 128 pp.*

Rural Lands."[7] The principal objectives of the Washington County Project, as set forth in the funding application to the U. S. Environmental Protection Agency, were:

1. To demonstrate, through a monitoring program, the effectiveness of land use control techniques in improving surface water quality.

2. To develop a model sediment control ordinance acceptable to landowners and the several governmental authorities responsible for regulatory measures in incorporated and unincorporated areas on a countywide basis.

3. To determine the combination of institutional arrangements in the form of laws and intergovernmental relationships involving federal, state, county, and municipal governments required for implementing the ordinance in incorporated and unincorporated areas.

4. To develop a description of the personnel required and the level of technical assistance needed to implement a sediment control program using a regulatory approach.

5. To develop and systemize the educational and informational dissemination effort required for implementing a sediment control program using a regulatory approach.

6. To predict the water quality benefits to be derived from the implementation of similar ordinances throughout the Great Lakes Drainage Basin and develop educational materials useful for implementing sediment control programs through the Region.

In addition to the Wisconsin Board of Soil and Water Conservation Districts and the University of Wisconsin System, the following governmental units and agencies participated in the conduct of the Washington County Project: the Wisconsin Geological and Natural History Survey; the U. S. Department of Agriculture, Soil Conservation Service; the U. S. Department of Interior, Geological Survey; the Washington County Board; the Washington County Soil and Water Conservation Supervisors; the Village of Germantown; and the Southeastern Wisconsin Regional Planning Commission.

The primary function of the Commission in this study is to provide data and information about the natural resource base and man-made features of Washington County. This data and information base have been assembled by the Commission as a result of its land and water resource planning efforts, including the Milwaukee and Menomonee River watershed planning programs, and the areawide water quality management planning program. In addition to the primary function of data and information provision, the Commission has assisted in the preparation of detailed land use plans for selected demonstration areas, served on committees established to manage the study, aided in the development and review of proposed control ordinances and other institutional topics, and will assist in implementation of the study findings. The Southeastern Wisconsin Regional Planning Commission provided the above services under contract to the University of Wisconsin.

Washington County was selected as the site for the demonstration project for a variety of reasons, including the extensive data and information base available from the Commission and the existence of a variety of rural and urban subbasins within the County. Another factor entering into the selection of Washington County was the expressed interest of local communities and governmental units in solving erosion and sedimentation problems attendant to agricultural activities and urbanization. The Washington County Project focused its field studies on two areas: an agricultural area tributary to Kewaskum Creek in the Milwaukee River watershed and an urbanizing area in the Village of Germantown tributary to the Menomonee River.

<u>Facilities Planning and Wastewater Discharge Permits in the Region</u>: The areawide water quality management planning program was conducted during a period of intense activity within the Region in the planning, design, and construction of facilities for the abatement of water pollution from municipal sanitary sewerage systems. The watershed and regional sanitary sewerage system plans adopted by the Commission served as the basis for the facilities planning efforts underway during the initial stages of the areawide water quality management planning effort. This procedure made it possible for the municipalities in the Region to proceed with the orderly development of needed pollution abatement facilities. In accordance with requirements of federal law, the areawide water quality plan will become the basis for all future reviews of federal grant requests for the construction of wastewater collection and treatment systems and for the discharge permits required under the National Pollutant Discharge Elimination System and the Wisconsin Pollutant Discharge Elimination System.

<u>Inland Lake Rehabilitation Studies in the Region</u>: Since 1973, the State of Wisconsin has encouraged the protection and rehabilitation of inland lakes through the Inland Lake Renewal Program, established under Chapter 33 of the Wisconsin Statutes. The Bureau of Inland Lake Renewal of the Wisconsin Department of Natural Resources administers a program of technical assistance and grants-in-aid to identify the problems, the control alternatives, and the implementation activities of concern to the residents of the area, as represented in official Inland Lake Protection and Rehabilitation Districts,

[7] *"Development and Implementation of a Sediment Control Ordinance: Institutional Arrangements Necessary for Implementation of Control Methodology on Urban and Rural Lands," application to the U. S. Environmental Protection Agency from the University of Wisconsin System on behalf of the Wisconsin Board of Soil and Water Conservation Districts, February 28, 1974, 50 pp.*

special purpose units of government authorized for creation under the same statute. In the Region, these specific and localized planning and implementation activities have been conducted in close coordination with the areawide water quality planning program. This coordination has been assured during the initial stages of the areawide water quality management planning period by the joint conduct of four of the lake management feasibility studies, with portions of the work funded by the Commission through the areawide water quality planning program. An additional nine lakes were studied with funding support provided under the areawide water quality management planning program to provide important technical data on the characteristics of special types of lakes. The Wisconsin Department of Natural Resources has assured the Commission that, for these nine lakes, the findings of the areawide water quality planning program will stand as the feasibility studies to be used by the State in the administration of implementation grants for lake management. For the other lakes studied directly under the provisions of Chapter 33 of the Wisconsin Statutes, the usual inland lake studies conducted jointly by the local inland lake protection and rehabilitation district, in cooperation with the Department of Natural Resources and the Commission, will serve this function.

Organization for the Areawide Water Quality Planning and Management Program

Areawide water quality management planning necessarily involves a broad array of levels, units, and agencies of government and of private interests. Accordingly, an organizational structure was established for the program to provide for active participation in the planning effort by these entities. The staff and consultant requirements, the advisory committee structure and public participation aspects of the program all were carefully designed to achieve a truly cooperative program. The organizational structure for the study is shown in Figure 2. As depicted in that Figure, the Southeastern Wisconsin Regional Planning Commission, as the officially designated planning agency, has the primary responsibility for preparation and adoption of the areawide water quality management plan for the Region. The Commission Planning and Research Committee provided basic policy guidance for the study. The breadth and complexity of the program, however, preclude the possibility of any single agency—whatever its function or authority—operating independently or unilaterally in the conduct of such a study. Accordingly, the basic organization for the study includes, as shown in Figure 2, a Technical Advisory Committee, an Intergovernmental Coordinating Committee, and a Citizens Advisory Panel for Public Participation.

The Technical Advisory Committee was established early in 1975 and provided assistance in the preparation of the study design and project grant. This Committee officially replaced the previously functioning Commission Technical Coordinating and Advisory Committee on Regional Sanitary Sewerage System Planning. The Technical Advisory Committee on Areawide Water Quality Management Planning actively involved—at the technical level—various governmental, business, industrial, agricultural, and university interests in the Region in the areawide water quality management planning process, placing at the disposal of the Commission the knowledge and experience of the members for use in directing the planning effort. Suitable subcommittees of this Technical Advisory Committee were established as necessary throughout the course of the study, specifically to select consultant firms as needed and to review technical reports prepared by the Commission staff. One of these subcommittees served as the technical advisory committee for the regional sludge management systems planning program, a work element of the areawide water quality planning and management program, and served concurrently as an advisory committee to the joint Sewerage Commissions of the City and County of Milwaukee in the facilities planning study for solids handling at the South Shore and Jones Island sewage treatment plants.

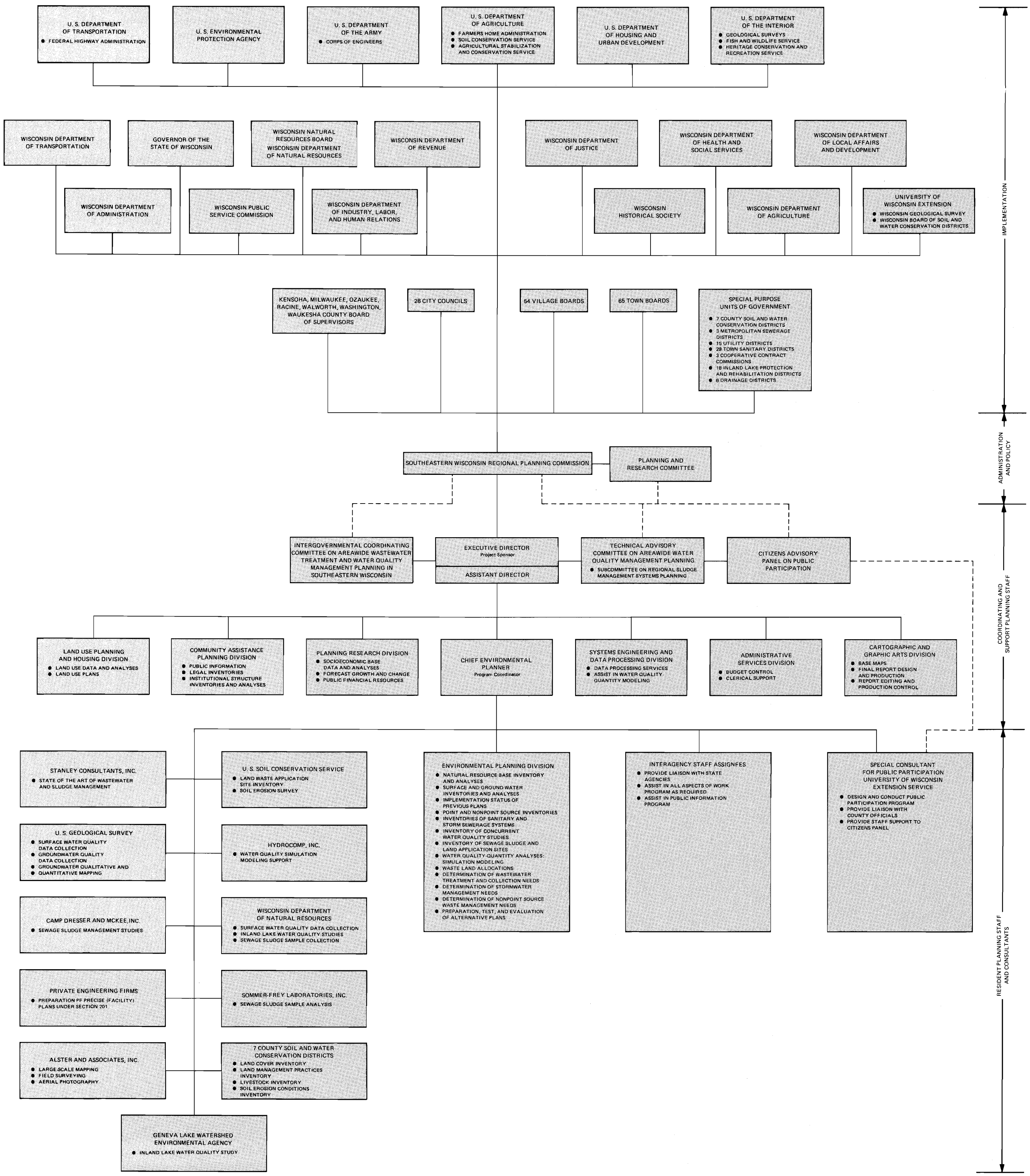
The Intergovernmental Coordinating Committee on Water Quality Management Planning was established for the basic purpose of guiding and shaping those aspects of the areawide water quality management planning effort having important intergovernmental and interagency policy implications. This Committee was charged with the specific responsibility of reviewing intraregional priorities for the funding of wastewater treatment and related sewerage facility construction and for integrating and coordinating these intraregional priorities with those established for other regions within the State of Wisconsin. For this reason the Committee composition included senior level representatives from the key federal, state, and local wastewater management agencies involved. The Committee, on its own initiative, also expressed special interest in the institutional aspects of the areawide water quality management planning program.

The Citizens Advisory Panel for Public Participation provided an opportunity for the representatives of citizen interest groups to become familiar with and influence the planning program, the resulting plan, and the implementation measures proposed. The Panel also provided the Commission with an opportunity to discuss with citizen interest groups both the subject and content of the areawide water quality planning program as well as the means of presenting relevant aspects of the planning program to the general public. The membership of each of these committees and selected subcommittees is set forth in Appendix A to this report.

In addition to the advisory committees directly involved with the areawide water quality planning and management program, the Commission and the Commission staff relied upon major input of interested and affected parties and governmental entities through the other standing advisory committees to the Commission. Through these other advisory committees, instituted for other specific Commission programs, additional factors bearing on the water quality planning effort—such as land use, transportation, and air quality—could be given consideration to assure that a comprehensive and integrated physical planning process occurred and was supported through the development of the areawide water quality planning

Figure 2

ORGANIZATIONAL STRUCTURE FOR AREAWIDE WATER QUALITY PLANNING AND MANAGEMENT PROGRAM



Source: SEWRPC.

and management project. Appendix B to this report identifies selected other communities advisory to the Commission, and presents their membership and composition. Clearly, these committees reflect the broadest possible spectrum of the social, economic, and governmental structure of the Region.

The necessary interdisciplinary staff for the conduct of this program was assembled by expanding the existing Commission staff. This course of action was selected because of the importance of conducting the areawide water quality planning program as an integral part of the comprehensive regional planning program because of the previous extensive experience of the Commission and its staff in water quality management planning, and because of the vital importance attached by the Commission to maintaining, after completion of the areawide water quality management plan, a continuing planning process to promote implementation of that plan. The staff work effort was augmented as necessary with contractual services provided by one federal agency, two state agencies, eight local agencies, and five consulting engineering firms, not including the numerous firms retained by local units of government for the planning and design of sewerage facilities. The Commission staff managed and directed all phases of the engineering and planning work under the supervision of the advisory committees. More specifically, the Commission staff was responsible for preparation of the detailed study design; formulation of areawide water quality management objectives, principles, and standards; conduct of all inventories; analysis of inventory data and information to identify urban and rural water quality and related problems as well as capabilities pertaining to water pollution control in the Region; synthesis and evaluation of alternative plan elements; and report writing. In the conduct of the regional sludge management systems planning program, however, the Commission staff oversaw—but did not perform—the writing of the regional sludge management systems plan.

Special assistance was deemed necessary in the areas of photogrammetric mapping and control surveys, groundwater analysis, streamflow measurement, surface water quality sampling and analysis, groundwater quality sampling and analysis, hydrologic-hydraulic-water quality simulation modeling, the assessment of pollution control costs and effectiveness for sludge and wastewater management techniques, public participation, analysis of sludge management practices, lake water quality data interpretation, soil erosion evaluation, and agronomy. Contractual arrangements, therefore, were executed with the U. S. Geological Survey; the Wisconsin Department of Natural Resources; the Soil and Water Conservation Districts of Kenosha, Milwaukee, Racine, Ozaukee, Walworth, Washington, and Waukesha Counties; the University of Wisconsin-Extension Service; the Geneva Lake Watershed Environmental Agency; Hydrocomp, Inc.; Stanley Consultants, Inc.; Camp Dresser and McKee, Inc.; Alster and Associates, Inc.; and Sommer-Frey Laboratories, Inc.

Under the study, the U. S. Geological Survey was responsible for those work elements relating to the mapping of groundwater resources and determination of groundwater-surface water relationships, as well as for obtaining selected streamflow measurements. The Wisconsin Department of Natural Resources was responsible for the collection and laboratory analysis of lake and stream water quality samples for the inland lake studies, the interpretation of lake- and related stream-water quality and quantity sampling data, the development of recommendations for management actions to resolve lake water quality problems, the collection and laboratory analysis of stream quality samples for use in water quantity-quality simulation modeling, the installation of selected staff gages for streamflow measurement, the administration of inland lake renewal and rehabilitation studies, and the collection of sewage sludge samples.

The University of Wisconsin Extension Service was responsible for the development and conduct of a unique public participation program for the areawide water quality management planning program. The University of Wisconsin-Milwaukee provided laboratory facilities at the Great Lakes Research facility to support the analysis of biological samples collected from the streams of the Region.

The Soil and Water Conservation Districts of the seven counties, inclusive of personnel from the U. S. Department of Agriculture Soil Conservation Service, Agricultural Stabilization and Conservation Service, and the University of Wisconsin Extension Service within the Region provided major services in the identification of cropping practices and livestock inventory data as well as in the identification of existing conservation practices within the Region and tillage, fertilization, and pesticide use.

Alster and Associates, Inc., provided professional services in the topographic mapping and attendant control surveys and in the measurement of stream channel and floodland cross sections and such water control facility structures as dams, bridges, and culverts. Hydrocomp, Inc., provided technical consulting services to support the Commission staff application of the hydrologic-hydraulic-water quality simulation model. Camp Dresser and McKee, Inc., was responsible for the technical development of the plan element for the management of sewage sludge within the Region. Sommer-Frey Laboratories, Inc. conducted the chemical and physical tests of sludge samples. Stanley Consultants, Inc., was responsible for preparation of the four-volume study of the state of the art of wastewater and sludge management in southeastern Wisconsin. The Geneva Lake Watershed Environmental Agency was responsible for the collection, laboratory analysis—through subcontracts with the University of Wisconsin at Whitewater—and interpretation of the lake and stream water quality data for the Geneva Lake watershed and for the preparation of a complete report identifying water quality problems, pollution sources, and recommended actions for Geneva Lake.

Scheme of Presentation

The major findings and recommendations of the areawide water quality planning and management program for southeastern Wisconsin are documented and presented in this three-volume report. This report first sets forth the basic concepts underlying the study and the factual findings of the extensive inventories conducted under the study. It identifies and quantifies the developmental and environmental problems pertaining to the water quality of the Region and presents forecasts of future economic activity, population growth, and land use and concomitant environmental problems relating to water quality. The report presents alternative proposals for eliminating pollution from point sources; for eliminating pollution from nonpoint sources in urban and rural areas; for the management and utilization of sewage sludge; and for the financial and management aspects of water quality control. The report further sets forth recommended plans for the prevention and abatement of water pollution in the Region and the attainment of established water use objectives and supporting standards. This report is intended to allow careful, critical review of alternative plan elements by public officials, agency, staff personnel, and citizen leaders within the Region and to provide the basis for plan adoption and implementation by the federal, state, and local agencies of government concerned.

In order to use this document effectively, the reader must recognize that it is written simply as a report of the process by which the recommendations were developed. Therefore—if read from front to back—it will describe to the user the Region, its water quality conditions, the factors determining those conditions, the alternative ways of achieving desired water quality conditions in the face of long-term development trends, the relative merits and faults of these alternatives, and the recommended water quality management plan together with the means for its implementation.

Ideally then, a consecutive reading is the best way for a reader with comprehensive, regional interest to grasp the full character and details of the plan. The report, however, offers many specific facts, conclusions, and recommendations which may be sought for everyday reference and as an aid to making local or topical decisions. In such cases, careful review of the summary chapter is offered as the most helpful point of entry into the document. If, based on such review, further information is desired on some aspect of the plan or its basis, then a careful review of the summary section of the appropriate chapter is suggested. Finally, if still more information is desired, reading of the entire appropriate chapter is suggested. Coupled with the use of the Table of Contents, this approach will provide any user with a means of locating desired information included in this report.

The report documenting the areawide water quality management plan for southeastern Wisconsin is published and organized in three volumes. This, the first volume, Inventory Findings, presents the basic data which underlie the development of alternative water pollution control measures and the selection and recommendation of certain of those measures, as well as the identification of implementing agencies. Following this introductory chapter, Chapter II sets forth the basic principles and concepts underlying the areawide water quality management planning program in the Region. Chapter III presents a description of the natural and man-made features of the Region as they relate to water quality management. Chapter IV describes the existing and historical water quality conditions of the lakes and streams of the Region, conditions described in greater detail in SEWRPC Technical Report No. 17, Water Quality of Lakes and Streams in Southeastern Wisconsin: 1964-1975. Chapter V describes the sources of water pollution within the Region, sources described in greater detail in SEWRPC Technical Report No. 21, Sources of Water Pollution in Southeastern Wisconsin: 1975. Chapter VI presents the existing institutional and legal structures for the management of water quality within the Region, while the existing financial expenditures for water quality management are summarized in Chapter VII. Chapter VIII concludes the first volume by presenting a summary and conclusions which bear upon the development of alternative areawide water quality management plans.

Volume 2 of this report, Alternative Plans, is composed of five chapters. Chapter I provides an introduction explaining the relationship of the alternative plans to the inventory findings set forth in Volume 1. Chapter II presents a set of water quality objectives, principles, and standards which provide the basic foundation for the development of alternative water quality management plans, the recommended plan, and the recommendations for implementing agencies. Chapter III presents the anticipated changes in the demographic, economic, and land use characteristics of the Region over the approximate planning period to the year 2000, changes which affect water quality management decisions. Chapter IV sets forth the alternative plans for water pollution abatement within each of the major watersheds of the Southeastern Wisconsin Region. Chapter V constitutes a summary and conclusion to Volume 2.

Volume 3 of this report, entitled Recommended Plan, consists of four chapters and provides a concise summary of the plan recommendations and implementing agencies. Following the introductory chapter, Chapter II of Volume III presents the recommended plan, synthesized on the basis of the evaluation of the alternatives set forth in Volume 2. Chapter III deals with plan implementation, identifies the management agencies designated to carry out the plan, and sets forth specific measures required to translate the recommended plan into action. Chapter IV consists of a summary, and is followed by the supporting appendices, including an environmental assessment of the areawide water quality management plan for southeastern Wisconsin.

This report can only summarize briefly the large volume of information assembled in the extensive data collection analysis and forecasting phases of the areawide water quality planning and management program for southeastern Wisconsin. Although the reproduction of all of this information in report form is impractical due to the magnitude and complexity of the data collected and analyzed, all of the basic data have been assembled in "Areawide Water Quality Plan Development Study Volumes." These Study Volumes are maintained in the Commission offices and are available to member units and agencies of government and to the general public upon specific request. Due to the sheer mass of some of the data, it is necessary that interested parties either review such data in the Commission offices or pay the cost of assembly, duplication, and delivery. This report, therefore, serves the additional purpose of indicating the types of water quality and related data which are available from the Commission and which may be of value to federal, state, or local units of government or to private interests within the Region.

In addition, the following SEWRPC reports have been compiled as part of the areawide water quality planning and management program for southeastern Wisconsin to supplement and complement this report: Planning Report No. 29, A Regional Sludge Management Plan for Southeastern Wisconsin; Technical Report No. 2, (Revised Edition), Water Law in Southeastern Wisconsin; Technical Report No. 6 (Revised Edition), Planning Law in Southeastern Wisconsin; Technical Report No. 17, Water Quality of Lakes and Streams in Southeastern Wisconsin: 1964-1975; Technical Report No. 18, State of the Art of Water Pollution Control for Southeastern Wisconsin: Volume One, Point Sources; Volume Two, Sludge Management; Volume Three, Urban Storm Water Runoff; and Volume Four, Rural Storm Water Runoff; Technical Report No. 21, Sources of Water Pollution in Southeastern Wisconsin: 1975; a series of Lake Use Reports; and a Staff Memorandum, Water Quality Simulation Modeling in Southeastern Wisconsin. A unique opportunity existed during the areawide water quality planning program to develop a planning methodology for locating, sizing, and evaluating underground storm water storage facilities in developed urban areas while, at the same time, assisting the Village of Fox Point in Milwaukee County. Accordingly, the Commission prepared SEWRPC Community Assistance Planning Report No. 19, Storm Water Storage Alternatives for the Crossway-Bridge and Port Washington-Bayfield Drainage Areas in the Village of Fox Point. Also published by the Commission to document efforts to involve all interested and affected parties in the plan development and to fulfill mandatory requirements of water quality planning programs conducted pursuant to the Federal water pollution control laws are the Report of Public Involvement in Areawide Water Quality Planning for Southeastern Wisconsin, prepared in cooperation with the University of Wisconsin Extension Service; and the Record of Public Hearings on the Areawide Water Quality Management Plan for Southeastern Wisconsin.

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Chapter II

BASIC PRINCIPLES AND CONCEPTS

INTRODUCTION

Water quality, and the practices and the devices by which it is managed, dramatically influence the lives of all residents of an urban region. Water based recreation and water supply are among the important aspects of human existence affected by these practices. More indirectly related are the methods and costs of wastewater treatment, the means of storm water management, and the aesthetic and ecological effects of changes in the natural condition of lakes and streams and associated wetlands. Solid waste management practices, local planning and zoning, local potential for new industrial and commercial growth, and many other aspects of human life are affected by water quality management decisions. Without proper attention, water quality management can become a major impediment to the smooth functioning of these necessary elements of healthy regional development.

Water quality management is not new. Earliest concerns for water quality have been for control of the gross aspects of pollution. Floating solids, aesthetic offense, and water-borne contagious disease were among the first dimensions of water quality problems which were addressed. These have generally been abated within the Region over the period since the late 1840's, when the first sewers were built in Milwaukee.

In many ways more difficult to control are the problems recently discovered with more sensitive methods of chemical detection, increased urbanization and increased use of water resources. Sanitary sewage is a major source of pollution—it may spread disease, increase the cost and complexity of providing water supplies, contribute to stream and lake sedimentation and fertilization, destroy the habitat of fish and other aquatic life, destroy recreational opportunities, reduce property values, and create aesthetic nuisances. Sanitary sewage, however, is not the only source of pollution which requires careful attention. Industrial pollutants with unique physical or chemical characteristics are derived in the preparation of products which are deemed both useful and marketable, but these pollutants may have adverse and unforeseen effects in the environment. Similarly, storm water runoff cleanses the lawns and streets of urban areas, but must carry whatever substances or particles fall there as a result of ever changing urban activities. Agriculture, so critical to human welfare and an essential human endeavor, in fact provides the excess wealth for human development in urban areas and specialized functional society; but also changes the face of the land surface, exposing to the elements both the natural soil particles and the industrial fertilizers and pesticides for their potential carriage with storm water. As human experience and the number and sensitivity of available chemical tests increase, so do the known forms of adverse effects from many of these substances. The enrichment of lakes and streams causes noxious algal and weed growth and the eutrophication of lakes to speed their aging process. The attendant adverse effects upon fish and other wildlife are now well known pollution effects. In addition, sickness and disease, birth defects, mutations, decreased stability of biological populations, simplifications of food chains, and both chronic and acute toxicity—often lethal—have become increasingly recognized as being pollution-caused.

It may be that the detailed and itemized control of the offending substances—when they are known and detectable—control of their generation and use, limitations on their discharge, and their management in the environment can address these problems. Historically, however, it appears that the adverse and unforeseen effects of such substances and, indeed, of substances which have been the more traditional objects of water pollution control programs, may best reside in the general protection of the many forms of aquatic life, using observations of their general welfare and protection to indicate the safety of the waters as elements of the human environment. Thus, in addition to the clear need for protection of public health where hazards can be readily identified, the hidden hazards must be minimized by the protection of the natural environment. Similar conclusions could be reached from a moral argument, if one believes that humans have no right to inflict harm and suffering on other species of plant and animal life or to impose such insults on the lakes or streams themselves.

Water quality management facilities and practices also affect land use development and therefore the social and economic, as well as the physical and public health aspects of regional development. This is particularly true in regions like southeastern Wisconsin with environmentally sensitive areas such as the Lake Michigan shoreline, the inland lakes and streams and associated shorelands and floodlands, the wetlands and woodlands, the groundwater recharge areas, and the significant areas covered by soils unsuited to the use of onsite sewerage treatment systems. Land use development in the public interest requires careful consideration of wastewater management and water quality. Water quality management planning should therefore be conducted as an integral part of a comprehensive regional planning effort and should be designed to support and implement long-range areawide land use plans. Only within the framework of a comprehensive areawide planning effort can both land use development and the planning, design, and implementation of water quality control measures such as sanitary sewerage systems, storm water management systems, and land management practices be purposefully directed in the public interest.

In a rapidly urbanizing region, in which the natural resource base is subject to continuing development pressure and intensifying use, the functional relationships between land use and water quality management facilities and practices must be recognized in both land use and areawide water quality management planning. The aggregate effects of many detailed local land use decisions must be considered for their joint potential impacts which may be of regional concern, despite the basic local nature and appropriately local jurisdiction of the planning and control of these specific decisions.

THE GEOGRAPHIC AREA FOR WATER QUALITY MANAGEMENT PLANNING

Water resources planning conceivably can be carried out on the basis of a number of different geographic areas, including areas defined by governmental jurisdictions, social and economic linkages, or natural watershed boundaries. None of these areas is perfect as a comprehensive water resources planning unit. There are, however, certain advantages to the selection of the natural watershed as a comprehensive water and water-related natural resources planning unit.

Storm water drainage and flood control facilities should form a single integrated system over an entire watershed, a system capable of carrying off present and future runoff loads generated by changing land use and water control facility patterns within the watershed. Therefore, storm water drainage, flood control, and associated water quality problems can best be considered on a watershed basis. Drainage and flood control problems are closely related to other land and water use problems. Consequently, floodland protection, the provision of park and outdoor recreation facilities that are related to water resources, and natural resource conservation-related open space reservation can also best be considered on a watershed basis.

Most importantly in the selection of a geographic unit for water quality management planning, surface water quality problems can best be considered on a watershed basis in which the sources of the pollutants being discharged into the surface water system from all point and diffused sources can be identified, their effects analyzed, and their relationships to other water resource-related problems established. The effects on water and water-related natural resources of changes in land use, not only within shoreland and floodland areas but also within entire catchment areas, can best be studied on a watershed basis. This conclusion recognizes that a watershed is more than a system of interconnected waterways, shorelands, and floodlands which, in fact, comprise only a small portion of the total watershed area. Land treatment measures, soil and water conservation practices, and land use over the entire watershed are of major importance in the conservation and wise use of the water and water-related resources. Land use within the watershed affects the amount and spatial distribution of the hydraulic and pollution loadings to be accommodated by the surface water resources and related water control facilities. In turn, water control facilities and their effect upon water quality and the historic floodways and floodplains determine to a considerable extent the use to which such land areas may be put. Finally, the interrelated physical problems of a watershed tend to create a community of interest among the residents of the watershed. Consequently, citizen action groups can more readily be formed to assist in solving water and water-related resource problems on a watershed basis.

It may be concluded, therefore, that the watershed is a logical unit to be selected for water and water-related natural resources planning purposes. Accordingly, the Commission's regional planning program embodies a recognition of the need to consider watersheds within the Region as rational planning units if workable solutions are to be found to interrelated land and water use problems. This recognition is reflected in the formulation of Watershed Committees, of local officials and interested citizens, and in the completion under the direction of these Committees of comprehensive plans for the Root, Fox, Milwaukee, Menomonee, and Kinnickinnic River watersheds. Thus, comprehensive watershed planning programs have been completed for five major watersheds encompassing a total area of 1,731 square miles, or about 64 percent of the Region. These comprehensive watershed plans constitute long-range plans which provide, within the limits of each watershed, one of the key elements of a comprehensive regional development plan; namely, a long-range plan for water-related community facility development, with particular emphasis upon drainage, flood control, and water pollution abatement. While the watershed plans are centered on water quality and flood control facilities, it must be recognized that these plans are prepared in consideration of all of the related problems of land and water use, including park, outdoor recreation, and related open space preservation; soil and water conservation; propagation of fish and wildlife; and maintenance and protection of groundwater as well as surface water resources. As such, the watershed plans are intended to achieve full coordination of local, state, and federal natural resource management programs within the various watersheds of the Region. Important among the goals to be achieved by these plans are the protection of floodways and floodplains and the abatement of flood damages, protection of water quality and supply, the preservation of land for park and related open-space use, and in general the promotion of the wise and judicious use of the limited land and water resources of each of the watersheds. Thus, the Commission's watershed planning programs are closely linked to the broad problem of natural resource conservation.

Although recognizing the importance of the watershed as a rational planning unit within the Region, the Commission's comprehensive planning effort also recognizes the need to conduct individual watershed planning programs within the broader framework of comprehensive areawide planning. This is essential for three reasons. First, areawide urbanization and the basic social, economic, and even political factors that underlie urbanization indiscriminately cross the natural watershed boundaries and exert an overwhelming external influence on the physical development of the affected watersheds. Second, the meandering pattern of watershed boundaries rarely, if ever, coincides with the artificial, generally rectilinear boundaries of civil divisions and special purpose districts. Finally, as discussed below, certain physical systems which are directly related to the creation and the resolution of water quality problems are organized on a basis which often does not correlate to the boundaries of the natural watersheds.

Land use patterns, which determine the amount and spatial distribution of the pollution loadings to be accommodated by the lakes and streams, develop over an entire urbanizing region in response to basic social and economic forces and to the operation of the urban land market, with little regard to corporate limits or natural watershed boundaries. Conversely, the availability of such water quality management facilities as sanitary sewerage systems determines to a considerable degree the potential for land uses in specified areas. These facilities often cross not only corporate limits, but also watershed boundaries. Thus, it may be concluded that water quality management planning must be accomplished not within the context of single municipalities or even single counties but rather within natural watersheds, provided that those watersheds are considered within a broader regional framework that permits full consideration of all of the factors that impact upon water quality problems and solutions to those problems across watershed divides. Urban and rural land use development, water supply, and sanitary sewerage frequently involve problems that cross watershed boundaries, and therefore are problems which must be approached on a regional basis. Indeed, water quality control practices and facilities and public water supply system planning become important and specific means for interrelating and coordinating individual watershed plans. Recognition of the need to relate comprehensive watershed plans and the water quality control elements of such plans to areawide regional development plans through areawide land use, sanitary sewerage systems, and public water supply system planning is perhaps the singularly most important factor which determines the unique nature of the Commission's approach to the water quality management planning effort in southeastern Wisconsin.

THE AREAWIDE WATER QUALITY MANAGEMENT PLANNING PROBLEM

The extent and spatial distribution of water quality control measures are related to the protection of public health, the aesthetics of life in the Region, land use and physical development decisions, and the long-term protection and stability of the natural resource base. These pertinent water quality control measures include sanitary sewerage systems, the associated wastewater sludge management systems, storm water management systems, and urban and rural land management practices. For these reasons, the development of these facilities and practices involves important public policy determinations which should be based on a comprehensive planning process that weighs changing demands against the ability of the existing water quality management facilities and practices and of the limited natural resource base to meet these demands. Only through such a process can the effects of different courses of action be evaluated, the best course of action chosen, and available funds most effectively invested.

The ultimate purpose of such a planning process for areawide water quality management decisions is threefold:

1. To permit public evaluation and choice of alternative water quality management policies and plans.
2. To develop a cost-effective systems plan to achieve the intended water use objectives and supporting standards, considering not only the economic costs, but also the potential social and environmental impacts.
3. To provide, through an agreed-upon long-range plan for water quality management for the coordination of local, state, and federal pollution control programs.

Goals to be attained by this process include protection of public health; abatement of water pollution; sound investment of public funds in efficient and effective sanitary sewerage systems and storm water management; development of a sound, areawide pattern of land use development; establishment of sound patterns of land management practice; and wise use of limited land and water resources.

BASIC PRINCIPLES

Based on these considerations, seven principles were formulated as the basis for the planning process applied in the areawide water quality management planning program:

1. Water quality management planning must be regional in scope, recognizing subregional planning areas related to existing water quality control facilities and practices, potential management agencies, natural watershed boundaries, and urban concentrations with well developed sanitary sewerage systems and storm water management systems.
2. Water quality management planning must be conducted concurrently with land use planning. The land use pattern determines the amount and spatial distribution of sanitary, industrial, and precipitation-related wastewaters to be controlled

by the water quality management practices. The adequacy of the wastewater management systems in turn is one of the most important determinants of the developing land use pattern.

3. Both land use and water quality management planning must recognize the existence of a limited natural resource base to which rural and urban development must be adjusted to ensure a pleasant and habitable environment.

4. The extent and spatial arrangement of water quality control facilities and practices must be adjusted to the waste assimilation capacity of the receiving environment, particularly to the soils, lakes, streams, and air resources, and must assist in attaining areawide land use, air quality, and water quality objectives.

5. Areawide water quality control facilities and practices must be planned as integrated systems or as coordinated subsystems. The capacity of each proposed facility or practice in the total system or subsystem must be carefully fitted to present and probable future waste loadings. The performance of the proposed facilities and practices as well as their effects on the receiving environment must be quantitatively determined and evaluated.

6. Primary emphasis should be placed on solutions within the Region to the water quality management problems. The export of water resources problems to other watersheds in downstream areas should be considered only as a last resort.

7. Plans for the solution of regional water quality management problems and the development of resources should offer as flexible an approach as possible in order to avoid "dead end" solutions and to provide latitude for continued adaptation to changing conditions.

THE AREAWIDE WATER QUALITY MANAGEMENT PLANNING PROCESS

The Commission has developed a seven-step planning process through which the factors affecting water quality management can be described; the operation of the water quality control facilities and practices can be simulated; and the effect of different land uses, resource management practices, storm water facilities, and sanitary sewerage facilities can be tested and evaluated. These steps are study design; formulation of objectives and standards; data inventory; data analysis and forecast; plan design; plan test and evaluation; and plan selection and adoption. Plan implementation, although a step beyond and growing out of the foregoing planning process, must be considered throughout the process if the plans are to be realized. Moreover, the process of plan development must provide the Commission with sound technical analyses, complete data files, and fully documented and reproducible conclusions to support its advisory role in assisting local government units and private investors as they act to implement the recommendations.

This planning process results in an areawide water quality management plan to abate and control water pollution through sound land use development and management practices; to extend sanitary sewer service to urbanizing areas of the Region, consistent with the adopted regional land use plan; to provide adequate storm water management systems; and to protect and wisely use the natural resource base. In addition, the process is the beginning of a continuing planning effort that permits modification and adaptation to changing conditions of the plans and the means of implementation. Each step in this process includes individual operations which must be carefully designed, scheduled, and controlled.

Each step and its major component operations is diagrammed in Figure 3 and described briefly below.

Study Design

Every planning program must follow a structured process—a study design—if it is to be logical and consistent. This study design must specify the facts to be gathered, define the geographic area to be addressed, outline the manner of data analysis, specify needed forecasts and their accuracy, define the nature of the plans to be prepared, and identify the criteria for plan evaluation and selection.

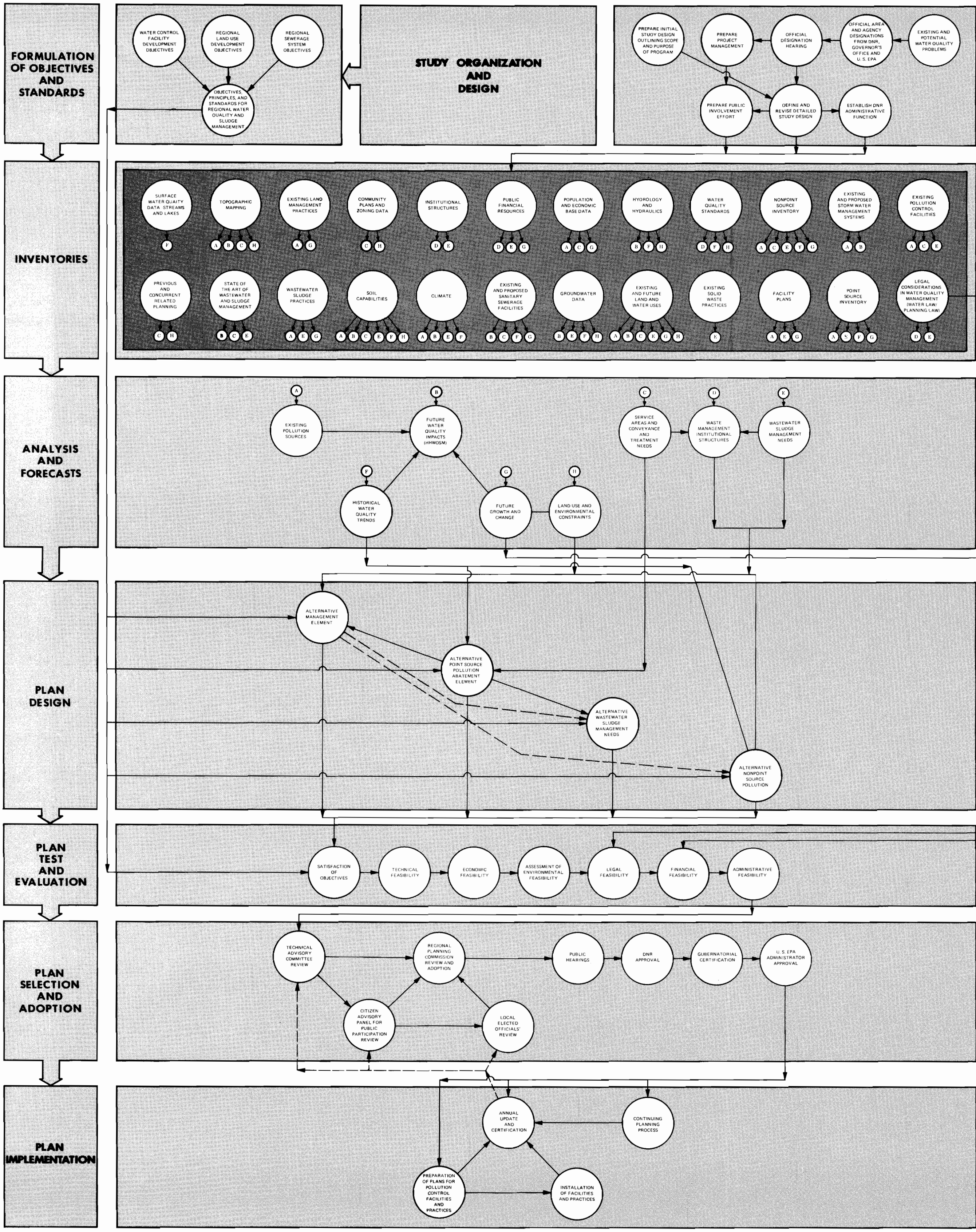
The study design for the areawide water quality management planning program was published in draft form in April 1975 and set forth the methods and procedures to be followed as well as the objectives, scope, and content of the study. This study design was approved by the Technical Advisory Committee on Areawide Water Quality Management Planning on May 7, 1975; by the Wisconsin Department of Natural Resources on December 4, 1975; and by the U. S. Environmental Protection Agency on January 19, 1976, serving as the working guide for program execution and review.

Formulation of Objectives and Standards

In its most basic sense, planning is a rational process for establishing and meeting objectives. The formulation of objectives, therefore, is an essential task which must be undertaken before plans can be prepared. To be useful, the objectives must be stated clearly, be logically sound, and relate to alternative physical development proposals. It is the duty and function of the Commission to prepare a comprehensive plan for the Region's physical development, and it is the purpose of the areawide water quality planning program to provide one of the key elements of such a plan. Only if the objectives clearly relate to physical water quality control measures, and can be quantified and tested, can a choice be made to select the alternative plan which best meets the agreed-upon objectives. Logically conceived and well expressed objectives accordingly must be supplemented by detailed standards to provide the basis for plan preparation, test, and evaluation. The objectives and standards formulated for the program ranged from general objectives on the extension of

Figure 3

GENERAL STEPS IN THE AREAWIDE WATER QUALITY PLANNING AND MANAGEMENT PROGRAM



Source: SEWRPC.

adequate sewer service to urbanizing areas, to detailed standards relating to per capita wastewater flow contributions. All objectives and standards were carefully reviewed and adopted by the Technical Advisory Committee.[1]

Inventory

Reliable planning and engineering data, collected on a uniform, areawide basis, are essential to the formulation of workable plans. Consequently, inventory becomes the first operational step in any planning process, since no intelligent forecasts can be made or alternatives selected without knowledge of current conditions affecting the system under study.

Sound water quality plan formulation requires data on climate; topography; the hydrologic and hydraulic characteristics of the Region's lakes and streams, especially their waste assimilation capacities; existing surface water quality conditions of lakes and streams; groundwater conditions and pollution potential and the location of groundwater discharge and recharge areas; soil capabilities; the kind, location, and intensity of existing and probable future land uses; population levels and densities; economic activity levels; public financial resources; the state of the art of wastewater and sludge management; the status of implementation of previous water quality-related plans; identification and review of concurrent water quality planning and management efforts; community plans and zoning data; locally prepared sanitary sewerage facility plans; industrial wastewater sources; existing and proposed storm water management systems; existing and proposed sanitary sewerage facilities; nonpoint pollution sources; location and capacity of existing pollution control facilities; sewage sludge and land waste application practices and sites; solid waste management and disposal practices; water quality standards; legal considerations; and land management and water management institutional structures and practices. In the study, data collection procedures included review of prior publications, use of specially designed questionnaires and data inventory forms, perusal of agency files, personal interviews with knowledgeable public officials, meetings with local residents and urban and rural land managers, committee meetings of staff and technical advisors, and field investigations.

Analysis and Forecast

Inventories provide factual information about past and present situations, but analyses and forecasts are necessary to estimate and evaluate future conditions, particularly the need for land, supporting sanitary sewerage facilities, storm water management systems, and land management practices. Future needs must be determined from a sequence of interlocking forecasts. Economic and population forecasts provide estimates of the probable future growth in the Region, and can be translated into future demands for land and water use and the attendant effects on wastewater types and amounts. These demands can then be scaled against existing pollution control capabilities, and plans formulated to meet deficiencies.

An especially important consideration in preparing forecasts is the plan design period. Other important Commission planning programs—notably the regional land use and transportation planning program—bear critically upon the selection of this design period for the development of an areawide water quality management plan. The design period utilized for the regional transportation plan is set by federal guidelines as approximately the expected life of the first facilities to be constructed in plan implementation, or the 25-year period from 1975 to the year 2000. It can be argued that the design period for land use development plans should be longer than for public works facilities plans, since many land development decisions are long-term and in effect irreversible. But practical considerations, including limitations on the ability to make the necessary economic and demographic forecasts, as well as the need to correlate the land use and supporting facility plan design periods, dictate that the land use plan design year be scaled to the facility design year requirement. Coordination and integration of water quality management planning with land use planning requires the use of the same basic forecast and design years. This period, 1975 through the year 2000, while conservative, provides the means for relating the water quality forecast and design periods and requirements to the previously determined regional land use forecast and design periods.

Certain components of sanitary sewerage and storm water management systems have longer periods of physical life than the plan design period, however, extending in some cases to more than 50 years. Similarly, certain structural land management measures also exhibit useful

[1] *It is important to note that there are differences between the official state and federally adopted water quality standards—composed of "use designations" and "supporting criteria"—as described in regulatory form in Chapter VI of this volume, and the water quality management objectives—inclusive of the adopted water use objectives and supporting water quality standards—as set forth in Chapter II of Volume Two, as a basis for plan evaluation. The U. S. Environmental Protection Agency and the Wisconsin Department of Natural Resources, being regulatory agencies, utilize water quality standards as a basis for a shorter term period for enforcement actions and compliance monitoring. To be enforceable, the standards must have a rigid basis in research findings and in field experience. By contrast, the Commission as a long-range planning agency must forecast regulations and technology far into the future and document assumptions needed to analyze conditions and problems which may not currently exist anywhere, much less in southeastern Wisconsin. As a result, more recent—and sometimes more controversial—study findings must sometimes be applied. This results from the Commission's use of the water quality standards as criteria to measure relative merits of alternative long-range plans rather than criteria to define and monitor the necessary enforceable short-term or interim actions which lead to the ultimate implementation of the selected long-range plan.*

physical lives in excess of 25 years. The associated periods may go well beyond the period for which population, economic activity, and land use demand forecasts can be made with any acceptable reliability. Yet the planning process must provide a means for evaluating the potential effect of long facility life on the structure and economic soundness of the plans. Therefore, in the development of the regional sanitary sewerage system plan which serves as an important basis for this areawide water quality management plan, an "ultimate" land use pattern which might be expected to evolve within the Region by the year 2000 was postulated assuming a continuation of development policies consistent with the objectives and standards adopted by the Commission. It was initially intended that this potential development pattern would be utilized to fully explore two alternative sanitary sewerage systems for each of the analysis areas—one sized to serve development through the year 1990 with parallel facilities proposed to serve development through the year 2020, and the second being initially sized to serve development through the year 2020. The regional sanitary sewerage system planning program concluded, after engineering and economic analyses of several alternative systems, that on an equivalent annual cost basis it would generally be more economical to construct parallel trunk sewer facilities after the plan design year in order to accommodate relatively large increases in flows from the anticipated additional development, rather than to provide the larger capacity at the early stage.[2]

Such later construction of parallel sewers was found not only to require a lower initial capital investment, but also to provide greater flexibility in responding to unforeseen conditions. Where the anticipated incremental urban development is relatively small, the trunk sewer design criteria utilized generally yielded commercial pipe sizes which would provide sufficient excess capacity for the relatively modest flow increases from the anticipated additional development following the plan design year. Accordingly, it was concluded that there rarely would be an economic advantage in providing for the "ultimate" trunk sewer design capacity and the analytic step was deleted from the alternatives analyses. The only exceptions were in the analysis of major trunk and relief sewer facilities to be constructed in deep tunnels; all such sewers were sized and analyzed to the design year 2020. The basic analytical work being separated by only a five-year period, and the intervening period having provided 1970 census data indicating reduced population growth rates within the Region, it was concluded in the preparation of the areawide water quality management planning program that these findings of the regional sanitary sewerage system planning program should be adopted and applied to this regional water quality management plan. Similarily, in the analysis of alternative storm water management systems for control of urban and rural storm water runoff, it was necessary to consider the longer physical life of certain of these facilities, but it was concluded that the possible land use changes beyond the plan design year would not, on an areawide basis, result in significant differences in the findings and recommendations of the plan since even during the initial plan period only approximately 125 square miles of existing agricultural land in the Region are anticipated to be converted from rural to urban use.

[2] *The detailed analyses and results thereof are documented in the computation sheets on file in the Commission offices. See "Areawide Water Quality Plan Development Study Volumes," Study Memorandum 7100-97.*

Plan Design

Plan design is the heart of the planning process. The most well conceived objectives; the most sophisticated data collection, processing, and analysis operations; and the most accurate forecasts are of little value if they do not lead to sound plan alternatives providing clear choices for the different management measures to control and abate water pollution. The outputs of the preliminary planning steps—formulation of objectives and standards, inventory, and forecast—become inputs to the design task of alternative plan generation and synthesis of a single recommended course of action.

The water quality management plan design problem requires consideration of pollutant loadings from sewage treatment plant effluents; sanitary and combined sewerage system overflows; industrial wastewater effluents; urban and rural storm water runoff; existing lake and stream water quality conditions; forecast pollutant loadings derived from the adopted land use plan; sanitary sewerage system and storm water management and rural land management design standards; existing sanitary and storm sewer system capacities; and new facility costs. In the system design phase, future pollution control facilities are synthesized to satisfy the regional water quality management facility objectives and standards formulated under the study while meeting the criteria for system integration and cost. The process is a cyclic one, approximating the best design solutions, proposing specific solutions for specific system problems in each cycle, and then testing the expected operation and performance of the proposed system by simulating the effects of hydrologic, hydraulic, and pollution loadings on the water quality of the lakes and streams.

In the areawide water quality plan synthesis, preliminary design solutions to be tested and evaluated were drawn from the following sources:

1. Sanitary sewerage system improvement proposals recommended in the adopted regional sanitary sewerage system plan.

2. Sanitary sewerage, storm water management, and soil and water conservation system development proposals recommended in the adopted comprehensive watershed plans and in associated lake use plans.

3. Sanitary sewerage system development proposals identified in local facilities plans as prepared

pursuant to the provisions of Section 201 of the 1972 Federal Water Pollution Control Act Amendments and as approved by state and federal agencies.

4. Sanitary sewerage system development proposals and storm water management system development proposals identified in local plans as reported by the local units of government.

5. Analysis of network loadings, which provided knowledge of the existing and probable future loadings on sanitary sewerage and storm water management systems in the Region, and the resulting apparent solutions to those system deficiencies.

6. Analysis of land management practices which provided knowledge of the existing and probable future storm water management problems in both urban and rural portions of the Region, and the resulting apparent solutions to the associated water quality problems.

7. Land use plan recommendations, from which requirements for service or for land management measures based on land use development objectives were defined.

These improvement proposals originated with experienced professional engineers, planners, resource managers, and soil conservationists working for federal, state, and local units of government, and having intimate knowledge and long-standing experience in the water pollution control practices and systems in the Region. In addition, the Technical Advisory Committee members were consulted to review the measures considered.

Plan Test and Evaluation

Since plan design was directed towards attaining regional land use and water quality management objectives set forth in Chapter II of Volume Two of this report, it is essential to evaluate the resulting plans in light of their ability to meet these objectives. This was done by testing the suitability of each plan against the supporting standards formulated for development objectives. Such test and evaluation required the application of a water quality simulation model to quantitatively test the proposed system of land uses, land management practices, and pollution control facilities, thereby permitting adjustment of the spatial distribution and capacities of the system to existing and probable future pollution loadings. This analysis had to be related to the dynamic aspects of the hydrologic cycle, including the number, frequency, and duration of storms; the length of intervening dry periods; and the effects of the configuration of the land and surface water system. In addition, numerous analytical procedures were applied to support the development of basic data for the hydrologic-hydraulic water quality simulation model. Examples include the development of meteorologic data files, wasteloads from land surface runoff, contributions from sanitary sewage flow relief devices, effects of urban storm water management systems, development of alternative sewage treatment and sludge management systems, and the analysis and forecast of the entire complex of land use and transportation patterns.

To assure that plans developed in the design stage can result in sound facility development, measures are applied to quantitatively test them before they are adopted and implemented. Engineering performance and technical and economic feasibility are tested; but the plans also must be rigorously subjected to additional review and evaluation against other criteria including financial feasibility, legality, and political reaction. Testing and evaluation range from assigning hydraulic and pollution loadings to the existing and proposed pollution control facilities, to interagency meetings and public hearings.

Plan test and evaluation should clearly show which plans or parts of plans are technically and economically sound, financially feasible, legally possible, and politically realistic.

Plan Selection and Adoption

The areawide water quality management planning program developed alternative plans capable of serving the adopted regional land use plan. The approach used to select a plan or plan element from the alternatives was to present the alternatives and their technical, economic, financial, and legal feasibility analyses to the Technical Advisory Committee on Areawide Water Quality Planning, the Citizens Advisory Panel for Public Participation, involved public agency representatives, groups of local elected officials and interested citizens as identified and organized by the University of Wisconsin Extension Service, and the Regional Planning Commissioners themselves. This was done through the distribution of the Commission Newsletter, through distribution of the "Update" brochures prepared in cooperation with the University of Wisconsin Extension Service, through the use of mass media, public meetings, interagency meetings, and public hearings. The Commission then made formal decisions and adopted a plan in accordance with the provisions of the state regional planning enabling legislation and with the Section 208 requirements. The Commission's appropriate role is to recommend to federal, state, and local units of government and to private investors the best final plan for consideration and action. The final step is the review and acceptance or rejection of the plan by those federal, state, and local units of government concerned, and subsequent plan implementation by public and private action. The use of advisory committees and formal and informal public meetings and hearings appears to be the most practical, effective way to involve government bodies, technical agencies, private interest groups, and individual citizens in a fair and orderly planning process, and to reach agreement on a final plan which can be cooperatively adopted and jointly implemented.

Chapter III

DESCRIPTION OF THE REGION
MAN-MADE FEATURES AND NATURAL RESOURCE BASE

INTRODUCTION

The seven-county Southeastern Wisconsin Region is a complex of natural and man-made features which together form a rapidly changing environment for human life. The important man-made features of the Region include its land use pattern, public utility base, transportation system, and solid waste disposal system. Together with the resident population and the economic activities of the Region, these features may be thought of as the socioeconomic base of the Region. The principal elements of the natural resource base are the climate, physiography, geology, soils, surface water resources, and associated shorelands and floodlands, woodlands, wetlands, fish and wildlife habitat areas, and agricultural lands. An understanding of both the man-made features and the natural resource base and of their interaction is essential to sound areawide water quality management planning.

This chapter describes the socioeconomic and the natural resource base of the Region. The first section describes the Region and its internal political and governmental boundaries. The second and third sections describe the demographic and economic base of the Region in terms of historic trends and existing conditions with respect to population size, distribution, and composition, and employment levels and distribution. The fourth section describes the patterns of land use in the Region in terms of historic development and existing conditions. The fifth and sixth sections describe the public utility and transportation systems within the Region.

With respect to the natural resource base, the seventh section, this chapter indicates the spatial distribution and extent of the various elements of that base; characterizes, where possible, the quality of each component element; and identifies those elements and characteristics of the natural resource base which must be considered in the preparation and implementation of an areawide water quality management plan. The importance of such consideration cannot be overemphasized, since the maintenance of good water quality and the protection and enhancement of the Region's natural heritage and environmental quality are inextricably interrelated. The last section of the chapter discusses the environmental corridors of the Region.

MAN-MADE FEATURES

Regional Setting and Political Boundaries

The seven counties which comprise the southeastern Wisconsin planning Region have a combined area of 2,689 square miles, or about 5 percent of the total area of Wisconsin. An estimated resident population of 1.8 million persons, or about 40 percent of the State's population, however, resides within the seven-county Region. The Region contains about 40 percent of all the tangible wealth in the State, as measured by equalized assessed property valuation, and represents the greatest wealth-producing area of the State, with about 38 percent of the total work force of the State being employed in the Region. From 1950 to 1975, the Region accounted for about 48 percent of the total population increase in the State.

Geographically, the Region is located in a relatively good position with regard to continued growth and development. It is bounded on the east by Lake Michigan, which provides an ample supply of fresh water for both domestic and industrial use, as well as being an integral part of a major international transportation network. It is bounded on the south by the rapidly expanding northeastern Illinois metropolitan region and on the west and north by the fertile agricultural lands and desirable recreational areas of the rest of the State of Wisconsin. Many of the most important industrial areas and heaviest population concentrations in the Midwest are located approximately within 250 miles of the Region, and slightly more than 35 million people reside within this radius, an increase of approximately five million persons over the 1960 level.

A complex of 154 general-purpose local units of government and an even greater number of special-purpose units of government comprise the Southeastern Wisconsin Region. The 154 general-purpose local units of government include the seven counties comprising the Southeastern Wisconsin Region: Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, and Waukesha; 28 cities, 54 villages, and 65 towns.

Certain of the special-purpose units of government are of particular interest to the areawide water quality management planning program. Among these are the 44 legally established, active, town sanitary and utility districts operating within the Region.[1] This type of

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[1] *In addition to the 44 legally established, active, town sanitary and utility districts in the Region, records of the Wisconsin Department of Natural Resources indicate other town sanitary or utility districts which apparently had been formed in the past, but which presently are either totally inactive or have been supplanted by city or village utility services. These include in Kenosha County the Town of Bristol Sanitary District No. 2, the Town of Pleasant Prairie Sanitary District No. 1, the Paddock Lake Dells Sanitary District in the Village of*

(Footnote 1 continued on next page)

special-purpose local unit of government is created to provide various urban-related services, such as sanitary sewerage, water supply, and solid waste collection and disposal to designated portions of rural towns having urban service needs. These districts encompass a total area of about 116 square miles, or about 4 percent of the total area of the Region. The name, location, and service areas of these districts are shown on Map 3.

Another special-purpose unit of government within the Region having important areawide responsibilities for drainage and flood control and for water pollution control, as well as for the provision of sanitary sewerage service and sewage treatment, is the Metropolitan Sewerage District of the County of Milwaukee. This District, which includes all of Milwaukee County except the City of South Milwaukee, presently also provides sewerage service under contracts to portions of the Cities of New Berlin and Brookfield, to the Villages of Butler and Elm Grove, and to portions of Menomonee Falls in Waukesha County; and to portions of the City of Mequon, and to that part of the Village of Bayside in Ozaukee County. In addition, the District has contracted to serve portions of the City of Muskego in Waukesha County as trunk sewers are extended. The system operated by the District is also designed to provide service to all of the Village of Thiensville in Ozaukee County, all of the Village of Germantown, that portion of the City of Milwaukee in Washington County, and to small portions of the Town of Caledonia in Racine County.

Other special-purpose units of government in the Region having important responsibilities for the provision of areawide sanitary sewerage service and sewage treatment are the Western Racine County Sewerage District which serves the Village of Rochester and Waterford and a portion of the Town of Rochester; and the Walworth County Metropolitan Sewerage District which is proposed to serve the City of Delavan, the City of Elkhorn, and portions of the Towns of Darien, Delavan, Geneva, Lafayette, Sugar Creek, and Walworth. In addition, the Delafield-Hartland Water Pollution Control Commission is constructing facilities to provide sanitary sewerage service to the City of Delafield, the Villages of Hartland and Nashotah, and the urban development along the shorelines of the Nashotah and Nemahbin Lakes in the Town of Summit.

The total existing and proposed service areas of the Milwaukee, Western Racine County, Walworth County Metropolitan Sewerage Districts, and the Delafield-Hartland Water Pollution Control Commission are 415. 2.8, 12.2, and 13.6 square miles, respectively. These service areas are also shown on Map 3.

In addition to these special areawide and local units of government directly concerned with the provision of sanitary sewerage service, there are certain other special-purpose units and agencies of government in existence within the Region of concern to any areawide water quality management planning program. These include the soil and water conservation districts, the drainage districts, and the inland lake protection and rehabilitation districts, all of which have important water resource or water resource-related management responsibilities. There are seven soil and water conservation districts within the Region, the boundaries of these districts being coterminous with the boundaries of the seven counties. There are a total of six drainage districts within the Region, which, according to official records, are both legally constituted and active, and include five agricultural drainage districts and one urban storm water drainage district. These drainage districts encompass a total area of 106 square miles, or about 4 percent of the total area of the Region (see Map 4). Other areas in the Region with substantial agricultural drainage improvements, including several inactive agricultural drainage districts, are also shown on Map 4. As of 1978, there were 19 inland lake protection and rehabilitation districts in the Region, as shown on Map 5. These include the Ashippun, Big Cedar, Como, Comus, George, Hartford, Honey, Lilly, Little Cedar, Little Muskego, Mill Pond, Okauchee, Paddock, Phantom, Potter, Pretty, School Section, Silver, Tichigan, and Twin Lakes lake districts.

Superimposed upon these local and areawide units and agencies of government are the state and federal governments. Certain of the agencies of these governments also have important responsibilities in water resources management and are described in later chapters of this report, along with their legal authority and responsibilities. These include the Wisconsin Department of Natural Resources; the Wisconsin Department of Health and Social Services; the University of Wisconsin-Extension Service; the State Geological and Natural History Survey; the Soil Conservation Board of Wisconsin; the U. S. Department of the Interior, Geological Survey; the U. S. Environmental Protection Agency; the U. S. Department of Agriculture, Soil Conservation Service; the U. S. Army Corps of Engineers; and the U. S. Department of Housing and Urban Development.

DEMOGRAPHIC BASE

Since the ultimate purpose of the areawide water quality management planning effort is to improve the environment in which the resident population lives, an

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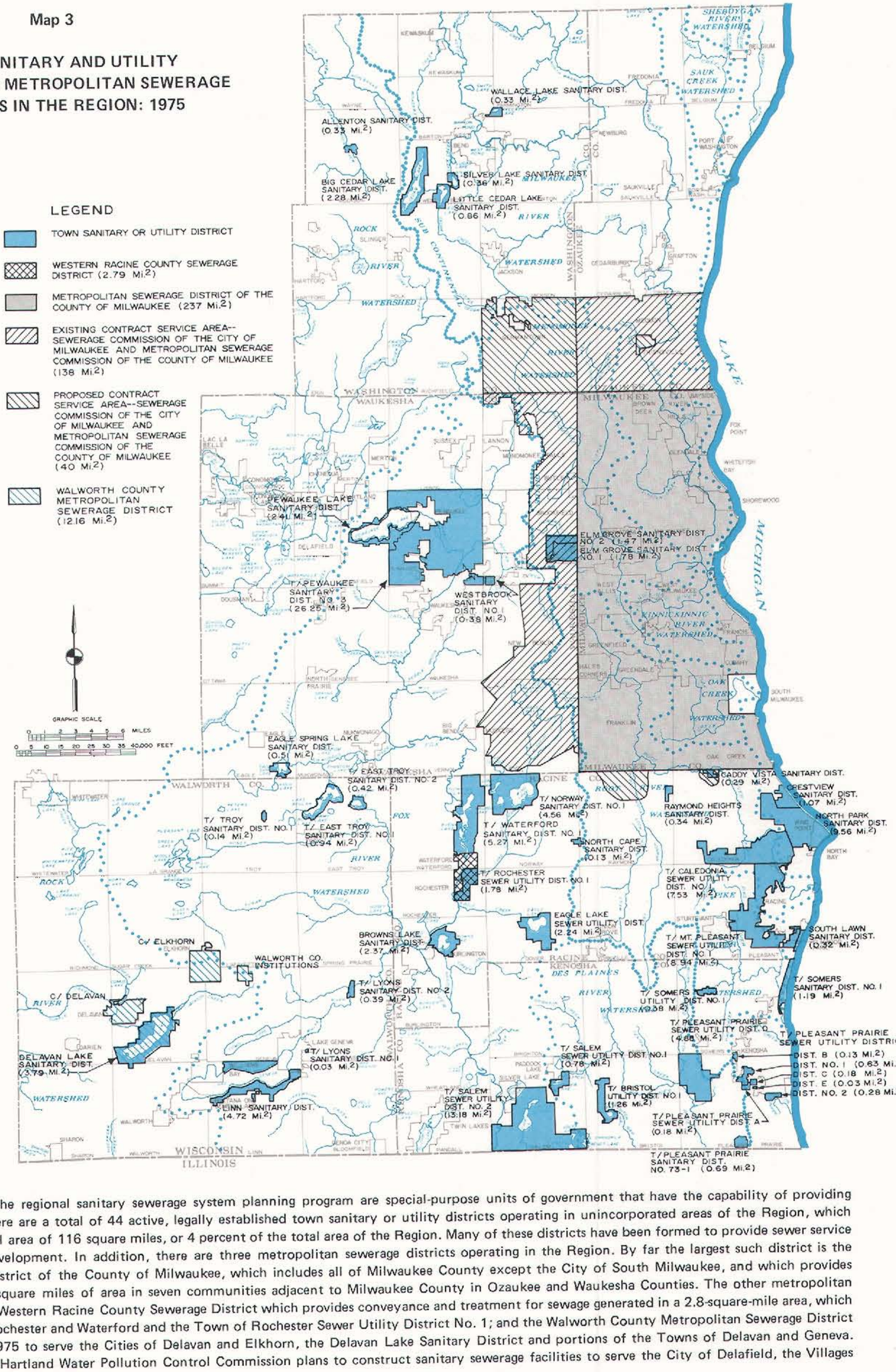
(Footnote 1 continued)
Paddock Lake, and the Edgewater Sanitary District and Town of Somers Sanitary District No. 3 in the Town of Somers; in Milwaukee County the Broson Manor, Hales Corners, and Lapham-Orchard Sanitary Districts in the Town of Greenfield, the Lakeside Sanitary District in the Town of Lake, the First New Deal, Oak View, and Rowan Estates Sanitary Districts in the Town of Oak Creek, and the Blue Mound Manor and Lovers Lane Estates Sanitary Districts in the Town of Wauwatosa; in Racine County the Trautwein, West Terrace, Colonial Heights, Consolidated Town, and Fairlawn Sanitary Districts in the Town of Mt. Pleasant; in Washington County the Germantown Sanitary District No. 1 in the Town of Germantown and the Newburg Sanitary District; and in Waukesha County the Greenfield Heights, Hidden Woods Estates, and Westchester Sanitary Districts in the Town of Brookfield. A number of the foregoing sanitary districts at one time operated relatively small sewerage systems which have been connected to and made a part of larger, centralized municipal sanitary sewerage systems.

Map 3

TOWN SANITARY AND UTILITY DISTRICTS AND METROPOLITAN SEWERAGE DISTRICTS IN THE REGION: 1975

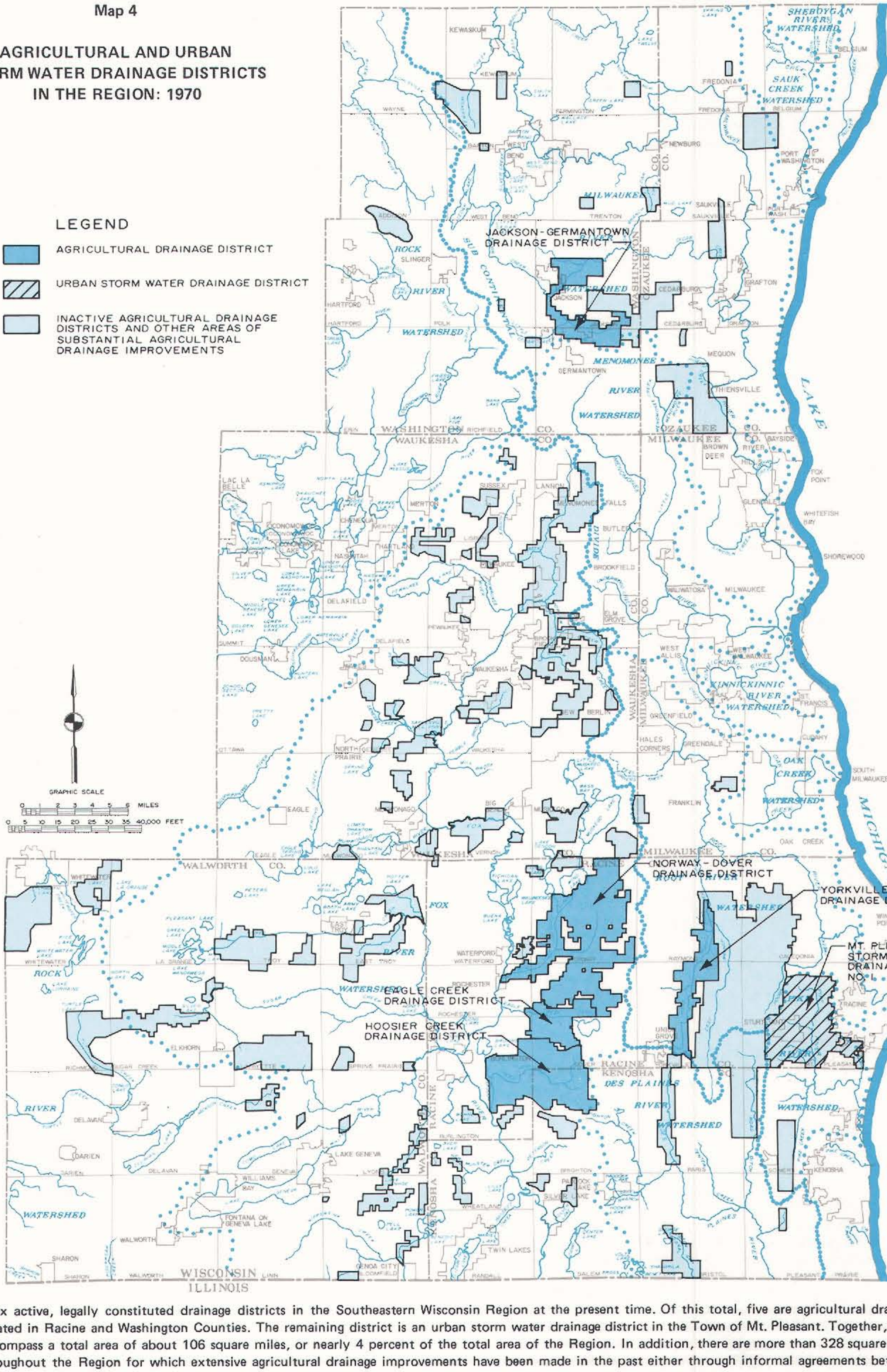


Particularly pertinent to the regional sanitary sewerage system planning program are special-purpose units of government that have the capability of providing sanitary sewer service. There are a total of 44 active, legally established town sanitary or utility districts operating in unincorporated areas of the Region, which together encompass a total area of 116 square miles, or 4 percent of the total area of the Region. Many of these districts have been formed to provide sewer service to lake-oriented urban development. In addition, there are three metropolitan sewerage districts operating in the Region. By far the largest such district is the Metropolitan Sewerage District of the County of Milwaukee, which includes all of Milwaukee County except the City of South Milwaukee, and which provides contract services to 138 square miles of area in seven communities adjacent to Milwaukee County in Ozaukee and Waukesha Counties. The other metropolitan sewerage districts are the Western Racine County Sewerage District which provides conveyance and treatment for sewage generated in a 2.8-square-mile area, which includes the Villages of Rochester and Waterford and the Town of Rochester Sewer Utility District No. 1; and the Walworth County Metropolitan Sewerage District which was proposed in 1975 to serve the Cities of Delavan and Elkhorn, the Delavan Lake Sanitary District and portions of the Towns of Delavan and Geneva. In addition, the Delafield-Hartland Water Pollution Control Commission plans to construct sanitary sewerage facilities to serve the City of Delafield, the Villages Hartland and Nashotah, and portions of the Town of Summit.

Source: SEWRPC.

Map 4

AGRICULTURAL AND URBAN STORM WATER DRAINAGE DISTRICTS IN THE REGION: 1970

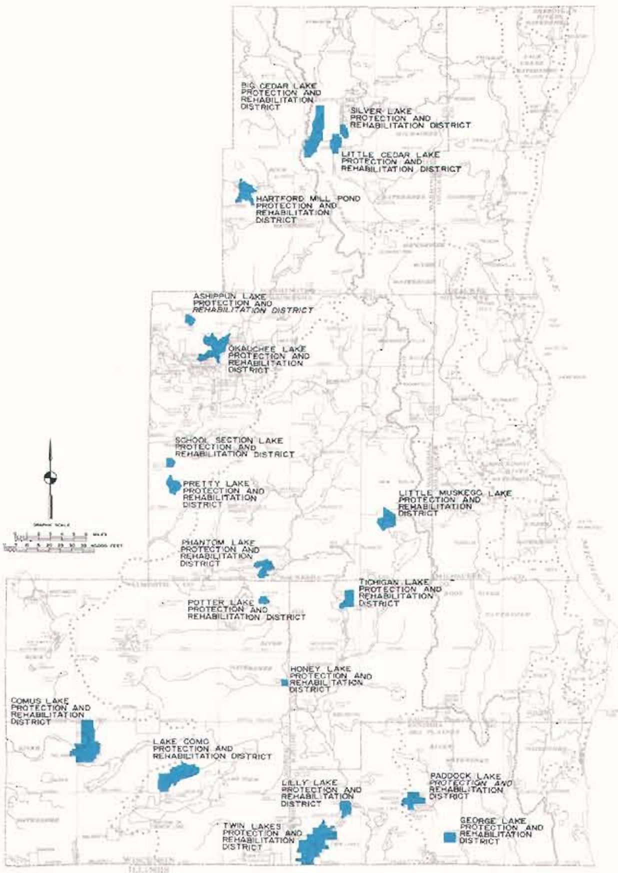


There are six active, legally constituted drainage districts in the Southeastern Wisconsin Region at the present time. Of this total, five are agricultural drainage districts located in Racine and Washington Counties. The remaining district is an urban storm water drainage district in the Town of Mt. Pleasant. Together, these districts encompass a total area of about 106 square miles, or nearly 4 percent of the total area of the Region. In addition, there are more than 328 square miles of land throughout the Region for which extensive agricultural drainage improvements have been made in the past either through informal agreements between individual farmers or through now inactive agricultural drainage districts.

Source: SEWRPC.

Map 5

INLAND LAKE PROTECTION AND REHABILITATION DISTRICTS



As of October 1, 1978, there were 19 Inland Lake Protection and Rehabilitation Districts established in the Southeastern Wisconsin Region. These districts constitute special-purpose units of government established under Chapter 33 of the Wisconsin Statutes for purposes of inland lake management. Of these, 14 had completed one-year water quality sampling studies, as part of the feasibility studies designed to develop measures to abate pollution and enhance the quality of the lake waters.

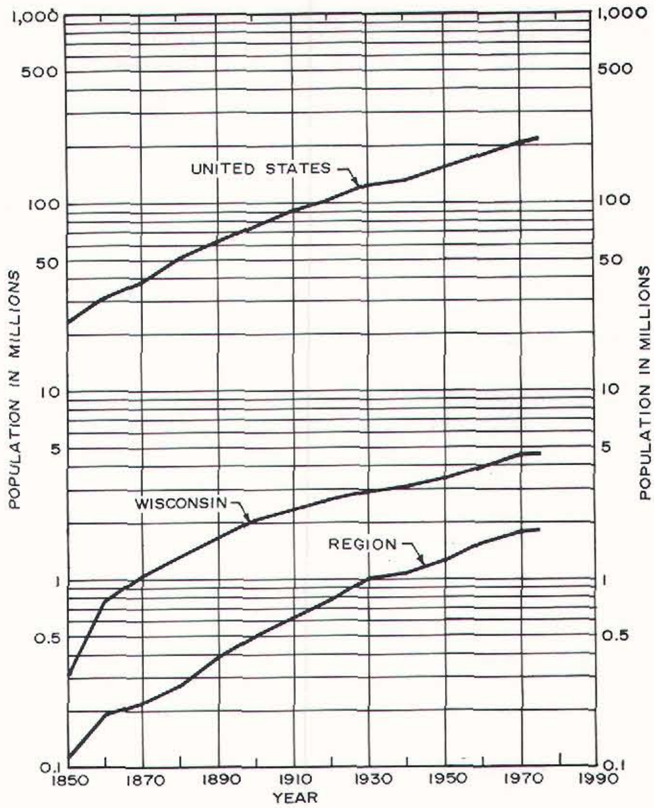
Source: Wisconsin Department of Natural Resources and SEWRPC.

understanding of the size, characteristics, and spatial distribution of this population is basic to that planning effort. Resident population levels bear a direct relationship to the demand for land, water, and other elements of the natural resource base, as well as the demand for various kinds of transportation, utility, and community facilities and services. The size and characteristics of the population of an area are greatly influenced by growth and change in economic activity. Population and economic activity must, therefore, be considered together.

Population growth within the Region over the past century has generally occurred at a higher rate than for the state and nation (see Figure 4 and Table 1).

Figure 4

POPULATION LEVELS IN THE REGION, WISCONSIN, AND THE UNITED STATES: 1850-1975



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

Table 1

POPULATION TRENDS IN THE REGION, WISCONSIN, AND THE UNITED STATES SELECTED YEARS: 1850-1975

Year	Population			Region Population as a Percent of	
	Region	Wisconsin	United States	United States	Wisconsin
1850	113,389	305,391	23,196,876	0.49	37.1
1860	190,409	775,881	31,443,321	0.61	24.5
1870	223,546	1,054,670	38,558,371	0.58	21.2
1880	277,119	1,315,497	50,155,783	0.55	21.0
1890	386,774	1,693,330	62,947,714	0.61	22.8
1900	501,808	2,069,042	75,994,575	0.66	24.2
1910	631,161	2,333,860	91,972,266	0.69	27.0
1920	783,681	2,632,067	105,710,620	0.74	29.7
1930	1,006,118	2,939,006	122,775,046	0.82	34.2
1940	1,067,699	3,137,587	131,669,270	0.81	34.0
1950	1,240,618	3,434,575	151,325,798	0.82	36.1
1960	1,573,620	3,952,771	179,323,175	0.88	39.8
1970	1,756,086	4,417,933	203,184,772	0.86	39.7
1975	1,789,871[a]	4,581,700[a]	212,796,000	0.84	39.1

[a] *Wisconsin Department of Administration Estimates.*

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

Consequently, the regional share of the total national population increased from 0.49 percent in 1850 to 0.88 percent in 1960, while the regional share of the State population increased from 37 percent in 1850 to nearly 40 percent in 1960. Between 1960 and 1970, however, the population growth rate for the Region was somewhat lower than that for the nation and State, and, consequently, the regional share of the total population of the nation and State declined slightly over the past decade.

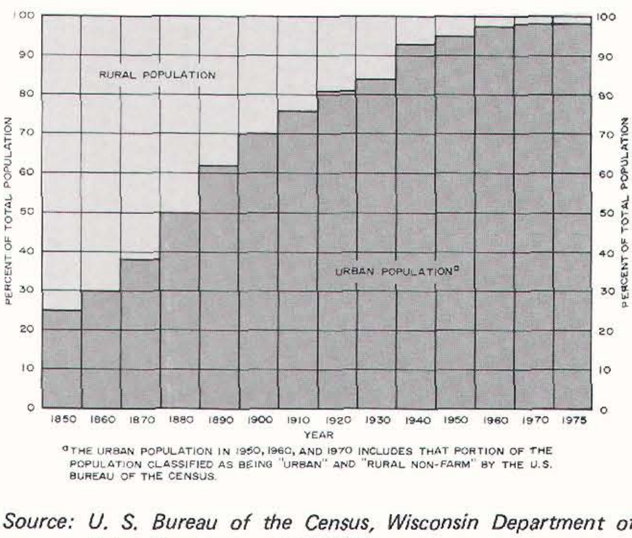
Population Distribution

The long-term growth trend in the regional population has been marked by two phenomena which are of considerable importance to understanding existing as well as future water quality needs. First, the Southeastern Wisconsin Region, like most metropolitan regions in the United States, is becoming increasingly urban. In 1850, the population of the Region was approximately 75 percent rural and 25 percent urban; by 1900, this relationship had almost reversed to 30 percent rural and 70 percent urban; and by 1975, only 12.4 percent of the regional population was considered rural, of which 11 percent was classed as rural nonfarm and only 1.4 percent as rural farm, while 87.6 percent was considered urban. The 125-year rural-urban change is shown graphically in Figure 5. Water quality conditions and the need for and type of water quality control facilities are affected by urban development. Accordingly, this trend toward urbanization is an important consideration in the water quality management planning effort.

Secondly, the population within the Region is being increasingly decentralized, and attendant urban development is being diffused across established municipal and county boundaries. During the 30-year period from 1900 to 1930, the highest rates of population increase within the Region occurred in the three urban counties of Kenosha, Milwaukee, and Racine. Urban decentralization over the last four decades (1930-1970) has reversed this trend. Between 1960 and 1970 rates of population growth of more than 35 percent were observed in certain outlying counties of the Region, notably Ozaukee, Washington, and Waukesha Counties, while the population increased by only 2 percent in Milwaukee County (see Table 2). One effect of this population decentralization has been an increase in the need for certain kinds of water quality control and related facilities in the suburban and rural-urban fringe areas of the Region.

Figure 5

DISTRIBUTION OF URBAN AND RURAL POPULATION IN THE REGION: 1850-1975



[a] THE URBAN POPULATION IN 1950, 1960, AND 1970 INCLUDES THAT PORTION OF THE POPULATION CLASSIFIED AS BEING "URBAN" AND "RURAL NON-FARM" BY THE U.S. BUREAU OF THE CENSUS.

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

The varying rates of population growth have resulted in significant distributional shifts of population among the seven counties. The most dramatic distributional changes over the 70-year period have occurred in Milwaukee and Waukesha Counties (see Figure 6). The Milwaukee County proportion of the total regional population increased by about 6 percent from 1900 to 1930 and then decreased by over 12 percent from 1930 to 1970. The proportion of the total regional population in Waukesha County decreased by about 2 percent from 1900 to 1930 and then increased by about 8 percent from 1930 to 1970. The result of the most recent changes in population distribution within the Region has been an areawide diffusion of population around the central cities of Milwaukee, Racine, and Kenosha.

There are, as will be discussed later herein, 12 major watersheds in the Region. As shown in Table 3, in 1975 the size of the resident population of these watersheds ranged from a low of about 1,000 persons in the Sheboygan River watershed within the Region, or about 0.06 percent of the total population of the Region, to a high of more than 483,000 persons in the Milwaukee River watershed within the Region, or about 27 percent of the total population of the Region. The Menomonee River and the Fox River watersheds also contain sizable portions of the Region's population, with populations of approximately 337,000 persons, or about 19 percent, and approximately 225,000 persons, or over 12 percent, respectively, of the 1975 resident population of the Region. These three watersheds contained a total of 1,045,000 persons, or more than 58 percent of the 1975 regional population. These same three watersheds contained almost 62 percent of the Region's population in 1950, however, with the Milwaukee River watershed accounting for more than 34 percent, the Menomonee River more than 19 percent, and the Fox River about 8 percent of the Region's 1950 population total. The Kinnickinnic River watershed, which had contained more than 12 percent of the Region's 1950 population, now contains less than 10 percent. The three largest watersheds of 1950 in terms of population are the same watersheds that have been losing population since 1970; this pattern verifies the trend toward decentralization of the Region's population.

Table 2

POPULATION IN THE REGION BY COUNTY: 1900-1975

County	Population								
	1900	1910	1920	1930	1940	1950	1960	1970	1975
Kenosha	21,707	32,929	51,284	63,277	63,595	75,238	100,615	117,917	126,651
Milwaukee . . .	330,017	433,187	539,449	725,263	766,885	871,047	1,036,047	1,054,249	1,012,536
Ozaukee	16,363	17,123	16,335	17,394	18,985	23,361	38,441	54,461	64,932
Racine.	45,644	57,424	78,961	90,217	94,047	109,585	141,781	170,838	178,916
Walworth. . . .	29,259	29,614	29,327	31,058	33,103	41,584	52,368	63,444	67,511
Washington . .	23,589	23,784	25,713	26,551	28,430	33,902	46,119	63,839	76,579
Waukesha. . . .	35,229	37,100	42,612	52,358	62,744	85,901	158,249	231,335	262,746
Region	501,808	631,161	783,681	1,006,118	1,067,699	1,240,618	1,573,620	1,756,083	1,789,871

County	Percent Change								
	1900-1910	1910-1920	1920-1930	1930-1940	1940-1950	1950-1960	1960-1970	1970-1975	1900-1975
Kenosha	51.7	55.7	23.4	0.5	18.3	33.7	17.2	7.4	483.5
Milwaukee . . .	31.3	24.5	34.4	5.7	13.6	18.9	1.8	- 4.0	206.8
Ozaukee	4.6	- 4.6	6.5	9.1	23.0	64.6	41.7	19.2	296.8
Racine.	25.8	37.5	14.3	4.2	16.5	29.4	20.5	4.7	292.0
Walworth. . . .	1.2	- 1.0	5.9	6.6	25.6	25.9	21.2	6.4	130.7
Washington . .	0.8	8.1	3.3	7.1	19.2	36.0	38.4	20.0	224.6
Waukesha. . . .	5.3	14.9	22.9	19.8	36.9	84.2	46.2	13.6	645.8
Region	25.8	24.2	28.4	6.1	16.2	26.8	11.6	1.9	256.7

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

Table 3

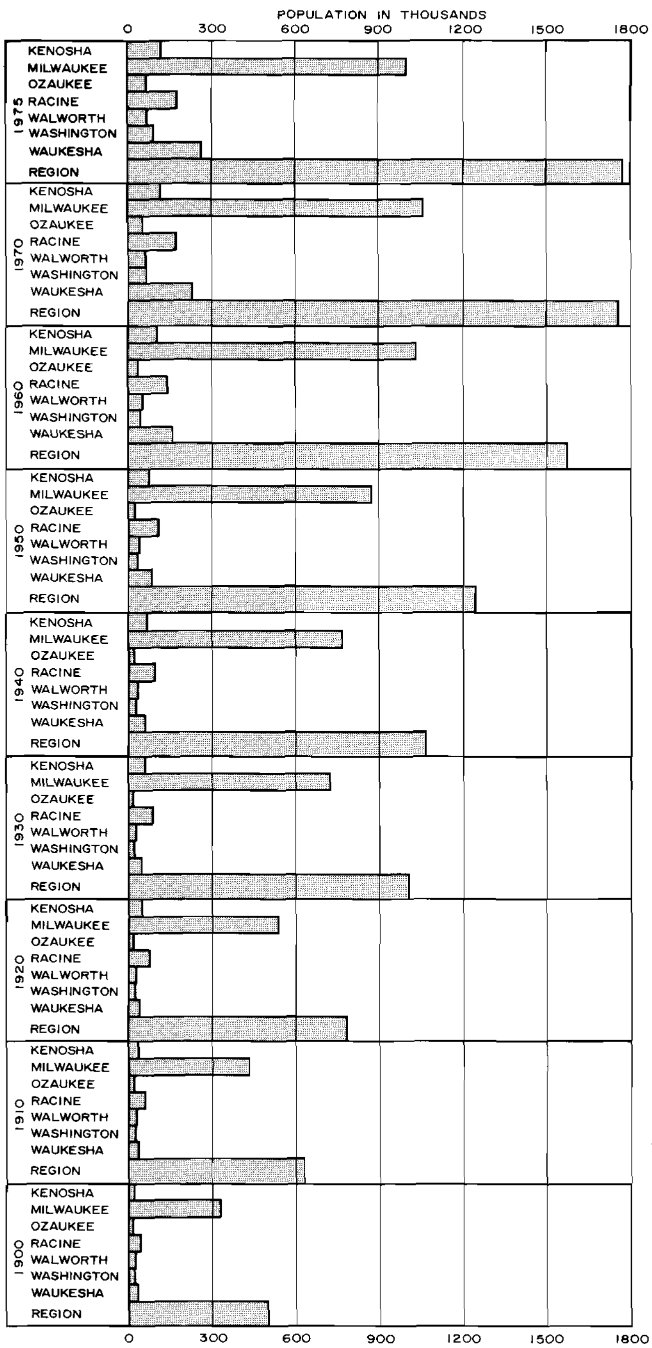
POPULATION GROWTH BY WATERSHED: 1950-1975

Watershed	Population				Percent Change			
	1950	1960	1970	1975	1950-1960	1960-1970	1970-1975	1950-1975
Des Plaines.	7,707	11,436	14,551	15,811	48.4	27.2	8.7	105.2
Fox	96,077	144,090	195,566	225,075	50.0	35.7	15.1	134.3
Kinnickinnic.	153,286	177,598	173,914	165,088	15.9	- 2.1	- 5.1	7.7
Menomonee	240,006	309,121	344,614	336,824	28.8	11.5	- 2.3	40.3
Milwaukee	428,880	501,390	494,754	483,193	16.9	- 1.3	- 2.3	12.7
Oak Creek	18,173	25,431	36,498	39,519	39.9	43.5	8.3	117.5
Pike	12,903	17,779	23,471	27,800	37.8	32.0	18.4	115.4
Rock.	49,850	66,842	87,469	97,334	34.1	30.9	11.3	95.3
Root.	64,066	103,212	141,790	152,431	61.1	37.4	7.5	137.9
Sauk Creek.	4,003	4,980	6,865	7,377	24.4	37.8	7.5	84.3
Sheboygan	784	1,004	991	1,005	28.1	- 1.3	1.4	28.2
Minor Tributaries Draining to Lake Michigan. . .	164,883	210,737	235,600	238,414	27.8	11.8	1.2	44.6
Regional Total	1,240,618	1,573,620	1,756,083	1,789,871	26.8	11.6	1.9	44.3

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

Figure 6

POPULATION DISTRIBUTION IN THE REGION BY COUNTY: 1900-1975



Source: U. S. Bureau of the Census and SEWRPC.

Population Size and Growth

Large variations in the patterns of population change have also been exhibited by the individual watersheds. Between 1950 and 1975, the populations of the Root River and the Fox River watersheds both grew by more than 130 percent, while the Kinnickinnic River watershed increased in population by only about 8 percent. While all 12 watersheds have increased in population since 1950, three watersheds have shown a decrease in population since 1970. These three are the Kinnickinnic River, the Menomonee River, and the Milwaukee River watersheds, all of which are urban in character. By contrast, the Pike River and the Fox River watersheds have shown the largest increases in population since 1970, 18 percent and 15 percent, respectively. Since 1970, the Region has grown by 1.9 percent and the State by 3.7 percent (see Table 4).

Occupation: Occupation is an important factor in determining the composition of the residential population, the nature of existing and anticipated water uses, and the income potential to support the abatement of water pollution which may impair those uses. The Census Bureau divides the employed population into four broad occupational classifications: white collar workers, blue collar workers, farm workers, and service workers. White collar workers include professional, technical, and kindred workers; managers and administrators, except farm-related positions; and sales workers. Blue collar workers consist of craftsmen, foremen, and kindred workers; operatives; and laborers, except farm laborers. Farm workers include farmers, farm managers, farm laborers, and farm foremen. Service workers are composed of persons employed in such activities as the cleaning, food, health, and protective services as well as private household workers. The distribution of the employed population age 14 years and over according to these occupation classifications is presented for the Region in Table 5 and Figure 7.

As indicated in Table 5, the proportion of white collar workers in the Region has increased in recent times, rising from 41.6 percent of the employed population 14 years old and over in 1960 to 45.3 percent in 1970. Conversely, the proportion of blue collar workers decreased from 42.4 percent to 36.0 percent between 1960 and 1970, with an actual decline in the number of blue collar workers occurring during this period. The proportion of farm workers also declined slightly, from 1.9 percent to 1.1 percent between 1960 and 1970, while the proportion of service workers increased from 9.6 percent to 11.9 percent during this time.

The occupational status of the population varies considerably among the seven counties in the Region (see Table 6). As reported by the Census Bureau, white collar workers comprise varying proportions of the total employed population, ranging from a low of 36 percent in Washington County to a high of 51 percent in Waukesha County in 1970. On the other hand, among the seven counties the proportion of blue collar workers ranged from a low of 34 percent in Waukesha to a high

Table 4

POPULATION DISTRIBUTION IN THE REGION BY WATERSHED AND COUNTY: 1950-1975

Watershed	County	1950 Population	Percent of Watershed	Watershed as Percent of Region	1960 Population	Percent of Watershed	Watershed as Percent of Region	1970 Population	Percent of Watershed	Watershed as Percent of Region	1975 Population	Percent of Watershed	Watershed as Percent of Region
Des Plaines	Kenosha . . .	6,275	81.4		9,450	82.6		12,475	85.7		13,568	85.8	
	Racine.	1,432	18.6		1,986	17.4		2,076	14.3		2,243	14.2	
	Total	7,707	100.0	0.6	11,436	100.0	0.7	14,551	100.0	0.8	15,811	100.0	0.9
Fox	Kenosha . . .	5,298	5.5		9,698	6.7		11,748	6.0		14,097	6.3	
	Milwaukee . .	4	..[a]		11	..[a]		14	..[a]		14	..[a]	
	Racine.	14,997	15.6		21,109	14.7		26,849	13.7		29,069	12.9	
	Walworth. . .	21,922	22.8		27,694	19.2		31,384	16.1		34,635	15.4	
	Washington .	4	..[a]		6	..[a]		12	..[a]		14	..[a]	
	Waukesha. . .	53,852	56.1		85,572	59.4		125,559	64.2		147,246	65.4	
	Total	96,077	100.0	7.7	144,090	100.0	9.2	195,566	100.0	11.2	225,075	100.0	12.6
Kinnickinnic	Milwaukee . .	153,286	100.0		177,598	100.0		173,914	100.0		165,088	100.0	
	Total	153,286		12.4	177,598	-	11.3	173,914		9.9	165,088		9.2
Menomonee	Milwaukee . .	225,997	94.2		265,281	85.8		278,833	80.9		266,761	79.2	
	Ozaukee . . .	615	0.2		1,337	0.4		1,901	0.6		2,026	0.6	
	Washington .	2,451	1.0		4,578	1.5		7,378	2.1		9,077	2.7	
	Waukesha. . .	10,943	4.6		37,925	12.3		56,502	16.4		58,960	17.5	
	Total	240,006	100.0	19.4	309,121	100.0	19.6	344,614	100.0	19.6	336,824	100.0	18.8
Milwaukee	Milwaukee . .	395,324	92.2		449,134	89.6		420,718	85.0		393,559	81.4	
	Ozaukee . . .	14,340	3.3		26,135	5.2		37,950	7.7		46,375	9.6	
	Washington .	19,216	4.5		26,121	5.2		36,086	7.3		43,259	9.0	
	Total	428,880	100.0	34.6	501,390	100.0	31.9	494,754	100.0	28.2	483,193	100.0	27.0
Oak Creek	Milwaukee . .	18,173	100.0		25,431	100.0		36,498	100.0		39,519	100.0	
	Total	18,173		1.5	25,431		1.6	36,498		2.1	39,519		2.2
Pike	Kenosha . . .	6,031	46.7		10,264	57.7		11,213	47.8		13,238	47.6	
	Racine.	6,872	53.3		7,515	42.3		12,258	52.2		14,562	52.4	
	Total	12,903	100.0	1.0	17,779	100.0	1.1	23,471	100.0	1.3	27,800	100.0	1.6
Fox	Walworth. . .	19,662	39.5		24,674	37.0		32,060	36.7		32,876	33.8	
	Washington .	12,231	24.5		15,414	23.0		20,363	23.3		24,229	24.9	
	Waukesha. . .	17,957	36.0		26,754	40.0		35,046	40.0		40,229	41.3	
	Total	49,850	100.0	4.0	66,842	100.0	4.3	87,469	100.0	5.0	97,334	100.0	5.1
Root	Kenosha . . .	38	..[a]		51	..[a]		62	..[a]		62	..[a]	
	Milwaukee . .	18,537	29.0		40,380	39.1		63,417	44.7		70,144	46.0	
	Racine.	42,342	66.1		54,783	53.1		64,083	45.2		65,914	43.3	
	Waukesha. . .	3,149	4.9		7,998	7.8		14,228	10.1		16,211	10.7	
	Total	64,066	100.0	5.2	103,212	100.0	6.6	141,790	100.0	8.1	152,431	100.0	8.5
Sauk Creek	Ozaukee . . .	4,003	100.0		4,980	100.0		6,865	100.0		7,377	100.0	
	Total	4,003		0.3	4,980		0.3	6,865		0.4	7,377		0.4
Sheboygan	Ozaukee . . .	784	100.0		1,004	100.0		991	100.0		1,005	100.0	
	Total	784		..[a]	1,004		..[a]	991		..[a]	1,005		..[a]
Minor Tributaries Draining to Lake Michigan	Kenosha . . .	57,596	34.9		71,152	33.8		82,419	35.0		85,686	35.9	
	Milwaukee . .	59,726	36.2		78,212	37.1		80,855	34.3		77,451	32.5	
	Ozaukee . . .	3,619	2.2		4,985	2.4		6,754	2.9		8,149	3.4	
	Racine.	43,942	26.7		56,388	26.7		65,572	27.8		67,128	28.2	
	Total	164,883	100.0	13.3	210,737	100.0	13.4	235,600	100.0	13.4	238,414	100.0	13.3
Regional Total		1,240,618		100.0	1,573,620		100.0	1,756,083		100.0	1,789,871		100.0

[a]*Percentage less than one-tenth of 1 percent.*

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

Table 5

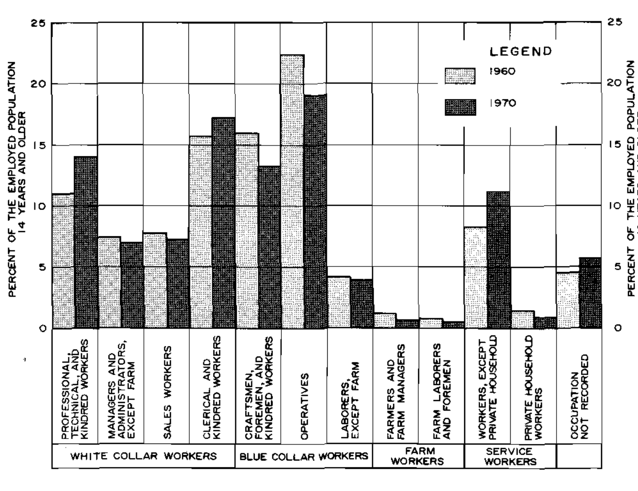
OCCUPATIONAL STATUS OF THE EMPLOYED POPULATION 14 YEARS OLD AND OVER IN THE REGION: 1960 and 1970

Occupation	Employed Population 14 Years Old and Over			
	1960		1970	
	Number	Percent	Number	Percent
White Collar Workers	254,799	41.6	324,609	45.3
Professional, Technical, and Kindred Workers	67,085	11.0	100,506	14.0
Managers and Administrators, except Farm	44,692	7.3	49,365	6.9
Sales Workers	46,694	7.6	51,523	7.2
Clerical and Kindred Workers	96,328	15.7	123,215	17.2
Blue Collar Workers	260,073	42.4	257,849	36.0
Craftsmen, Foremen, and Kindred Workers	97,309	15.9	94,591	13.2
Operatives	137,543	22.4	136,081	19.0
Laborers, except Farm	25,221	4.1	27,177	3.8
Farm Workers	11,769	1.9	7,827	1.1
Farmers and Farm Managers	7,566	1.2	4,604	0.6
Farm Laborers and Foremen	4,203	0.7	3,223	0.5
Service Workers	58,438	9.6	85,112	11.9
Workers, except Private Household	50,176	8.2	79,672	11.1
Private Household Workers	8,262	1.4	5,440	0.8
Occupation Not Reported	27,644	4.5	41,024	5.7
Total	612,723	100.0	716,421	100.0

Source: U. S. Bureau of the Census and SEWRPC.

Figure 7

OCCUPATIONAL DISTRIBUTION OF THE EMPLOYED POPULATION 14 YEARS OF AGE AND OLDER IN THE REGION 1960 AND 1970



Source: U. S. Bureau of the Census and SEWRPC.

of 44 percent in Washington. As further indicated in Table 6, Walworth County had the highest proportion of farm workers among the seven counties, 6.7 percent, while Milwaukee County had the lowest proportion, 0.2 percent. Finally, the proportion of service workers ranged from a low of 9 percent in Ozaukee County to 15 percent in Walworth County.

Income: The level of income is an important determinant of water use and of the ability of the resident population to support the implementation of water pollution control plans. Personal income in the Region totaled more than $6 billion (see Table 7) in 1969. From 1949 to 1969, total income in the Region increased by $4.4 billion, or 263 percent, a rate much greater than the 54 percent increase in the cost of living during this time.[2] Since the increase in total income has occurred at a much faster rate than the increase in the regional population, the average per capita income in the Region increased considerably from $1,338 in 1949 to $3,433 in 1969, a relative increase of 157 percent. Similarly, the average

[2] *The cost of living was measured by the consumer price index prepared by the U. S. Bureau of Labor Statistics.*

Table 6

OCCUPATIONAL STATUS OF THE EMPLOYED POPULATION 14 YEARS OLD AND OVER IN THE REGION BY COUNTY: 1970

Occupation	Employed Population 14 Years Old and Over															
	Kenosha		Milwaukee		Ozaukee		Racine		Walworth		Washington		Waukesha		Region	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
White Collar Workers	17,602	38.5	204,937	46.4	10,032	45.9	27,082	41.1	9,783	38.3	9,197	36.2	45,976	50.8	324,609	45.3
Professional, Technical, and Kindred Workers	5,500	12.0	61,847	14.0	3,271	15.0	8,894	13.5	3,130	12.3	2,766	10.9	15,098	16.7	100,506	14.0
Managers and Administrators, except Farm	2,844	6.2	27,406	6.2	2,171	9.9	4,195	6.4	2,130	8.3	1,612	6.3	9,007	9.9	49,365	6.9
Sales Workers	2,475	5.4	32,960	7.5	1,632	7.5	3,826	5.8	1,286	5.0	1,416	5.6	7,928	8.8	51,523	7.2
Clerical and Kindred Workers	6,783	14.9	82,724	18.7	2,958	13.5	10,167	15.4	3,237	12.7	3,403	13.4	13,943	15.4	123,215	17.2
Blue Collar Workers	19,297	42.2	153,225	34.7	8,071	36.9	26,744	40.5	8,742	34.2	11,271	44.3	30,499	33.6	257,849	36.0
Craftsmen, Foremen, and Kindred Workers	6,857	15.0	54,879	12.4	2,999	13.7	9,772	14.8	3,116	12.2	3,891	15.3	13,077	14.4	94,591	13.2
Operatives	10,651	23.3	81,580	18.5	4,405	20.1	14,299	21.7	4,523	17.7	6,196	24.4	14,427	15.9	136,081	19.0
Laborers, except Farm	1,789	3.9	16,766	3.8	667	3.1	2,673	4.0	1,103	4.3	1,184	4.6	2,995	3.3	27,177	3.8
Farm Workers	804	1.8	680	0.2	830	3.8	1,176	1.8	1,700	6.7	1,498	5.9	1,139	1.3	7,827	1.1
Farmers and Farm Managers	506	1.1	211	0.1	512	2.3	649	1.0	1,008	4.0	984	3.9	734	0.8	4,604	0.6
Farm Laborers and Foremen	298	0.7	469	0.1	318	1.5	527	0.8	692	2.7	514	2.0	405	0.5	3,223	0.5
Service Workers	6,103	13.3	53,226	12.1	1,956	8.9	8,136	12.3	3,879	15.2	2,486	9.8	9,326	10.3	85,112	11.9
Workers, except Private Household	5,766	12.6	50,184	11.4	1,756	8.0	7,536	11.4	3,527	13.8	2,264	8.9	8,639	9.5	79,672	11.1
Private Household Workers	337	0.7	3,042	0.7	200	0.9	600	0.9	352	1.4	222	0.9	687	0.8	5,440	0.8
Occupation Not Reported	1,899	4.2	29,254	6.6	976	4.5	2,860	4.3	1,418	5.6	972	3.8	3,645	4.0	41,024	5.7
Total	45,705	100.0	441,322	100.0	21,865	100.0	65,998	100.0	25,522	100.0	25,424	100.0	90,585	100.0	716,421	100.0

Source: U. S. Bureau of the Census and SEWRPC.

Table 7

PERSONAL INCOME TRENDS IN THE REGION: SELECTED YEARS 1949-1969

Year	Total Income (Millions of Dollars)		Per Capita Income		Per Household Income	
	Actual	Constant[a]	Actual	Constant[a]	Actual	Constant[a]
1949	$1,660	$2,299	$1,338	$1,858	$ 4,682	$6,487
1959	3,492	3,941	2,219	2,505	7,496	8,460
1969	6,029	5,189	3,433	2,954	11,238	9,671

[a] *Adjusted for price change, base year equals 1967.*

Source: U. S. Bureau of the Census and SEWRPC.

per household income in the Region grew rapidly between 1949 and 1969, increasing from $4,682 to $11,238, or by 140 percent, during that time. It should be noted that this trend in the average household income reflects not only an increase in the earnings of the heads of each household, but also the tendancy of other household members, wives in particular, to supplement household income.

Trends in real per capita and per household income, expressed in constant dollars, are similar to the trends in per capita and per household income expressed in actual dollars.[3] Measured in constant 1967 dollars, real per capita income in the Region increased from $1,858 in 1949 to $2,954 in 1969, an increase of 59 percent. Real per household income increased from $6,487 in 1949 to $9,671 in 1969, an increase of 49 percent (see Table 7). These trends in real per capita and per household income within the Region may be assumed to have been accompanied by increases in discretionary disposable income.

[3] *The U. S. Bureau of Labor Statistics 1967 Consumer Price Index was used to adjust actual dollar figures to constant dollars. Constant dollar figures allow comparison free of price distortion.*

As shown in Table 8 and Figure 8, there was much variation in household income among the seven counties in the Region in 1969. Household incomes were generally quite high in Ozaukee and Waukesha Counties. Thus, the proportion of households with incomes of $15,000 or more was relatively high in both these counties (30 percent in Ozaukee and 31 percent in Waukesha) while the proportion of households with incomes less than $7,000 in these counties was small (less than 20 percent). On the other hand, relatively low household incomes were found in Walworth County, where 40 percent of all households had an income of less than $7,000 and only 16 percent of all households had an income of $15,000 or more. The median household income presented in Table 8 summarizes the variation in household income among the seven counties. As might be expected in view of these figures, the median household income ranged from a low of $8,500 in Walworth County to more than $12,000 in Ozaukee and Waukesha Counties.

Despite the general increase in the level of personal income in recent times, the Region contains a large number of lower-income households with limited financial resources to support costs beyond those of providing food, housing, clothing, and other necessities. For example, 31 percent of all households in the Region received less than $7,000 and 22 percent of all households received less than $5,000 in 1969. Such households would be strained by major increases in water use costs or sewage treatment user charges.

Table 8

INCOME LEVELS FOR HOUSEHOLDS IN THE REGION BY COUNTY: 1969

County	Income Level[a]							
	Less Than $3,000		$3,000-4,999		$5,000-6,999		$7,000-9,999	
	Number	Percent[b]	Number	Percent	Number	Percent	Number	Percent
Kenosha	4,720	13.3	3,216	9.1	3,787	10.7	7,580	21.4
Milwaukee	48,554	14.3	32,341	9.6	33,330	9.8	65,591	19.4
Ozaukee	1,189	8.1	808	5.5	906	6.1	2,414	16.4
Racine.	6,110	12.3	4,337	8.7	4,679	9.4	10,069	20.2
Walworth.	3,381	18.2	2,081	11.2	1,964	10.6	3,771	20.3
Washington	1,782	10.2	1,386	8.0	1,273	7.3	3,547	20.4
Waukesha.	4,592	7.4	3,472	5.6	3,588	5.8	9,493	15.3
Region	70,328	13.1	47,641	8.9	49,527	9.2	102,465	19.1

County	Income Level						Total Households		Median Household Income[c]
	$10,000-14,999		$15,000-24,999		$25,000 or More				
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	
Kenosha	10,368	29.2	4,942	13.9	855	2.4	35,468	100.0	$ 9,400
Milwaukee	94,071	27.8	52,065	15.4	12,653	3.7	338,605	100.0	9,500
Ozaukee	5,007	33.9	3,279	22.2	1,150	7.8	14,753	100.0	12,100
Racine.	15,190	30.5	7,614	15.3	1,797	3.6	49,796	100.0	9,900
Walworth.	4,353	23.5	2,391	12.9	603	3.3	18,544	100.0	8,500
Washington . . .	5,436	31.3	3,159	18.2	802	4.6	17,385	100.0	10,600
Waukesha.	21,588	34.9	15,004	24.2	4,198	6.8	61,935	100.0	12,300
Region	156,013	29.1	88,454	16.5	22,058	4.1	536,486	100.0	$10,000

[a] *The household income excludes the incomes of persons living in the unit but not related to the head of the household.*

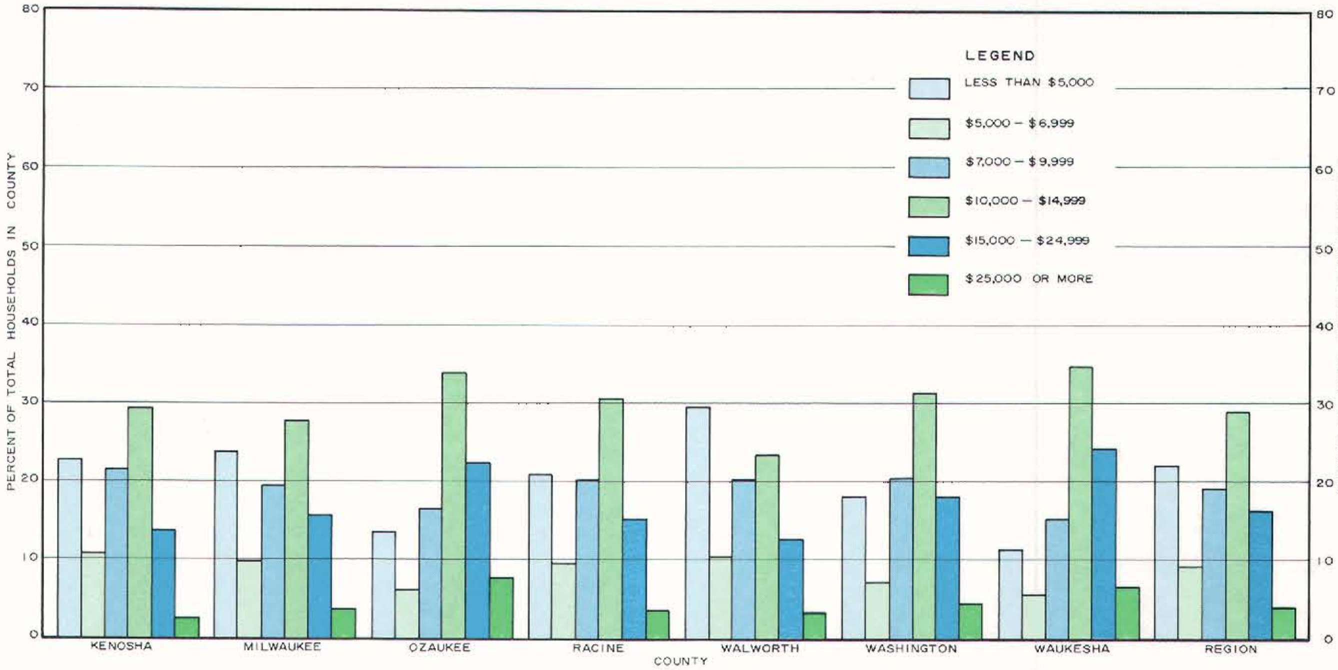
[b] *Percent refers in each citation to percent of total households in county.*

[c] *The median household income is that income which divides the distribution of households into two equal parts, half having a higher income than the median and half having a lower income.*

Source: U. S. Bureau of the Census and SEWRPC.

Figure 8

DISTRIBUTION OF HOUSEHOLDS IN THE REGION BY HOUSEHOLD INCOME BY COUNTY: 1969



Source: U. S. Bureau of the Census and SEWRPC.

THE ECONOMIC BASE

Size of the Economy

Increases in the population of the Region are closely related to increases in the amount of economic activity within the Region. A major indicator of economic activity is the number of jobs available in the Region as reflected in employment levels. In 1975, the total number of jobs available within the Region was 779,000 as shown in Table 9. This is about 41 percent more jobs than were available in the Region in 1950, and closely parallels the 44 percent increase in population over the same time span. While the number of jobs did increase, the civilian labor force—defined as those persons 14 years old and older who are either employed or actively seeking employment, enumerated at their place of residence—increased by an even larger percentage. Between 1950 and 1975 the labor force in the Region grew by 54 percent, compared with more than 52 percent for the State, and almost 60 percent of the nation as a whole, as shown in Figure 9 and Table 10.

Distribution of Economic Activity

More than 66 percent of the economic activity of the Region, as measured by jobs, was located in Milwaukee County in 1975. An additional 15 percent was located in Racine and Kenosha Counties combined. Approximately 81 percent of the regional jobs are, therefore, located in these three counties. The remaining 19 percent of the regional jobs is distributed as follows: Waukesha County, about 10 percent; Walworth County, about 3 percent; Washington County, about 3 percent; and Ozaukee County, about 3 percent (see Table 9).

As further indicated in Table 9, significant changes in the distribution in economic activity within the Region have occurred in the past 25 years. The number of jobs in the Region increased 41 percent, from 552,700 in 1950 to 779,000 in 1975. During the 1950's the number of jobs in the Region increased by 17 percent. The counties which experienced the largest relative job growth rates during the 1950's were Kenosha, Ozaukee, Walworth, Washington, and Waukesha Counties. The growth rates in these counties, which were greater than the regional average, indicate a general shift in economic activity toward the suburban and rural counties of the Region. The exception to this type of shift can be seen in Kenosha County, where job growth was directly related to prosperity in the transportation equipment industry in that county. Conversely, Milwaukee and Racine Counties both experienced job growth from 1950 to 1960 at a lower rate than the regional average, indicating a shift of economic activity out of these areas.

The number of jobs in the Region increased 15 percent from 1960 to 1970. During this period, the largest relative job growth occurred in Ozaukee, Racine, Walworth, Washington, and Waukesha Counties, indicating a further

Table 9

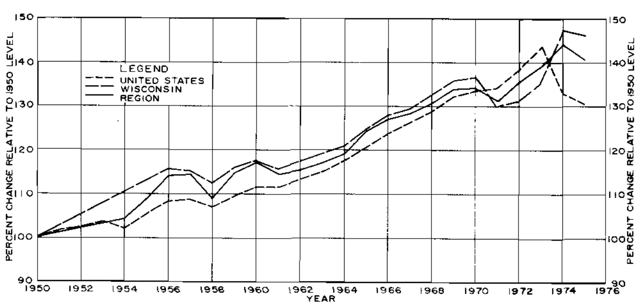
DISTRIBUTION OF JOBS IN THE REGION BY COUNTY: SELECTED YEARS 1950-1975

County	1950		1960		1970		1975		Change							
									1950-1960		1960-1970		1970-1975		1950-1975	
	Jobs	Percent	Jobs	Percent	Jobs	Percent	Jobs	Percent	Jobs	Percent	Jobs	Percent	Jobs	Percent	Jobs	Percent
Kenosha . . .	27,700	5.0	40,100	6.2	39,200	5.3	46,700	6.0	12,400	44.8	- 900	- 2.2	7,500	19.1	19,000	68.6
Milwaukee . .	438,100	79.3	486,200	75.0	510,900	68.9	515,700	66.2	48,100	11.0	24,700	5.1	4,800	0.9	77,600	17.7
Ozaukee . . .	6,200	1.1	9,500	1.5	17,900	2.5	20,200	2.6	3,300	53.2	8,400	33.4	2,300	12.8	14,000	225.8
Racine.	43,200	7.8	48,500	7.5	61,900	8.2	68,600	8.8	5,300	12.3	13,400	27.6	6,700	10.8	25,400	58.8
Walworth. . .	12,300	2.2	18,300	2.8	24,200	3.3	25,700	3.3	6,000	48.8	5,900	32.2	1,500	6.2	13,400	108.9
Washington .	9,700	1.8	14,500	2.2	20,300	2.7	22,600	2.9	4,800	49.5	5,800	40.0	2,300	11.3	12,900	133.0
Waukesha. . .	15,500	2.8	30,800	4.8	67,200	9.1	79,500	10.2	15,300	98.7	36,400	118.2	12,300	18.3	64,000	412.9
Region	552,700	100.0	647,900	100.0	741,600	100.0	779,000	100.0	95,200	17.2	93,700	14.5	37,400	5.0	226,300	40.9

Source: Wisconsin Department of Industry, Labor, and Human Relations and SEWRPC.

Figure 9

RELATIVE JOB GROWTH IN THE REGION, WISCONSIN, AND THE UNITED STATES: 1950-1970



Source: Wisconsin Department of Industry, Labor, and Human Relations; U. S. Department of Labor; and SEWRPC.

shift in economic activity toward the suburban and rural areas of the Region and away from the urban areas. These shifts are a continuation of the economic activity location trends identified in the initial economic studies of the Commission.[4]

Employment in the individual watersheds that comprise the Region ranged in 1972 from a low of 754 persons employed in the Sheboygan River watershed to a high of 271,830 persons employed in the Milwaukee River watershed, as shown in Table 11. The two largest watersheds in terms of total employment are the Milwaukee and the Menomonee River watersheds. These two watersheds combined contained 59 percent of the jobs in the Region in 1972, and represent a major concentration of economic activity within the Region.

Structure of the Economy

The character of the regional economy can best be described in terms of its industrial structure, since the number and types of industry are related to water quality management needs. In this regard, economic activity within the Region can be classified into nine major industry groups: agriculture; mining; construction; manufacturing; transportation, communication, and utilities; trade; finance, insurance, and real estate; services; and government.

Economic activity within the Region is heavily concentrated in manufacturing (see Figure 10). In 1975, approximately 32 percent of the total jobs in the Region was in manufacturing compared to 23 percent nationally. The proportion of economic activity in all other industry groups within the Region except private services, as measured by jobs, was less than the national averages.

The structure of economic activity within manufacturing is also quite different from the structure of the manufacturing industry nationally (see Figure 11). In contrast to the manufacturing industry of the United States, the manufacturing industry in the Region is more heavily concentrated in the production of durable goods, particularly machinery, and electrical equipment. In 1975, about 42 percent of the total manufacturing jobs within the Region was in these industries compared to about 20 percent nationally. Compared to the national distribution, there is also a high concentration of fabricated metal product manufacturing activities. On the other hand, there is a relatively low concentration of activity associated with the production of nondurable goods such as textile, apparel, leather, paper, wood, chemical, petroleum, rubber, and plastic products.

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[4] *The results of this work were published in SEWRPC Planning Report No. 3, The Economy of Southeastern Wisconsin, June 1963; and SEWRPC Planning Report No. 7, Volume 2, Forecasts and Alternative Plans—1990, June 1966.*

Table 10

LABOR FORCE TRENDS IN THE UNITED STATES, WISCONSIN, AND THE REGION BY COUNTY: SELECTED YEARS 1950-1975

County	Labor Force				Change 1950-1960		Change 1960-1970		Change 1970-1975		Change 1950-1975	
	1950	1960	1970	1975	Absolute	Percent	Absolute	Percent	Absolute	Percent	Absolute	Percent
Kenosha	32,600	39,800	47,700	58,800	7,200	22.1	7,900	19.8	11,100	23.3	26,200	80.4
Milwaukee	386,500	433,100	458,600	491,500	46,600	12.1	25,500	5.9	32,900	7.2	105,000	27.2
Ozaukee	9,600	14,400	22,400	27,100	4,800	50.0	8,000	55.5	4,700	21.4	17,500	182.3
Racine	46,800	55,000	69,300	78,800	8,200	17.5	14,300	26.0	9,500	13.7	32,000	68.4
Walworth	16,500	20,500	26,800	29,100	4,000	24.2	6,300	30.7	2,300	8.6	12,600	76.4
Washington	14,300	17,400	26,100	31,600	3,100	21.7	8,700	50.0	5,500	21.1	17,300	121.0
Waukesha	33,800	58,500	93,600	114,600	24,700	73.1	35,100	60.0	21,000	22.4	80,800	239.0
Region	540,100	638,700	744,500	831,500	98,600	18.3	105,800	16.6	87,000	11.7	291,400	54.0
Wisconsin	1,396,400	1,533,000	1,799,300	2,128,000	136,600	9.8	266,300	17.4	328,700	18.3	731,600	52.4
United States	59,304,000	68,144,000	82,897,000	94,773,000	8,840,000	14.9	14,753,000	21.6	11,876,000	14.3	35,469,000	59.9

Source: U. S. Department of Labor, Bureau of Labor Statistics; Wisconsin Department of Industry, Labor, and Human Relations; and SEWRPC.

Table 11

1972 EMPLOYMENT BY WATERSHED FOR THE REGION

Watershed	Employment	
	Jobs	Percent
Des Plaines	2,317	0.3
Fox	59,647	8.0
Kinnickinnic	76,957	10.3
Menomonee	170,615	22.8
Milwaukee	271,830	36.3
Oak Creek	9,277	1.2
Pike	10,405	1.4
Rock	26,092	3.5
Root	38,298	5.1
Sauk	3,798	0.5
Sheboygan	754	0.1
Minor Tributaries Draining to Lake Michigan	78,966	10.5
Total	748,956	100.0

Source: SEWRPC.

LAND USE BASE

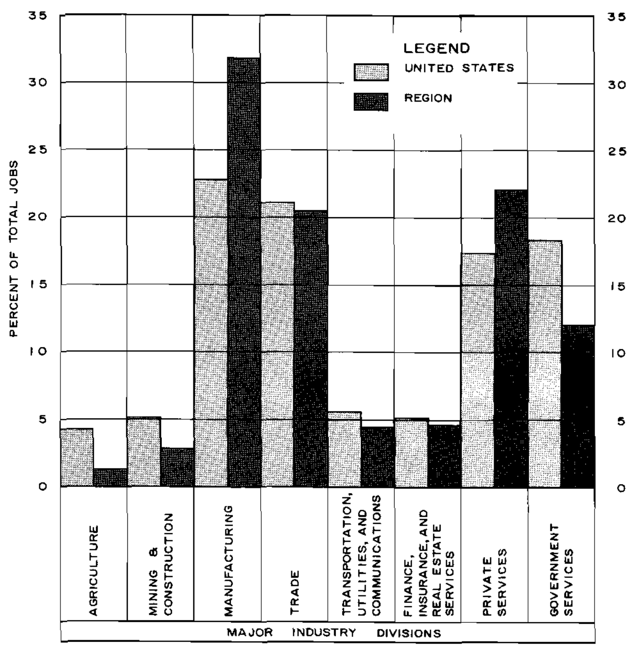
One of the central concepts underlying the areawide water quality management planning program is that land use and water quality are inextricably interrelated. An understanding of the amount, type, intensity, and spatial distribution of urban and rural land uses within the Region is therefore essential to any water quality management planning effort. Furthermore, such an understanding of existing land use patterns, and of trends in such patterns, is important to the sound formulation of a plan to meet the identified water quality management needs. Accordingly, attention is focused herein upon historic as well as existing land use development patterns.

Historic Growth Patterns

The first permanent European settlement in the Region was established in 1795 as a trading post on the east side of the Milwaukee River, just north of what is now Wisconsin Avenue in the City of Milwaukee. The origins of most of the other major cities and villages within the Region can be traced to the establishment of certain types of agricultural services such as saw and grist mills. The location of these earliest urban activities was heavily influenced by water power and water transportation needs. The rapid settlement by Europeans of what is now the Southeastern Wisconsin Region had its beginning following the Indian cessions of 1829 and 1833, which transferred to the federal government ownership of all of the lands that now comprise the State of Wisconsin south of the Fox River and east of the Wisconsin River. After the close of the Blackhawk War of 1832, federal land surveyors began to survey, subdivide, and monument the federal lands and by 1836 the U. S. Public Land Survey had been completed within the Region. The subsequent sale of the public lands brought many settlers from New England, Germany, Austria, and Scandinavia. Initial urban development occurred along the Lake Michigan shoreline at the ports of Milwaukee, Port Washington, Racine, and Southport (now Kenosha), as these settlements were more directly accessible to immigration from the east coast through the Erie Canal-Great Lakes transportation route. By 1850, there were more than 113,000 people in the Region, and the accompanying historic development map indicates that many scattered urban developments existed in the Region at the time (see Map 6).

Figure 10

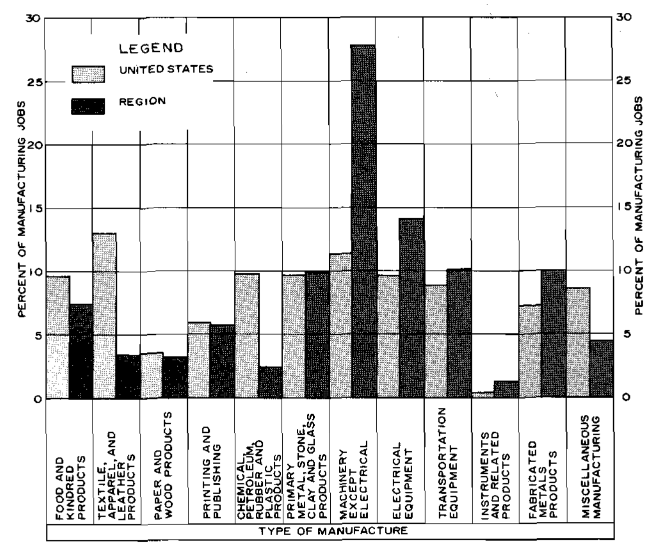
PERCENTAGE DISTRIBUTION OF JOBS BY MAJOR STANDARD INDUSTRIAL CLASSIFICATION (S.I.C.) DIVISIONS IN THE UNITED STATES AND THE REGION: 1975



Source: U. S. Department of Labor; Wisconsin Department of Industry, Labor, and Human Relations; and SEWRPC.

Figure 11

PERCENTAGE DISTRIBUTION OF MANUFACTURING JOBS BY TYPE OF MANUFACTURING IN THE UNITED STATES AND THE REGION: 1975



Source: U. S. Department of Commerce, Bureau of Economic Analysis; Wisconsin Department of Industry, Labor, and Human Relations; and SEWRPC.

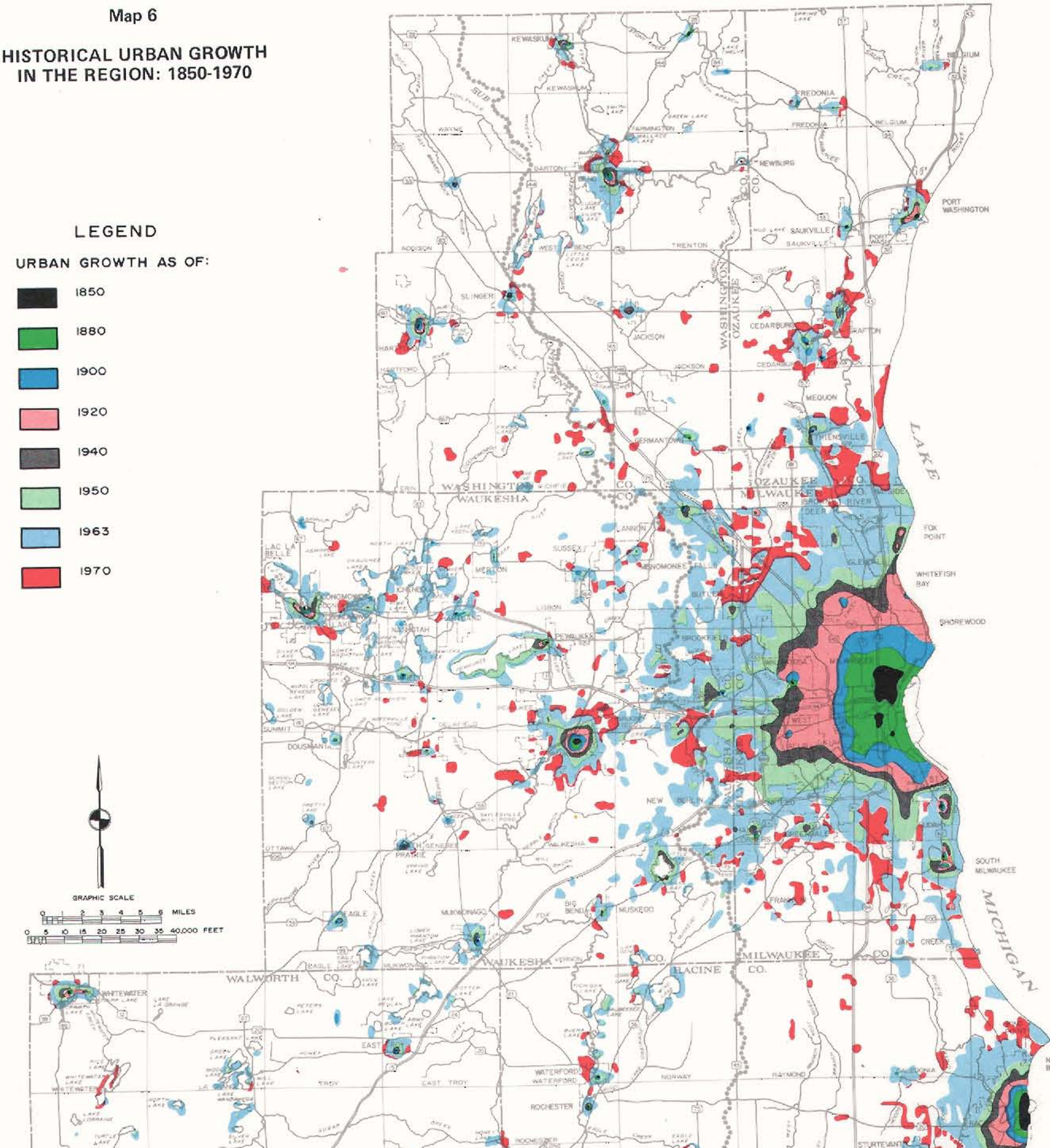
Changes over time in the amount of land devoted to urban use within the Region are indicated in Table 12. The amount of land devoted to urban development within the Region has increased steadily since 1850. Over the 100-year period extending from 1850 to 1950, urban development within the Region occurred in relatively tight, concentric rings outward from the established urban centers of the Region, a pattern resembling the annual growth rings of a tree. A very dramatic change in the pattern of urban development within the Region, however, occurred in about 1950. From 1950 to 1963, while the regional population increased by about 35 percent, the amount of land devoted to urban use increased by almost 150 percent, or by about 202 square miles. Urban development became discontinuous and highly diffused, the term "urban sprawl" being quite descriptive of this more recent pattern of urban development within the Region. This pattern continued from 1963 to 1970, during which period an additional 57 square miles of land were converted from rural to urban use within the Region. Under this type of urbanization, the entire seven-county Region is becoming a single mixed rural-urban land use complex. Many once isolated and independent communities are growing together, and urban development is spilling over the subcontinental divide, which traverses the Region, into the Fox-Illinois River Valley. Map 6 indicates that much of the dispersed urban development is being attracted by the prime recreational resources of the Region, clustering around the many inland lakes within the Region, spreading out along the Lake Michigan shoreline, and intruding into the riverine areas of the streams and watercourses and into the Kettle Moraine Forest areas of the Region.

Historic Density Trends

The changes in population density within the Region from 1850 to 1970 are shown in Table 13. During this 120-year period, the population of the Region increased nearly 15-fold, from 113,400 persons to 1,756,100 persons, while the amount of land devoted to urban use increased almost 100-fold, from four square miles to 397 square miles. Overall population densities within the Region increased steadily from 42 persons per square mile in 1850 to 653 persons per square mile in 1970. Overall population densities within the developed urban area of the Region, however, have exhibited a quite different trend. Such population densities increased steadily from 7,156 persons per square mile in 1850 to a peak of 11,346 persons per square mile in 1920. Urban population densities then began a steady decline to a level of 8,544 persons per square mile in 1950. After 1950, urban population densities declined even more sharply to 4,807 persons per square mile in 1963, and continued to decline to 4,355 persons per square mile

Map 6

HISTORICAL URBAN GROWTH IN THE REGION: 1850-1970



Urban development within the Region occurred in a fairly regular pattern until about 1950, forming concentric rings of relatively high-density urban development contiguous to, and outward from, the existing urban areas and long-established mass transit, utility, and community facility systems. Soon after World War II, however, the character of urban growth in the Region began to change to a much more diffused pattern of development, with relatively low densities and high proliferation of clusters of noncontiguous development. Between 1963 and 1970, this sprawl pattern of development continued with an additional 96 square miles of land committed to urban use within the Region over the period, representing a rate of approximately 14 square miles per year. The continuation of this sprawl pattern of land use development threatens further destruction of prime agricultural lands and of the underlying and sustaining natural resource base, and the creation of urban enclaves in essentially rural areas that will be difficult to serve economically, if at all, with necessary public utilities and services.

Source: SEWRPC.

Table 12

LAND DEVOTED TO URBAN LAND USE IN THE REGION

County	Urban/ Nonurban Status	1963		1970		Change: 1963-1970	
		Acres	Percent of County	Acres	Percent of County	Acres	Percent
Kenosha	Urban[a]	24,899	14.0	27,715	15.6	2,816	11.3
	Nonurban[b]. . . .	153,199	86.0	150,385	84.4	- 2,814	- 1.8
	Total	178,098	100.0	178,100	100.0	2[c]	--[d]
Milwaukee	Urban	96,857	62.5	106,251	68.5	9,394	9.7
	Nonurban	58,139	37.5	48,813	31.5	- 9,326	- 16.0
	Total	154,996	100.0	155,064	100.0	68[c]	--[d]
Ozaukee	Urban	19,078	12.7	23,746	15.8	4,668	24.5
	Nonurban	130,935	87.3	126,267	84.2	- 4,668	- 3.6
	Total	150,013	100.0	150,013	100.0	--	--
Racine	Urban	29,821	13.7	35,070	16.1	5,249	17.6
	Nonurban	187,725	86.3	182,491	83.9	- 5,234	- 2.8
	Total	217,546	100.0	217,561	100.0	15[c]	--[d]
Walworth	Urban	27,948	7.6	32,315	8.7	4,367	15.6
	Nonurban	342,034	92.4	337,667	91.3	- 4,367	- 1.3
	Total	369,982	100.0	369,982	100.0	--	--
Washington	Urban	20,408	7.3	26,127	9.4	5,719	28.0
	Nonurban	258,326	92.7	252,607	90.6	- 5,719	- 2.2
	Total	278,734	100.0	278,734	100.0	--	--
Waukesha	Urban	61,214	16.5	76,619	20.6	15,405	25.2
	Nonurban	310,432	83.5	295,027	79.4	- 15,405	- 5.0
	Total	371,646	100.0	371,646	100.0	--	--
Region	Urban	280,225	16.3	327,843	19.0	47,618	17.0
	Nonurban	1,440,790	83.7	1,393,257	81.0	- 47,533	- 3.3
	Total	1,721,015	100.0	1,721,100	100.0	85[c]	--[d]

[a] *Includes residential; commercial; manufacturing, wholesaling, and storage; transportation, communication, utilities, and off-street parking; governmental and institutional; and active recreational land uses.*

[b] *Includes agricultural lands, woodlands, water and wetlands, and unused and other open lands, including quarries.*

[c] *Increases due to landfill operations along Lake Michigan.*

[d] *Less than 0.1 percent.*

Source: SEWRPC.

Table 13

POPULATION DENSITY TRENDS IN THE REGION: 1850-1970

Year	Urban Population		Rural Population		Total Population	Area (Square Miles)		Persons Per Square Mile	
	Number	Percent of Total	Number	Percent of Total		Urban	Total	Urban	Total
1850	28,623	25.2	84,766	74.8	113,389	4	2,689	7,155.8	42.2
1880	139,509	50.3	137,610	49.7	277,119	18	2,689	7,750.5	103.1
1900	354,082	70.6	147,726	29.4	501,808	37	2,689	9,569.8	186.6
1920	635,376	81.1	148,305	18.9	783,681	56	2,689	11,346.0	291.4
1940[a]	991,535	92.9	76,164	7.1	1,067,699	90	2,689	11,017.1	397.1
1950[a]	1,179,084	95.0	61,534	5.0	1,240,618	138	2,689	8,544.1	461.4
1963[a]	1,634,200	97.6	40,100	2.4	1,674,300	340	2,689	4,806.5	622.6
1970[a]	1,728,949	98.5	27,137	1.5	1,756,086	397	2,689	4,355.0	653.1

[a] *The "rural-nonfarm" population is included in the urban total.*

Source: U. S. Bureau of the Census and SEWRPC.

in 1970. It should be noted, however, that although overall population densities within the developed urban areas of the Region have been steadily declining since 1920, this decline has been accompanied by localized increases in population densities. Such localized population increases have been the result of urban renewal activities or, in isolated instances, of what in effect constitutes new community development. For example, the Northridge Lakes community development within the northwestern portion of the City of Milwaukee will have population densities of about 15,000 persons per square mile when fully developed. Similarly, the redevelopment of certain older residential areas of the central cities and older suburbs within the Region, which replaces residential development of single-family homes, duplexes, and flats with apartment development—often high-rise apartment development—may result in population density increases in localized areas. With respect to overall population densities within the Region, however, such high-density development and redevelopment is offset by large areas of new suburban and exurban development which, even when it involves apartment projects, has overall a relatively low urban population density. This continued overall decline in urban population density, although accompanied by localized increases, has important implications for the provision of many public facilities and services, including the provision of sewerage and other water quality management-related facilities, and complicates the planning and design for such facilities.

Existing Land Use

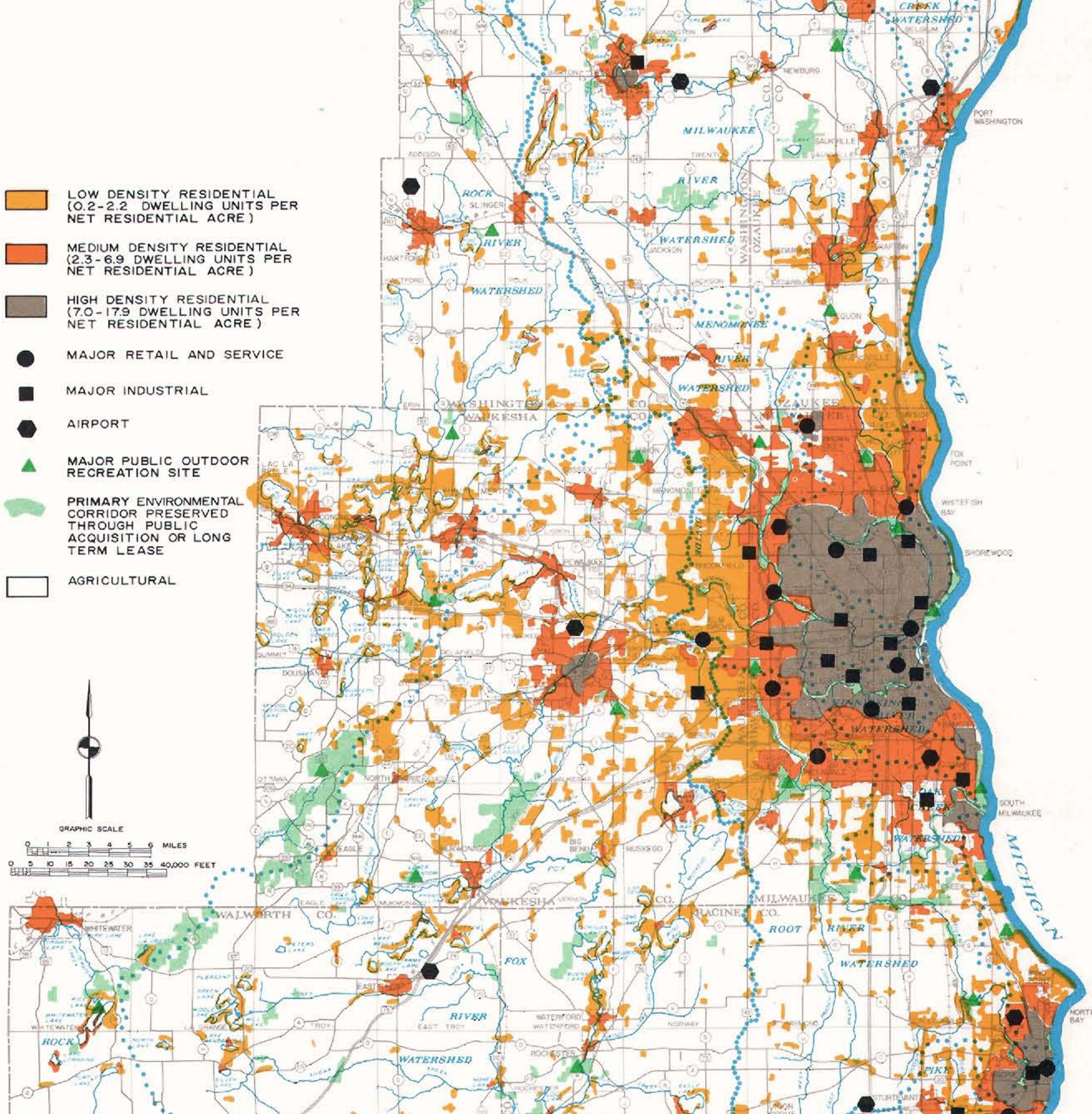
The spatial distribution of land uses existing within the Region as of 1975 is summarized graphically on Map 7. This map provides a picture of existing regional development at a given point in time, and its study can provide certain valuable insights into an understanding of regional activity and development and of the areawide problems related thereto. The absolute and proportional areas presently devoted to each major land use category within the Region are summarized by county in Table 14.

In 1970, as part of its continuing land use and transportation planning program, the Commission conducted a detailed inventory of the location and extent of land devoted to 41 specific land use categories. This inventory provided quantification—at the level of the U. S. Public Land Survey one-quarter section—of these land use categories. Since only a 5 percent increase in the amount of developed urban land has occurred since 1970, the 1970 data still provide a valid characterization of the basic urban-rural structure of the Region as of 1975. Accordingly, the 1970 data are presented here for general descriptive purposes.

In 1975, a water quality-related land cover inventory of a specialized nature addressing 21 land cover categories of different physical or land management characteristics was undertaken by the Commission. These categories are defined primarily according to their imperviousness and vegetation cover characteristics and their anticipated effects on the quantity and quality of storm water runoff. The categories include golf courses and other recreation-related uses; croplands including row crops, grain crops, vegetables, hay, orchards, nurseries, and sod farms; woodlands and other open space; lakes, rivers, streams, and canals; mining; landfills and dumps; freeways, expressways, and other arterial streets; railroad yards and terminals; airfields and terminals; and residential lands and associated land access and collector streets of low, medium, and high imperviousness. The resulting data are reported and utilized by watershed in the inventory of pollution sources analyzed and published in SEWRPC Technical Report No. 21, Sources of Water Pollution in Southeastern Wisconsin: 1975; are reported

Map 7

GENERALIZED EXISTING LAND USE IN THE REGION: 1975



The spatial distribution of land uses existing within the Region as of 1975 is summarized on this map. Although southeastern Wisconsin is a highly urbanized Region, less than 20 percent of its total area is presently devoted to urban-type land uses. As of 1970 agriculture, while declining in economic importance within the Region, still occupied 60 percent of the total land area within the Region, with the remaining 20 percent of the area occupied by water, wetlands, and woodlands. The diffusion of low-density urban development which has occurred within the Region since 1950 is evident from an examination of the map. While some of these areas currently shown as low-density development may eventually through additional development become medium-density, many of these areas are scattered far from the existing and proposed service areas of public utility systems. They represent, therefore, a permanent commitment to urban development without centralized public sanitary sewer and water supply services. It is important that future urban development within the Region be encouraged to occur in those areas recommended for such development in the adopted regional land use plan so that essential public utility services can be provided in an efficient and economical manner.

Source: SEWRPC.

Table 14

DISTRIBUTION OF LAND USE IN THE SOUTHEASTERN WISCONSIN REGION BY COUNTY: 1970

County	Land Use									
	Residential[a]	Commercial	Industrial[b]	Transportation[c]	Government[d]	Recreation	Water and Wetlands	Open Lands[e]	Agricultural	Total
Kenosha										
Acres . . .	13,477	504	811	8,927	1,324	2,672	19,445	17,010	113,930	178,100
Percent . .	7.6	0.3	0.5	5.0	0.7	1.5	10.9	9.5	64.0	100.0
Milwaukee										
Acres . . .	45,632	2,875	4,899	35,431	7,490	9,924	4,207	15,999	28,607	155,064
Percent . .	29.4	1.9	3.2	22.9	4.8	6.4	2.7	10.3	18.4	100.0
Ozaukee										
Acres . . .	12,321	330	444	8,054	940	1,657	14,879	10,897	100,491	150,013
Percent . .	8.2	0.2	0.3	5.4	0.6	1.1	9.9	7.3	67.0	100.0
Racine										
Acres . . .	16,625	575	1,099	12,442	1,744	2,585	17,712	17,572	147,207	217,561
Percent . .	7.6	0.3	0.5	5.7	0.8	1.2	8.1	8.1	67.7	100.0
Walworth										
Acres . . .	13,408	593	827	12,020	1,192	4,275	39,160	36,763	261,744	369,982
Percent . .	3.6	0.2	0.2	3.3	0.3	1.2	10.6	9.9	70.7	100.0
Washington										
Acres . . .	11,525	299	434	11,286	919	1,664	35,638	30,503	186,466	278,734
Percent . .	4.1	0.1	0.2	4.1	0.3	0.6	12.8	10.9	66.9	100.0
Waukesha										
Acres . . .	43,278	1,341	1,525	21,247	3,009	6,219	49,789	43,562	201,676	371,646
Percent . .	11.6	0.4	0.4	5.7	0.8	1.7	13.4	11.7	54.3	100.0
Region										
Acres . . .	156,266	6,517	10,039	109,407	16,618	28,996	180,830	172,306	1,040,121	1,721,100
Percent . .	9.1	0.4	0.6	6.3	1.0	1.7	10.5	10.0	60.4	100.0

[a] *Includes all residential areas, developed and under development.*

[b] *Includes all manufacturing, wholesale, and storage.*

[c] *Includes off-street parking of more than 10 spaces.*

[d] *Includes institutional uses.*

[e] *Includes woodlands, unused lands, and quarries.*

Source: SEWRPC.

in summary form in Volume One, Chapter V of this report; and were applied to characterize the tributary land surface in the hydrologic-hydraulic-water quality simulation model used as the key analytical tool in this report. The traditional SEWRPC land use inventory is also being completed for 1975 to provide a basis for the monitoring of land use plan implementation and for trend analysis, and to support the Commission's other work programs. As these data are assembled for portions of the Region, they will be held available in the Commission files for use by local units of government and private investors.

Although southeastern Wisconsin is a highly urbanized Region, less than 20 percent of its total area is presently devoted to urban-type land uses. The largest land use category within the Region is still agriculture, which presently occupies about 60 percent of the total area of the Region. The next largest land use categories are water and wetlands, which occupy about 10 percent of the total area, and woodlands and open lands, which occupy another 10 percent of the total area of the Region. Therefore, more than 80 percent of the Region is presently devoted to agriculture, woodlands, wetlands, other open lands, and surface waters.

The single "urban" type land use occupying the greatest area is residential, which presently accounts for about 9 percent of the total area of the Region. A close second is the category of transportation, utilities, and communications, which accounts for about 6 percent of the total area. The very small amount and proportion of land presently devoted to the urban economic activities, which are so important to the support of regional growth and development, are both surprising and significant. The total land area presently devoted to commercial, manufacturing, and wholesaling functions within the Region (minus onsite parking) amounts to only 16,556 acres, or 1 percent or the total land area, yet this small area provides the basis for more than 212,900 commercial, 252,100 manufacturing, and 32,000 wholesale jobs, or in all about two-thirds of the total jobs in the Region.

Residential: The residential land use category includes and identifies both land actually occupied by a residence of some kind and vacant land which was either under development for residential use or immediately available for such use in 1975. "Vacant land," as used in the inventory, includes vacant building sites between existing residences and improved but still vacant residential subdivisions.

At the time of the 1970 land use inventory, there were 156,280 acres of residential land in the Region, or about 9 percent of the regional total. Table 15 details the amounts and relative proportions of land devoted to the different types of residential use. The largest land consumer in this group is the single-family detached residence, which occupies about 78 percent of the total residential land area in the Region. Lands under residential development accounted for about 16 percent of the total, while two-family residences accounted for about 4 percent of the total. Mobile homes and multifamily residences combined consumed approximately 2 percent of the total residential land in the Region.

Commercial: The commercial land use category includes all retail and service-type commercial uses, including both local and regional shopping centers, highway-oriented commercial areas, and professional and executive offices, but excluding onsite parking of more than 10 spaces. There are presently 6,517 acres of land, or less than 1 percent of the regional total, devoted to this land use category.

Table 15

RESIDENTIAL LAND USE IN THE REGION BY TYPE: 1970

Type of Residential Use	Acres	Percent
Single-family	122,521	78.4
Two-family	5,574	3.6
Multifamily (less than 4 stories)	2,969	1.9
Multifamily (4 or more stories)	118	0.1
Mobile Homes	515	0.3
Residential Land Under Development	24,584	15.7
Total	156,281	100.0

Source: SEWRPC.

Industrial: This land use category includes all manufacturing activities, wholesaling offices, warehouses, and storage yards but excludes onsite parking of more than 10 spaces. There are presently 10,039 acres of land, or less than 1 percent of the regional total, devoted to this land use category.

Transportation, Communication, and Utility: The transportation, communication, and utility land use category includes all street and highway rights-of-way; railroad rights-of-way and yards; airport, rail, ship, bus, and truck terminals; communications facilities such as radio or television stations and transmission towers; utility rights-of-way and plants, such as sewage disposal and water treatment and storage facilities; and all off-street parking areas containing more than 10 parking spaces. There are presently 109,453 acres of land, or about 6 percent of the regional total, devoted to this land use category.

Government and Institutional: The land areas devoted to governmental and institutional uses are classified according to local or regional service orientation. If the service emphasis of a governmental or institutional use is oriented toward more than one community it is classified as regional. If such service emphasis is oriented toward a single community or neighborhood, except for high schools in the City of Milwaukee, it is classified as local. Regional uses include colleges and universities, high schools, large central libraries, museums, hospitals, nursing homes, county courthouses, welfare agencies, military installations, and others. Local uses include elementary schools, churches, branch libraries, and fire stations, as well as city, village, and town halls. At the time of the land use inventory in 1970, 16,773 acres of land in southeastern Wisconsin were devoted to governmental and institutional uses, representing 1 percent of the total area of the Region. Government and institutional land with a local service orientation comprised 5,479 acres, or 32.7 percent of this category; the large balance of government and institutional land had a regional orientation.

Recreation: The active recreational land use category includes lands actually devoted to recreational uses such as playgrounds, parks, golf courses, zoos, campgrounds, picnic areas, marinas, and others. In conducting land use inventories, all recreational facilities were further classified as public and nonpublic. The 1970 land use inventory reported a total of 32,420 acres of active recreational lands in southeastern Wisconsin, representing 1.9 percent of the total area of the Region. Public recreational areas comprised 15,806 acres, or 48.8 percent of this total, while the balance of the active recreational areas in the Region was privately owned.

Woodlands and Open Lands: This land use category includes all land areas presently containing trees or heavy brush; lands which are not presently devoted to urban use, cropped, or grazed; land areas presently devoted to such temporary uses as open pits for trash or garbage disposal; and quarries either operating or nonoperating. There are presently 170,105 acres of land, or nearly 10 percent of the regional total, devoted to this land use category. Approximately 73 percent of this area is devoted to woodlands, with most of the remaining area, 22 percent, classified as unused land. Only 5 percent, or 8,348 acres, is classified as quarries or pits.

Water and Wetlands: The water and wetland use category includes all inland lakes excluding Lake Michigan; all streams, rivers, and canals more than 50 feet in width; and open lands which are intermittently covered with water or which are wet due to a high water table. Presently there are 179,877 acres of water and wetland areas in the Region, or about 10 percent of the regional total.

Agricultural: The agricultural land use category includes all croplands, pasturelands, orchards, nurseries, and fowl and fur farms. Farm dwelling sites were classified as residential land and assigned a site area of 20,000 square feet. All other farm buildings were included in the agricultural land use category. Agriculture is the singularly largest land use in the Region, and about 60 percent of the total area of the Region, or 1,039,636 acres, is devoted to this use.

Land Use by Watershed

As set forth in Table 16, a wide distribution of land use mixes is found within the 12 watersheds of the Region. Although agriculture at 60.4 percent comprises the largest single land use in the Region, the proportion of land used for agricultural purposes varies from 2 percent in the Kinnickinnic River watershed to 83 percent in the Sauk Creek and Sheboygan River watersheds. Similarly, water and wetlands vary from 1 percent in the Kinnickinnic River watershed to 13 percent in the Fox and Rock River watersheds. Open lands vary from 4.7 percent in the Sauk Creek watershed to 14.7 percent in the Oak Creek watershed. Based on the proportions of the watershed areas devoted to urban land uses—i.e., all land uses other than agricultural, open lands, and water and wetlands—the most urban watersheds in 1970, ranked in declining order, were the Kinnickinnic River watershed with 14,606 acres, or about 89 percent urban; the Menomonee River watershed with about 45,872 acres, or about 53 percent urban; the minor streams tributary to the Lake Michigan watershed with about 32,215 acres, or about 51 percent urban; the Oak Creek watershed with 7,524 acres, or about 43.6 percent urban; the

Table 16

DISTRIBUTION OF LAND USE IN THE SOUTHEASTERN WISCONSIN REGION BY WATERSHED: 1970

Watershed		Land Use									
		Residential[a]	Commercial	Industrial[b]	Transportation[c]	Government[d]	Recreation	Water and Wetlands	Open Lands[e]	Agricultural	Total
Des Plaines	Acres	3,259.25	72.41	72.41	3,502.09	255.86	568.20	8,363.07	5,999.83	63,900.27	85,993.39
	Percent . . .	3.8	0.1	0.1	4.0	0.3	0.7	10.0	7.0	74.0	100.0
Fox	Acres	39,216.57	1,211.43	1,718.54	26,065.73	2,768.34	8,821.15	77,800.11	68,453.53	373,212.81	599,268.21
	Percent . . .	7.0	0.2	0.3	4.0	0.5	2.0	13.0	11.0	62.0	100.0
Kinnickinnic	Acres	5,408.27	453.24	895.00	5,844.00	1,173.30	831.74	195.50	1,352.79	246.66	16,400.59
	Percent . . .	33.0	3.0	5.0	36.0	7.0	5.0	1.0	8.0	2.0	100.0
Menomonee	Acres	21,691.70	1,134.95	1,966.67	14,175.47	3,256.04	3,647.31	2,840.81	9,168.46	28,920.44	86,801.85
	Percent . . .	25.0	1.4	2.3	16.3	3.8	4.2	3.3	10.7	33.0	100.0
Milwaukee	Acres	28,806.90	1,366.17	1,967.73	21,505.06	3,360.58	4,517.23	32,965.16	26,117.61	155,782.42	276,388.86
	Percent . . .	10.4	0.5	0.8	7.8	1.2	1.6	11.9	9.4	56.4	100.0
Minor Streams	Acres	16,421.19	700.91	1,535.76	7,746.17	2,285.18	2,125.54	1,545.81	5,866.14	22,522.43	60,749.13
	Percent . . .	27.0	1.2	2.5	12.8	3.8	3.5	2.5	9.7	37.0	100.0
Oak Creek	Acres	3,236.71	170.81	350.03	2,651.91	540.36	574.38	507.93	2,534.46	6,696.38	17,262.97
	Percent . . .	18.7	1.0	2.1	15.4	3.1	3.3	2.9	14.7	38.8	100.0
Pike River	Acres	3,244.04	82.17	326.41	2,141.35	616.80	809.42	828.05	1,938.80	22,443.10	32,430.14
	Percent . . .	10.0	0.3	1.0	6.6	1.9	2.6	2.6	6.0	69.0	100.0
Rock River	Acres	18,451.96	582.74	681.28	13,519.93	1,613.28	3,399.46	49,557.68	39,822.67	264,016.61	391,645.61
	Percent . . .	5.0	0.1	0.2	3.4	0.4	0.9	13.0	10.0	67.0	100.0
Root River	Acres	15,725.95	711.59	429.97	10,229.44	1,473.53	3,492.92	5,468.91	9,387.85	78,415.06	125,335.22
	Percent . . .	12.5	0.6	0.3	8.2	1.2	2.8	4.4	7.5	62.5	100.0
Sauk Creek	Acres	673.72	26.90	75.68	1,162.96	120.91	9.57	615.67	1,039.70	18,335.84	22,060.95
	Percent . . .	3.1	0.2	0.3	5.3	0.5	0.1	2.8	4.7	83.0	100.0
Sheboygan River	Acres	125.53	3.53	17.96	212.25	18.61	3.95	139.44	614.85	5,626.79	6,762.91
	Percent . . .	1.9	0.1	0.3	3.1	0.3	0.1	2.1	9.1	83.0	100.0
Region	Acres	156,261.79	6,516.85	10,037.44	108,756.36	17,482.79	28,800.87	180,828.14	172,296.69	1,040,118.80	1,721,099.80
	Percent . . .	9.0	0.4	0.6	6.0	1.0	2.0	11.0	10.0	60.0	100.0

[a] *Includes all residential areas, developed and under development.*

[b] *Includes all manufacturing, wholesale, and storage.*

[c] *Includes off street parking of more than 10 spaces.*

[d] *Includes institutional uses.*

[e] *Includes woodlands, unused lands, and quarries.*

Source: SEWRPC.

Root River watershed with 32,063 acres, or about 25.6 percent urban; the Pike River watershed with 7,220 acres, or about 22.4 percent urban; the Milwaukee River watershed with 61,524 acres, or about 22.3 percent urban; the Fox River watershed with 79,802 acres, or about 13 percent urban; the Rock River watershed with 38,249 acres, or about 9.7 percent urban; the Sauk Creek watershed with 2,070 acres, or about 9.4 percent urban; the Des Plaines River watershed with 7,730 acres, or about 9 percent urban; and the least urbanized watershed—the Sheboygan River watershed with 382 acres, about 5.7 percent urban.

PUBLIC UTILITY BASE

Urban development today is highly dependent upon public utility systems which serve individual land uses with power, light, communications, heat, water, and sewerage. How well the Region and its principal parts can sustain urban development depends to a considerable extent upon the location and capacities of the utility facilities. Of particular importance to areawide water quality management planning is the consideration of those utility facilities which are closely linked to the surface and groundwater resources of the Region and which may, therefore, greatly affect the overall quality of the regional environment. This is particularly true of sanitary sewerage, storm water management, and water supply facilities which are, in a sense, modifications of, or extensions to, the natural lake, stream, and watercourse system of the Region, and which may, therefore, influence its quality and ability to support the intended uses. A knowledge of the location and existing service areas of water supply systems, sanitary sewerage systems, and storm water management systems within the Region is essential to areawide water quality management planning.

Most water and sewerage utilities and storm water management facilities in the Region are organized as water and sewer or public works departments of incorporated municipalities, and serve only those areas within the political boundaries of a municipality. Where sanitary districts have been organized, sanitary sewer and water service areas will often tend to be coterminous. Therefore, a general pattern of water and sewer service areas following political boundary lines rather than natural topographic boundaries, such as watershed boundaries, exists within the Region. Similarly, urban storm water management facilities are often constructed only to those limits of political boundaries. The governing bodies of these utilities tend to be concerned primarily, if not solely, with the problems existing within the individual political subdivisions served, rather than with problems affecting the area as a whole and the individual political subdivisions in part. The artificial limitations thus placed on sewerage system and storm water management planning and development at the local level make it extremely difficult to realize the full benefits which may be available from such planning and development.

Sanitary Sewerage Utilities

Virtually all sanitary sewer service within the Region is provided by public agencies. These agencies generally take the form of a commission in the case of utilities providing areawide sewer service, a department in the case of utilities providing sewer service to an incorporated municipality, and a town sanitary or utility district board in the case of utility sewer service to an unincorporated area. Inventories as reported in Volume One, Chapter V of this report indicate that in 1975 there were a total of 95 centralized public sanitary sewerage systems operated by utilities within the Region. These 95 systems serve a total area of about 353 square miles, or about 13 percent of the total area of the Region, and a total population of about 1.54 million persons, or about 86 percent of the total population of the Region. A total of 61 sewage treatment facilities are currently operated by the utilities owning, operating, and maintaining the 95 public sanitary sewerage systems, with many of the utilities contracting with adjacent utilities for sewage treatment purposes. In addition, there are 67 privately owned sewage treatment plants presently in operation within the Region. These generally serve isolated land use enclaves associated primarily with relatively large industrial, commercial, and recreational enterprises. In all, then, there were 128 sewage treatment facilities within the Region in 1975. The existing public sanitary sewerage service areas together with the location of the existing sewage treatment facilities within the Region are shown on Map 8.

Septic Tank System Development: The construction of public sanitary sewerage facilities has not fully kept pace with the rapid urbanization of the Region, and this has been a contributing factor to the widespread use of onsite soil absorption sewage disposal systems. An estimated total of 246,500 persons in the Region, or about 14 percent of the total resident population, rely on such septic tank sewage disposal systems for domestic sewage disposal. About 24,000 of these persons live on farms. The remaining 222,000 persons constitute urban dwellers generally living in scattered fashion throughout the rural and rural-urban fringe area of the Region. An estimated 28 percent of the area presently devoted to urban land uses within the Region is unserved by sanitary sewerage facilities.

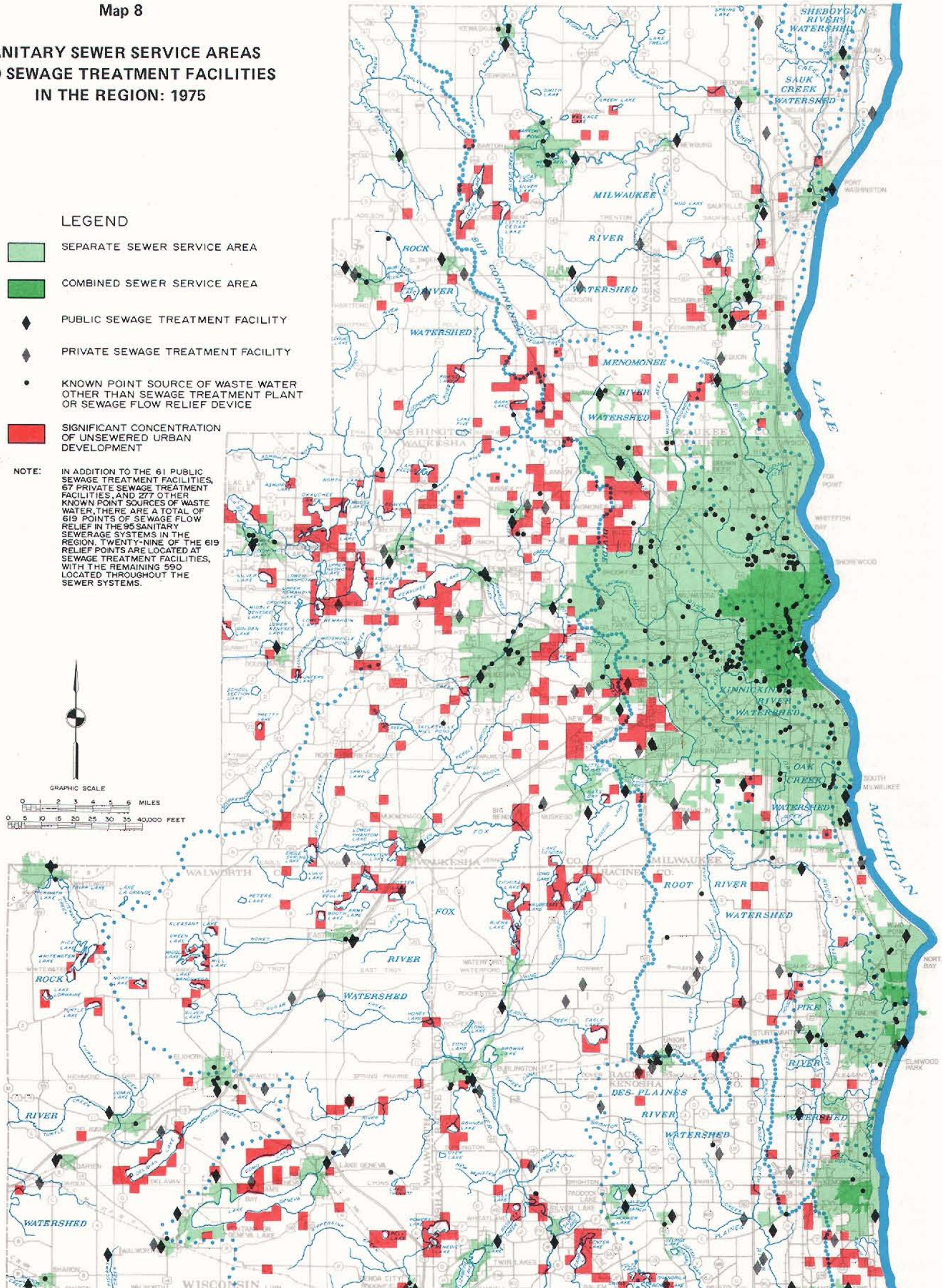
Urban Storm Water Management Systems

The engineered urban storm water management systems of the Region are constructed and maintained by public agencies in the form of commissions, departments of general purpose governments, or urban drainage district boards. In 1975, there were a total of 55 engineered urban storm water management systems within the Region consisting of a combination of piped and channelized drains and in some cases natural drainage channels. Systems mapping was available for such systems in 48 civil divisions. The remaining seven civil divisions are known to operate storm water drainage systems, but could not provide systems mapping.

The systems for which mapping was available, serve a total area of about 183 square miles, or about 7 percent of the total area of the Region, with a total resident population of about 1.50 million persons, or about 84 percent of the total resident population of the Region.

Map 8

SANITARY SEWER SERVICE AREAS AND SEWAGE TREATMENT FACILITIES IN THE REGION: 1975



Centralized public sanitary sewer service in the Region is currently provided by 95 public sewerage systems to an area of about 353 square miles, or 13 percent of the total area of the Region. These 95 systems serve more than 1.5 million persons, or about 86 percent of the total population of the Region. About 27 square miles, primarily located in the central cities of Kenosha, Milwaukee, and Racine, are served by combined storm and sanitary sewers. Treatment for sewage generated in the Region is provided at 61 public sewage treatment facilities, which collectively discharge about 293 million gallons of sewage effluent per day. Of this total, 254 mgd, or 87 percent, are discharged directly to Lake Michigan. There are also 67 sewage treatment facilities serving isolated enclaves of urban land use development, as well as 277 known point sources of wastewater other than sewage treatment plants, which consist primarily of industrial cooling, rinse, process, and wash waters discharged directly to storm sewers or streams. While not shown on this map, there are an additional 590 known points of sewage flow relief in the Region, consisting of combined sewer overflows, relief pumping stations, crossovers from the sanitary to the storm sewer system, and gravity bypasses directly to the streams of the Region. In total, then, there are nearly 1,000 point sources of raw sewage, sewage effluent, and industrial waste discharge throughout the Region.

Source: SEWRPC.

In addition to natural watercourses, improved surface drainageways, and subsurface conduits, these systems are known to include occasional pumping stations, detention-retention basins, and experimental installations for the treatment of combined sewer overflows. The location and extent of existing storm water management systems for which mapping was available within the Region as of 1975 are shown on Map 9.

Water Utilities

Most of the water supply service within the Region is provided by public water utilities. In 1975, there were a total of 72 publicly owned water utilities within the Region (see Table 17). Of these 72 utilities, all but one—the North Shore Water Utility in Milwaukee County—provide retail water service to consumers. The North Shore Water Utility provides wholesale water service only to three other water utilities—the Glendale Water Utility, the Village of Whitefish Bay Water Utility, and the Water Utility of the Village of Fox Point. Together, these 72 publicly owned water utilities serve an area of about 327 square miles, or about 12 percent of the total area of the Region, and about 1.59 million persons, or about 89 percent of the total resident population of the Region. The existing service areas of these 72 publicly owned water utilities as of 1975 are shown on Map 10.

In addition to the publicly owned water utilities, there are 79 known private or cooperatively owned water systems in operation within the Region (see Table 18). Many of these small water systems serve isolated residential enclaves. Some serve summer residents only and suspend operations during cold weather. Very few of these private systems have standby supply or storage facilities, and the great majority do not keep detailed records or file annual reports with state or regulatory bodies. It is anticipated that many of these systems will eventually be absorbed into publicly owned municipal water utilities. The locations of these 79 known privately owned water utilities are also shown on Map 10.

All water supplied by the publicly owned water utilities is drawn either from Lake Michigan or from the two district groundwater aquifers underlying the Region. Treated Lake Michigan water in an amount averaging 322 millions of gallons per day (mgd) was supplied in 1975 to an aggregate service area of about 252 square miles, or about 10 percent of the total area of the Region, and a resident population of about 1.35 million persons, or about 76 percent of the total resident population of the Region. Twenty-one of the 72 public utilities in the Region utilize Lake Michigan as a sole source of supply. Of these 21, seven own and operate water intake and treatment facilities, while 14 purchase water on a wholesale basis. Generally, Lake Michigan offers an unusually good source of supply to those areas lying east of the subcontinental divide and within economic reach of this source of supply.

Well water in an amount averaging about 35 mgd was supplied in 1975 to an aggregate area of about 75 square miles, or about 3 percent of the total area of the Region, and a population of about 235,000 persons, or about 13 percent of the total resident population of the Region. Fifty-one of the public utilities in the Region utilize the groundwater as a source of supply. In general, water service from a municipal utility is, as a matter of local policy, furnished only to property within the municipal limits of that municipality. Only the Cities of Kenosha, Milwaukee, and Racine in the Region provide water service beyond their corporate limits in any substantial amounts.

Gas Utilities

Three gas utilities are authorized to operate within the Region and provide all public gas service therein. The Wisconsin Gas Company is authorized to operate in parts of Milwaukee, Ozaukee, Washington, and Waukesha Counties. The Wisconsin Natural Gas Company is authorized to operate in parts of Kenosha, Milwaukee, Racine, Walworth, and Waukesha Counties. The Wisconsin Southern Gas Company is authorized to operate in parts of Kenosha, Racine, and Walworth Counties. Only in the Towns of Erin and Wayne, both in Washington County, is there no gas utility presently authorized to operate. Natural gas is supplied to the three gas utilities by the Michigan-Wisconsin Pipeline Company and the Natural Gas Pipeline Company of America. Gas service may be considered to be virtually ubiquitous and does not constitute a major constraint on the location and intensity of urban development in the Region.

Electric Utilities

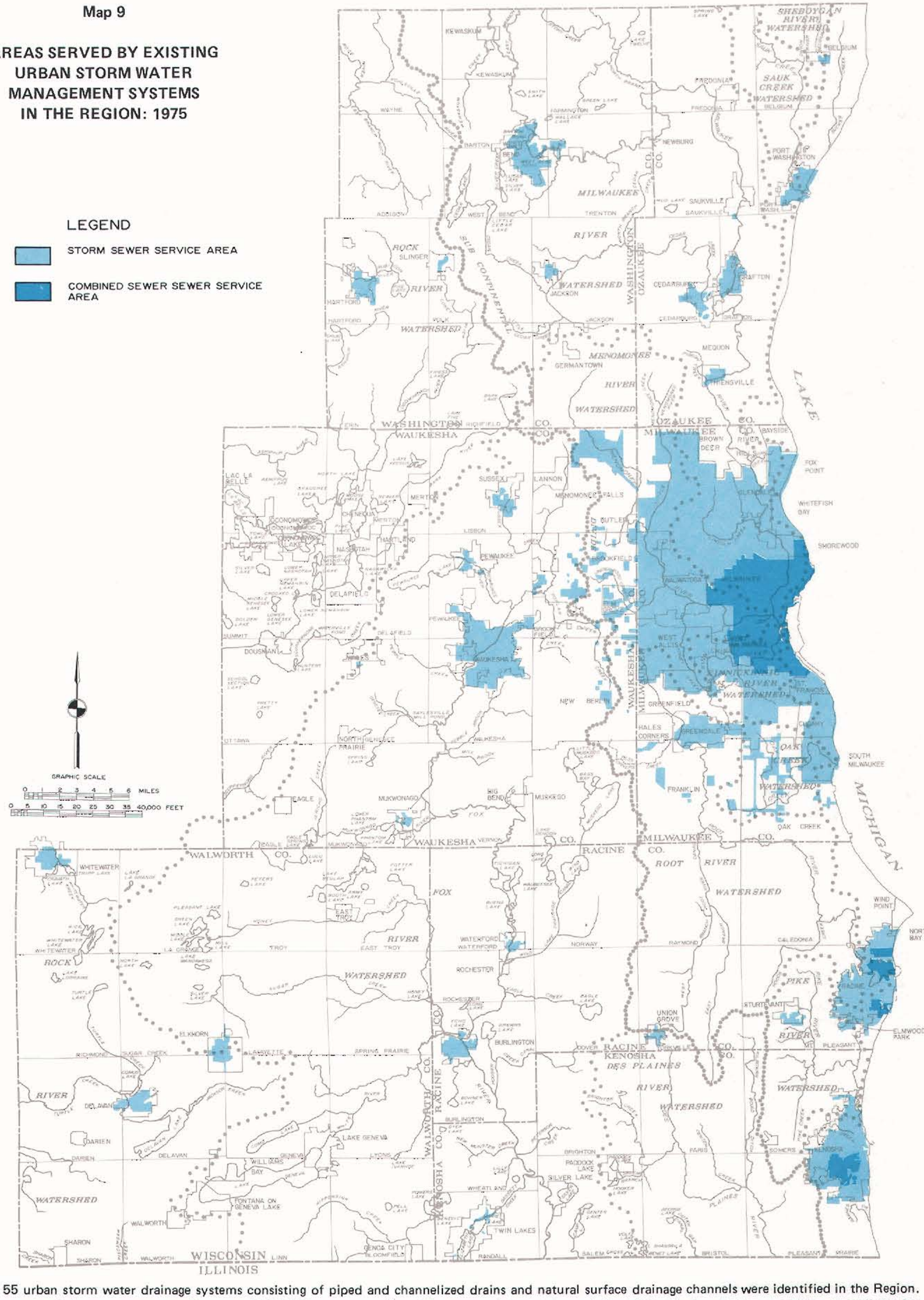
Two major privately owned electric utilities are authorized within the Region which, together with five small municipal utilities, provide service to the entire Region. The Wisconsin Electric Power Company is authorized to operate throughout nearly the entire Region. The Wisconsin Power and Light Company is authorized to operate in parts of Kenosha and Walworth Counties. Municipal electric power utilities are operated by the Cities of Cedarburg, Elkhorn, Hartford, and Oconomowoc, and the Village of Slinger. Generally, an adequate supply of electric power is available throughout the Region. Residential service is available on demand anywhere within the Region, and low voltage lines are in place along virtually every rural highway. Therefore, electric power service, like gas service, may be considered virtually ubiquitous and not a major constraint on the location and intensity of urban development in the Region.

TRANSPORTATION BASE

The extensively developed, all-weather, high-speed highway system within the Region has had a marked influence on the spatial location of urban development. This influence has, however, been significantly modified by the location within the Region of such natural resources as lakes, streams, woodlands, and fertile farmlands. The major arterial street and highway network within the Region, as shown on Map 11, consists of an essentially

Map 9

AREAS SERVED BY EXISTING URBAN STORM WATER MANAGEMENT SYSTEMS IN THE REGION: 1975



A total of 55 urban storm water drainage systems consisting of piped and channelized drains and natural surface drainage channels were identified in the Region. These storm water drainage systems serve just over 1,500,000 persons, or about 84 percent of the total population of the Region. System mapping was available for 48 of these 55 systems. The systems for which mapping was available serve a total area of about 183 square miles, or about 7 percent of the Region and contain 1,358 known outfalls. During periods of wet weather, these storm water drainage systems discharge pollutants to the lakes and streams of the Region. The total runoff discharged from the outfalls in the 48 systems for which mapping was available as they existed in 1975—excluding the combined sewer systems—during an average year was estimated at about 22.9 billion gallons occurring in about 70 discrete events.

Source: SEWRPC.

Table 17

PUBLIC WATER UTILITIES IN THE REGION: 1975

Public Water Utility: Name	Public Water Utility: Location	Area Served (square miles)	Estimated Population Served	Estimated Average Consumption (MGD)
KENOSHA COUNTY				
Kenosha Water Utility[a,b]	City of Kenosha	15.50	87,500	15.355
Paddock Lake Municipal Water Utility	Village of Paddock Lake	0.16	1,100	0.024
Pleasant Park Utility Company, Inc.[c]	Town of Pleasant Prairie - Pleasant Homes Subdivision	0.28	800	0.027
Pleasant Prairie Water Works[c]	Unincorporated Village of Pleasant Prairie	0.26	400	0.111
Sanitary District No. 1, Town of Somers[a]	Town of Somers	0.82	1,500	0.184
Town of Bristol Water Utility	Town of Bristol	0.19	500	0.039
Subtotal—Kenosha County		17.21	91,800	15.740
MILWAUKEE COUNTY				
Brown Deer Municipal Water Utility[a]	Village of Brown Deer	4.36	13,600	1.484
City of Franklin Industrial Park	City of Franklin	0.16	N/A	0.097
City of Oak Creek Water and Sewer Utility[d]	City of Oak Creek	6.67	12,000	2.347
Cudahy Water Department[a]	City of Cudahy	4.66	21,700	2.809
Glendale Water Utility[a]	City of Glendale	5.97	13,500	3.153
Milwaukee Water Works[a,e]	City of Milwaukee	147.91	882,500	239.675
North Shore Water Utility[a,f]	City of Glendale	--	--	--
Shorewood Municipal Water Utility[a]	Village of Shorewood	1.70	14,300	1.566
South Milwaukee Water Utility[a]	City of South Milwaukee	4.78	23,400	7.992
Village of Greendale Water and Sewer Utility[a]	Village of Greendale	4.90	16,800	1.453
Village of Whitefish Bay Water Utility[a]	Village of Whitefish Bay	2.13	16,200	2.031
Water Utility of the Village of Fox Point[a]	Village of Fox Point	2.88	7,900	0.920
Wauwatosa Water Works[a]	City of Wauwatosa	13.28	55,700	6.602
West Allis Water Utility[a]	City of West Allis	10.37	69,000	12.098
Subtotal—Milwaukee County		209.77	1,146,600	282.227
OZAUKEE COUNTY				
Belgium Municipal Water Utility	Village of Belgium	0.42	900	0.142
Cedarburg Light and Water Commission	City of Cedarburg	2.56	10,400	1.186
Fredonia Municipal Water and Sewer Utility	Village of Fredonia	0.56	1,300	0.124
Grafton Sewer and Water Utility	Village of Grafton	2.21	8,800	1.165
Port Washington Municipal Water Utility[a]	City of Port Washington	2.30	9,500	1.045
Saukville Municipal Water and Sewer Utility	Village of Saukville	1.06	2,400	0.696
Subtotal—Ozaukee County		9.11	33,300	4.358
RACINE COUNTY				
Burlington Water Works	City of Burlington	2.38	8,900	1.286
Caddy Vista Sanitary District	Town of Caledonia	0.31	1,000	0.052
Crestview Sanitary District	Town of Caledonia	0.80	2,500	0.239
North Cape Sanitary District	Towns of Norway and Raymond	0.06	200	0.164
North Park Sanitary District[a,g]	Town of Caledonia	1.34	5,200	0.832
Racine Water Department[a,h]	City of Racine	16.90	96,700	22.156
South Lawn Sanitary District[a]	Town of Mt. Pleasant	0.68	1,900	0.199
Sturtevant Water and Sewer Utility[a]	Village of Sturtevant	1.03	4,400	0.362
Town of Caledonia Water Utility District No. 1[a]	Town of Caledonia	1.98	1,400	N/A
Union Grove Water Department	Village of Union Grove	0.77	3,000	0.574
Waterford Water Utility	Village of Waterford	0.83	2,300	0.178
Wind Point Municipal Water Utility[a]	Village of Wind Point	1.21	2,000	0.166
Subtotal—Racine County		28.29	129,500	26.208
WALWORTH COUNTY				
Darien Municipal Water and Sewer Utility	Village of Darien	0.54	1,000	0.074
Delavan Water and Sewerage Commission	City of Delavan	2.41	5,800	0.799
East Troy Municipal Water Utility	Village of East Troy	1.17	2,200	0.607
Elkhorn Light and Water Commission	City of Elkhorn	1.98	4,300	0.523
Fontana Municipal Water Utility	Village of Fontana-on-Geneva Lake	1.75	1,800	0.334
Genoa City Municipal Water and Sewer Utility	Village of Genoa City	0.61	1,100	0.085
Lake Geneva Water Commission	City of Lake Geneva	1.91	5,600	1.044
Lyons Sanitary District No. 1	Town of Lyons	0.04	300	N/A
Town of Troy Sanitary District No. 1	Town of Troy	0.16	100	0.002
Village of Sharon Water Works and Sewer System	Village of Sharon	0.62	1,300	N/A
Walworth Municipal Water and Sewer Utility	Village of Walworth	0.85	1,700	0.243
Whitewater Municipal Water Utility	City of Whitewater	2.39	11,000	1.492
Williams Bay Municipal Water Utility	Village of Williams Bay	1.49	1,700	0.235
Subtotal—Walworth County		15.92	37,940	5.438

Table 17 (continued)

Public Water Utility: Name	Public Water Utility: Location	Area Served (square miles)	Estimated Population Served	Estimated Average Consumption (MGD)
WASHINGTON COUNTY				
Allenton Sanitary District No. 1	Town of Addison	0.33	800	0.130
City of Hartford Utilities Department	City of Hartford	1.91	7,700	0.731
City of West Bend Water Department	City of West Bend	5.53	19,300	3.344
Jackson Municipal Water Department	Village of Jackson	0.46	2,000	0.211
Kewaskum Municipal Water Department	Village of Kewaskum	0.82	2,400	0.408
Slinger Utilities	Village of Slinger	0.57	1,300	0.197
Village of Germantown Water Utility	Village of Germantown	1.41	2,800	0.241
Subtotal–Washington County		11.03	36,300	5.262
WAUKESHA COUNTY				
Butler Water Utility	Village of Butler	0.80	2,200	0.667
City of Brookfield Water Utility	City of Brookfield	4.93	4,800	0.985
City of Oconomowoc Electric and Water Departments	City of Oconomowoc	3.48	11,000	1.306
Hartland Municipal Water Utility	Village of Hartland	1.40	4,000	1.308
Mukwonago Municipal Water Utility	Village of Mukwonago	1.45	3,400	0.345
Muskego Water Utility	City of Muskego	2.36	4,800	N/A
New Berlin Water Utility	City of New Berlin	2.99	7,300	1.082
Pewaukee Water and Sewage Utility	Village of Pewaukee	1.28	4,400	0.520
Sussex Municipal Water Utility	Village of Sussex	0.96	4,100	N/A
Village of Dousman Water Utility	Village of Dousman	0.49	1,000	0.065
Village of Eagle Water Utility	Village of Eagle	0.37	900	0.046
Village of Menomonee Falls Water Utility	Village of Menomonee Falls	4.38	18,800	2.181
Waukesha Water Utility	City of Waukesha	9.96	49,000	9.141
Westbrooke Sanitary Districts Nos. 1 and 2	Town of Brookfield	0.39	1,000	0.050
Subtotal–Waukesha County		35.24	116,700	17.696
Region Total		326.57	1,592,100	356.929

NOTE: N/A indicates not applicable.

[a] *These utilities utilize Lake Michigan as the sole source of water supply.*

[b] *The Kenosha Water Utility provides retail water service to portions of the Towns of Pleasant Prairie and Somers and wholesale water service to the Town of Somers Sanitary District No. 1. The data presented in this table for the Kenosha Water Utility include the communities served on a retail basis.*

[c] *The Pleasant Park Utility Company, Inc. and the Pleasant Prairie Water Works are not public water utilities since they are privately owned. Because, however, these utilities operate in the same fashion as a public water utility and because they are capable of ready expansion much the same as a public water utility, they have been classified for analysis purposes in this study as public water utilities.*

[d] *The City of Oak Creek Water and Sewer Utility provides retail service to a portion of the City of Franklin. These data are shown under the City of Oak Creek Water and Sewer Utility totals.*

[e] *The Milwaukee Water Works provides retail water service to the Cities of Greenfield and St. Francis and the Village of West Milwaukee and a portion of the City of Franklin and provides wholesale water service to the Cities of Wauwatosa and West Allis and the Villages of Brown Deer, Greendale, and Shorewood. The data presented in this table for the Milwaukee Water Utility include the communities served on a retail basis.*

[f] *The North Shore Water Utility provides no retail water service and exists only to sell water on a wholesale basis to the City of Glendale and the Villages of Fox Point and Whitefish Bay.*

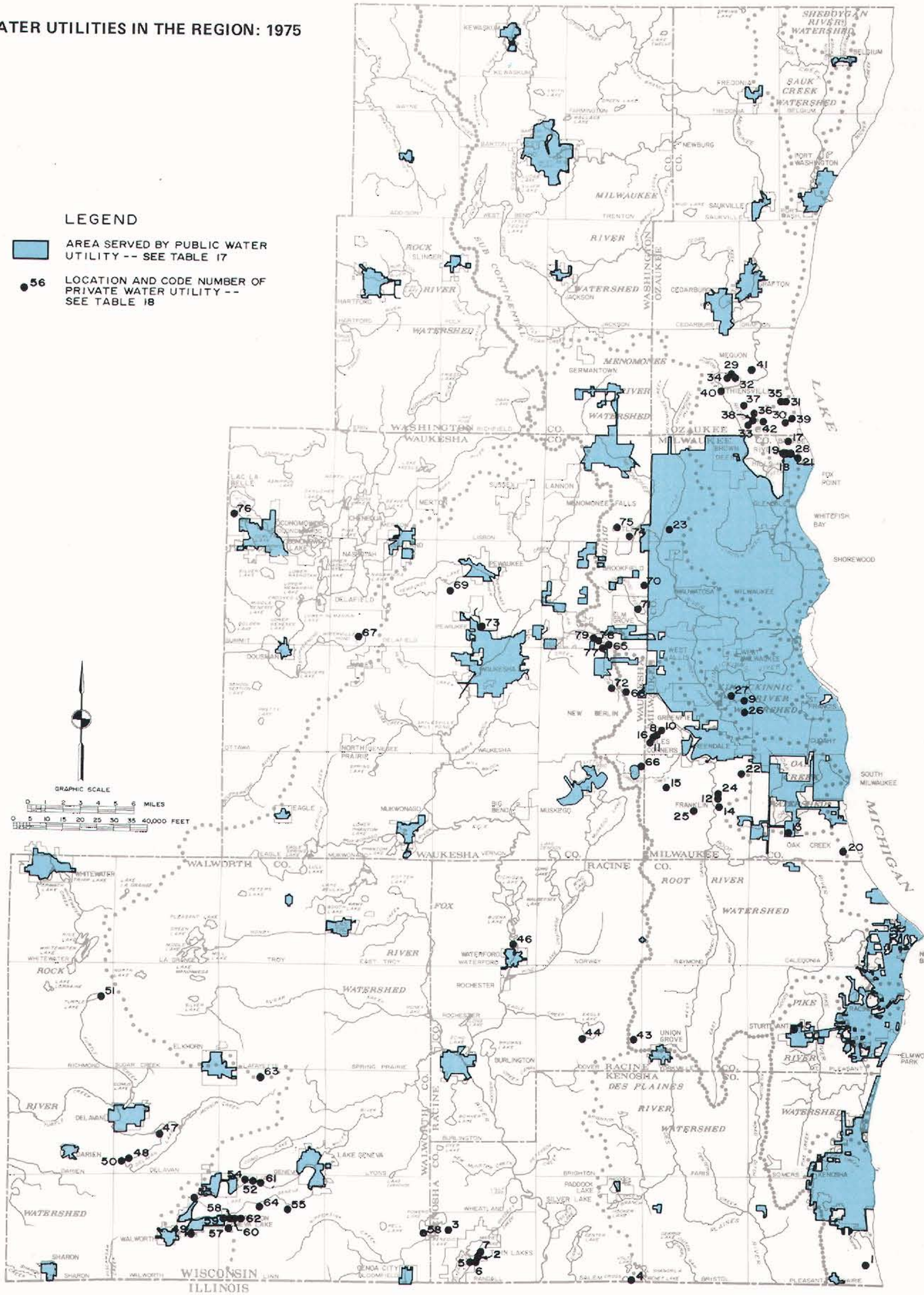
[g] *The North Park Water Utility provides water on a wholesale basis to the Wind Point Municipal Water Utility.*

[h] *The Racine Water Department provides retail water service to the Villages of North Bay and Elmwood Park and the Town of Mt. Pleasant and wholesale water service to the Village of Sturtevant, the North Park Sanitary District, the South Lawn Sanitary District, and the Town of Caledonia Utility District No. 1. The data presented in this table for the Racine Water utility include the communities served on a retail basis.*

Source: Wisconsin Public Service Commission, Wisconsin Department of Natural Resources, and SEWRPC.

Map 10

WATER UTILITIES IN THE REGION: 1975



Most of the water supply service in the Region is provided by 72 publicly owned water utilities. The service areas of these 72 utilities are shown on this map. In addition, there are 79 known private or cooperatively owned water supply systems in the Region which provide water service generally to individual subdivisions. The location of these private systems is also shown on this map. Lake Michigan is by far the most important source of water supply in the Region, with about 1.35 million persons, or 76 percent of the total Region population, currently being supplied from that source. An additional 235,000 persons, or about 13 percent of the total Region population, are supplied by public utilities relying on groundwater.

Source: SEWRPC.

Table 18

PRIVATE WATER UTILITIES IN THE REGION: 1975

Code Number on Map 10	Name	Civil Division
	KENOSHA COUNTY	
1	Carol Beach Water Company	Town of Pleasant Prairie
2	Edgewater Subdivision	Town of Randall
3	Lake Knolls Subdivision	Town of Randall
4	Oakwood Knolls Subdivision	Town of Salem
5	Twin Lakes Park Water Company	Town of Randall
6	Van Woods Estates Water Company	Town of Randall
7	Wy-Wood Co-operative	Town of Randall
	MILWAUKEE COUNTY	
8	Blossom Heath Water Trust	Village of Hales Corners
9	Franklin Estates Subdivision	City of Franklin
10	Hales Happiness Homesites Subdivision	Village of Hales Corners
11	Hales Park Meadows	Village of Hales Corners
12	Hawthorn Glens Subdivision	City of Franklin
13	Howell Avenue Estates Subdivision	City of Oak Creek
14	Milwaukee County House of Correction	City of Franklin
15	Mission Hills Subdivision	City of Franklin
16	Monaco Heights	Village of Hales Corners
17	North Shore East Subdivision	Village of Bayside
18	Northway Co-operative No. 1	Village of Bayside
19	Northway Co-operative No. 2	Village of Bayside
20	Oakview Subdivision No. 3	City of Oak Creek
21	Pelham Heath Subdivision	Village of Bayside
22	Rawson Homes Subdivision	City of Franklin
23	Robert Williams Park	City of Milwaukee
24	Root River Water Trust[a]	City of Franklin
25	Security Acres Water Trust	City of Franklin
26	Southgate Manor Estates Subdivision	City of Greenfield
27	Town View Water Co-operative Association	City of Milwaukee
28	Vista Del Mar Water Trust	Village of Bayside
	OZAUKEE COUNTY	
29	Alberta Subdivision	Village of Thiensville
30	Apple Orchard Acres Subdivision	City of Mequon
31	Bonnie Lynn Highlands Subdivision	City of Mequon
32	Century Estates Subdivision No. 1 and Additions	Village of Thiensville
33	Lac du Cours Subdivision	City of Mequon
34	Laurel Acres Subdivision	Village of Thiensville
35	Mequon Water Trust	City of Mequon
36	North Shore Estates Subdivision	City of Mequon
37	North Shore Heights Subdivision	City of Mequon
38	Range Line Hills Subdivision	City of Mequon
39	Ravine Farm Acres	City of Mequon
40	Village Heights Co-operative	Village of Thiensville
41	Villa Du Parc	City of Mequon
42	Whitman Place Subdivision	City of Mequon
	RACINE COUNTY	
43	Center for the Developmentally Disabled (Wisconsin Southern Colony)	Town of Dover
44	Eagle Lake Manor Community Association	Town of Dover
45	St. Bonaventure Prep School[b]	Village of Mt. Pleasant
46	Waterford Woods Association	Town of Waterford
	WALWORTH COUNTY	
47	Assembly Grounds Association	Town of Delavan
48	Chicago Club	Town of Delavan
49	Country Club Estates	Town of Walworth
50	Crest View Estates Corporation	Town of Delavan
51	Crystal Bowl, Inc.	Town of Richmond
52	Elgin Club	Town of Linn
53	Gardens Association	Town of Walworth
54	Knollwood and Cisco Beach Subdivision	Town of Linn
55	Lake Geneva Beach Subdivision	Town of Linn
56	Lake Geneva Club	Town of Linn
57	Maple Hills Subdivision	Town of Linn
58	Nippersink Subdivision	Town of Bloomfield
59	Oak Shores Subdivision	Town of Linn
60	Shore Havens Association	Town of Linn
61	Sunset Hills Association	Town of Linn
62	Sybil Lane Subdivision	Town of Linn
63	Walworth County Institutions and Lakeland Nursing Corporation	Town of Geneva
64	Wooddale Lake Shore Properties	Town of Linn
	WASHINGTON COUNTY	
	None	
	WAUKESHA COUNTY	
65	Brookfield Hills Apartment Complex	City of Brookfield
66	Durham Meadows	City of Muskego
67	Ethan Allen School (Wisconsin School for Boys-Wales)	Town of Delafield
68	Glendale Park Subdivision	City of New Berlin
69	Highlands Water Co-operative	Town of Pewaukee
70	Lynwood Water Company	City of Brookfield
71	Marion Heights Terrace	Village of Elm Grove
72	Monterey Heights Subdivision	City of New Berlin
73	Northview Home and Hospital	City of Waukesha
74	River View Manors Well Association	Village of Menomonee Falls
75	Silver Springs Terrace Subdivision	Village of Menomonee Falls
76	Sunnyfield Acres Subdivision	Town of Oconomowoc
77	Westchester Water Co-operative No. 1	City of Brookfield
78	Westchester Water Co-operative No. 2	City of Brookfield
79	Westfield Co-operative Water Systems, Inc.	Town of Brookfield

[a] *Operation of the Root River Water Trust and Hawthorn Glens Subdivision wells were taken over by the City of Franklin in July 1977 and as of that date should be considered as a public water utility.*

[b] *St. Bonaventure School was connected to the Village of Sturtevant water system in 1977 and as of that date should be considered as a portion of the Village of Sturtevant public water utility.*

Source: SEWRPC.

Map 11

ARTERIAL STREETS AND HIGHWAYS IN THE REGION: 1972

LEGEND

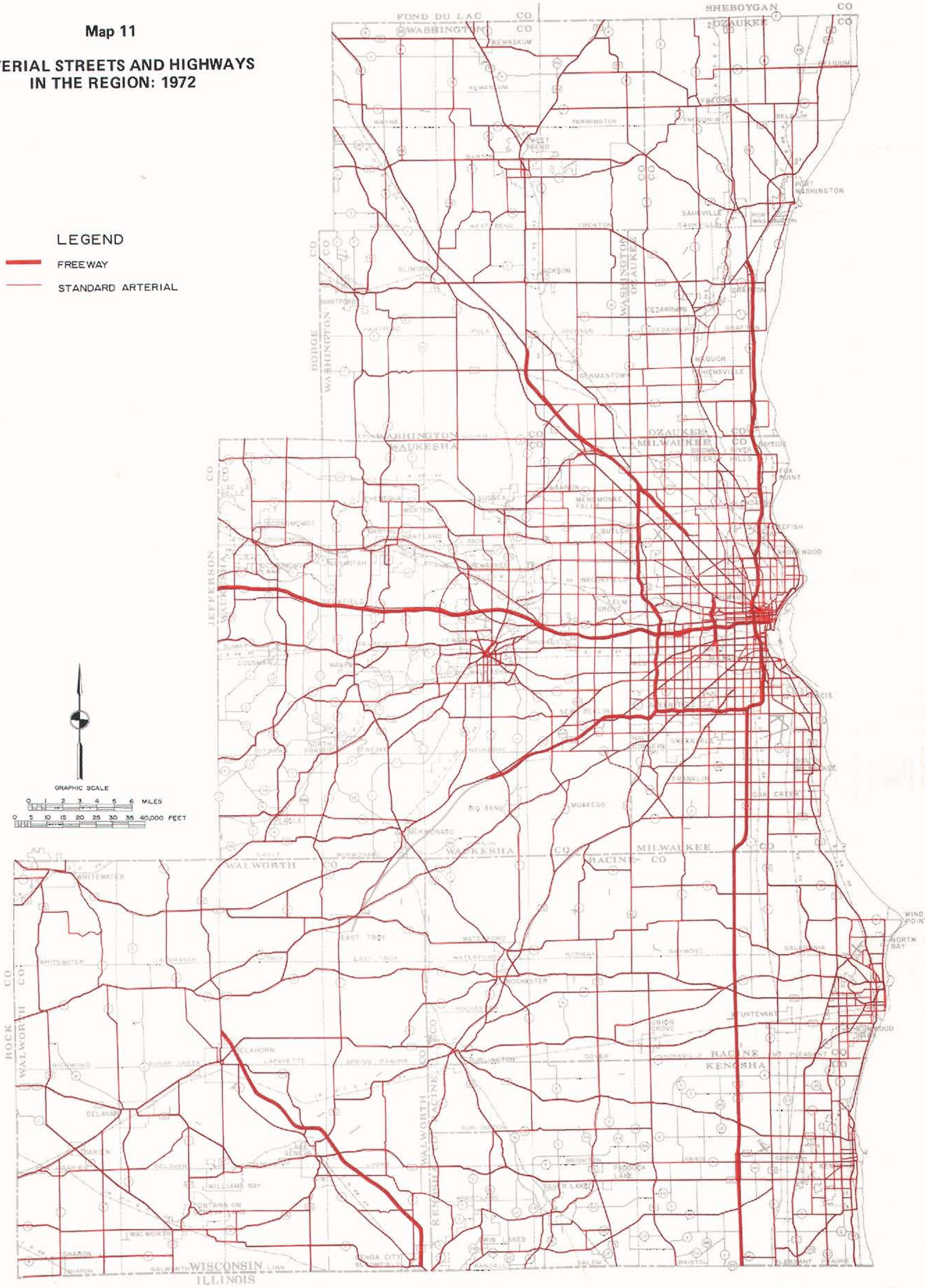
FREEWAY

STANDARD ARTERIAL

GRAPHIC SCALE

0 1 2 3 4 5 6 MILES

0 5 10 15 20 25 30 35 40,000 FEET



By 1972 there were a total of 9,819 miles of streets and highways of all kinds open to traffic within the Region, of which 3,119 miles, or 32 percent, were functioning as arterial streets and highways. This represents a reduction of 69 miles, or about 2 percent, from the total arterial street and highway mileage existing in the Region in 1963. This reduction in the arterial street system was the result of refinements in the delineation of the arterial network under the county jurisdictional highway system planning programs. These refinements reflect, in part, the effects of new facility—particularly freeway—construction and, in part, a greater acceptance of the neighborhood unit concept in local planning with its important implications for the location and spacing of arterial street and highway facilities. The arterial facilities removed from the system in this process were reverted to collector or land access classification and use.

Source: SEWRPC.

radial pattern of state trunk highways interconnecting the urban and rural areas of the Region, supplemented by an essentially grid pattern of local arterials.[5]

Interregional bus service is provided between the various communities comprising the Region, as shown on Map 12. This intercity bus service is provided by seven private companies: Badger Coaches, Inc.; Central-West Motor Stages, Inc.; Greyhound Lines West; Peoria-Rockford Bus Company; Tri-State Coach Lines, Inc.; Wisconsin Coach Lines, Inc.; and Wisconsin-Michigan Coaches, Inc., which together operate bus lines over 484 miles of streets and highways. Also, one supplemental carrier, Scholastic Transit Company (North American Coach Company) provides service on a demand basis.

Intraregional bus service is provided within Milwaukee County by Milwaukee County and by the Wisconsin Coach Lines, Inc.; within the City of Racine by the City of Racine; within the City of Kenosha by the City of Kenosha; and within the City of Waukesha by Wisconsin Coach Lines, Inc. In 1972 the transit systems provided about 1,126 round trip route miles of service and served almost all of the most intensely urbanized areas of the Region. In 1972, 202.5 square miles were served by local transit systems, and about 1.2 million persons, or about 69 percent of the resident population, were located within one-quarter mile of a public intracity transit route (see Map 13 and Map 14).

Intercity rail service in the Region presently is limited to freight hauling, except for scheduled passenger service, as shown on Map 12, to the City of Milwaukee and the Village of Sturtevant by the National Railroad Passenger Corporation (AMTRAK) operating over the trackage of the Chicago, Milwaukee, St. Paul, and Pacific Railroad Company (Milwaukee Road). Other Chicago-area commuter service is provided by the Chicago and North Western Railway (C&NW) from the City of Kenosha, but providing freight service only, is the Soo Line Railroad Company.

NATURAL RESOURCE BASE

Introduction

The natural resource base is a primary determinant of the development potential of a region and of its ability to provide a pleasant and habitable environment for all forms of life. The principal elements of the natural resource base are climate, physiography, geology, soils, mineral and organic resources, vegetation, fish and wildlife, and water resources. Without a proper understanding and recognition of these elements and of their interrelationships, human use and alteration of the natural environment proceeds at the risk of excessive costs in terms of both monetary expenditures and destruction of nonrenewable or slowly renewable resources. In this age of high resource demand, urban expansion, and rapidly changing technology, it is especially important that the natural resource base be a primary consideration in any areawide planning effort since these aspects of contemporary civilization make the underlying and sustaining resource base highly vulnerable to misuse and destruction.

Climate

Climate, especially the extreme variations in the three principal elements of climate—temperature, precipitation, and snow cover—directly affects the growth and development of an area, as well as the characteristics of its water resources. Climate determines to a large extent the recreational interests and pursuits that can be followed by residents of an area ranging from swimming, boating, and numerous other summer recreational activities to skiing, snowmobiling, and ice-skating in the winter. Climate also has important economic implications. Rainfall and temperature affect the kinds of agricultural crops which can be produced as well as the yields. Rainfall, temperature, and snow cover affect the design of buildings and structures of various kinds and the costs of operating and maintaining both private and public facilities and services. Climate effects on water resources include temperature influences on the solubility of oxygen in water, evaporation rates, rates of chemical reactions, types of organisms present in water bodies, health and growth of organisms, and the toxicity of certain substances; wind-induced shoreline erosion by waves; rainfall-intensity and quantity effects on erosion and the subsequent deposition of materials in lakes and streams; and snow cover on frozen water bodies which affects light penetration and the resultant rate of photosynthesis and associated oxygen production, and consequently the fish and aquatic life.

The Region has a continental climate which spans four seasons, one season succeeding the other through varying time periods of unsteady transition. Summer generally spans the months of June, July, and August. The summers are relatively warm with occasional periods of hot, humid weather and sporadic periods of very cool weather. Winter generally spans the months of December, January, and February, but it may in some years be lengthened to include all or parts of the months of November and March. Winters tend to be cold, cloudy, and snowy. There is often a short midwinter thaw occasioned by brief periods of unseasonably warm weather. Streams and lakes begin to freeze over in November, with the larger and deeper bodies of water usually being covered with ice by mid-December. Lake and stream ice breakup occurs in late March and early April due to increased solar radiation.

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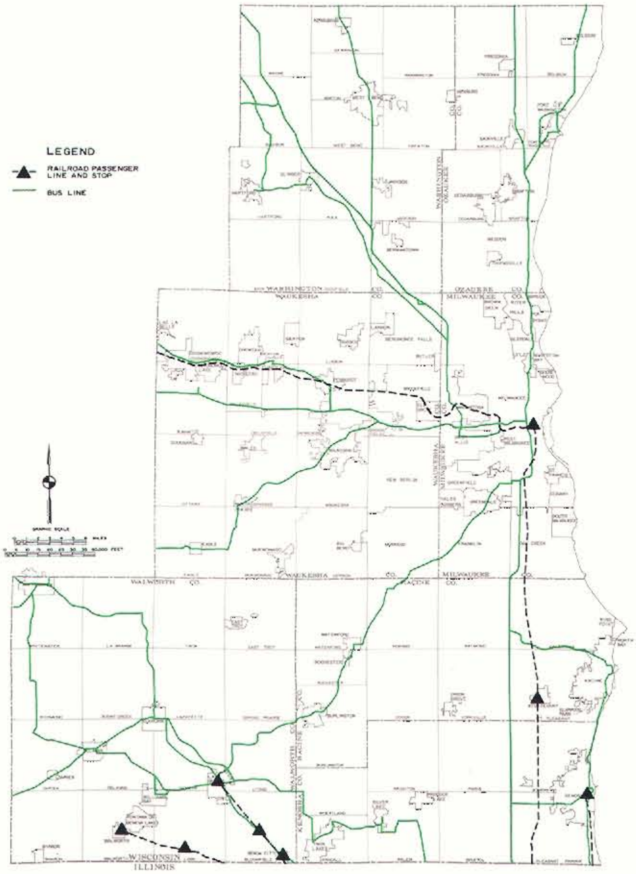
[5] *Extensive and detailed data on the transportation system of the Region are available from the Commission's ongoing areawide transportation planning program and were applied in the areawide water quality planning program as needed. For additional details describing the existing and anticipated future elements of the transportation systems, see SEWRPC Planning Report No. 25, A Regional Land Use and a Regional Transportation Plan for Southeastern Wisconsin.*

Map 12

INTERURBAN AND SUBURBAN BUS AND RAILROAD PASSENGER SERVICE IN THE SOUTHEASTERN WISCONSIN REGION: 1972

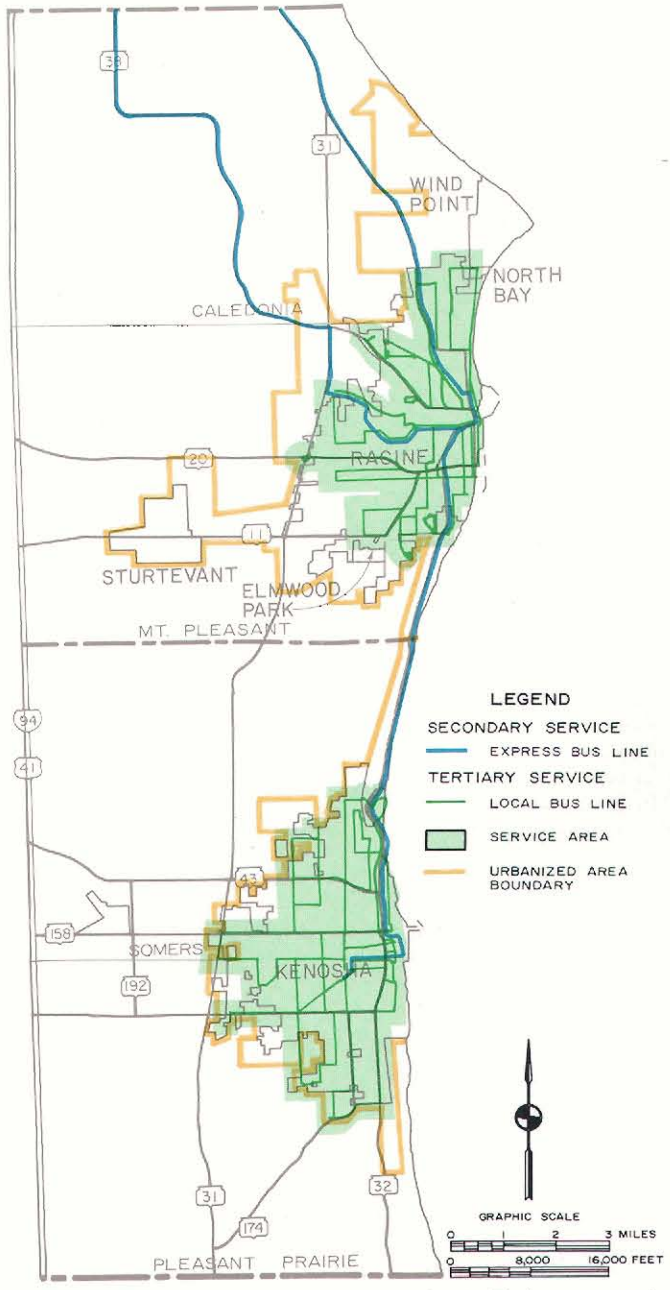


Seven private companies provide intercity bus service within the Region, operating bus lines over a total of 484 miles of public streets and highways. The only remaining scheduled rail passenger service in the Region consists of the national AMTRAK service, operated over the Milwaukee Road trackage, and Chicago-oriented commuter service from communities in Kenosha and Walworth Counties. Subsequent to 1972 the commuter service to the communities in Walworth County was discontinued.

Source: SEWRPC.

Map 13

INTRAREGIONAL MASS TRANSPORTATION SERVICE IN THE KENOSHA AND RACINE URBANIZED AREAS MAY 1972



In 1972, the local mass transportation system for the Racine area served about 100,600 persons who lived within one-quarter mile of local transit lines. At the same time, the local mass transportation system for the Kenosha area served about 83,900 persons who lived within one-quarter mile of local transit lines. Both systems are operated by the municipalities involved.

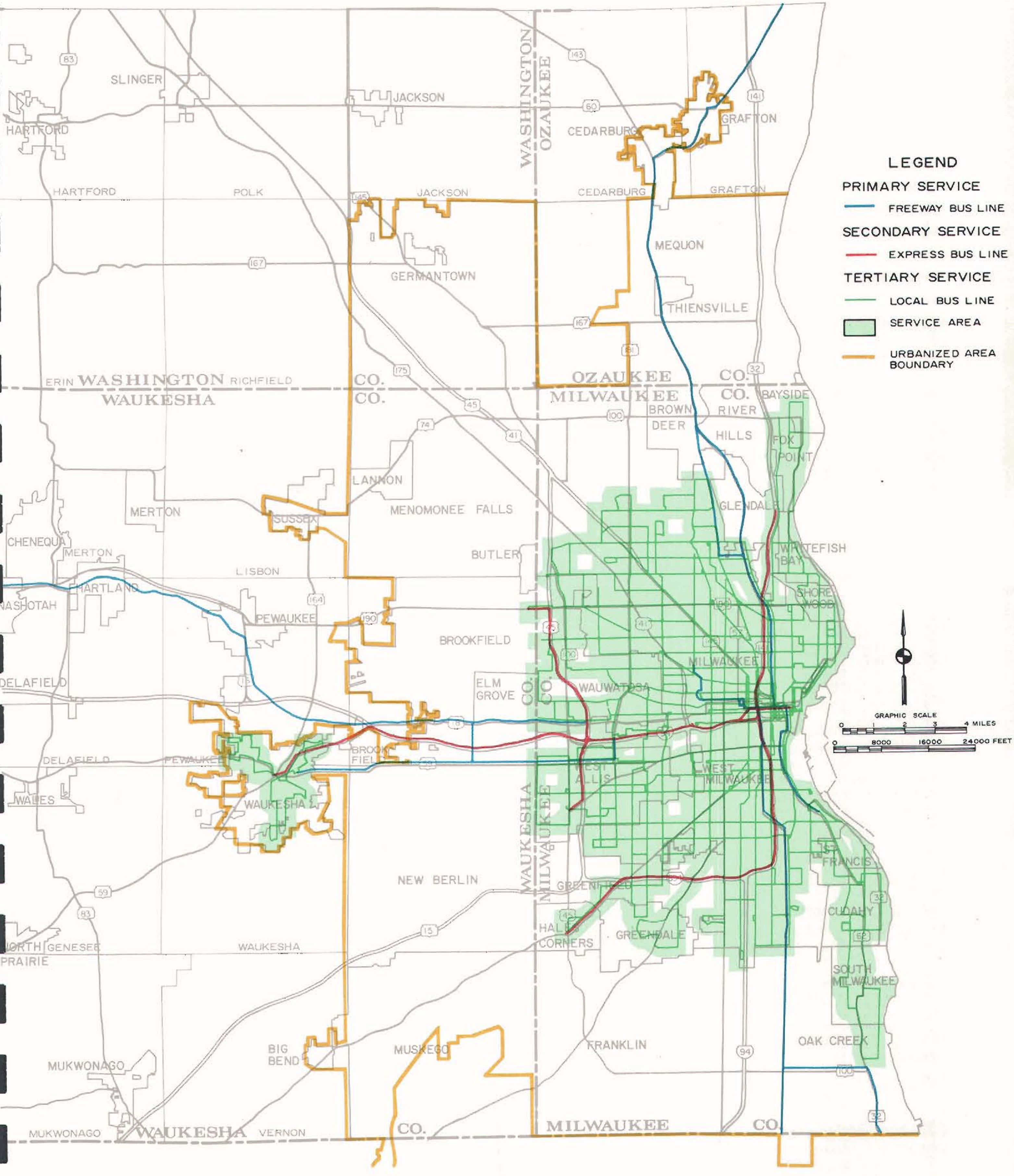
Source: SEWRPC.

Autumn and spring in the Region are transitional times of the year between the dominant seasons and are usually periods of unsettled weather conditions. Temperatures are extremely varied and long periods of precipitation are common. Early spring is marked by moderation of the low temperature of winter. By late March, rainfall replaces snow as the predominant form of precipitation. Typical spring weather may extend from March through May and is characterized by cool, wet weather. Typical autumn weather may extend from September through November, and is characterized by pleasant, mild, sunny days and cool nights.

Air temperatures within the Region are subject to great seasonal change and yearly variation as well as diurnal variations and to a large extent determine many of the chemical processes which occur in the lakes and streams of the Region. Data for 24 temperature observation

Map 14

INTRAREGIONAL MASS TRANSPORTATION SERVICE IN THE MILWAUKEE URBANIZED AREA: MAY 1972

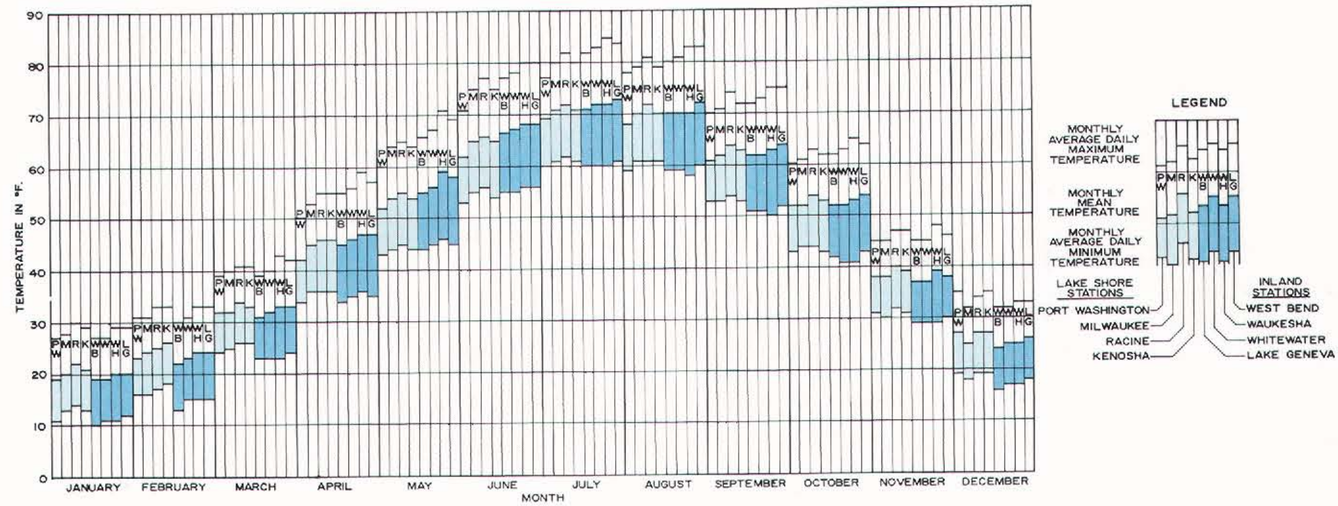


In 1972, about 1.04 million persons lived within one-quarter mile of local transit lines in the Milwaukee urban area and were served by the Milwaukee and Suburban Transport Corporation and Wisconsin Coach Lines, Inc. However, as of July 1, 1975, Milwaukee County has operated the local transit system in Milwaukee County.

Source: SEWRPC.

Figure 12

TEMPERATURE CHARACTERISTICS AT SELECTED LOCATIONS IN THE REGION



Source: SEWRPC.

Table 19

TEMPERATURE CHARACTERISTICS AT SELECTED LOCATIONS IN THE REGION

	Observation Station[a]											
	Lakeshore Locations											
	Port Washington 1959-1977			Milwaukee 1940-1976			Racine 1940-1977			Kenosha 1948-1977		
Month	Average Daily Maximum[b]	Average Daily Minimum[b]	Mean[c]	Average Daily Maximum[b]	Average Daily Minimum[b]	Mean[c]	Average Daily Maximum[b]	Average Daily Minimum[b]	Mean[c]	Average Daily Maximum[b]	Average Daily Minimum[b]	Mean[c]
January	27	11	19	28	13	20	30	14	22	29	13	21
February	31	16	23	31	16	24	33	17	25	33	18	26
March	39	24	32	40	25	32	41	26	34	41	26	33
April	50	34	42	53	36	45	55	36	46	53	36	45
May	60	43	52	64	44	54	65	45	55	64	44	54
June	71	53	62	75	55	65	77	56	66	75	54	65
July	77	60	69	80	61	71	82	62	72	80	61	71
August	77	59	68	79	61	70	81	61	72	79	61	70
September	70	53	61	71	53	62	74	54	64	72	53	63
October	60	43	52	61	43	52	63	44	54	62	43	53
November	45	31	38	45	30	38	47	32	40	47	31	39
December	35	19	27	32	18	25	34	19	27	35	19	27
Yearly Average	53.5	37.2	45.4	54.9	37.9	46.5	56.8	38.8	48.1	55.8	38.3	47.3

	Observation Station[a]															
	Inland Locations															
	West Bend 1940-1977			Waukesha 1940-1977			Whitewater 1949-1977			Lake Geneva 1945-1977			Regional Summary			
Month	Average Daily Maximum[b]	Average Daily Minimum[b]	Mean[c]	Average Daily Maximum[b]	Average Daily Minimum[b]	Mean[c]	Average Daily Maximum[b]	Average Daily Minimum[b]	Mean[c]	Average Daily Maximum[b]	Average Daily Minimum[b]	Mean[c]	Average Daily Maximum[d]	Average Daily Minimum[d]	Mean[e]	Month
January	27	10	19	27	11	19	29	11	20	29	12	20	28.2	11.9	20.0	January
February	30	13	22	31	15	23	33	15	24	33	15	24	31.9	15.6	23.9	February
March	39	23	31	40	23	32	43	23	33	42	24	33	40.6	24.2	32.5	March
April	55	34	45	56	35	46	59	36	47	57	35	47	54.8	35.2	45.4	April
May	66	44	55	67	45	56	71	46	59	69	45	58	65.8	44.5	55.4	May
June	77	55	66	78	55	67	80	56	68	80	56	68	76.6	55.0	65.9	June
July	82	60	71	83	60	72	85	60	72	84	61	73	81.6	60.6	71.4	July
August	80	59	70	81	59	70	83	58	70	83	60	72	80.4	59.8	70.2	August
September	72	51	62	73	51	62	75	50	63	75	52	64	72.8	52.1	62.6	September
October	62	42	52	63	41	52	65	41	53	64	43	54	62.5	42.5	52.8	October
November	45	29	37	48	29	37	48	29	39	46	30	38	46.0	30.1	38.2	November
December	32	16	24	32	17	25	33	17	25	33	18	26	33.2	17.9	25.8	December
Yearly Average	55.6	36.3	46.2	56.3	36.8	46.8	58.7	36.8	47.8	57.9	37.6	48.1	56.2	37.4	47.0	Yearly Average

[a] *Observation stations were selected both on the basis of the length of record available and geographic location within the Southeastern Wisconsin Region. Port Washington, Milwaukee, Racine, and Kenosha are representative of areas with temperatures influenced by Lake Michigan, whereas West Bend, Waukesha, Whitewater, and Lake Geneva are typical of inland areas having temperatures that are not generally influenced by Lake Michigan. Kenosha and Lake Geneva are representative of southerly areas in the Region, whereas Port Washington and West Bend typify northern locations.*

[b] *The monthly average daily maximum temperature and the monthly average daily minimum temperature are obtained by using daily measurements to compute an average for each month in the period of record the results are then averaged for all the months in the period of record.*

[c] *The monthly mean temperature is the mean of the average daily maximum temperature and the average daily minimum temperature for each month.*

[d] *The monthly average daily maximum and minimum temperatures for the Region as a whole were computed as averages of the corresponding values for the eight observation stations.*

[e] *The monthly mean for the Region as a whole is the mean of the Regional monthly average daily maximum and average daily minimum, which is equivalent to the average of the monthly means for the eight observation stations.*

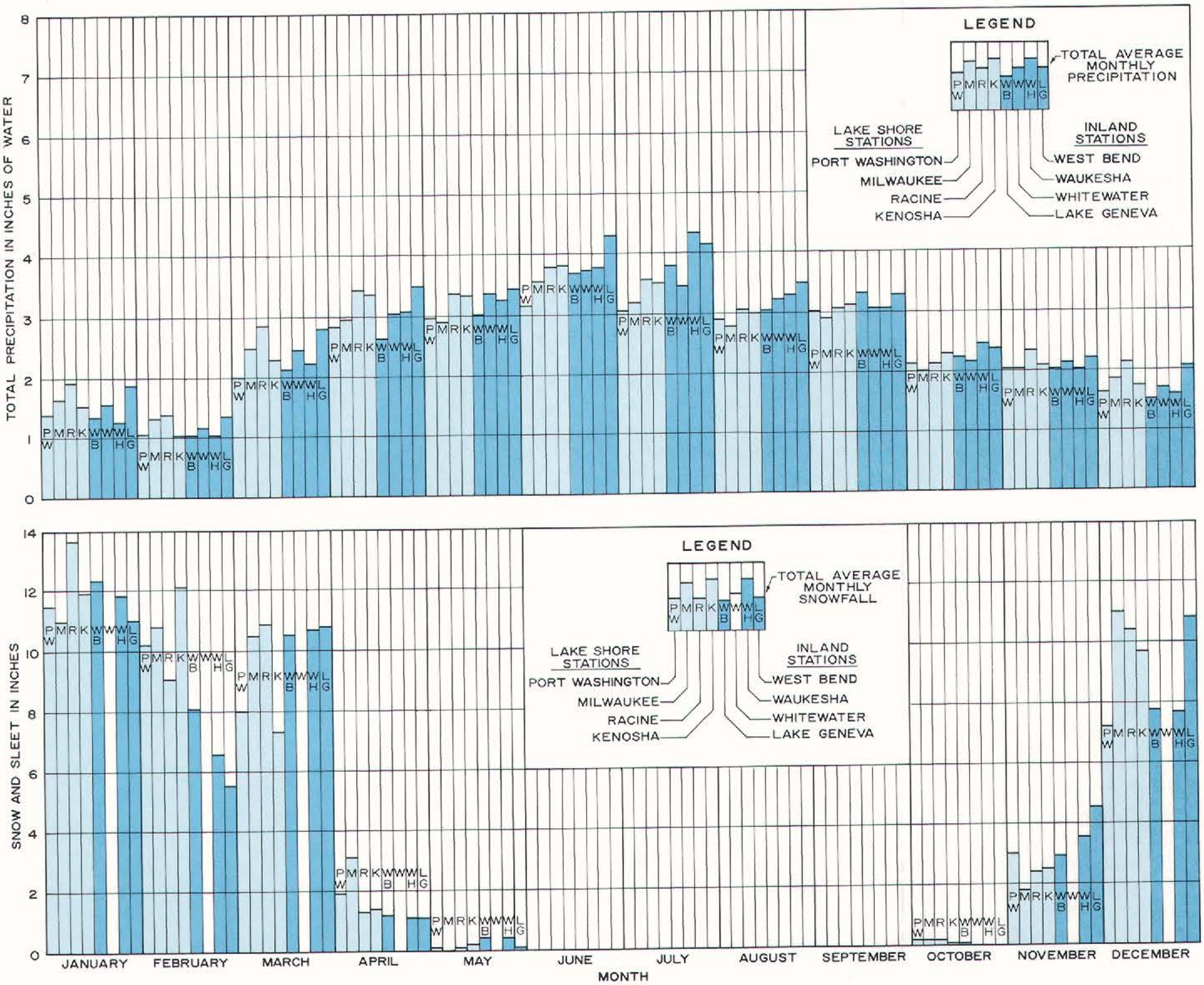
Source: SEWRPC.

stations in and near southeastern Wisconsin are available in Commission files, and data for eight selected temperature observation stations are presented in Figure 12 and Table 19. Four of these temperature observation stations—Port Washington, Milwaukee, Racine, and Kenosha—are located on the Lake Michigan shoreline, and four of these—West Bend, Waukesha, Whitewater, and Lake Geneva—are located at least 15 miles inland. These data, which encompass periods of record ranging from 1940 to March 1977 for the various observation stations in the Region, indicate the temporal and spatial variations in temperature which may be anticipated within the Region. Summer temperatures throughout the Region, as reflected by monthly means for July and August, range between 68°F and 73°F with northerly lake shore locations exhibiting lower monthly mean summer temperatures than southerly inland locations. Winter temperatures, as reflected by monthly means for January and February, range between 19°F to 26°F for all stations.

Daily precipitation data are available in the Commission files for 25 observation stations in and near the Region. Precipitation and snowfall data for eight geographically representative observation stations in and near the Region are shown in Figure 13 and Table 20. The average annual total precipitation based on these eight observation stations is 31.26 inches expressed as water equivalent. Monthly averages range from a February low of 1.19 inches to a June high of 3.77 inches. Snow is most likely to occur in southeastern Wisconsin during the months of December, January, and February and average 44.5 inches annually, or 4.45 inches of precipitation. The percentage of maximum possible sunshine in

Figure 13

PRECIPITATION CHARACTERISTICS AT SELECTED LOCATIONS IN THE REGION



Source: SEWRPC.

Table 20

PRECIPITATION CHARACTERISTICS AT SELECTED LOCATIONS IN THE REGION

	Observation Station																		
	Lakeshore Locations								Inland Locations										
	Port Washington		Milwaukee		Racine		Kenosha		West Bend		Waukesha		Whitewater		Lake Geneva		Regional Summary		
	1940-1977	1894-1950	1940-1976		1940-1977	1950-1973	1945-1977	1945-1959	1940-1977	1930-1959	1940-1977	1930-1959	1948-1977		1945-1977	1945-1959			
Month	Average Total Precipitation	Average Snow and Sleet	Average Total Precipitation	Average Snow and Sleet	Average Total Precipitation	Average Snow and Sleet	Average Total Precipitation	Average Snow and Sleet	Average Total Precipitation	Average Snow and Sleet	Average Total Precipitation	Average Snow and Sleet	Average Total Precipitation	Average Snow and Sleet	Average Total Precipitation	Average Snow and Sleet	Average Total Precipitation	Average Snow and Sleet	Month
January	1.38	11.5	1.62	11.0	1.92	13.6	1.54	11.9	1.37	12.3	1.55	11.8	1.29	N/A	1.88	11.0	1.57	11.9	January
February	1.08	10.2	1.31	10.8	1.49	9.1	1.03	12.1	1.04	8.1	1.18	6.6	1.03	N/A	1.37	5.5	1.19	8.9	February
March	2.00	8.0	2.48	10.5	2.85	10.9	2.30	7.3	2.12	10.5	2.43	10.7	2.24	N/A	2.80	10.1	2.40	9.7	March
April	2.86	1.9	2.97	3.1	3.46	1.3	3.40	1.4	2.66	1.2	3.05	1.1	3.10	N/A	3.51	1.1	3.13	1.6	April
May	2.98	0.1	2.89	Trace	3.37	0.1	3.26	0.2	3.01	0.4	3.38	0.4	3.27	N/A	3.43	0.1	3.20	0.2	May
June	3.25	0.0	3.58	0.0	3.84	0.0	3.86	0.0	3.70	0.0	3.77	0.0	3.80	N/A	4.33	0.0	3.77	0.0	June
July	3.07	0.0	3.21	0.0	3.58	0.0	3.51	0.0	3.79	0.0	3.47	0.0	4.36	N/A	4.15	0.0	3.64	0.0	July
August	2.92	0.0	2.79	0.0	3.08	0.0	3.00	0.0	3.04	0.0	3.22	0.0	3.31	N/A	3.51	0.0	3.11	0.0	August
September	3.11	0.0	2.91	0.0	3.08	0.0	3.14	0.0	3.34	0.0	3.09	0.0	3.08	N/A	3.29	0.0	3.13	0.0	September
October	2.13	0.2	2.01	0.2	2.15	0.2	2.31	0.1	2.21	0.1	2.15	0.0	2.44	N/A	2.37	0.0	2.22	0.1	October
November	2.03	3.0	2.03	1.8	2.35	2.4	2.10	2.5	2.02	2.9	2.16	3.5	2.01	N/A	2.21	4.5	2.11	2.9	November
December	1.65	7.2	1.88	11.0	2.15	10.4	1.74	9.7	1.50	7.8	1.75	7.7	1.61	N/A	2.07	10.8	1.79	9.2	December
Year	28.46	42.1	29.68	48.4	33.32	48.0	31.19	45.2	29.80	43.3	31.20	41.8	31.54	N/A	34.92	43.1	31.26	44.5	Year

Source: SEWRPC.

the Region ranges from a low of about 40 percent from December through February to a high of 60 percent or greater from May through September.

Ambient Air Quality

Air quality is not only an important determinant of the overall quality of life in an area, but has important direct and indirect effects on water quality. Air generally contains some substances in the form of smoke, soot, dust, fly ash, fumes, mists, odors, pollens, and spores, which—through atmospheric fallout and washout—may directly affect surface water quality. Although some of the foreign particulate and gaseous matter in air is contributed by natural sources, much is contributed by man from such activities as land cultivation; heat and power generation; industrial processes; transportation movements; and waste burning, including incineration of waste solids produced by wastewater treatment facilities. Urbanization tends to intensify the contribution of air pollutants from human activities because it concentrates the distribution of pollutant sources. When the level of pollutants in the air becomes so severe as to seriously and adversely affect health and property, an air pollution problem exists. Because of the direct and indirect linkages involved, air and water quality management programs must be conducted in a coordinated, if not integrated, manner.

Five major pollutants have been identified as having significant adverse effects on human health and property: particulate matter, sulfur dioxide, carbon monoxide, nitrogen dioxide, and photochemical oxidants. A sixth pollutant, hydrocarbons, may under certain atmospheric conditions influence the formation of ozone, and consequently, ambient air quality standards have been established for these compounds. Commission studies indicate that national ambient air quality standards, as established by the U. S. Environmental Protection Agency, for particulate matter, carbon monoxide, sulfur dioxide, and photochemical oxidants are presently exceeded or have a potential for being exceeded in the most highly urbanized areas of the Region—the central portions of Milwaukee, Racine, and Kenosha urbanized areas. A detailed analyses of historic, current, and anticipated future air quality conditions in the Region, as well as recommendations for air pollution control are to be set forth in a separately published SEWRPC planning report documenting a regional air quality maintenance plan for southeastern Wisconsin.

Air quality monitoring for gaseous pollutants was first initiated on a regular basis in the Southeastern Wisconsin Region in 1957 as part of the National Air Surveillance Network. The initial installation included a high volume air sampler located in downtown Milwaukee to collect suspended particulate samples on a twice monthly basis for analysis and interpretation at the U. S. Public Health Service Laboratories. In 1961, this sampler site was upgraded to include monitoring for sulfur dioxide and nitrogen dioxide, and in 1963, two additional similar stations were located above the Police Headquarters in the City of Racine and above the Municipal Building in the City of Kenosha. In 1967, Milwaukee County expanded its ambient air quality monitoring effort by securing 10 additional high-volume particulate samplers with instrumentation to monitor gaseous pollutant levels on a continuous basis. Presently, Milwaukee County operates high-volume samplers to measure suspended particulates at 16 locations, and uses a mobile van, operational since early 1969 and equipped to measure particulates, sulfur dioxide, nitrogen dioxide, ozone, carbon monoxide, and wind speed and direction, to monitor air quality at five sites throughout the county.

A network of ambient air quality monitoring stations has been established within the Region by the Wisconsin Department of Natural Resources to provide a continuous record of air quality levels. This network consists of nine monitoring sites, including seven in Milwaukee County, one in the City of Racine, and one in the City of Waukesha. Each station continuously monitors the presence of particulate matter, sulfur dioxide, carbon monoxide, nitrogen dioxide, and ozone. In addition, several sites are instrumented to measure methane and total hydrocarbons in the atmosphere. Meteorological instruments will eventually be located at all of the sites to provide important weather data.

Under the Federal Clean Air Act, the U. S. Environmental Protection Agency (EPA) must promulgate minimum ambient air quality standards which must be met throughout the United States. By 1975, the EPA had issued such standards for six pollutants: particulate matter, sulfur dioxide, carbon monoxide, nitrogen dioxide, photochemical oxidants (ozone), and hydrocarbons. As discussed in SEWRPC Planning Report No. 25, A Regional Land Use and a Regional Transportation Plan for Southeastern Wisconsin—2000, Volume One, Inventory Findings, pages 106-111, two sets of standards are provided for each pollutant: a primary standard, specifying the pollutant level which should not be exceeded in order to protect human health; and a secondary standard, specifying the pollutant level which should not be exceeded in order to protect animal and plant life and property from damage, and thereby protect the public welfare from any known or anticipated adverse effects of an air pollutant.

Measured and estimated levels of particulate matter within the Region exceeded in 1973 the primary standard (75 micrograms per cubic meter) and secondary standard (60 micrograms per cubic meter) on an annual average basis over very small areas of the Region. These areas included the central business district of Milwaukee, the Menomonee River Valley industrial area and the adjacent intensely urbanized area of Milwaukee County; and the intensely urbanized and industrialized areas of eastern Racine and Kenosha Counties. On an annual average basis, levels of particulate matter as high as 242 micrograms per cubic meter were recorded in the Milwaukee area, with maximum daily levels exceeding 700 micrograms per cubic meter. The primary pollutant origins of these excessive levels of particulate matter were industrial processes, power generation, and space heating.

The adopted primary standard for sulfur dioxide specifies that the level of sulfur dioxide present in the atmosphere on the basis of the annual arithmetic mean should not exceed 0.03 parts per million, or 80 micrograms per cubic meter, and on the basis of the second highest 24-hour average over a one-year period shall not exceed 0.14 parts per million, or 365 micrograms per cubic meter. Estimated levels of sulfur dioxide within the Region in 1970 approached the primary air quality standard on an average annual basis in the highly industrialized Menomonee River Valley of Milwaukee County. The primary sources of sulfur dioxide were industrial processes, electric power generation, and space heating. Because of the limited facilities available to monitor ambient air quality within the Region, the currently available data and estimates derived from these data may not adequately represent the ambient air quality impacts of the emissions from the major electric power generating plants located in the City of Oak Creek in Milwaukee County and in the City of Port Washington in Ozaukee County. Consequently, the established standards may be exceeded in other areas of the Region as well as in the Menomonee Valley area of Milwaukee County. The effects of unique meteorological conditions adjacent to the shoreline of Lake Michigan, within which the major electric power generation plants are located, may further aggravate the air pollution problem within the Region. On an annual average basis, maximum levels of sulfur dioxide approaching 0.04 parts per million have been recorded within the Region in and immediately adjacent to the highly industrialized Menomonee River Valley area of Milwaukee County. The highest value reported by the Wisconsin Department of Natural Resources as of July 1, 1974, of sulfur dioxide measured during 1973 in the Southeastern Wisconsin Region was an annual arithmetic mean value of 0.02 ppm.

With respect to carbon monoxide, the adopted primary and secondary national air quality standards specify that the second highest level of carbon monoxide over a one-year period shall not exceed nine parts per million (10 micrograms per cubic meter) over an eight-hour period, and 35 parts per million (40 micrograms per cubic meter) over a one-hour period. Only very limited ambient air quality monitoring data are available in the Region to support a comparison of the carbon monoxide in the ambient air with the specified standards. A review of these limited data indicates that during a single eight-hour period in 1973, maximum levels of carbon monoxide in excess of 10 parts per million (11 micrograms per cubic meter) were measured in Milwaukee County. Thus it is likely that the specified carbon monoxide standards may be exceeded within this portion of the Region. The primary sources of carbon monoxide are gasoline powered motor vehicles. It is estimated that in the Milwaukee area such vehicles account for over 90 percent of the carbon monoxide emissions.

The adopted primary and secondary standards for nitrogen dioxide specify that the level of nitrogen dioxide in the atmosphere shall not exceed 0.05 parts per million (100 micrograms per cubic meter). The primary sources of nitrogen dioxide are gasoline powered motor vehicles and industrial processes. Because measured nitrogen dioxide concentrations within the Region have not been exceeded, and because a reduction in automotive emissions can be expected as federally established emission controls are met, pollution from nitrogen dioxide is not expected to be a serious problem within the Region.

As of 1976, the adopted primary and secondary standards for photochemical oxidants specified that the level of ozone in the atmosphere should not exceed 0.08 parts per million averaged over a one-hour period. Average hourly levels of ozone as high as 0.29 parts per million have been measured in Milwaukee County and as high as 0.297 parts per million in Racine County in 1974. These levels are also in excess of the 1978 proposed revision of the primary ozone standard to require 0.10 parts per million as an average over a one-hour period, and of the secondary standard proposed to remain at 0.08 parts per million. Photochemical oxidants result from a complex series of atmospheric reactions initiated by sunlight. When reactive organic substances and oxides of nitrogen accumulate in the atmosphere and are exposed to the ultraviolet components of sunlight, the formation of new compounds, including ozone and peroxyacyl nitrates, takes place. A primary source of reactive organic substances and oxides of nitrogen are gasoline powered motor vehicles, which emit unburned hydrocarbons, which in turn form ozone. Another major source of substances instrumental in the formation of ozone are bulk storage areas for motor fuels and certain commercial or industrial processes, including certain dry cleaning establishments.

Although the present level of air pollution within the Region generally may not be as serious as it is in certain other regions of the United States, evidence exists that the national ambient air quality standards established by the U. S. Environmental Protection Agency for particulate matter, sulfur dioxide, and photochemical oxidants are presently being exceeded or have the potential for being exceeded during the next decade in certain areas of the Region. The regional air pollution problem is extremely complex, and analysis of point, area, and line source emissions and meteorological phenomena is being conducted in the development of an Air Quality Maintenance Plan for the Region in cooperation with the Wisconsin Departments of Transportation and Natural Resources, and the U. S. Environmental Protection Agency. The abatement of air pollution within the Region through planning and implementation programs currently underway, especially with respect to particulate matter, should assist in improving surface water quality. The fallout and washout of particulate matter may contribute significant amounts of nutrients, particularly phosphorus, to surface waters, together with other potentially hazardous materials, such as heavy metals and exotic chemicals.

Air quality both affects and is affected by water quality conditions and control actions. As noted above, air quality control programs currently address particulate matter, sulfur dioxide, carbon monoxide, nitrogen dioxide, photochemical oxidants, and hydrocarbons which can affect ozone levels. Particulate matter may have an effect on water quality as a source of biochemical oxygen demand, nitrogen, and phosphorus in natural waters. Similarly, nitrogen dioxide can be provided to the natural waterways from atmospheric sources. The general magnitude of these effects is addressed in the analysis of existing water pollution sources in the Region as set forth in Chapter V of this volume and is analyzed for each individual major lake, as discussed in the alternative plans in Chapter IV of Volume Two of this report. However, the importance of such sources of water pollution for the attainment of water quality objectives was found to be of little practical importance except in isolated cases.

Sulfur dioxide as an air contaminant may be expected to contribute slightly to the concentration of sulfates in surface waters; but based on the Commission water quality analyses, including most specifically a 1964 benchmark study set forth in SEWRPC Technical Report No. 4, Water Quality and Flow of Streams in Southeastern Wisconsin, sulfates were not found to be present within the surface waters of the Region at such levels as to impair water use. At the levels presently found in the atmosphere in southeastern Wisconsin, carbon monoxide would not be expected to adversely affect water quality. Hydrocarbons, although critical in the formation of photochemical oxidants, have not been found in any of the Commission inland lake studies to be an important problem in lakes, based on the data obtained to date in Commission lake and stream studies. Moreover, any hydrocarbon contributions to streams would be expected to be overshadowed by the effects of urban storm water runoff containing oil and grease derived from street and highway surfaces, as well as from parking areas and industrial and commercial activities. Ozone, as a contaminant in the air, could in fact be beneficial to water quality by providing additional dissolved oxygen to support fish and other animal life in the lakes and streams of the Region.

Similarly, the effects of water pollutants and water quality control measures upon air quality in the Region were deemed to be minimal. One possible source of air pollutants might be the incineration of sludges generated as a by-product of wastewater treatment. In recognition of this potential problem, the sludge management element of the areawide water quality management plan as summarized in this report does not contain any proposals for new sludge incineration units. Existing sludge incineration units in the Cities of Brookfield and South Milwaukee are recommended to be maintained, but these were not found to constitute significant air pollution sources. In this respect, the regional air quality maintenance planning program identifies each significant point source of air contaminants, including the existing sludge incinerators, and evaluates its importance in the attainment of the ambient air quality standards.

The sludge management plan alternatives identified—for facilities plan review—the possibility of pyrolysis units for the Jones Island or South Shore Sewerage treatment facilities of the Milwaukee-Metropolitan Sewerage District. This alternative was, however, eliminated during the more detailed facilities planning analysis prepared by the Metropolitan Sewerage District in coordination with the areawide water quality management planning process.

The areawide water quality management plan will recommend some wastewater management facilities and practices which could potentially contribute to the localized degradation of air quality in the Region with respect to sulfur dioxide and nitrogen dioxide as by-products of wastewater treatment or hydrocarbons from the storage of fuels for alternate power sources. These effects would be modest and the engineering studies, which must precede the design and construction of such facilities would address these questions in the environmental assessments required for such projects. It is anticipated, however, that the regional air quality maintenance planning program will also evaluate the potential importance of this possibility for regional air quality changes. It is not expected that any of the facilities discussed in this plan will generate carbon monoxide to any significant degree.

It should be noted that the generation of nitrogen dioxide and its release to the atmosphere should be reduced by the water quality management plan. The sludge management plan element recommends storing sludge in proper facilities during periods of adverse weather for spreading, and thereby reducing nitrogen losses associated with larger surface residence times. The sludge element also recommends incorporating sludge into the land surface during application, further reducing atmospheric losses. Similarly, the recommendation for storage of livestock wastes, during the period of frozen ground and ice cover will in fact reduce the losses of nitrogen atmosphere and will enhance the value of the wastes for agricultural reuse.

Of major importance in the development of a sound comprehensive regional plan and the water quality management plan element thereof, is the consideration of the indirect effects of the recommended actions upon regional development and environmental management. It is sometimes held that the provision of sanitary sewerage service, as well as high-speed all-weather freeway facilities, will encourage urban sprawl and an attendant decline in air quality. In this regard, and by its regional planning strategy, the Commission has sought to minimize the indirect effects of the water pollution abatement measures, by providing for the accommodation of further urban residential development in accordance with three fundamental concepts. The first, calls for the accommodation of future development at medium and high population densities in areas contiguous to and outward from the existing areas served by public water supply, centralized sanitary sewerage systems, and other urban services. The second concept calls for protection of the primary environmental corridors, and the prime woodlands, wetlands, and wildlife habitat areas, the undeveloped shorelands and floodlands, the organic soils, and areas of ground water recharge and discharge located in these corridors of the Region, through the proper design and location of such urban development and through the preservation of the primary environmental corridors in essentially natural open uses. Finally, the Commission comprehensive planning programs are based on the principle that prime agricultural lands should be preserved from urban development wherever possible. Based on the land use plan underlying the development of the areawide water quality management plan, and application of that land use plan in the development of the air quality maintenance plan, it is intended that the indirect effects of urban development and of water quality management measures upon air quality be considered both implicitly and explicitly.

Physiography

The Southeastern Wisconsin Planning Region is located in the upper midwest between Lake Michigan on the east, the Green Bay-Lake Winnebago lowlands on the north, the Rock River basin on the west, and the low dunes swampland at the headwaters of the Illinois River on the south. The seven-county planning Region extends for approximately 52 miles from east to west at its widest extent and approximately 72 miles from north to south. The Region encompasses approximately 2,621 square miles of land area and 68 square miles of inland water area exclusive of Lake Michigan, or a total gross land and water area of approximately 2,689 square miles, or 1,720,000 acres. Topographic elevations range from approximately 580 feet above mean sea level at the Lake Michigan shore to about 1,320 feet above mean sea level at Holy Hill in southwestern Washington County. The Region lies astride a major subcontinental divide between the upper Mississippi River and the Great Lakes-St. Lawrence River drainage basins. Glaciation has largely determined the physiography and topography as well as the soils of this part of the State. There is evidence of four major stages of glaciation in the Region. The last and most influential in terms of present physiography and topography was the Wisconsin Stage which is believed to have ended about 11,000 years ago. The major physiographic features or superficial land forms of southeastern Wisconsin resulting from this glaciation are shown on Map 15. Variations in topographic elevations within the Region are shown in generalized form on Map 16.

One of the dominant physiographic and topographic features of the Region is the Kettle Moraine. An interlobate glacial deposit or moraine formed between the Green Bay and Lake Michigan tongues or lobes of the continental glacier which moved in a generally southerly direction from its point of origin in what is now Canada. Topographically high points in the Kettle Moraine include areas around Lake Geneva in Walworth County; areas in southwestern Waukesha County north of Eagle; areas in central Waukesha County around Lapham Peak, and areas around Holy Hill in Hartford in southwestern and western Washington County. The Kettle Moraine, which is oriented in a general northeast-southwest direction across western Washington, Waukesha, and Walworth Counties, is a complex system of kames or crudely stratified conical hills and kettle holes marking the site of glacial ice blocks that became separated from the ice mass and melted to form depressions; and eskers consisting of long narrow ridges of drift deposited in the drainageways formed within the glacial mass. The Kettle Moraine forms some of the most attractive and interesting landscapes within the Region, as well as providing the areas of highest elevation and relief within the Region. The Kettle Moraine of Wisconsin, much of which is within the Region, is considered one of the finest examples of glacial interlobate moraine in the world. Because of its still predominantly rural character and its exceptional natural beauty, the Kettle Moraine and the surrounding area is subject to increasing urban development pressure.

The remainder of the Region is covered by a variety of glacial land forms and features including kames, ground moraine or heterogeneous material deposited beneath the ice, recessional moraines consisting of material deposited at the forward margins of the ice sheet, the lacustrine basins or former lake sites, outwash plains formed by action of flowing glacial meltwater, eskers or elongated meandering ridges of rudely stratified water laid sand and gravel deposits, and drumlins or elongated mounds of drift molded by and parallel to the advancing glacier.

Glacial land forms are of economic significance because they determine the surface water drainage configuration and limit the land uses which may occur, and some are prime sources of sand and gravel for highway and other construction purposes. Many of the larger topographic depressions of the Region, including the kettle holes that have developed into the numerous lakes which dot large areas of western Washington, Waukesha, and Walworth Counties, are becoming increasingly popular both as recreation areas and as focal points for residential development.

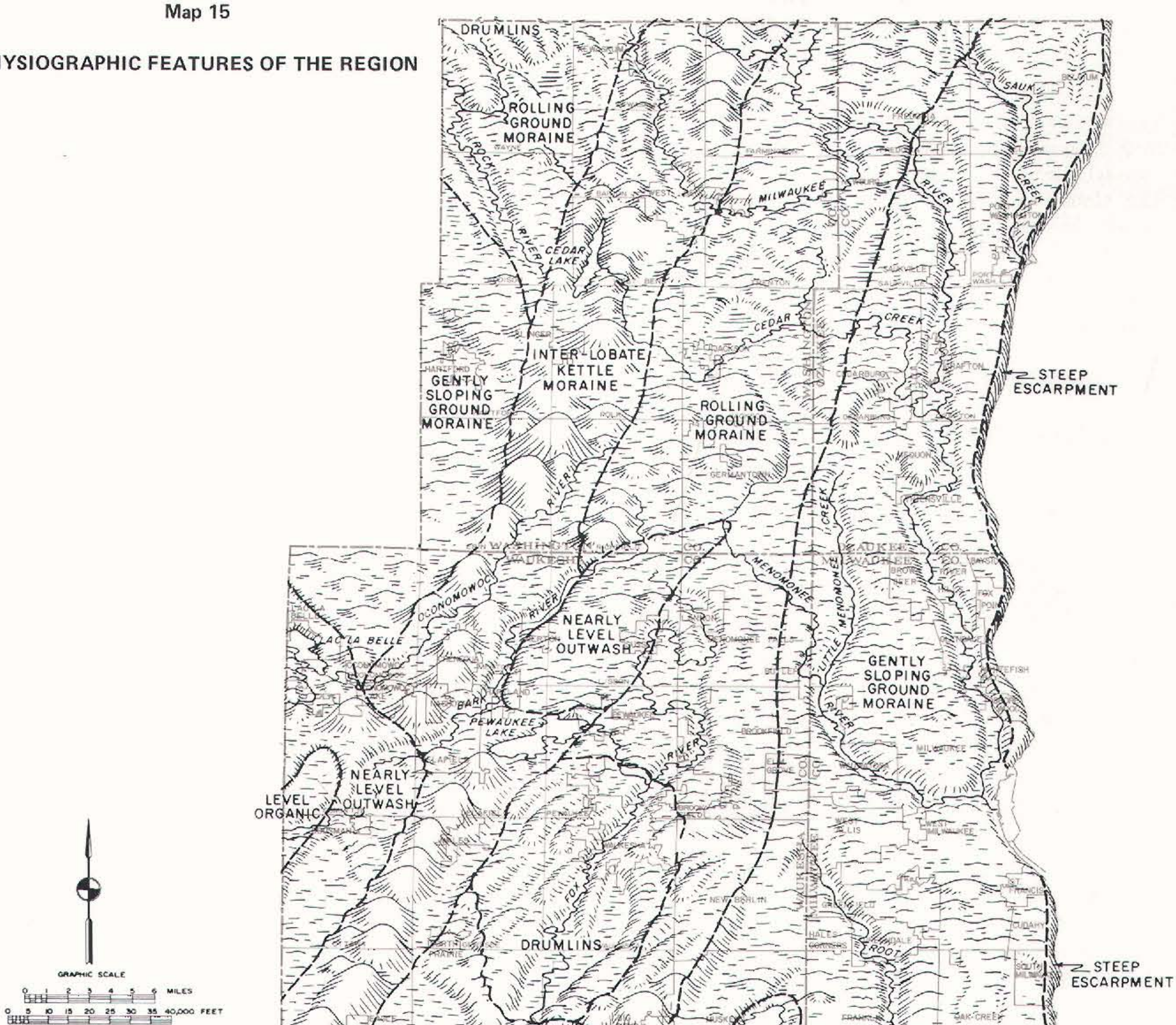
The surface drainage of the Planning Region is poorly developed but highly diverse due to the effects of the relatively recent glaciation. The land surface is complex as a result of being covered by glacial drift containing thousands of closed depressions that range in size from mere pits to large areas. Significant areas of the Region are covered by wetlands, and many streams are mere threads of water through these wetlands. The twelve major watersheds of southeastern Wisconsin as well as their subwatersheds are depicted on Map 17 along with the surface drainage pattern of the major perennial stream systems.

A major subcontinental divide oriented in a generally northwesterly-southeasterly direction divides the Region such that about 1,685 square miles, or 63 percent of the Region lying west of the divide, drain to the Mississippi River while the remaining 1,004 square miles, or 37 percent, are tributary to the Great Lakes-St. Lawrence River drainage basin. The subcontinental divide not only exerts a major physical influence on the gross drainage pattern of the Region, but carries with it certain legal constraints on the diversion of water across the divide and thereby constitutes an important consideration in developing an areawide water quality management plan.

The surface water drainage pattern of southeastern Wisconsin may be, as indicated above, further subdivided

Map 15

PHYSIOGRAPHIC FEATURES OF THE REGION



Physiographic features, or surficial land forms, throughout southeastern Wisconsin were determined largely by repeated stages of glaciation, the last of which, the Wisconsin stage, is believed to have ended about 10,000 years ago. Included in the great variety of interesting and attractive glacial land forms covering the Region are ground and recessional moraines, abandoned lake basins, outwash plains, kames, eskers, and drumlins. The dominant feature is the Kettle Moraine, an interlobate moraine lying in a northeasterly-southwesterly direction within the western part of the Region and formed by and between the Green Bay and Lake Michigan lobes of the continental glacier.

Source: SEWRPC.

Map 16

TOPOGRAPHIC CHARACTERISTICS OF THE REGION

LEGEND

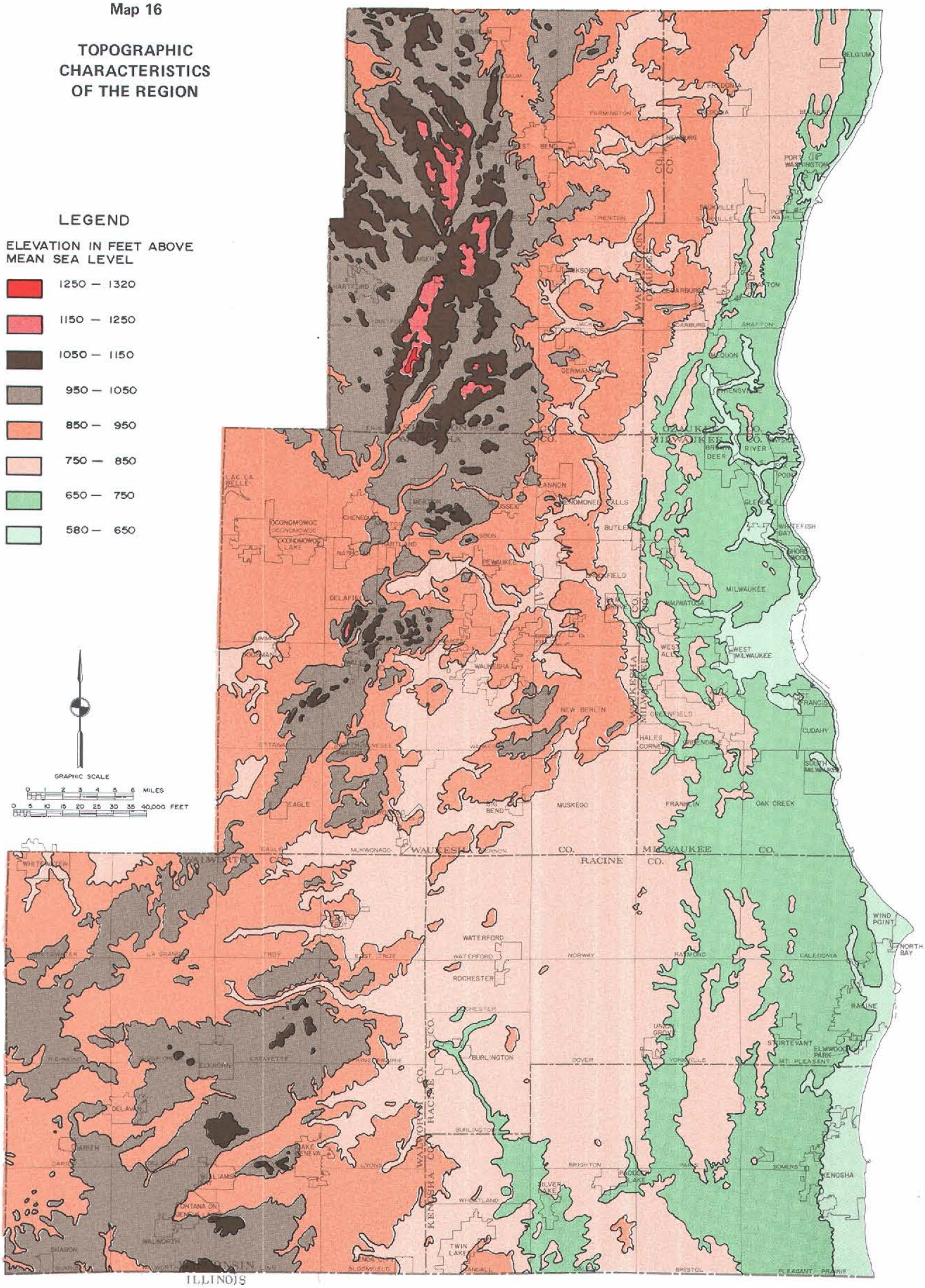
ELEVATION IN FEET ABOVE MEAN SEA LEVEL

- 1250 — 1320
- 1150 — 1250
- 1050 — 1150
- 950 — 1050
- 850 — 950
- 750 — 850
- 650 — 750
- 580 — 650

GRAPHIC SCALE

0 1 2 3 4 5 6 MILES

0 5 10 15 20 25 30 35 40,000 FEET

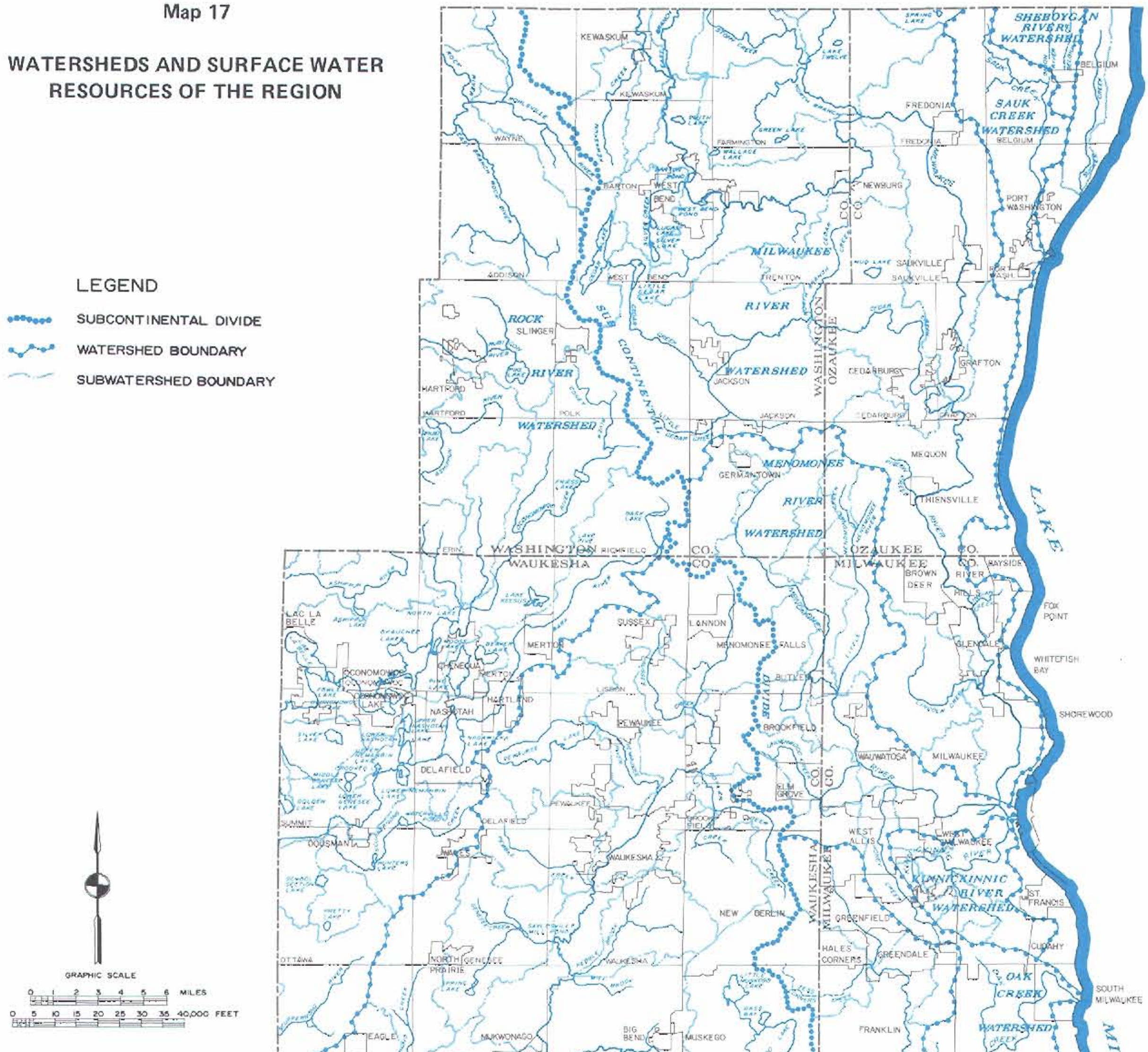


The topography, or relative elevation of the land surface throughout the Region, is determined by the configuration of the bedrock geology in combination with overlying glacial deposits. Elevations within southeastern Wisconsin range from a low of about 580 feet above mean sea level (MSL) on the Lake Michigan shore to a high of 1,320 feet MSL at Holy Hill in southwestern Washington County. Topographic highs and some of the most attractive landscapes and scenic vistas in the Region are coincident with the interlobate Kettle Moraine area in the western portion of the Region.

Source: SEWRPC.

Map 17

WATERSHEDS AND SURFACE WATER RESOURCES OF THE REGION



A subcontinental divide traverses the Southeastern Wisconsin Region. That part of the Region lying east of this divide is tributary to the Great Lakes-St. Lawrence River drainage system, while that part of the Region lying west of this divide is tributary to the Mississippi River drainage system. This subcontinental divide has important implications for water resources planning and management, since major diversions of water across this divide are restricted by law and interstate and international compacts. The generally dendritic surface water drainage pattern of the Region, which is the result of the glacial land forms and features, divides the Region into 11 individual watersheds, three of which—the Des Plaines, Fox, and Rock River watersheds—lie west of the subcontinental divide. In addition to the 11 watersheds, there are numerous small catchment areas along the Lake Michigan shoreline that drain directly to the lake, which together may be considered to comprise a twelfth watershed.

Source: SEWRPC.

so as to identify 12 major watersheds. Five of these major watersheds—the Root River, Menomonee River, Kinnickinnic River, Oak Creek, and Pike River watersheds—are wholly contained within the Region. The drainage in the Region tends to exhibit a disordered dendritic pattern except for a small area of trellised or rectilinear drainage evident in the Des Plaines River watershed and in the Racine County portion of the Root River watershed. The Fox River watershed and the headwaters of the Rock River and Des Plaines River watersheds drain to the south and southwest toward their confluence with the Illinois River, a tributary of the Mississippi River. The remainder of the Region generally drains in an easterly direction toward Lake Michigan by way of the Milwaukee River, Menomonee River, Root River, and other drainages.

Geology

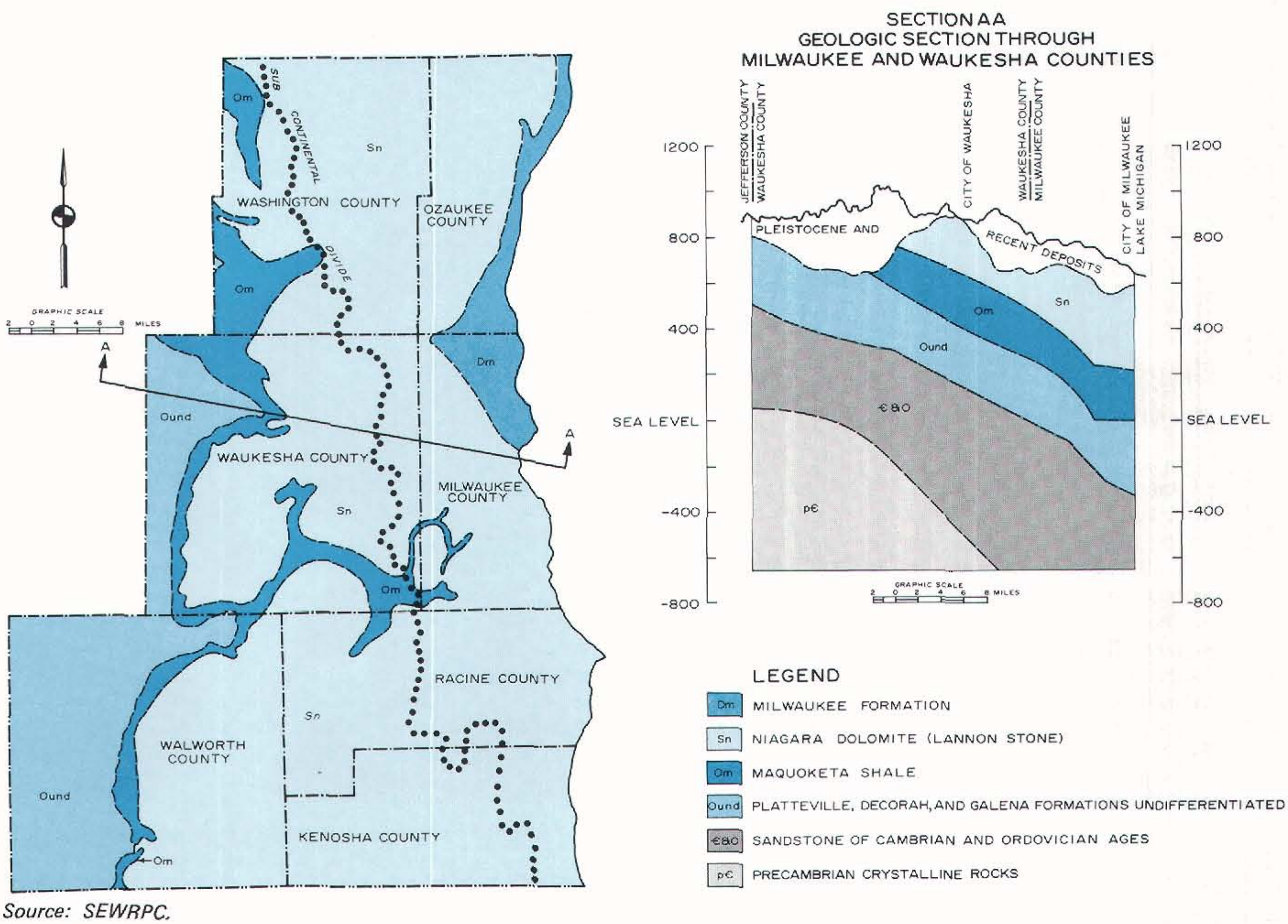
Bedrock: The bedrock formations underlying the unconsolidated surficial deposits of southeastern Wisconsin consist of Cambrian through Devonian period rocks of the Paleozoic era that attain a thickness in excess of 1,500 feet along the eastern limits of the Region, which are in turn underlain by older, predominantly crystalline rocks of the Precambrian era. The bedrock geology of the Region is shown in Figure 14 by means of a map of the surface of the bedrock supplemented with a representative vertical section.

A stratigraphic column including a description of the lithologic characteristics of bedrock formations beginning with those dating back to the Ordovician period and of glacial deposits is presented in Table 21. Bedrock formations in the Region dip gently down toward the east at an average slope of about 20 feet per mile, with the result that the bedrock lying immediately beneath the unconsolidated surficial deposits in the western extremities of the Region includes older rocks of the Ordovician period, whereas in the east along Lake Michigan younger rocks of the Silurian and Devonian periods lie immediately beneath the surficial deposits.

Surficial Deposits: The bedrock of the Region is, for the most part, covered by deep, unconsolidated glacial deposits, attaining a thickness in excess of 500 feet in some buried preglacial valleys. Bedrock lies within 20 feet

Figure 14

MAP AND CROSS SECTION OF BEDROCK GEOLOGY IN THE REGION



Source: SEWRPC.

Table 21

STRATIGRAPHIC COLUMN OF BEDROCK AND GLACIAL DEPOSITS IN THE REGION

System	Series	Formation	Lithologic Description
Quaternary		Recent Deposits	Soils, muck, peat, alluvium, beach sand, and gravel. 0 to 5 feet thick.
		Pleistocene Deposits	Till and outwash sand and gravel. 0 to 430 feet thick.
		Kenwood	Shale, black, carbonaceous. Fossiliferous. No outcrops. Found in City of Milwaukee intake tunnel—Lake Michigan. Approximately 55 feet thick.
Devonian	Middle Erian	Milwaukee	Shale, shaly limestone; lower 1/3 dolomite. Fossiliferous. Approximately 130 feet thick.
		Thiensville	Dolomite, thick to thin-bedded. Some fossils. Small amounts of bitumen. Approximately 65 feet thick.
		Lake Church	Dolomite, thick to thin-bedded. Fossiliferous. Pyritic in places. Approximately 27 feet thick.
Silurian	Cayugan	Waubakee	Dolomite, thin-bedded, hard and brittle. Fossils scarce. Approximately 30 feet thick.
	Niagaran	Racine	Dolomite, fine to coarsely crystalline. Thick- to thin-bedded. Barren to fossiliferous. Approximately 100 feet thick.
		Manistique	Dolomite—lower part thin-bedded. Fossils. Upper—fairly thin-bedded, cherty. Many corals. Approximately 150 feet thick.
		Burnt Bluff	Dolomite, thick-bedded or thin-bedded. Lower part, a few fossils. Upper part, semilithographic. No fossils. Approximately 110 feet thick.
	Alexandrian	Mayville	Dolomite, thick-bedded, compact to coarsely crystalline. Brecciated in places, cherty, many reef structures. Approximately 175 feet thick.
Ordovician	Cincinnatian	Meda	Red-brown oolitic iron ore and nonoolitic ore. Missing in Racine, Milwaukee, Ozaukee, Door, and Dodge Counties. In lenses up to approximately 55 feet thick.
		Maquoketa	Shale, dolomitic and beds of dolomite. Fossiliferous. 90 to 225 feet thick.
	Champlainian	Salena	Dolomite, thick- to thin-bedded, fine to coarsely crystalline. Cherty. Shaly and sandy in places; some fossils. Approximately 227 feet thick.

Source: SEWRPC.

of the ground surface within areas of the Region which together total only about 150 square miles in extent, and a few localized areas exist where the bedrock is actually exposed at the surface. These shallow drift areas and rock outcrops tend to occur in Washington and Waukesha Counties along a northeasterly-southwesterly alignment generally paralleling the interlobate Kettle Moraine, and reflect the presence of a preglacial ridge. Map 18 depicts the spatial variation of the thickness of surficial deposits overlying the bedrock that may be generally expected within the Region.

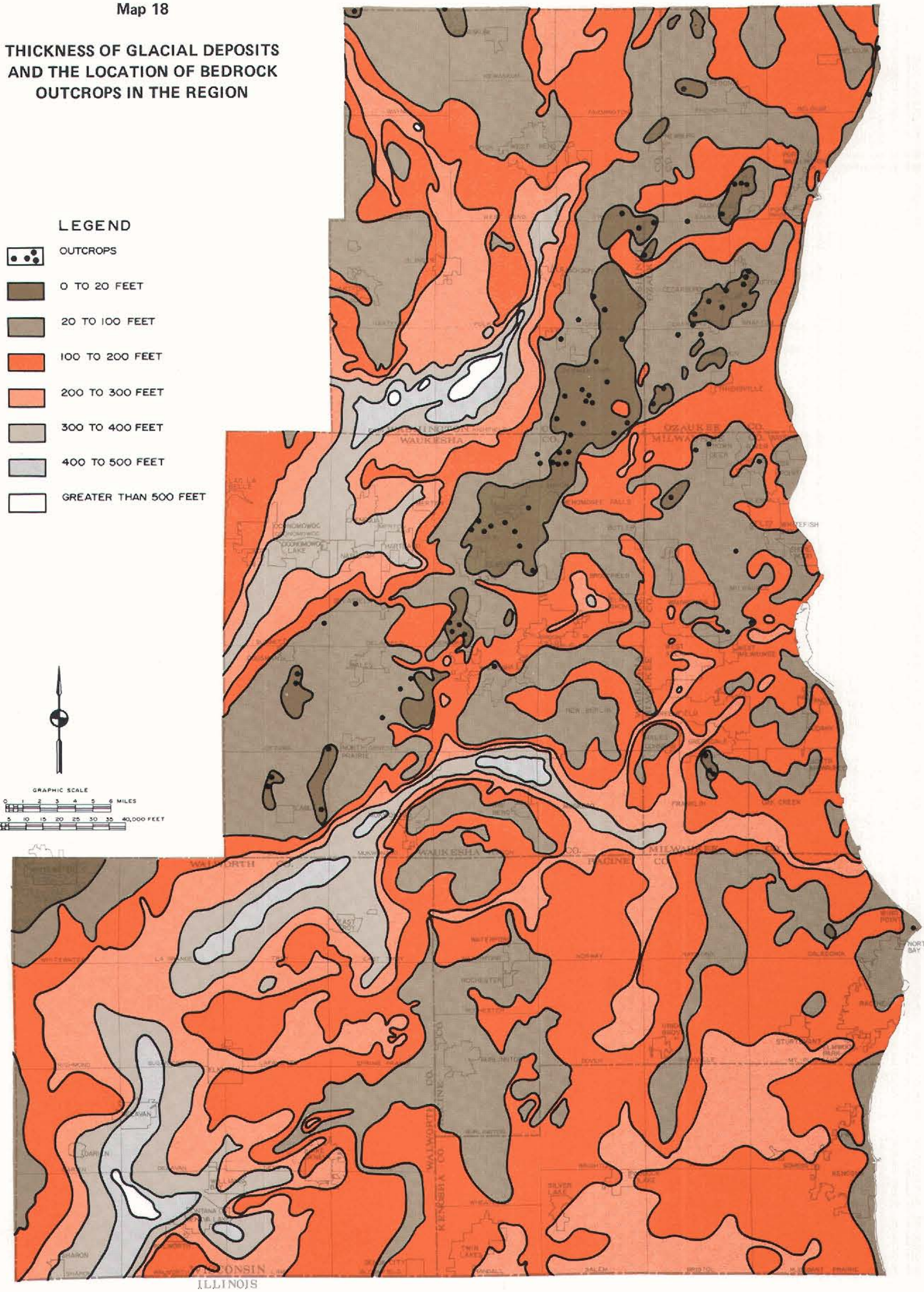
Mineral and Organic Resources

Sand and gravel, dolomite building stone, and organic material are the three principal mineral and organic resources in the Region that have significant commercial value as a result of their quantity, quality, and location. The commercial utilization of the Region's mineral resources, which is limited to the mining of nonmetal deposits, is primarily directed toward supplying the construction materials needed for the continuing development of southeastern Wisconsin. The Region as a whole has an abundant supply of sand and gravel deposits as a result of its glacial history, with the highest quality deposits being found in glacial outwash areas, particularly near the interlobate Kettle Moraine, where the washing action of flowing meltwaters has sorted the unconsolidated material so as to form more or less homogeneous and, therefore, commercially attractive deposits.

Sand and Gravel Stone Quarries: Deposits of sand and gravel are, as shown on Map 19, scattered throughout the Region. The greatest concentration of commercial strip-mining activity, however, occurs in Waukesha County

Map 18

THICKNESS OF GLACIAL DEPOSITS AND THE LOCATION OF BEDROCK OUTCROPS IN THE REGION

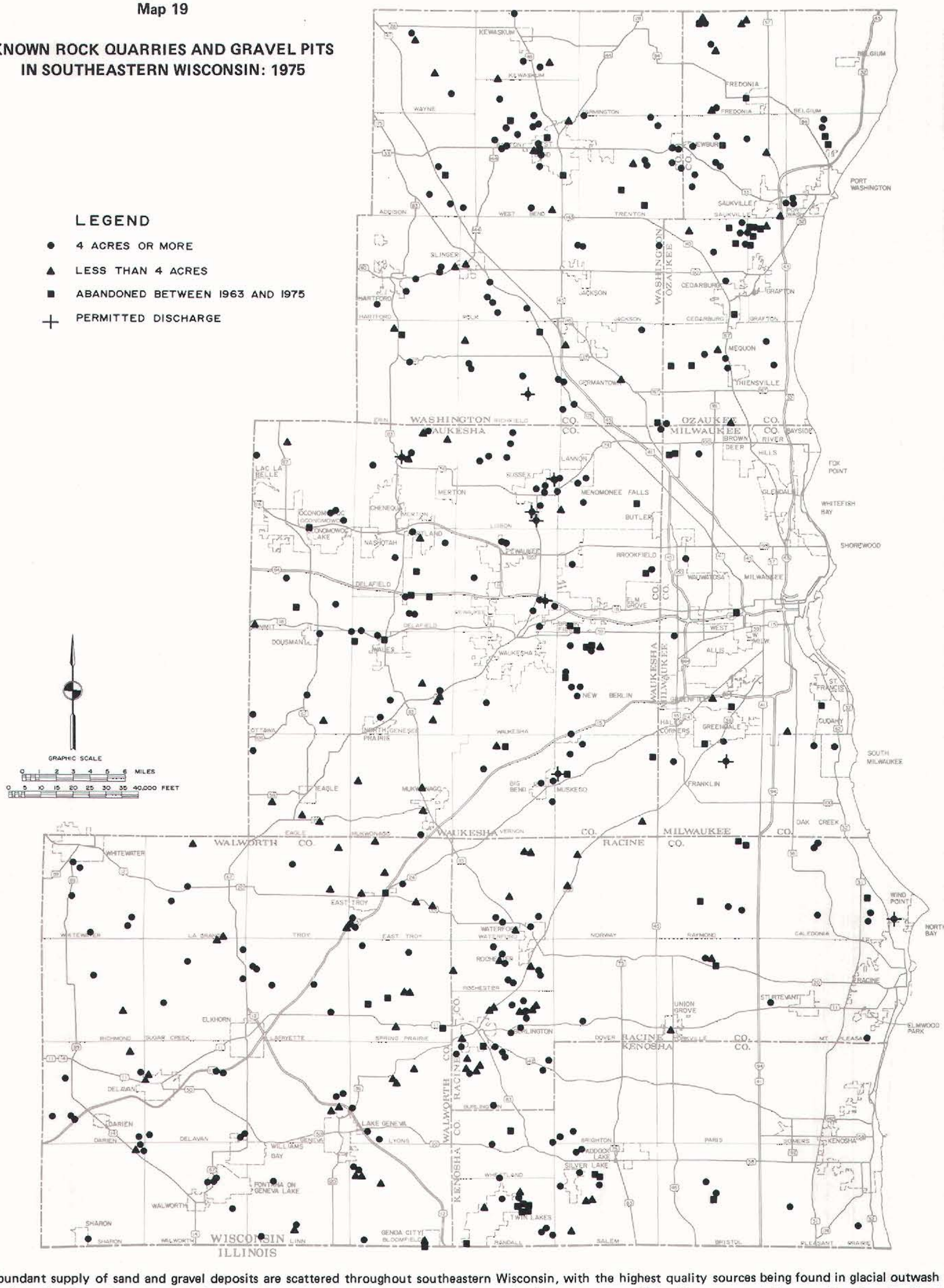


Most of the Region is covered by unconsolidated glacial drift deposited by continental glaciers. This drift attains a thickness in excess of 500 feet in some preglacial valleys. Dolomitic bedrock lies within 20 feet of the surface or is actually exposed as outcrops in areas totaling about 150 square miles. The northeasterly-southwesterly alignment of the rock outcrop sites indicates the presence of a buried preglacial bedrock ridge which is an important consideration in planning for and construction of septic tank systems, public sewerage systems, and other public works projects that involve extensive trenching and excavation.

Source: T. O. Friz, Man and the Materials of Construction, How They Interrelate in the Seven Counties of Southeastern Wisconsin, Ph.D. Dissertation, University of Wisconsin, Madison, Wisconsin, 1969.

Map 19

KNOWN ROCK QUARRIES AND GRAVEL PITS IN SOUTHEASTERN WISCONSIN: 1975



An abundant supply of sand and gravel deposits are scattered throughout southeastern Wisconsin, with the highest quality sources being found in glacial outwash areas where flowing melt waters tended to sort the sand and gravel so as to form more or less homogeneous, and therefore commercially attractive, deposits. Sand and gravel deposits, which are commercially mined by strip-mining techniques, constitute a very important raw material for construction and certain industrial activities in the Region in that they provide concrete aggregate, gravel for road subgrades and surfacing, sand for mortar, and molding sand. Conversely, these strip-mining activities are industrial in nature and may cause soil particles to be available for transport by significant amounts of precipitation runoff and by stream waters.

Source: Wisconsin Geological and Natural History Survey and SEWRPC.

because sand and gravel in that area has the most favorable quantity and quality characteristics. Sand and gravel deposits are important sources of concrete aggregate, gravel for road subgrade and surfacing, sand for mortar, and molding sand. Depending on the nature of the deposits, particularly their depth and areal extent, the grain size of the particles, and the depth to the water table, sand and gravel deposits may seriously hamper tunneling, trenching, and excavation work, and, therefore, detailed field investigations should be conducted in areas of known or expected deposits prior to initiation of sanitary sewerage system construction.

Niagara dolomite, which lies immediately below the glacial deposits throughout most of the Region (see Figure 14), has commercial value where it is found relatively close to the ground surface, both as a dimensional building stone and, when crushed, as an aggregate for construction or as a fertilizer for agricultural purposes. The dolomite is mined in open quarries, and all the regional commercial operations that produce stone for building purposes are located in Waukesha County, where they are concentrated in rock outcrop areas (see Map 18) in the northeastern portion of the county. Waukesha County quarries yield thinly bedded, compact, and fine-grained dolomite well suited for the mining and production of dimensional building stone. The high-quality dimensional building stone commercially mined and produced in Waukesha County is commonly known or referred to as limestone—that is, primarily calcium carbonate—or lannon stone, although it is, in fact, dolomite—that is, primarily calcium magnesium carbonate. Crushed limestone is produced not only in Waukesha County but also at other quarries located throughout the Region. The presence of quarrying operations in an area indicates relatively thin glacial deposits and close proximity of bedrock to the ground surface and is, therefore, an important consideration in the planning and execution of construction projects, such as sanitary sewerage systems, that entail extensive tunneling, trenching, and excavation.

Organic Deposits: Organic deposits are widely distributed throughout southeastern Wisconsin in small, scattered, low-lying, poorly drained areas. At these locations, excessive moisture inhibits oxidation and decay of the residues of water-tolerant plants, thus producing organic peat deposits and muck soils with significant resulting fertilization potential. These organic deposits overlay the glacial drift of the Region and exhibit variable depths ranging from less than a foot to many feet.

Organic deposits have environmental value, often covering areas suitable for certain kinds of wildlife habitat and recreation areas, and have commercial value in their ability to support field crops such as corn or soybeans, specialized crops such as vegetables, and sod farming and peat mining. Sod and peat are excavated from open pits and marketed as additives to improve soils for potted plants, gardens, and greenhouse nurseries. Agricultural use of organic deposits is contingent upon sufficient depth so that artificial drainage can be developed and maintained.

Organic deposits generally serve to identify those areas of southeastern Wisconsin that are least suited for extensive urbanization and attendant major construction activity. The presence of organic deposits may constitute a serious problem for the development of onsite sewage disposal systems, primarily because of the inherent moisture problem and resultant poor drainage characteristics. Such deposits may also prevent or complicate the construction of sanitary sewerage systems because of the difficulty of operating heaving equipment on, and of work with, organic deposits; because of the poor foundation characteristics of such deposits; and because of the potential infiltration problems through sewer pipe joints, attributable to the high moisture content of such deposits.

Soils

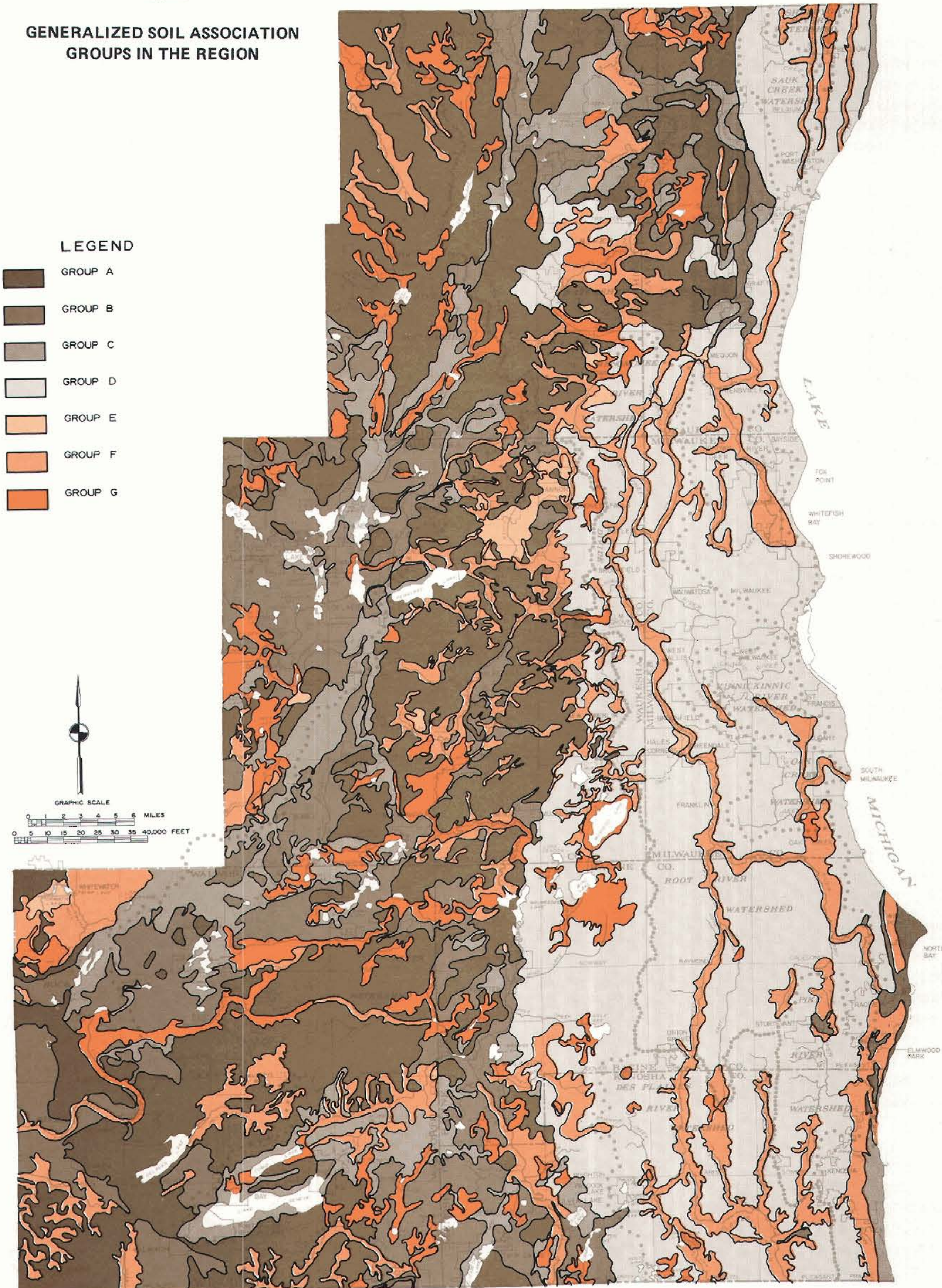
The nature of soils within southeastern Wisconsin has been determined primarily by the interaction of the parent glacial deposits covering the Region and by topography, climate, plants, animals, and time. Within each soil profile the effects of these soil-forming factors are reflected in the transformation of soil components by leaching or by physical removal by wind or water erosion, by additions through chemical precipitation or through physical deposition, and by transfer of some soil components from one part of the soil profile to another.

Soil Diversity and the Regional Soil Survey: Soil-forming factors, particularly topography and the nature of the parent glacial materials, exhibit wide spatial variations in southeastern Wisconsin; therefore, hundreds of different soil types have developed within the Region. In order to assess the significance of these unusually diverse soil types to sound regional development, the Commission in 1963 negotiated a cooperative agreement with the U. S. Soil Conservation Service under which detailed operational soil surveys were completed for the entire planning Region. The results of the soil surveys have been published in SEWRPC Planning Report No. 8, Soils of Southeastern Wisconsin. The regional soil surveys have resulted in the mapping of the soils within the Region in great detail. At the same time, the surveys have provided data on the physical, chemical, and biological properties of the soils, and have provided interpretations of the soil properties for planning, engineering, agricultural, and resource conservation purposes. Any generalization of the findings of the detailed agricultural soil surveys can be meaningful only in light of a full understanding of the complexity of the soil relationships in the Region and of the fact that such a generalization, while useful to a broad identification of general areawide development problems relating to soils, cannot be used in plan preparation and implementation.

Generalized Soil Suitability Interpretations: Map 20 shows, in very generalized form, the major soil relationships existing within the Region, based upon seven broad suitability associations. The soils designated on this map as Group "A," which cover about 29 percent of the Region, are generally well suited for both agricultural use and urban development. These soils are not only productive as cropland, but have good drainage and foundation characteristics for all types of urban

Map 20

GENERALIZED SOIL ASSOCIATION GROUPS IN THE REGION



As shown on this generalized soil map of the seven-county Southeastern Wisconsin Region, nearly one-half of the 2,689-square-mile Region is covered by soils in groups D, E, F, or G which are generally poorly suited for development with onsite soil absorption sewage disposal systems. The detailed soil survey completed for the Region in 1966 provides more definitive soils data for use in local, as well as regional, planning and development.

Source: U. S. Soil Conservation Service and SEWRPC.

development. This soils group occurs generally in a belt lying between the present westerly limits of intensive urban development and the easterly limits of the Kettle Moraine. It is interesting to note that this broad soils group does not occur at all in Milwaukee County and occurs to only a limited extent in Ozaukee, Kenosha, and Racine Counties.

The soils designated as Group "B" generally have a sandy-gravelly subsurface and are well suited to both agricultural use and urban development with septic tank sewage disposal systems. Approximately 14 percent of the Region is covered by this general soils group, which occurs in the Kettle Moraine and the Recessional Moraine areas of the Region and to a limited extent along the Lake Michigan shore.

The soils designated as Group "C" are fair to poorly suited for agricultural use. Their suitability for urban development is limited by characteristically steep slopes. These soils are suited for very large lot residential development which does not disturb the natural topogrpahy. Approximately 8 percent of the Region is covered by this soils group, which is prevalent in the Kettle Moraine and the Recessional Moraine areas of the Region.

The soils designated as Group "D" are generally well suited for agricultural use but generally unsuited for urban development requiring the use of onsite septic tank sewage disposal systems. Urban development on these soils generally requires a high level of municipal improvements and careful attention to stormwater drainage. Nearly 31 percent of the Region is covered by this general soils group, which occurs primarily between the Lake Michigan shore and the westerly limits of present urban development. Much of the existing urban development in the Region has occurred on the soils in this group.

The soils designated as Group "E" are generally not well suited for either cropland or urban development. Bedrock normally occurs within four feet of the surface, and bedrock outcrops are common. Good gravel and rock deposits, which are suitable for commercial development, occur in this group. Approximately 1 percent of the Region is covered by this group, which occurs primarily in isolated pockets throughout the Region.

The soils designated as Group "F" are generally poorly drained, have a high water table, and are interspersed with areas of peat, muck, and other organic soils. Approximately 11 percent of the Region is covered by this group, which generally occurs along streams and watercourses of the Region; and for this reason the soils in this group are commonly subject to flooding. These characteristics generally preclude their use for nearly all forms of development except limited agricultural, wetland, forest, wildlife conservation, and recreational use.

The soils designated as Group "G" are peat and muck soils generally unsuited for urban development of any kind. These areas, when left in a natural state, are ideally suited for wildlife habitat and, if properly drained, are suitable for certain types of agricultural use. Approximately 6 percent of the Region is covered by this soils group, which occurs in scattered corridors and pockets throughout the Region.

It is important to note that, irrespective of the generalized groupings described above, analysis of the detailed soil survey data to date indicates that soils having questionable characteristics for onsite sewage disposal are widespread throughout the Region. Approximately 40 percent of the estimated 125 soils series[6] occurring within the Region have been found to be troublesome in this respect. Urban development undertaken in disregard of these soil conditions has actually created severe environmental problems within the Region, with the result that state health authorities have placed restrictions on the development of new subdivision plats in certain areas of the Region and have issued orders for the installation of public sanitary sewer facilities in other areas originally developed with onsite soil absorption sewage disposal systems. It should also be noted that soils poorly suited or unsuited for urban development, even if served by a public sewer, are also widespread throughout the Region. These include generally wet soils which either have a high water table or a high water holding capacity, or are poorly drained. Urban development on these soil types is expensive to construct initially and expensive to maintain. Again, it should be stressed that the widespread occurrence of soils having questionable characteristics for certain types of urban development, coupled with the highly complex soil relationships, indicates the need for basing regional and local development plans on the results of the detailed soil surveys rather than on any generalized soils data.

Detailed Soil Suitability Interpretations: Particularly important to water quality management and related sanitary sewerage system planning are the soil suitability interpretations for specified types of urban development. These are: residential development with public sanitary sewer service, residential development without public sanitary sewer service on lots smaller than one acre in size, and residential development without public sanitary sewer service on lots one acre or larger in size. Some of the more important considerations in determining soil suitability for urban development include depth to bedrock, depth of water table, likelihood of flooding, soil permeability, and slope.

On the basis of the detailed soil surveys, it is evident that much of the Southeastern Wisconsin Region exhibits severe or very severe limitations for specific types of urban development. As illustrated by Map 21, approximately 716 square miles, or about 27 percent of the area of the Region, are covered by soils which are poorly suited for residential development with public sanitary

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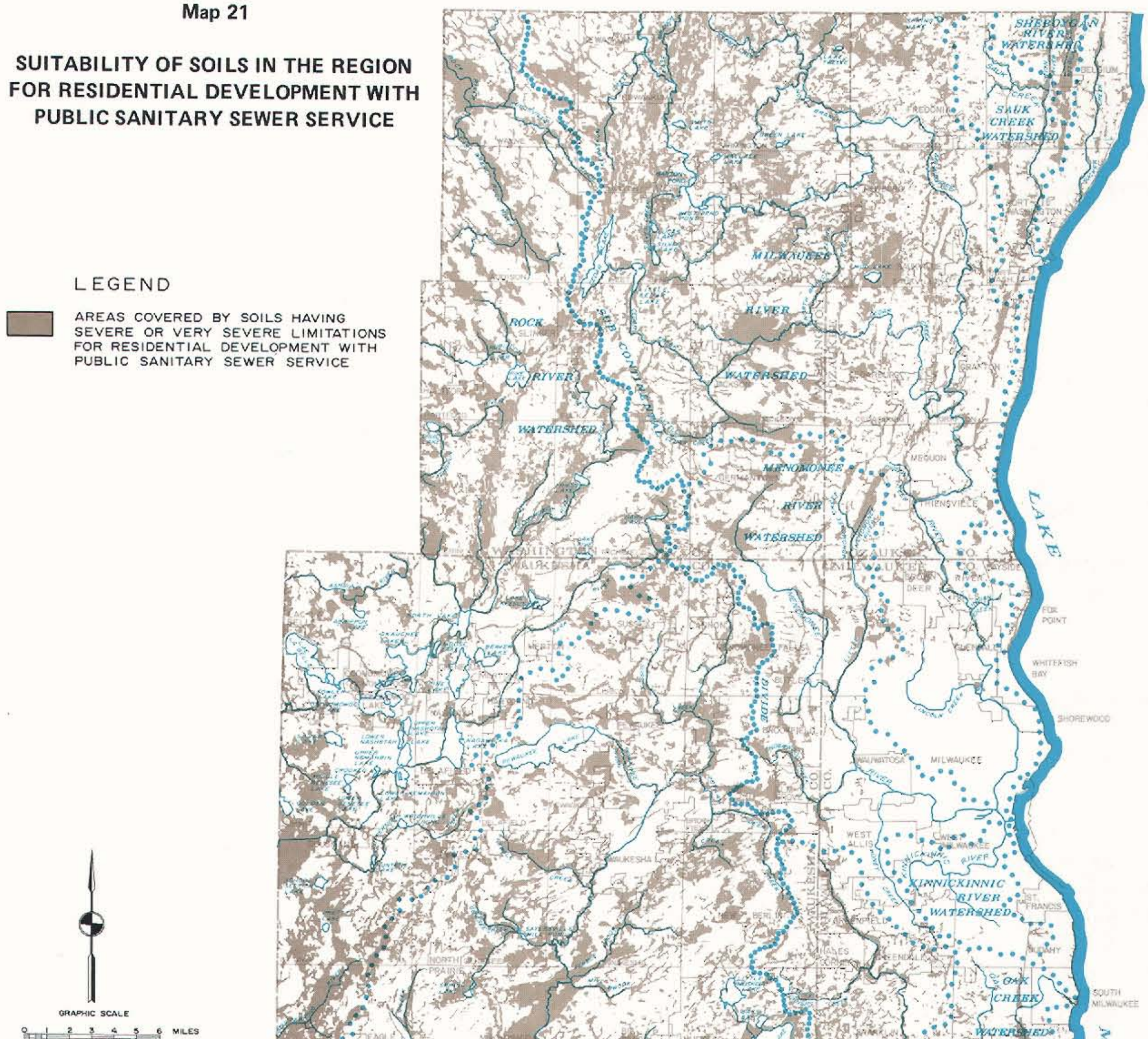
[6] *A soil series is defined as a group of soils developed from a common parent material and having horizons with similar characteristics, except for the texture of the surface soil.*

Map 21

SUITABILITY OF SOILS IN THE REGION FOR RESIDENTIAL DEVELOPMENT WITH PUBLIC SANITARY SEWER SERVICE



A recognition of the limitations inherent in the soil resource base is essential to the sound urban and rural development of the Region. About 716 square miles, or 27 percent of the area of the Region, are covered with soils which are poorly suited for residential development with public sanitary sewer service or, more precisely, residential development of any kind. These soils, which include wet soils having a high water table or poor drainage, organic soils which are poorly drained and provide poor foundation support, and soils which have a flood hazard, are especially prevalent in the riverine areas of the Region.

Source: U. S. Soil Conservation Service and SEWRPC.

sewer service, or stated differently, poorly suited for residential development of any kind. Approximately 1,637 square miles, or about 61 percent of the area of the Region, are, as shown on Map 22, covered by soils which are poorly suited for residential development without public sanitary sewer service on lots smaller than one acre in size. As illustrated by Map 23, approximately 1,181 square miles, or about 44 percent of the area of the Region, are covered by soils poorly suited for residential development without public sanitary sewer service on lots one acre or larger in size. It should be noted that the use suitability ratings on which these maps are based are empirical, being based upon the performance of similar soils elsewhere for the specified uses as well as upon such physically observed conditions as high water table, slow permeability, high shrink-swell potential, low bearing capacity, frost heave, and frequent flood overflow. Figure 15 summarizes the soil suitability situation within the Region with respect to the construction of sanitary sewerage systems and the use of onsite sewage disposal systems.

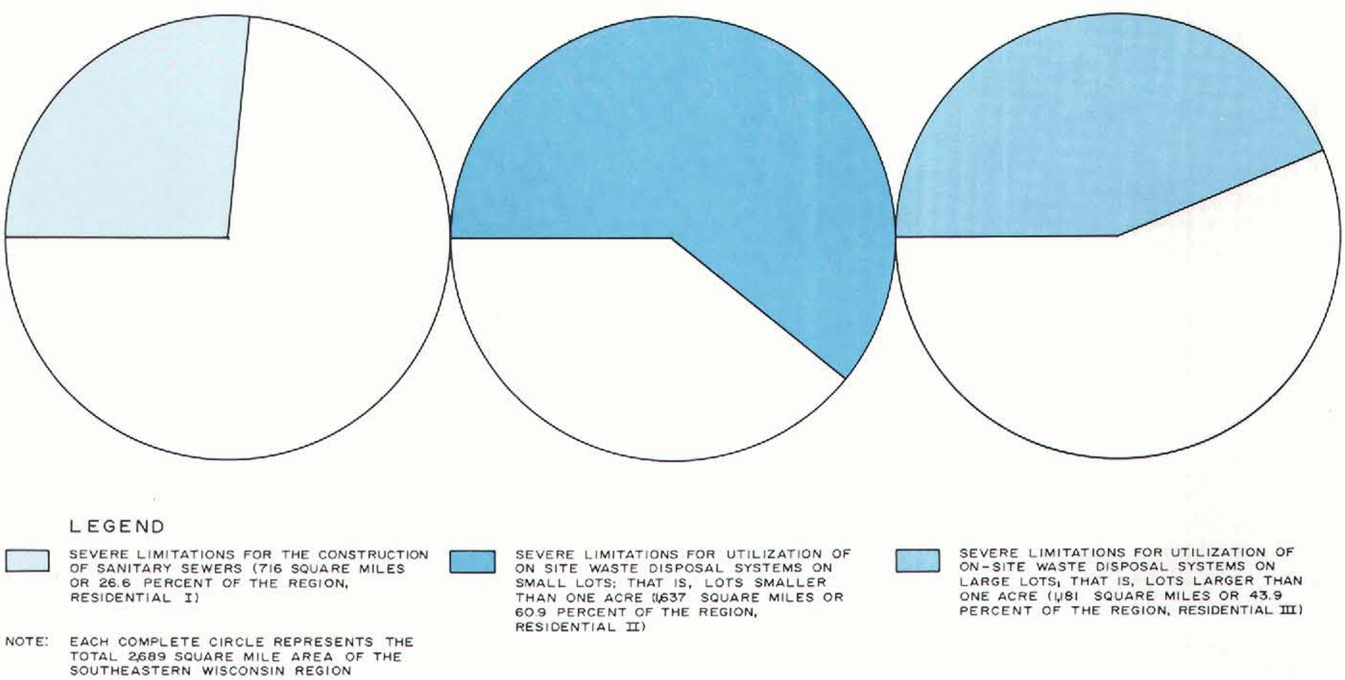
It is useful to interpret the soil suitability data presented in Figure 15 in light of the Commission's new year 2000 regional land use plan. Whereas urban land uses in 1970 encompassed about 512 square miles, or 15 percent of the total area of the Region, the year 2000 plan would accommodate forecast increases in urban population by converting an additional 113 square miles of rural land to urban land use, with that incremental urban development occurring primarily in compact, concentric rings around existing urban centers. Most of the incremental 113 square miles of urban development are, pursuant to the regional land use development objectives upon which the regional land use plan is based, to be served by sanitary sewers. Figure 15 indicates that soil conditions should not inhibit such planned urban development, since about 1,973 square miles, or about 73 percent of the area of the Region, are covered by soils suitable for urban use with sanitary sewers. Even if all of the present 512 square miles of urban development were conservatively assumed to lie within that 73 percent of the seven-county Region, it is apparent that more than a sufficient amount of land with favorable soil conditions is available to accommodate forecast urban expansion to the year 2000.

Approximately 754 square miles, or about 27 percent of the area of the Region, are classified in the year 2000 plan as prime agricultural land. The extent and spatial distribution of these areas are shown on Map 24. It is important to note that the delineation of these prime agricultural lands is based upon the identification of lands which are covered by the most productive soils; the size and extent of the areas farmed; the historic capability of the area to consistently produce better than average crop yields; and the amount of capital invested in farm improvements such as drainage and irrigation systems.

Suitability of Soils for Sludge Application: The suitability of soils for application of sewage sludge at acceptable application rates is highly site specific, being dependent

Figure 15

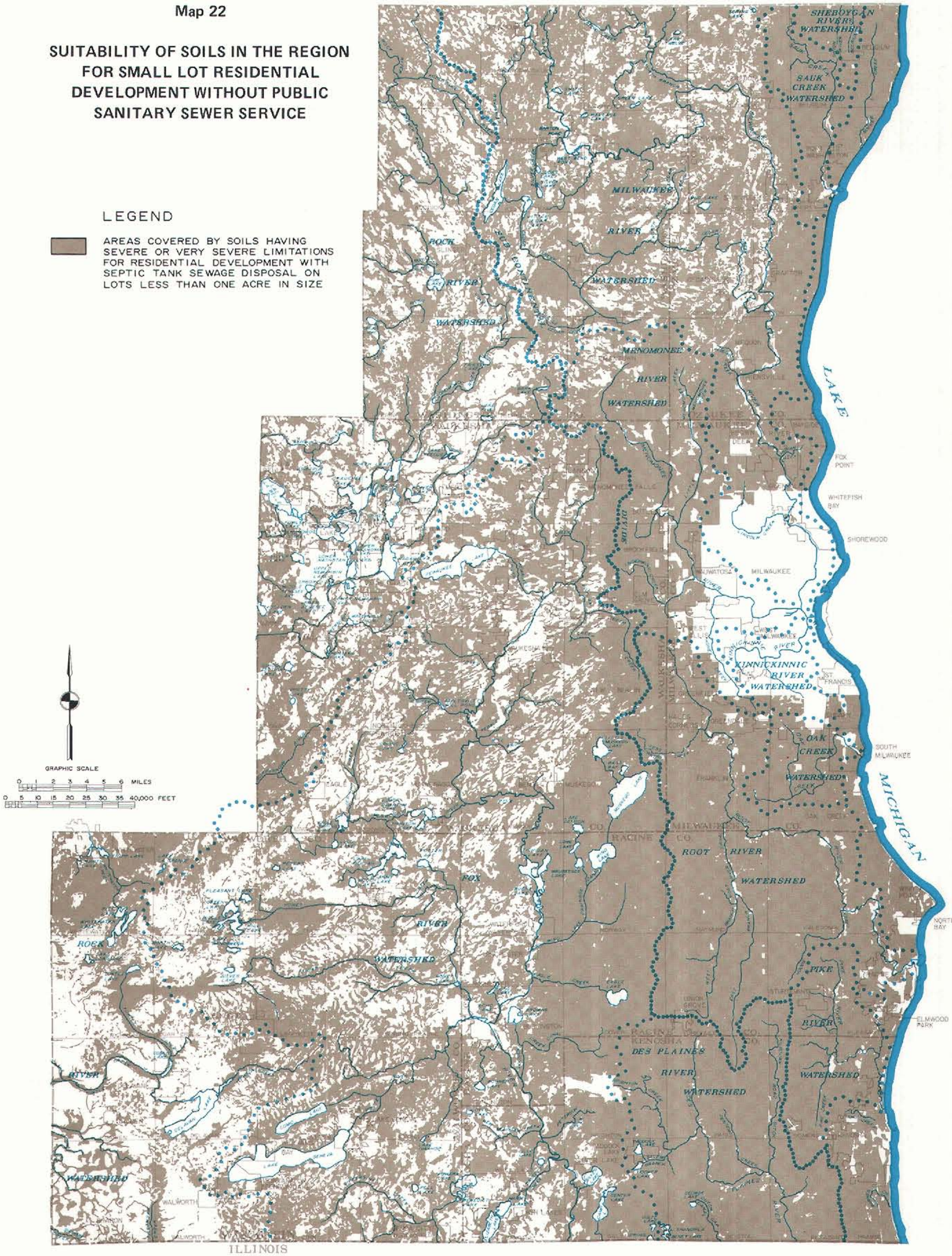
SUMMARY OF SOIL SUITABILITY RATINGS WITH RESPECT TO SEWERAGE SYSTEMS IN THE REGION



Source: SEWRPC.

Map 22

SUITABILITY OF SOILS IN THE REGION FOR SMALL LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE



Approximately 1,637 square miles, or about 61 percent of the area of the Region, are covered by soils poorly suited for residential development on lots having an area smaller than one acre and not served by public sanitary sewerage facilities. Reliance on septic tank sewage disposal systems in these areas, which are covered by relatively impervious soils or are subject to seasonally high water tables, can only result in eventual malfunctioning of such systems and the consequent intensification of water pollution and public health problems in the Region.

Source: U. S. Soil Conservation Service and SEWRPC.

on sludge characteristics, the chemical characteristics of the soil, slope, and soil permeability, and on location with respect to groundwater, location with respect to surface water, and location with respect to bedrock. Map 25 presents the areas of the Region which are covered by soils poorly suited for the application of sewage sludge. In general, thin soils over bedrock, soils with higher water tables, and low pH soils are poorly suited for sludge applications.

On the basis of the detailed soil surveys, interpretive mapping prepared by the Commission indicates that approximately 588 square miles, or about 22 percent of the area of the Region, are severely limited; 868 square miles, or about 32 percent of area of the Region, are moderately limited; 944 square miles, or about 35 percent of the area of the Region, are slightly limited; and about 290 square miles, or about 11 percent of the area of the Region, consist of made land, such as landfills, urban land, or water which would have to be analyzed on a case-by-case basis.

Vegetation

Presettlement Vegetation: Prior to the arrival of European settlers, the vegetation of the Region was influenced by climate, disease, glacial deposits, soil, fire, topography, and natural drainage characteristics. Historical records, including the original U. S. Public Land Survey carried out within the Region in 1836, indicate that frequent fires set by the Indians or initiated by natural causes maintained large portions of southeastern Wisconsin either as open level plains containing orchard-like stands of burr oak—known as oak openings—or as prairies dominated by grasses such as big bluestem and by colorful prairie forbs. Other portions of the Region that were protected from fire by the drainage pattern or local relief developed into deciduous hardwood forests. The upland vegetation of the Region was predominantly a medium wet, or mesic, forest composed of a variety of upland deciduous hardwoods such as maple, beech, basswood, ironwood, and slippery elm. Wetter conditions prevailed in floodlands, old glacial lake beds, and other poorly drained low areas. Tamarack, black ash, willow, and shrubs dominated the wetter areas, while silver maple and American elm grew in seasonally flooded sites. Depending on the susceptibility of certain wetlands to fire, portions of them may have been maintained as shallow marshes or sedge meadows dominated by cattails, sedges, and grasses.

Woodlands: Woodlands in the Region have both economic and ecologic value, and with proper management can serve a variety of uses which provide multiple benefits. The quality of life within an area is greatly influenced by the overall condition of the environment as measured by clean air, clean water, scenic beauty, and ecological diversity. Primarily located on ridges and slopes, along lakes and streams, and in wetlands, woodlands provide an attractive natural resource of immeasurable value. Not only is the beauty of the lakes, streams, and glacial land forms of the Region accentuated by woodlands, but woodlands are essential to maintain the overall quality of the environment. In addition to contributing to clean air and water, the maintenance of woodlands within the Region can contribute to the parallel maintenance of a diversity of plant and animal life in association with human life. The existing woodlands of the Region, which required a century or more to develop, can be destroyed through mismanagement, within a comparatively short time. Deforestation of hillsides contributes to the siltation of lakes and streams and the destruction of wildlife habitat. Woodlands can and should be maintained for their total values—scenic, wildlife, educational, recreational, and watershed protection—as well as for their forest products. Under balanced use and sustained yield management, woodlands can serve many of these benefits simultaneously.

Six forest types are recognized within the Region: northern upland hardwoods, southern upland hardwoods, northern lowland hardwoods, southern lowland hardwoods, northern lowland conifers, and northern upland conifers. The northern and southern upland hardwood types are the most common in the Region. The two upland hardwood types are most utilized for production of commercial forest products.

Inventories of woodlands within the Southeastern Wisconsin Region were conducted by the Commission in 1963 and 1970. As indicated in Table 22 and on Maps 26 and 27, woodlands in the Region in 1970 covered a total combined area of about 125,300 acres, or approximately 7 percent of the total area of the Region, with more than 91,700 acres, or 73 percent, located in Walworth, Washington, and Waukesha Counties. Milwaukee County, with about 3,200 acres of woodlands, had the smallest amount of any county in the Region.

Woodlands in the Region in 1963 covered a combined area of about 130,400 acres. Between 1963 and 1970, losses of woodlands were incurred in certain areas of the Region, due largely to the conversion of woodlands to intensive urban and agricultural land uses. Some of these losses were offset in other areas of the Region as a result of reforestation activities. The overall effect of these changes in woodlands between 1963 and 1970 was a net loss of about 5,100 acres of woodlands, representing a 4 percent decrease in the total amount of woodlands since 1963.

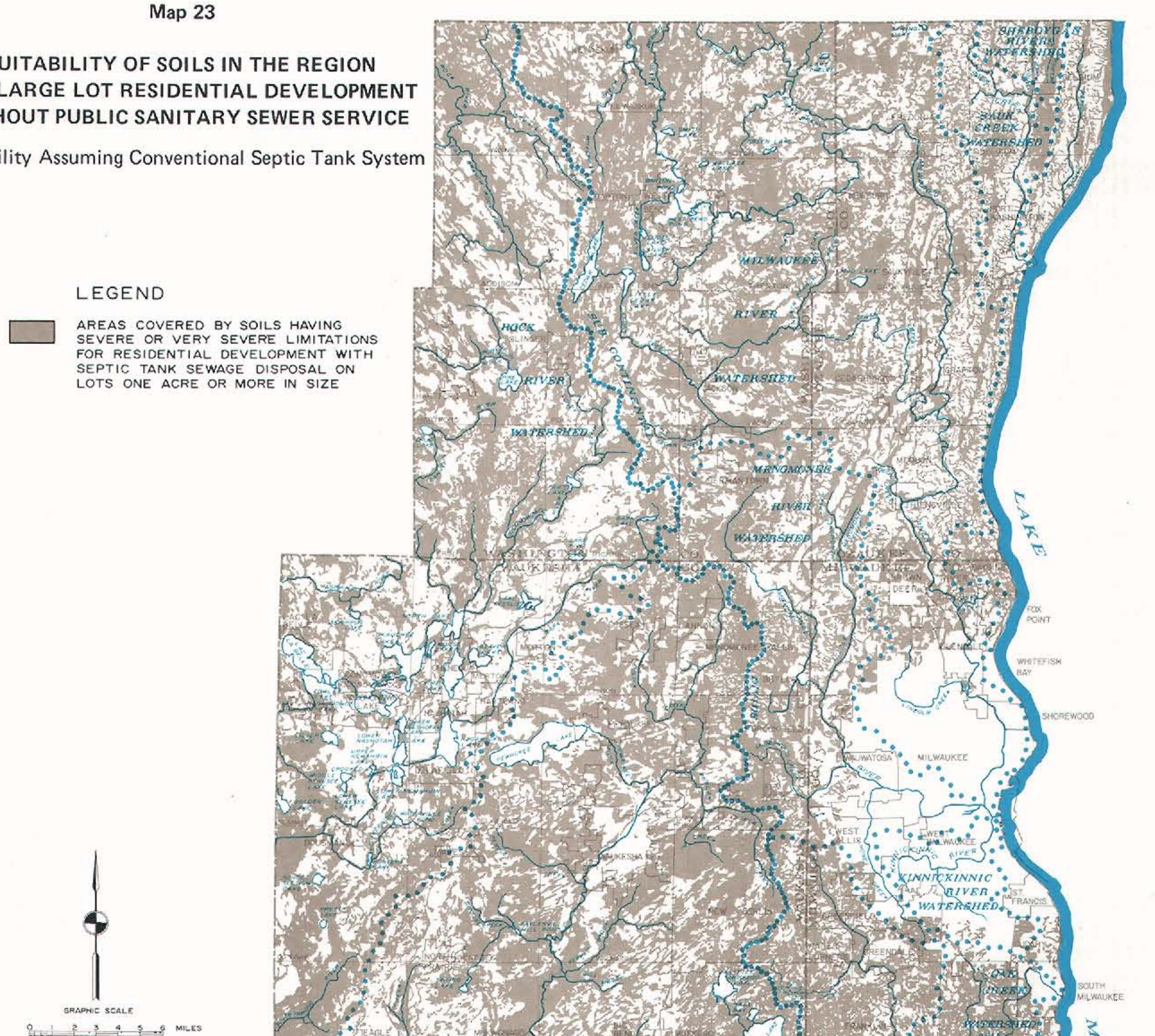
Wetlands: Water and wetland areas probably provide the singularly most important landscape feature within the Region, and can serve to enhance all proximate uses. Their contribution to resource conservation and recreation within the Region is immeasurable, and they contribute both directly and indirectly to the regional economy. Recognizing the many environmental attributes of wetland areas, continued efforts should be made to protect this resource by discouraging costly—both in monetary and environmental terms—wetland draining, filling, and urbanization.

Wetlands represent a variety of stages in the natural filling of lake and pond basins as well as floodplain areas. Wetlands are considered herein as areas in which the water table is at or near the land surface. Such areas

Map 23

SUITABILITY OF SOILS IN THE REGION FOR LARGE LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE

Suitability Assuming Conventional Septic Tank System

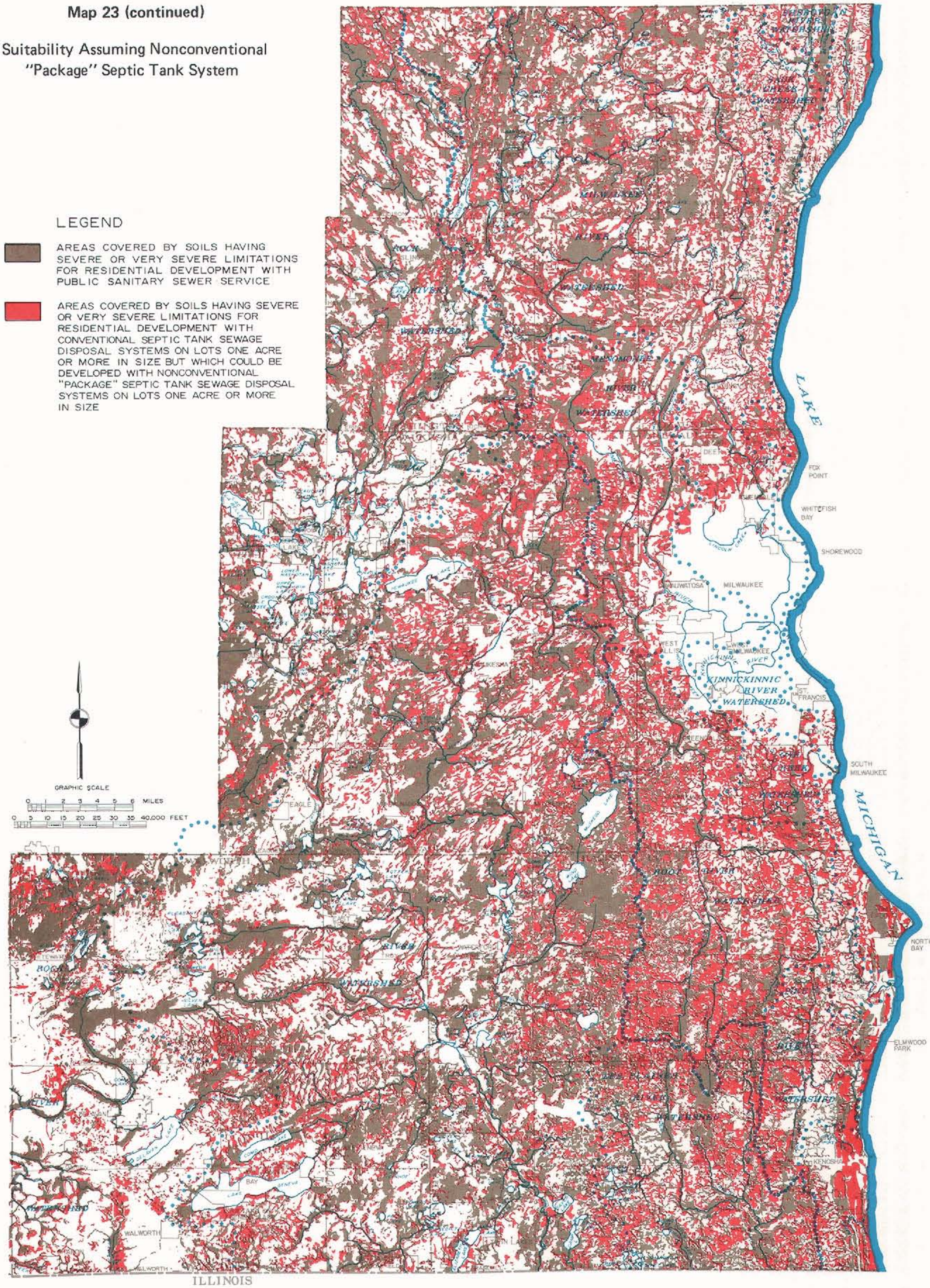


Approximately 1,181 square miles, or about 44 percent of the area of the Region, are covered by soils poorly suited for residential development on lots having an area of one acre or more and not served by public sanitary sewerage facilities. The inherent limitations of these soils for septic tank sewage disposal systems cannot be overcome simply by the provision of larger lots, and the use of such systems on these soils which cannot absorb the sewage effluent, ultimately results in surface ponding and runoff of partially treated wastes into nearby watercourses.

Source: SEWRPC.

Map 23 (continued)

Suitability Assuming Nonconventional "Package" Septic Tank System

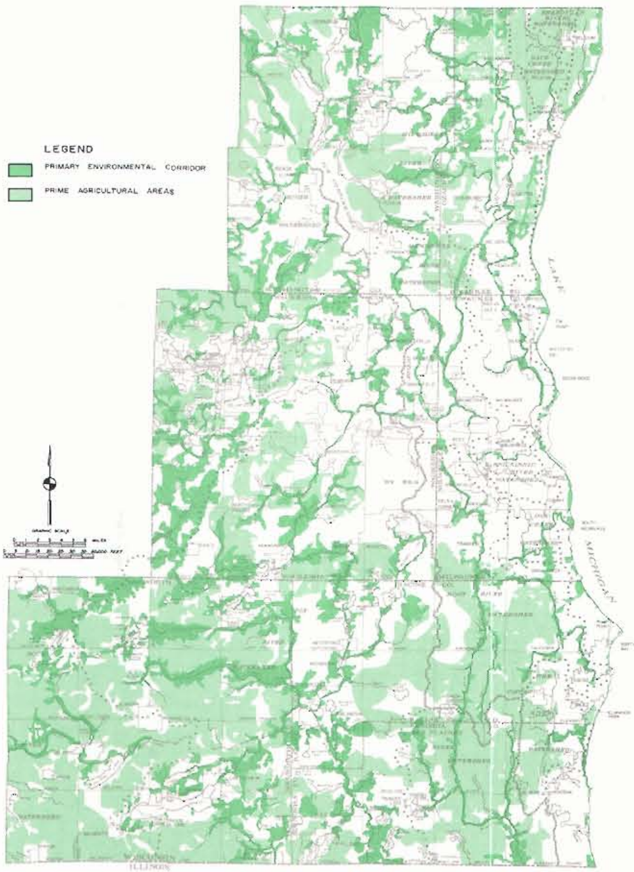


The above map identifies those areas of the Region which, while naturally unsuited for residential development with onsite soil absorption septic tank sewage disposal systems on large lots, could eventually be subject to such development assuming widespread use of the new "package" septic tank sewage disposal systems. Through the construction of artificial mounds and the utilization of mechanical dosing, the new systems overcome natural soil limitations relative to impermeability, high groundwater, and shallow bedrock. These additional areas amount to approximately 465 square miles, or about 17 percent of the area in the Region. Utilization of the new mound systems would require at least a one-acre parcel for a typical single-family home.

Source: SEWRPC.

Map 24

PRIME AGRICULTURAL AREAS
IN THE REGION
YEAR 2000 PLAN



About 754 square miles, or nearly 28 percent of the area of the Region, have been identified in regional planning analyses for the year 2000 as prime agricultural lands. The preservation of these lands in agricultural use will contribute significantly to the maintenance of a healthy ecological balance within the Region; provide for the production of certain food commodities within close proximity to the urban centers of the Region; provide open space to give form and structure to urban development; and contribute to the charm and beauty of the Region. To the extent practicable, sanitary sewer service should be planned so as to discourage urban development in these prime agricultural areas.

Source: SEWRPC.

are generally unsuited or poorly suited for most agricultural or urban development purposes. Wetlands, however, have important ecological value in a natural state. Wetlands contribute to flood control and stream purification, since such areas naturally serve to temporarily store excess runoff and thereby tend to reduce peak flood flows. It has been found that except during periods of unusually high runoff, concentrations of nutrients in waters leaving such areas are considerably lower than in waters entering the wetlands.

Wetlands within Wisconsin have been classified by the Wisconsin Department of Natural Resources according to the national wetland classification system.[7] Under this system, seven major classes of wetlands are recognized: potholes, fresh meadows, shallow marshes, deep marshes, shrub swamps, timber swamps, and bogs.

The wetlands with standing water are well suited for waterfowl and marsh furbearers, while drier types support upland game due to the protection afforded by vegetative cover. Shallow-water wetlands are subject to winter freeze and summer drought, and, therefore, are considered lower in value than the deep-water types of wetlands.

Inventories of water and wetlands within the Southeastern Wisconsin Region were conducted by the Commission as part of the 1963 and 1970 land use inventories. The water and wetland land use category includes all inland lakes, excluding Lake Michigan; all streams, rivers, and canals more than 50 feet in width; and open lands which are intermittently covered with water or which are wet due to a high water table. As indicated in Table 23 and on Map 28, water and wetland areas in the Region in 1970 covered about 180,800 acres, or about 11 percent of the area of the Region, with more than 124,500 acres, or 69 percent, being located in Walworth, Washington, and Waukesha Counties.

Of the total water and wetland category, only 48,000 acres, or 27 percent, actually consist of surface water. The remaining 132,800 acres consist of swamps, marshes, and other wetland areas. Large amounts of surface water areas are located in northwestern Waukesha County, southern Walworth County, and southwestern Kenosha County, while concentrations of wetland areas occur in the Cedarburg Bog in Ozaukee County, the Jackson and Theresa Marshes in Washington County, and the Menomonee Falls and Vernon Marshes in Waukesha County.

The extent of water and wetlands may change in a given area over time as a result of drainage and landfill operations, as well as the construction of new impoundment areas. Furthermore, variations in precipitation may cause the boundaries of wetland areas to fluctuate from time to time. As a result of these changes, there was a net decrease of about 1,600 acres, or approximately 1 percent, in the water and wetlands category in the Region between 1963 and 1970.

As shown on Map 29, both increases and decreases in water and wetland areas occurred in scattered fashion throughout the outlying areas of the Region. There was a net gain of almost 500 acres of water and wetland areas in Racine County between 1963 and 1970, while net decreases occurred in the other six counties, ranging from only four acres in Walworth County to more than 1,000 acres in Waukesha County.

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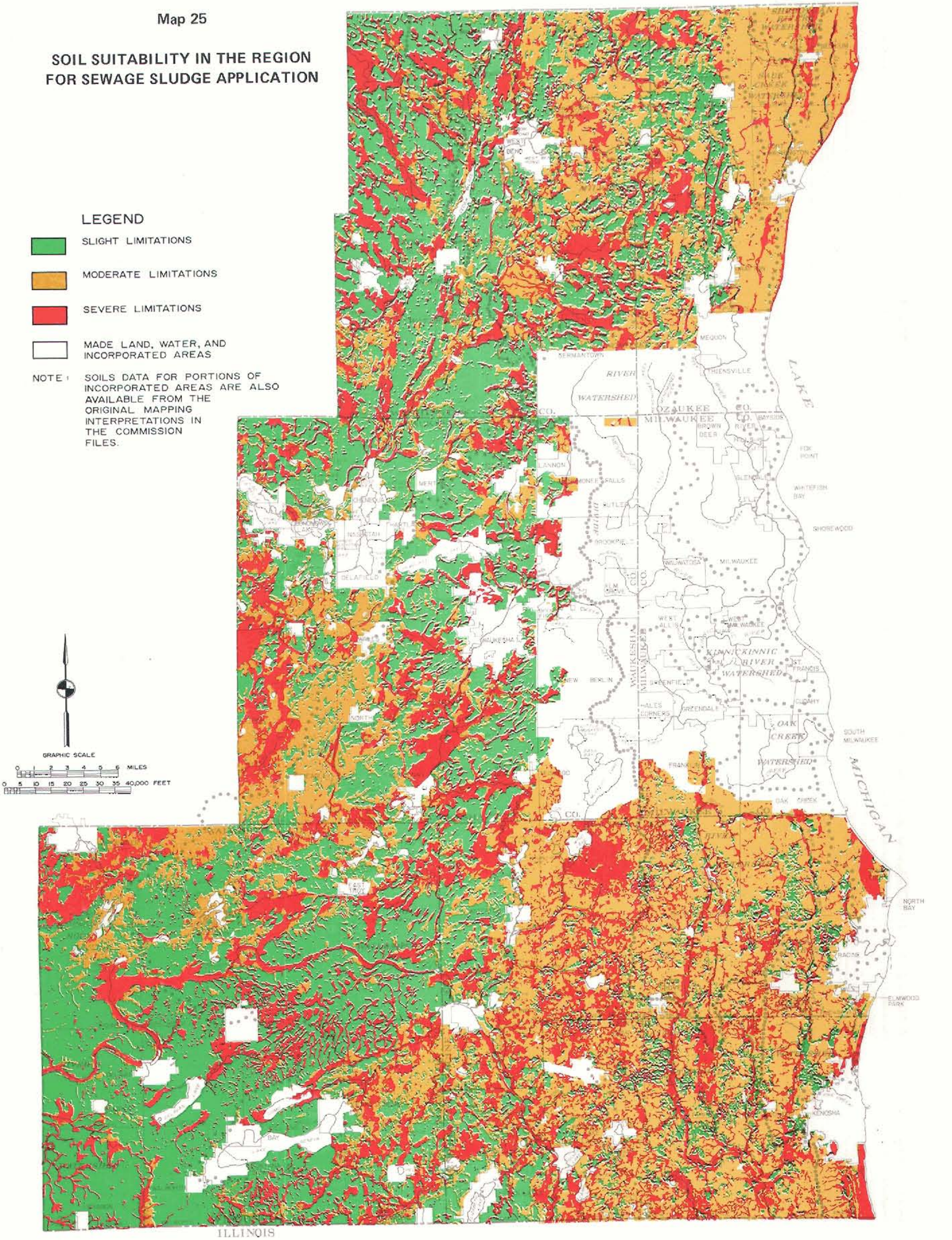
[7] *Classification of Wetlands in the United States, Special Scientific Report: Wildlife No. 20, Fish and Wildlife Service, 1953.*

Map 25

SOIL SUITABILITY IN THE REGION FOR SEWAGE SLUDGE APPLICATION

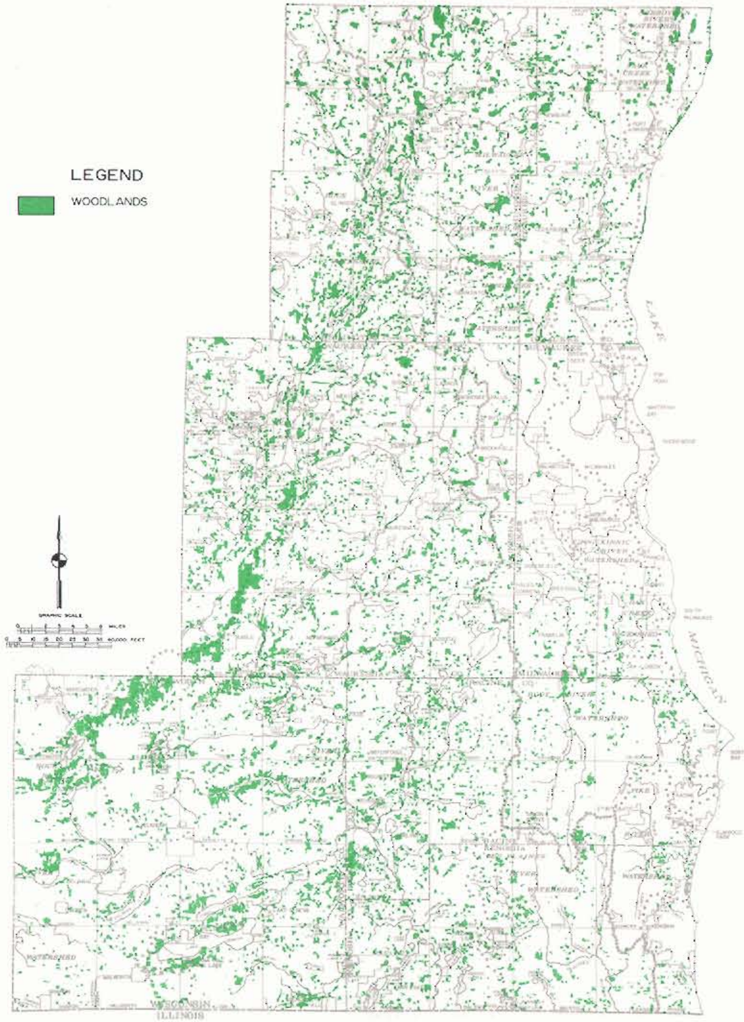


Soil slope, depth to bedrock and groundwater, soil chemistry, and soil permeability all affect the suitability of sites for land application of sludges. Within the Region, about 588 square miles, or 22 percent, are rated as severely limited for land application of sludge; 868 square miles, or 32 percent, are rated as moderately limited; 944 square miles, or 35 percent, are rated as slightly limited; and about 290 square miles, or 11 percent, are classified as made land such as landfills, urban land, or water which would have to be analyzed on a case-by-case basis.

Source: SEWRPC.

Map 26

WOODLANDS IN THE REGION: 1970

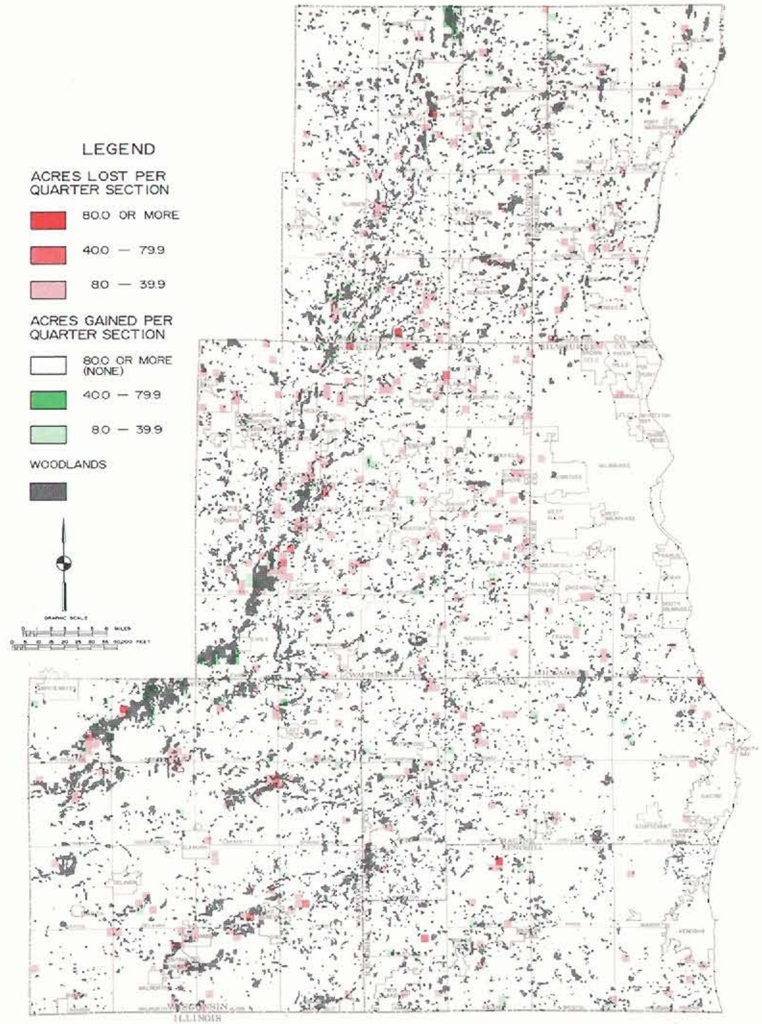


Woodlands currently occupy about 125,000 acres, or about 7 percent of the total land area of the Region. Woodlands have much value beyond monetary return for forest products. The maintenance of woodlands contributes to clean air and water and to the maintenance of a diversity of plant and animal life. Woodlands also provide an attractive natural resource of immeasurable value. Significant concentrations of woodlands are located in the Kettle Moraine State Forest and in several major stream valley areas in Walworth and Waukesha Counties. Together, these areas contain about 64,000 acres of woodland, representing slightly over one-half of the remaining woodlands in the Region.

Source: SEWRPC.

Map 27

CHANGE IN WOODLANDS IN THE REGION: 1963-1970



Between 1963 and 1970, there were both decreases in woodlands in certain areas of the Region, largely due to conversion of woodlands to intensive urban and agricultural land uses, as well as increases in woodlands in certain areas as a result of reforestation activity. The overall effect of these changes in woodlands between 1963 and 1970 was a net loss of about 5,100 acres, representing a decrease in the total amount of woodlands since 1963 of about 4 percent. As shown on the above map, there is a notable concentration of reforestation activities in the Kettle Moraine State Forest area. Woodland losses were greatest in Waukesha County, where nearly 1,900 acres were converted to intensive urban use.

Source: SEWRPC.

Table 22

WOODLANDS IN THE REGION BY COUNTY: 1963 AND 1970

County	Woodlands					
	1963[a]		1970		Change: 1963-1970	
	Acres	Percent	Acres	Percent	Acres	Percent
Kenosha	9,616	7.4	9,112	7.3	- 504	- 5.2
Milwaukee	3,455	2.6	3,213	2.6	- 242	- 7.0
Ozaukee	8,550	6.6	8,272	6.6	- 278	- 3.3
Racine.	13,709	10.5	12,927	10.3	- 782	- 5.7
Walworth.	32,750	25.1	31,755	25.3	- 995	- 3.0
Washington	27,855	21.4	27,410	21.9	- 455	- 1.6
Waukesha.	34,482	26.4	32,597	26.0	- 1,885	- 5.5
Region	130,417	100.0	125,286	100.0	- 5,131	- 3.9

[a] *Identification and quantification of woodlands in the Region was based upon aerial photo interpretation completed as part of the regional land use inventories conducted in 1963 and 1970. The 1963 woodland acreage data differ slightly from the 1963 forest and woodlands acreage data presented in SEWRPC Planning Report No. 7, The Land Use and Transportation Study, Volume One, Inventory Findings, since the latter acreage was determined by the Wisconsin Conservation Commission for SEWRPC and included swamp woodlands and wet mesic woodlands, which were considered wetlands in the SEWRPC land use inventories, and also included only those woodlands 20 acres or over in area.*

Source: SEWRPC.

Table 23

SURFACE WATER AND WETLANDS IN THE REGION: 1963 AND 1970

County	Surface Water and Wetlands					
	1963[a]		1970		Change: 1963-1970	
	Acres	Percent	Acres	Percent	Acres	Percent
Kenosha	19,584	10.7	19,445	10.8	- 139	- 0.7
Milwaukee	4,522	2.5	4,207	2.3	- 315	- 7.0
Ozaukee	15,083	8.3	14,879	8.2	- 204	- 1.4
Racine.	17,218	9.4	17,712	9.8	494	2.9
Walworth.	39,164	21.5	39,160	21.7	- 4	--[b]
Washington	36,032	19.7	35,638	19.7	- 394	- 1.1
Waukesha.	50,871	27.9	49,789	27.5	- 1,082	- 2.1
Region	182,474	100.0	180,830	100.0	- 1,644	- 0.9

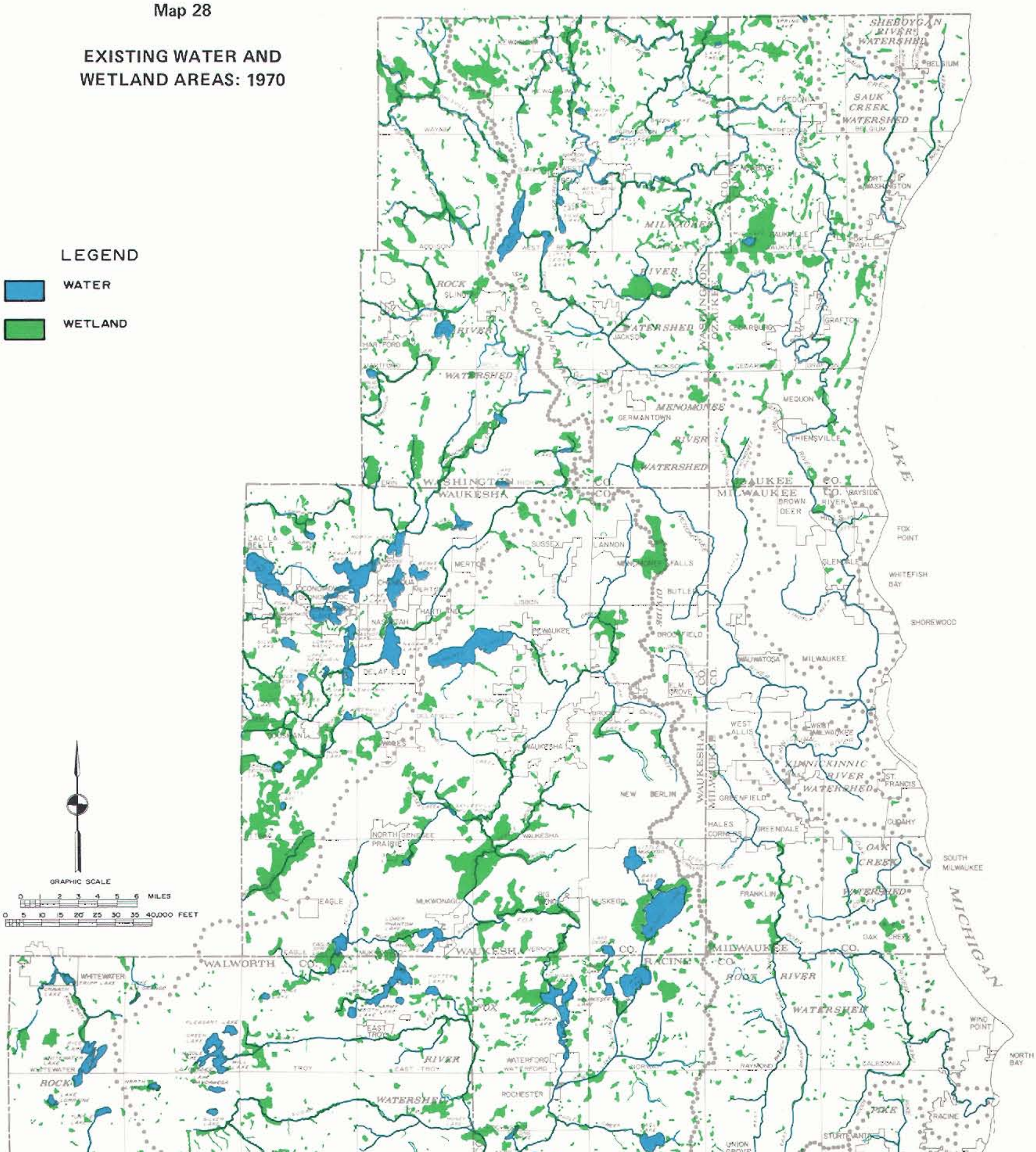
[a] *The 1963 water and wetland acreage data differ slightly from the data presented in SEWRPC Planning Report No. 7, The Land Use Transportation Study, Volume One, Inventory Findings, because the availability of more detailed information since 1963 permitted a refinement of water and wetland delineation for that year.*

[b] *Less than 0.1 percent.*

Source: SEWRPC.

Map 28

EXISTING WATER AND WETLAND AREAS: 1970

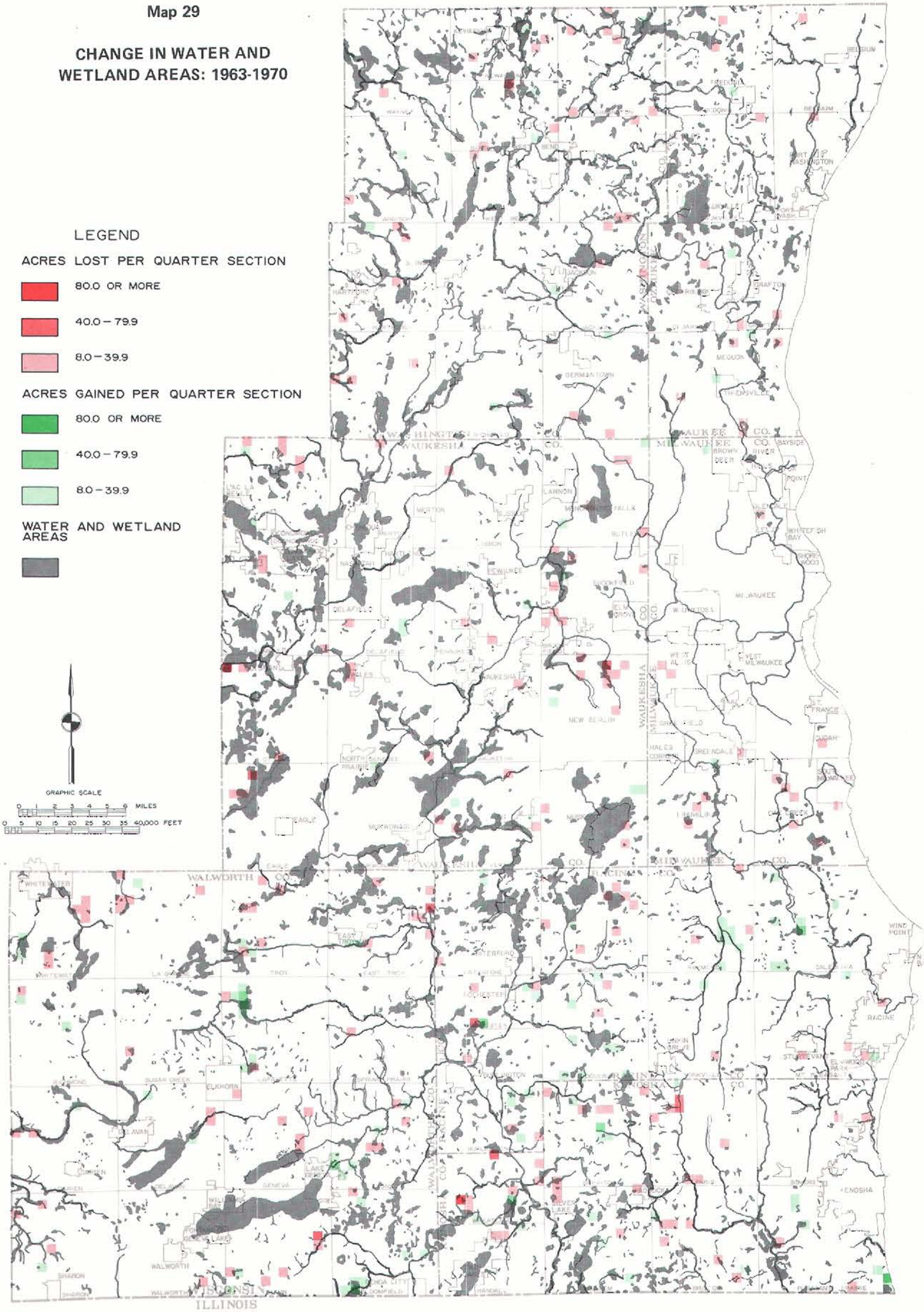


About 180,800 acres, or approximately 10 percent of the area of the Region, were covered by water and wetlands in 1970. These wetlands constitute a valuable resource, supporting wide varieties of desirable forms of plant and animal life; assisting in reducing storm water runoff, stabilizing streamflows, and enhancing stream water quality by functioning as nutrient and sediment traps; and providing aesthetically pleasing vistas on the landscape. The extent of water and wetlands may change slightly over time as a result of drainage and landfill operations, as well as the construction of new impoundment areas. Furthermore, variations in precipitation may cause the boundaries of wetland areas to fluctuate. As a result of these changes, there was a net decrease of about 1,600 acres, or approximately 1 percent, in the water and wetland category in the Region between 1963 and 1970.

Source: SEWRPC.

Map 29

CHANGE IN WATER AND WETLAND AREAS: 1963-1970



As shown on the map, both increases and decreases in water and wetland areas occurred in scattered fashion throughout the Region. On a county basis, the most significant change occurred in Waukesha County, where there was a net loss of 1,000 acres of wetlands between 1963 and 1970.

Source: SEWRPC.

Aquatic Vegetation: Unlike vegetative cover on the tributary land surface, which affects the potential for diffuse pollutant contributions to lakes and streams, aquatic vegetation demonstrates the relative fertility of the watercourses and bottom sediments. Accordingly, a knowledge and understanding of aquatic vegetation is important to the analysis of water quality problems.

Aquatic plant surveys of 62 of the 100 major lakes[8] in the planning Region indicate that lakes in the Region may be expected to have moderate to abundant vegetation in areas extending from the shore zone to depths as great as 20 to 30 feet. Higher densities of aquatic vegetation generally occur in lakes having extensive shallow areas, clear water, and muck bottoms, whereas lower aquatic vegetation densities are associated with lakes having limited shallow areas, turbid or tea-colored water, and marl, sand, gravel, or suspended-ooze bottoms. Lakes in the Region may be expected to contain 300 to 2,500 times as much plant material per unit of area as lakes in northern Wisconsin, the greater plant production of the former being partly attributable to their very hard, alkaline nature, coupled with their relatively high dissolved mineral and nutrient content conducive to aquatic plant growth. Some of the lakes within the Region were also found to display unusually high aquatic plant growth attributed to pollutants which artificially enrich the nutrient content of lakes above the natural levels.

Fish and Wildlife Resources

Fish and wildlife are invaluable elements of the Region's natural resource base. The variety and relative abundance of wildlife in the Region serve as indicators of the quality of the natural environment. At the same time, they provide numerous recreational opportunities for sightseers, tourists, fishermen, hunters, and other nature enthusiasts. Thus, activities associated with fish and wildlife contribute to the Region's economy.

Lake and Stream Fisheries: Most of the major lakes in southeastern Wisconsin are capable of supporting significant fish populations under existing conditions. However, Commission studies conducted as part of the Fox and Milwaukee River comprehensive watershed planning programs have found that a decline in lake water quality in general, and fishery suitability in particular, is occurring. This regional decline may be expected to continue in the absence of sound lake water quality plans and proper implementation of such plans.

[8] *See Aquatic Plant Survey of Major Lakes in the Fox River Watershed, Research Report No. 39, Wisconsin Department of Natural Resources, 1969; Aquatic Plant Survey of Milwaukee River Watershed Lakes, Research Report No. 52, Wisconsin Department of Natural Resources, 1970; and individual lake use reports prepared in cooperation with the Wisconsin Department of Natural Resources.*

Dominant fish species of lakes within the Region—in order of importance to its fishery—include bluegill, largemouth bass, northern pike, walleye, bullhead, black crappie, yellow perch, and carp. Other fish species existing in the lakes and streams, but of lesser importance to the fisherman, are pumpkinseed, warmouth, white sucker, and sunfish. Nearly every lake capable of supporting a fishery has a fish population comprised of northern pike, largemouth bass, bluegill, and bullhead. Few of the lakes, however, also support good walleye, muskellunge, cisco, and trout populations.

Lake fisheries are sustained primarily by natural spawning areas within the lakes. Presently, there are adequate shallow weedbed areas available for fish spawning within most major lakes. Other factors, however, such as deteriorating or fluctuating water quality and the lack of adequate boating regulations to protect spawning areas, tend to limit the effectiveness of these areas for natural spawning. In many instances, therefore, lake fisheries must be sustained by fish stocking.

Only limited quality stream fisheries are available within the Region. The Commission's Fox, Menomonee, and Milwaukee River watershed studies, for example, found that stream fisheries were generally limited in that only some of the relatively large streams in these three watersheds are capable of supporting self-sustaining populations of walleye, smallmouth bass, northern pike, or panfish. Very few streams presently support trout populations. It is recognized that not every stream in the Region can, or should, be of such quality that it can support walleye, smallmouth bass, or trout. These species are, however, important indicators of environmental quality, and should be maintained or restored in suitable selected streams throughout the area.

Wildlife Habitat Areas: Terrestrial wildlife in southeastern Wisconsin, in addition to nongame animals, is composed of small upland game such as rabbit and squirrel, predators such as fox and racoon, and game birds including pheasant and grouse. Waterfowl are also present. Deer are found in some areas, but the herds are small when compared to those of other regions of the State. The remaining habitat and wildlife therein provide valuable recreation, constitute an immeasurable aesthetic asset, and contribute by their presence to economic activity within the Region.

The complete spectrum of wildlife species originally native to the Region have, along with their habitat, undergone tremendous alteration since settlement of the watershed by Europeans. The change is the direct result of an extreme conversion of the basic environment, beginning with the clearing of forests and prairies and the drainage of wetlands and ending with extensive agricultural and urban land uses. This process, which began in the early nineteenth century when European settlers began to develop the Region, is still operative today. Successive cultural practices, both rural and urban, have been superimposed on the overall land use changes and have also affected the wildlife and wildlife habitat in the Region. In agricultural areas, these cultural practices include land drainage by ditching and tiling and the expanding use of fertilizers and pesticides. Examples of urban-area cultural practices that affect wildlife and their habitat are the use of fertilizers and pesticides, road salting, heavy traffic which produces disruptive noise levels, damaging air pollution, and the introduction of domestic animals.

Many of these land use changes and the cultural activity subsequently superimposed on those changes have proceeded with little explicit concern for wildlife and their habitat. The resiliency of wildlife to such impacts is truly remarkable, but a tremendous toll has been taken. Inexorably, the minimum life requirements have disappeared in much of the Region and, as a result, only remnants remain, to continue a precarious existence. The wildlife and wildlife habitat loss is only part of a much greater loss of diversity that is characteristic of natural communities.

Inventories of land and inland water in the Region known to be inhabitated by various forms of wildlife were carried out cooperatively by the Wisconsin Department of Natural Resources and the Southeastern Wisconsin Regional Planning Commission in 1963 and 1970. As indicated in Table 24 and on Maps 30 and 31, wildlife habitat areas in 1970 covered approximately 259,800 acres, or 15 percent of the total area of the Region. The overwhelming majority of this area, more than 192,500 acres, or 74 percent, occurred in Walworth, Washington, and Waukesha Counties. It should be noted that more than 77,900 acres, or 76 percent of the total high-value wildlife habitat areas, and more than 70,000 acres, or 75 percent of the total medium-value wildlife habitat areas, occur in these counties as well.

Wildlife habitat areas in 1963 covered 261,200 acres of the Region. This indicates a net loss of about 1,300 acres of wildlife habitat areas in the Region for the 1963 to 1970 period. The geographic distribution of losses in wildlife habitat areas during this period is shown on Map 31. While this loss of 1,300 acres of wildlife habitat may appear insignificant, further review of Table 24 indicates a decrease of more than 3,000 acres, or about 3 percent, of high-value wildlife habitat areas in the Region during this same period. Walworth County experienced a decrease of more than 1,800 acres, or almost 7 percent of its total high-value wildlife habitat areas during this period. Kenosha County, with an increase of about 120 acres of high-value wildlife habitat areas, is the only county to experience an increase during this period.

The destruction of wildlife habitat areas is primarily the result of urbanization. While some wildlife habitat areas are lost due to widening or new construction of transportation facilities, most have been destroyed as a result of residential development. It would appear, then, that some high-value wildlife habitat sites are high-value sites for residential development as well. If the remaining wildlife habitat in the Region is to be preserved, the forest lands, wetlands, and related surface water, together with the proximate croplands and pasture lands, must be protected from mismanagement and continued urban encroachment.

Water Resources

Surface water resources, consisting of lakes, streams, and associated floodlands, form the singularly most important element of the natural resource base of the Region. Their contribution to the economic development, recreational activity, and aesthetic quality of the Region is immeasurable. The groundwater resources of southeastern Wisconsin are closely interrelated with the surface water resources inasmuch as they sustain lake levels and provide the base flow of streams, and supply domestic, municipal, and industrial water users.

Surface Water Resources: Lakes and streams of the Region constitute focal points for water-related recreational activities popular with the inhabitants of the Region; provide attractive sites for properly planned residential development; and—when viewed in the context of open space areas—greatly enhance the aesthetic quality of the environment. It is important to note that lakes and streams are extremely susceptible to deterioration through improper land use development and management. Water quality can degenerate as a result of excessive nutrient loads from malfunctioning or improperly placed septic systems, inadequate operation of waste treatment facilities, careless agricultural practices, and inadequate soil conservation practices. Lakes and streams are also adversely affected by the excessive development of lakeshore and riverine areas in combination with the filling of peripheral wetlands, which remove valuable nutrient and sediment traps while adding nutrient and sediment sources. The regional surface water resources must be properly managed to adjust man's uses to the quantity and quality of surface waters that are available, and to achieve a reasonable balance between public and private use and enjoyment of those surface water resources.

Lakes: Major lakes are defined herein as those having 50 acres or more of surface water area, a size capable of supporting reasonable recreational use with relatively little degradation of the resource. There are 100 major lakes within the Region, the location and relative sizes of which are shown on Map 32. A tabular summary, by county, of the surface water resources of southeastern Wisconsin is presented in Table 25. Major lakes in the Region have a combined surface water area of about 57 square miles, or about 2 percent of the area of the Region, and provide a total of about 448 miles of shoreline. The distribution of major lakes ranges from none in Milwaukee County to 33 in Waukesha County. The remaining five counties of Walworth, Kenosha, Washington, Racine, and Ozaukee each contain, respectively, 25, 15, 15, 10, and 2 major lakes. Lake Geneva is by far the largest lake in southeastern Wisconsin, having

Table 24

WILDLIFE HABITAT AREAS IN THE REGION BY VALUE RATING[a] AND COUNTY: 1963 AND 1970

County	Value[a]	1963[b]		1970		Change: 1963-1970	
		Acres	Percent	Acres	Percent	Acres	Percent
Kenosha	High	9,965	44.4	10,083	44.0	118	1.2
	Medium	6,285	28.0	6,136	26.8	- 149	- 2.4
	Low	6,189	27.6	6,683	29.2	494	8.0
	Total	22,439	100.0	22,902	100.0	463	2.1
Milwaukee	High	0	0.0	0	0.0	0	0.0
	Medium	1,251	66.6	1,225	68.9	- 26	- 2.1
	Low	626	33.4	553	31.1	- 73	- 11.7
	Total	1,877	100.0	1,778	100.0	- 99	- 5.3
Ozaukee	High	6,082	38.4	6,033	38.1	- 49	- 0.8
	Medium	8,422	58.1	8,310	52.4	- 112	- 1.3
	Low	1,341	8.5	1,512	9.5	171	12.8
	Total	15,845	100.0	15,855	100.0	10	0.1
Racine	High	9,044	23.8	8,945	33.4	- 99	- 1.1
	Medium	8,177	30.5	8,015	30.0	- 162	- 2.0
	Low	9,553	35.7	9,803	36.6	250	2.6
	Total	26,774	100.0	26,763	100.0	- 11	--[c]
Walworth	High	28,754	45.2	26,890	42.7	- 1,864	- 6.5
	Medium	20,272	31.9	20,775	32.9	503	2.5
	Low	14,593	22.9	15,368	24.4	775	5.3
	Total	63,619	100.0	63,033	100.0	- 586	- 0.9
Washington	High	19,844	38.3	19,340	37.2	- 504	- 2.5
	Medium	21,380	41.2	21,414	41.2	34	0.2
	Low	10,623	20.5	11,240	21.6	617	5.8
	Total	51,847	100.0	51,994	100.0	147	0.3
Waukesha	High	32,421	41.1	31,710	40.9	- 711	- 2.2
	Medium	28,809	36.6	28,255	36.5	- 554	- 1.9
	Low	17,559	22.3	17,542	22.6	- 17	- 0.1
	Total	78,789	100.0	77,507	100.0	- 1,282	- 1.6
Region	High	106,100	40.6	103,001	39.6	- 3,109	- 2.9
	Medium	94,596	36.2	94,130	36.3	- 466	- 0.5
	Low	60,484	23.2	62,701	24.1	2,217	3.7
	Total	261,190	100.0	259,832	100.0	- 1,358	- 0.5

[a] *High-value wildlife habitat areas have a high diversity of species. The territorial requirements of the major species are met, in that minimum population levels are possible. The structure and composition of the vegetation provide for nesting, travel routes, concealment, and modification of weather impact. Also, such areas have experienced little or no disturbance as a result of man's activities and are located in close proximity to other wildlife habitat areas.*

Medium-value wildlife habitat areas maintain all of the criteria described for a high-value habitat, but at a lower level. The species diversity may not be as high as in the high-value areas. The territorial requirements of the major species may not be adequately met, in that minimum population levels are not possible or are just barely met. The structure and composition of the vegetation may not adequately provide for nesting, travel routes, concealment, or modification of weather impact. The areas may have undergone disturbance as a result of man's activities, and also may not be located in close proximity to other wildlife habitat areas.

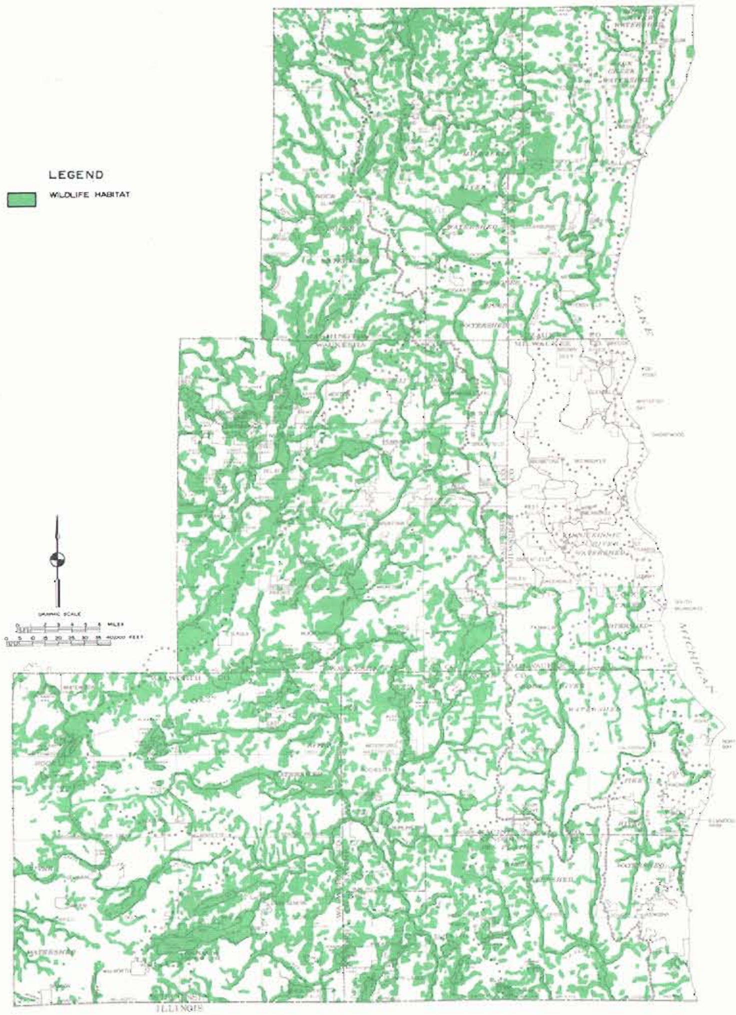
Low-value wildlife habitat areas are of a supplemental or remnant nature. They are usually considerably disturbed but are included in the inventory since they provide the only available range in the vicinity, supplement areas of a higher quality, or they provide corridors linking higher habitat areas.

[b] *The 1963 wildlife habitat acreage data differ slightly from the data presented in SEWRPC Planning Report No. 7, The Land Use Transportation Study, Volume One, Inventory Findings, because the availability of more detailed information since 1963 permitted a refinement of the wildlife habitat delineation for that year.*

[c] *Less than 0.05 percent.*

Map 30

WILDLIFE HABITAT IN THE REGION: 1970

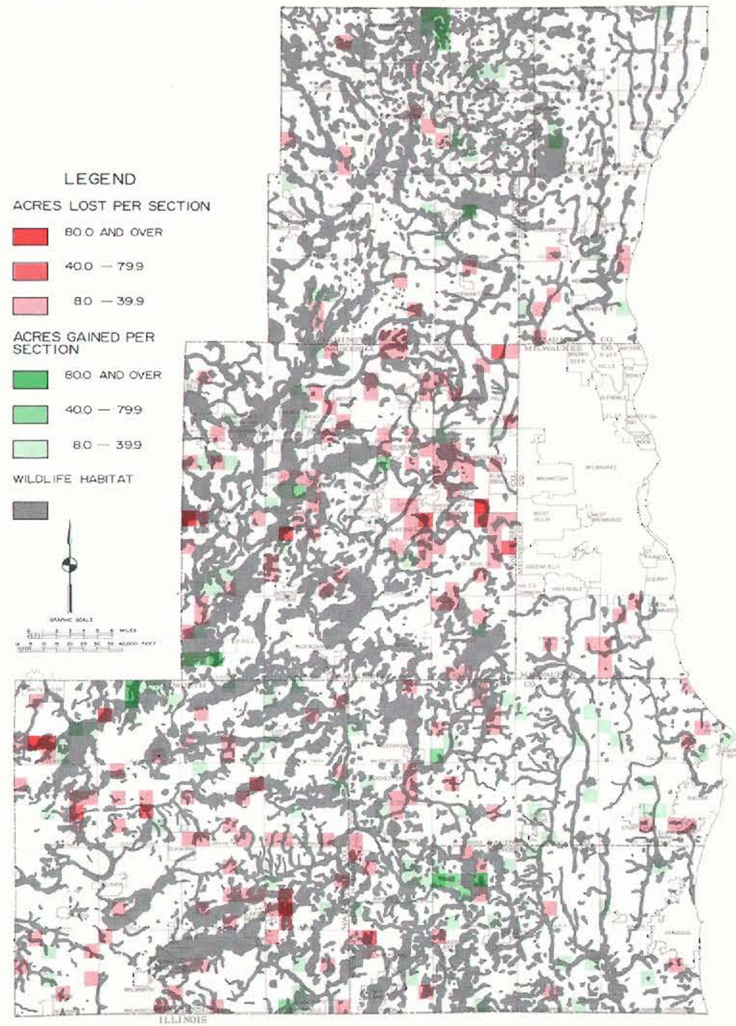


The remaining wildlife habitat areas and the wildlife therein provide an important recreational resource and constitute a valuable aesthetic asset of southeastern Wisconsin. As of 1970, approximately 260,000 acres, or 15 percent of the area of the Region, were identified as wildlife habitat.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Map 31

CHANGE OF WILDLIFE HABITAT AREAS IN THE REGION: 1963-1970



From 1963 to 1970 there was a net loss of about 1,300 acres of wildlife habitat in the Region. This loss represents about one-half of 1 percent of the approximately 261,000 acres of wildlife habitat that existed in the Region in 1963. The above map identifies those areas of the Region where wildlife habitat was destroyed by conversion to urban development during this period, as well as those areas where additional wildlife habitat areas were found in the 1970 inventory. The increases in wildlife habitat may be attributed to a number of reasons, including reforestation, impoundment and wetland creations, and the restoration of lands formerly used for agriculture to "natural" uses, including the establishment of wildlife cover. The most severe losses in the high-value wildlife habitat areas during the 1963 to 1970 period occurred in Waukesha and Walworth Counties. Continued encroachment of incompatible rural as well as urban development into the remaining wildlife habitat areas of the Region will inevitably lead to a decline in wildlife population and contribute to the deterioration of the overall quality of life within the Region.

Source: SEWRPC.

a surface area of 5,262 acres, and is 2.1 times as large as Pewaukee Lake, the second largest lake in the Region, with an area of 2,493 acres.[9]

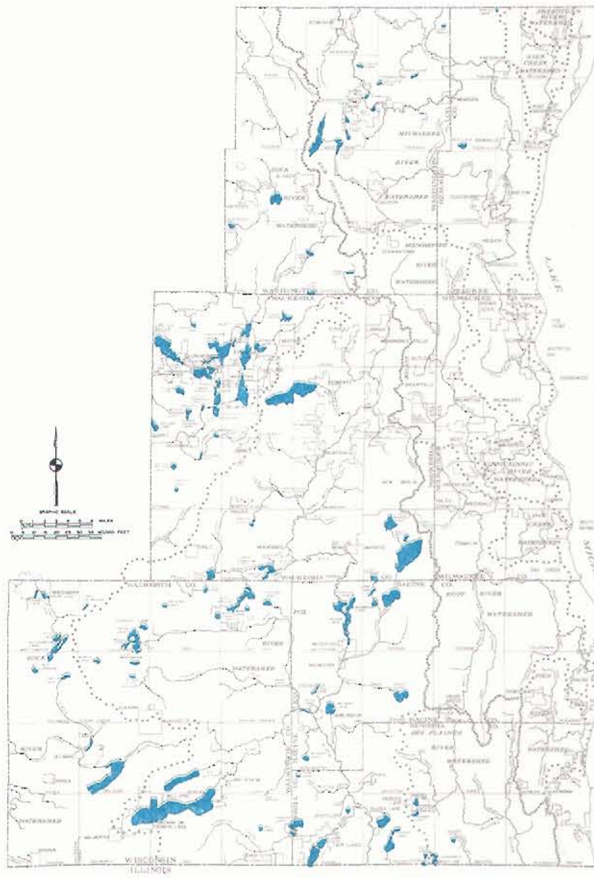
The lakes of southeastern Wisconsin are almost exclusively of glacial origin, being formed by depressions in outwash deposits, terminal and interlobate moraines, and ground moraines. Some lakes, such as Green Lake in northeastern Washington County or Browns Lake in southwestern Racine County, owe their origin to kettles, that is, depressions formed in the glacial drift as a result of the melting of ice blocks that became separated from the melting continental ice sheet, and the subsequent subsidence of sand and gravel contained on and within those blocks. By virtue of their origin, glacially formed lakes are fairly regular in shape, with their deepest points located predictably near the center of the basin, or near the center of each of several connected basins. The beaches are characteristically gravel or sand on the windswept north, east, and south shores, while fine sediments and encroaching vegetation are common on the protected west shores and in the bays.

There are 228 lakes and ponds in the Region of less than 50 acres of surface water area, which are considered in this report as minor lakes. These minor lakes, the regional distribution of which is summarized in Table 25, have a combined surface water area of four square miles, or about 0.15 percent of the area of the Region, and provide 141 miles of shoreline. These small lakes generally have few riparian owners and only marginal fisheries. In most cases, the primary values of the minor lakes are ecological and aesthetic, and are fragile and readily lost with any degree of improper shoreland development.

Streams: As discussed earlier and as shown on Map 17, the surface drainage system of southeastern Wisconsin may be viewed as existing within 12 individual watersheds, of which five, the Root River, Menomonee River, Kinnickinnic River, Oak Creek, and Pike River watersheds, are contained entirely within the Region. The Region contains only a very small part of the Wisconsin portion of the Rock River watershed, the streams of that watershed within the Region being limited to the headwater portions of such tributaries to the Rock as the Bark and Oconomowoc Rivers and Turtle Creek.

Map 32

MAJOR LAKES IN THE REGION



There are 100 major lakes, 50 acres or larger, in the Southeastern Wisconsin Region. These lakes are located in four of the 12 major watersheds of the Region—the Des Plaines, Fox, Milwaukee, and Rock River watersheds—and in six of the seven counties comprising the Region, Milwaukee County being the only county containing no major lakes. Of the 100 major lakes, 42 are flow-through lakes having one or more major inlets and outlets; 30 are headwater lakes having outlets but no inlets; and 28 are groundwater or internally drained lakes—sometimes called kettle lakes—having no inlets or outlets. The largest and deepest lake in southeastern Wisconsin is Geneva Lake with a surface area of 5,262 acres and a maximum depth of 135 feet. Of the 65 lakes rated for trophic status as of 1975, 19 percent were categorized as very eutrophic (highly fertile); 12 percent as eutrophic (fertile); 57 percent as mesotrophic (moderately fertile); and 12 percent as oligotrophic (infertile). The lakes are an integral part of the aesthetic, biological, and recreational fabric of the Region. They constitute some of the Region's most important natural resources, and stir a unique level of concern for resource management decisions among the residents of southeastern Wisconsin.

Source: SEWRPC.

Three of the 12 watersheds contained wholly or partly in southeastern Wisconsin—the Fox, Rock, and Des Plaines River watersheds, which have a combined area of 1,680 square miles, or 63 percent of the area of the Region—lie west of the subcontinental divide. As a result,

[9]*See Appendix C of SEWRPC Planning Guide No. 5, Floodland and Shoreland Development Guide, for a more detailed tabulation, by county, of lakes and ponds in southeastern Wisconsin, which indicates the location of each lake and pond and also summarizes pertinent morphometric parameters such as surface area, maximum depth, and shoreline length. Some of the morphometric parameters for major lakes have been revised under the Commission's Fox and Milwaukee River watershed studies published as SEWRPC Planning Report No. 12, A Comprehensive Plan for the Fox River Watershed, Volumes 1 and 2, and SEWRPC Planning Report No. 13, A Comprehensive Plan for the Milwaukee River Watershed, Volumes 1 and 2.*

Table 25

LAKES AND STREAMS IN THE REGION BY COUNTY

County		Lakes[a]									
		Major[b]						Minor[c]			
			Total Surface Area			Largest Lake			Total Surface Area		
Name	Area (square miles)	Number	Square Miles	Percent of County	Total Shoreline Length (miles)	Name	Area (acres)	Number	Square Miles	Percent of County	Total Shoreline Length (miles)
Kenosha	278.28	15	5.06	1.82	48.62	Elizabeth Lake	637.80	9	0.27	0.10	5.85
Milwaukee . . .	242.19	--	--	--	--	--	--	40	0.26	0.11	14.99
Ozaukee	234.49	2	0.47	0.20	4.75	Mud Lake	245.40	36	0.63	0.27	25.40
Racine.	339.87	10	5.48	1.61	59.52	Wind Lake	936.20	7	0.17	0.05	4.59
Walworth. . . .	578.08	25	19.52	3.38	131.40	Lake Geneva	5,262.40	9	0.35	0.06	9.10
Washington . .	435.50	15	4.22	0.97	40.59	Big Cedar	932.00	43	0.70	0.16	24.32
Waukesha. . . .	580.66	33	22.07	3.80	162.89	Pewaukee	2,493.00	84	1.62	0.28	57.08
Region	2,689.07	100	56.82	2.11	447.77	--	10,506.80	228	4.00	0.15	141.33

County		Lakes[a]				Major Streams[d]			
		Total							
			Total Surface Area					Total Surface Area	
Name	Area (square miles)	Number	Square Miles	Percent of County	Total Shoreline Length (miles)	Number	Total Length (miles)	Square Miles	Percent of County
Kenosha	278.28	24	5.33	1.92	54.47	19	106.40	0.73	0.03
Milwaukee . . .	242.19	40	0.26	0.11	14.99	15	102.99	0.62	0.03
Ozaukee	234.49	38	1.10	0.47	30.15	29	112.20	1.25	0.05
Racine.	339.87	17	5.65	1.66	64.11	14	100.55	0.96	0.01
Walworth. . . .	578.08	34	19.87	3.44	140.50	29	173.00	0.58	0.01
Washington . .	435.50	58	4.92	1.13	64.91	38	219.80	1.03	0.02
Waukesha. . . .	580.66	117	23.69	4.08	219.97	50	333.30	1.31	0.02
Region	2,689.07	328	60.82	2.26	589.10	194	1,148.24	6.48	0.02

[a] *Appendices B, C, and D to SEWRPC Planning Guide No. 5, Floodland and Shoreland Development Guide, contain detailed tabulations, by county, of all streams, lakes, and ponds in the Southeastern Wisconsin Region. These appendices indicate the location of each stream, lake, and pond and summarize pertinent morphometric parameters. Surface areas and shoreline lengths for some of the major lakes have been revised under the Commission Fox and Milwaukee River watershed studies, documented in SEWRPC Planning Report No. 12, A Comprehensive Plan for the Fox River Watershed, Volumes One and Two, and SEWRPC Planning Report No. 13, A Comprehensive Plan for the Milwaukee River Watershed, Volumes One and Two. Entries in this table reflect the revised figures for major lakes.*

[b] *A major lake is defined as one having 50 acres or more of surface water area.*

[c] *A minor lake is defined as one having less than 50 acres of surface water area.*

[d] *Major streams include those watercourses having a perennial flow or those intermittent streams that have been named in SEWRPC Planning Guide No. 5.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

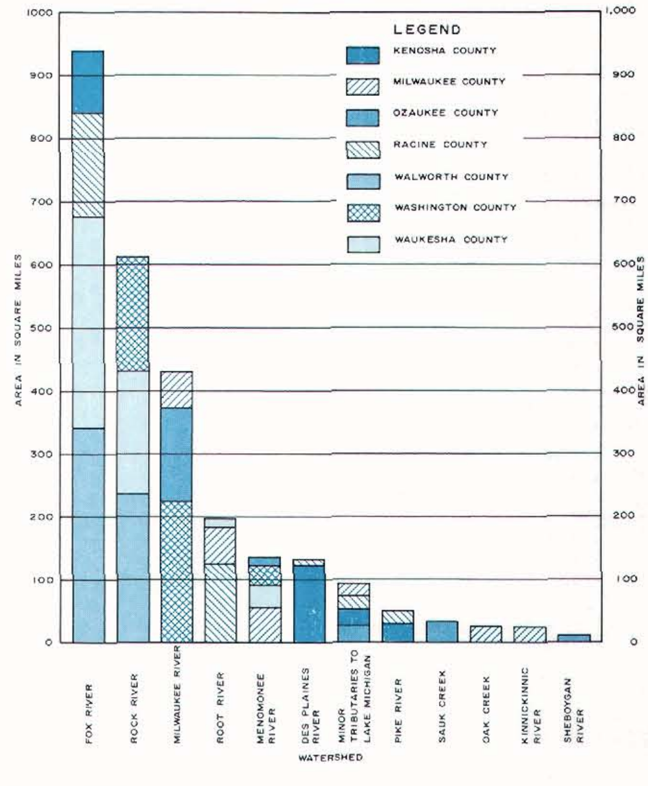
the rivers and streams within these catchment areas flow in a generally south and southwesterly direction, and are a part of the Mississippi River drainage system. The rivers and streams in the nine watersheds comprising the remainder of southeastern Wisconsin, which have a combined area of 1,009 square miles, or 37 percent of the area of the Region, flow in an easterly direction and discharge into Lake Michigan, and are a part of the Great Lakes-St. Lawrence River drainage system. A tabular summary of watershed characteristics for southeastern Wisconsin is presented in Table 26, and a graphical representation of the range of watershed sizes is shown in Figure 16.

One of the most interesting, variable, and occasionally unpredictable features of each watershed is the ever-changing, sometimes widely fluctuating, discharges and stages of its river and stream system. The stream systems of the Region receive a relatively uniform flow of groundwater from the shallow aquifer underlying the Region. This groundwater discharge constitutes the base flow of the streams. The streams also periodically intercept surface water runoff from rainfall and snowmelt, which is superimposed on the base flow and sometimes causes the streams to leave their channels and occupy the adjacent floodlands. The volume of water drained annually from southeastern Wisconsin by the stream system is equivalent to seven to eight inches of water spread over the seven-county Region, which amounts to about one-fourth of the average annual precipitation.

Major streams are defined herein as perennial streams which maintain, at a minimum, a small, continuous flow

Figure 16

SIZE AND DISTRIBUTION OF WATERSHEDS IN THE REGION BY COUNTY



Source: SEWRPC.

Table 26

WATERSHEDS IN THE REGION BY COUNTY

Watershed[a,b]	County														Total Watershed Area Within Region (square miles)	Percent of Region
	Kenosha		Milwaukee		Ozaukee		Racine		Walworth		Washington		Waukesha			
	Area (square miles)	Percent of Watershed	Area (square miles)	Percent of Watershed	Area (square miles)	Percent of Watershed	Area (square miles)	Percent of Watershed	Area (square miles)	Percent of Watershed	Area (square miles)	Percent of Watershed	Area (square miles)	Percent of Watershed		
Fox River[d,f]	96.33	10.31	0.46	0.05	--	--	164.34	17.59	337.39	36.11	0.30	0.03	335.49	35.90	934.31	34.74
Rock River[d]	--	--	--	--	--	--	--	--	239.06	39.04	178.68	29.18	199.67	31.79	612.41	22.77
Milwaukee River[e,f]	--	--	57.40	13.26	150.62	34.79	--	--	--	--	224.98	51.96	--	--	433.00	16.10
Root River[c,e,f]	2.18	1.11	58.65	29.79	--	--	122.94	62.45	--	--	--	--	13.10	6.65	196.87	7.32
Menomonee River[c,e,f] . .	--	--	55.08	40.52	11.76	8.65	--	--	--	--	31.75	23.36	37.75	27.77	135.94	5.06
Des Plaines River[d]	122.61	91.51	--	--	--	--	11.37	8.49	--	--	--	--	--	--	133.98	4.98
Minor Tributaries to Lake Michigan[c,e] . . .	27.14	28.41	19.89	20.82	27.47	28.76	21.02	22.00	--	--	--	--	--	--	95.52	3.55
Pike River[c,e]	30.02	59.26	--	--	--	--	20.64	40.74	--	--	--	--	--	--	50.66	1.88
Sauk Creek[e]	--	--	--	--	33.71	100.00	--	--	--	--	--	--	--	--	33.71	1.25
Oak Creek[c,e]	--	--	26.33	100.00	--	--	--	--	--	--	--	--	--	--	26.33	0.97
Kinnickinnic River[c,e] . . .	--	--	24.85	100.00	--	--	--	--	--	--	--	--	--	--	24.85	0.92
Sheboygan River[e]	--	--	--	--	11.43	100.00	--	--	--	--	--	--	--	--	11.43	0.43
Total	278.28	--	242.66	--	234.99	--	340.31	--	576.45	--	435.71	--	580.61	--	2,689.01	100.00

[a] *Includes only that area of each watershed that lies within the seven-county Southeastern Wisconsin Region.*

[b] *Watersheds are listed in order of decreasing size within the Region.*

[c] *Indicates watershed wholly contained within the Region.*

[d] *Indicates watershed west of the subcontinental divide that is tributary to the Mississippi River basin. Three watersheds having a combined area of 1,682.66 square miles, or about 62.6 percent of the Region, are in this category.*

[e] *Indicates watershed east of the subcontinental divide that is tributary to the Great Lakes-St. Lawrence River basin. Nine watersheds having a combined area of 1,006.56 square miles, or 37.4 percent of the Region, are in this category.*

[f] *Indicates watersheds for which comprehensive watershed plans have been prepared and adopted by the Southeastern Wisconsin Regional Planning Commission.*

Source: SEWRPC.

throughout the year except under unusual drought conditions. Within the Region, there are approximately 1,148 miles of such major streams, as summarized by county in Table 25. The length of major streams per county ranges from a low of 100 lineal miles in Racine County to a high of 333 lineal miles in Waukesha County. Waukesha County also has the largest number of major lakes, and is, therefore, particularly well endowed with surface water resources.

The existing chemical and biological conditions of the lakes and streams of the planning area, together with long-term trends in those conditions, must be a primary consideration of any sound water quality management planning program. For this reason, a complete analysis of the substantial amounts of water quality data available from within the Region, for the period of more than a decade from 1964 through 1975, was conducted by the Commission and documented in SEWRPC Technical Report No. 17, Water Quality in Lakes and Streams of Southeastern Wisconsin: 1964-1975. This report updated an earlier report, SEWRPC Technical Report No. 4, Water Quality and Flow of Streams in Southeastern Wisconsin, which documented the results of a 14-month study of stream water quality conditions at 87 locations in the Region in 1964-1975. The results of the reports are summarized in Volume One, Chapter IV of this report, but the general conclusions of both reports should be noted here. Stream water quality within the Region over the entire period of record was found to be generally inadequate to meet the applicable standards for dissolved oxygen and fecal coliform and the recommended levels for nitrogen and phosphorus. The standards for ammonia were occasionally violated, but the standards for temperature and pH were generally achieved. Some trends to improved water quality were observed, generally below sites of upgraded or abandoned sewage treatment facilities, but a subtle decline in water quality was the more general trend observed. Although the inland lakes generally exhibited good water quality, the nutrient concentrations and the conditions of the inflowing streams indicate that sound land management practices are needed to slow the eutrophication process. In general, it is apparent from all of the Commission's stream water quality data that many miles of major streams in southeastern Wisconsin have been degraded as a result of existing pollution sources, such that they are unfit for many intended uses. All of the Commission's water quality studies also clearly demonstrate the very basic relationship between land use and stream water quality, and thereby emphasize the need for concurrent areawide planning of land use and water quality control measures.

Floodlands: The floodlands of a river or stream are the wide, gently sloping areas contiguous with, and usually lying on, both sides of a river or stream channel. Rivers and streams occupy their channels most of the time. However, during even minor flood events, stream discharges increase markedly such that the channel is not able to convey all the flow. As a result, stages increase and the river or stream spreads laterally over the floodlands. The periodic flow of a river onto its floodlands is a normal phenomenon and, in the absence of major, costly structural flood control works, will occur regardless of whether urban development occurs on the floodlands.

For planning and regulatory purposes, floodlands are normally defined as the areas, excluding the channel, subject to inundation by the 100-year recurrence interval flood event. This is the event that would be reached or exceeded in severity once on the average of every 100 years. Stated another way, there is a 1 percent chance that this event will be reached or exceeded in severity in any given year. Commission studies indicate that about 7 to 10 percent of the total land area of any given watershed will be within the 100-year floodplain of the Region's rivers and streams. The 100-year recurrence interval floodplain contains within its boundaries the areas inundated by floods of less severe but more frequent occurrence such as the 50-, 25-, and 5-year recurrence interval events.

Floodland areas are generally not well suited to urban development because of flood hazards, high water tables, and inadequate soils. These floodland areas are, however, generally prime locations for much needed park and open space areas, and, therefore, within the context of regional land use planning, every effort should be made to discourage indiscriminant urban development in the floodplain while encouraging open space uses.

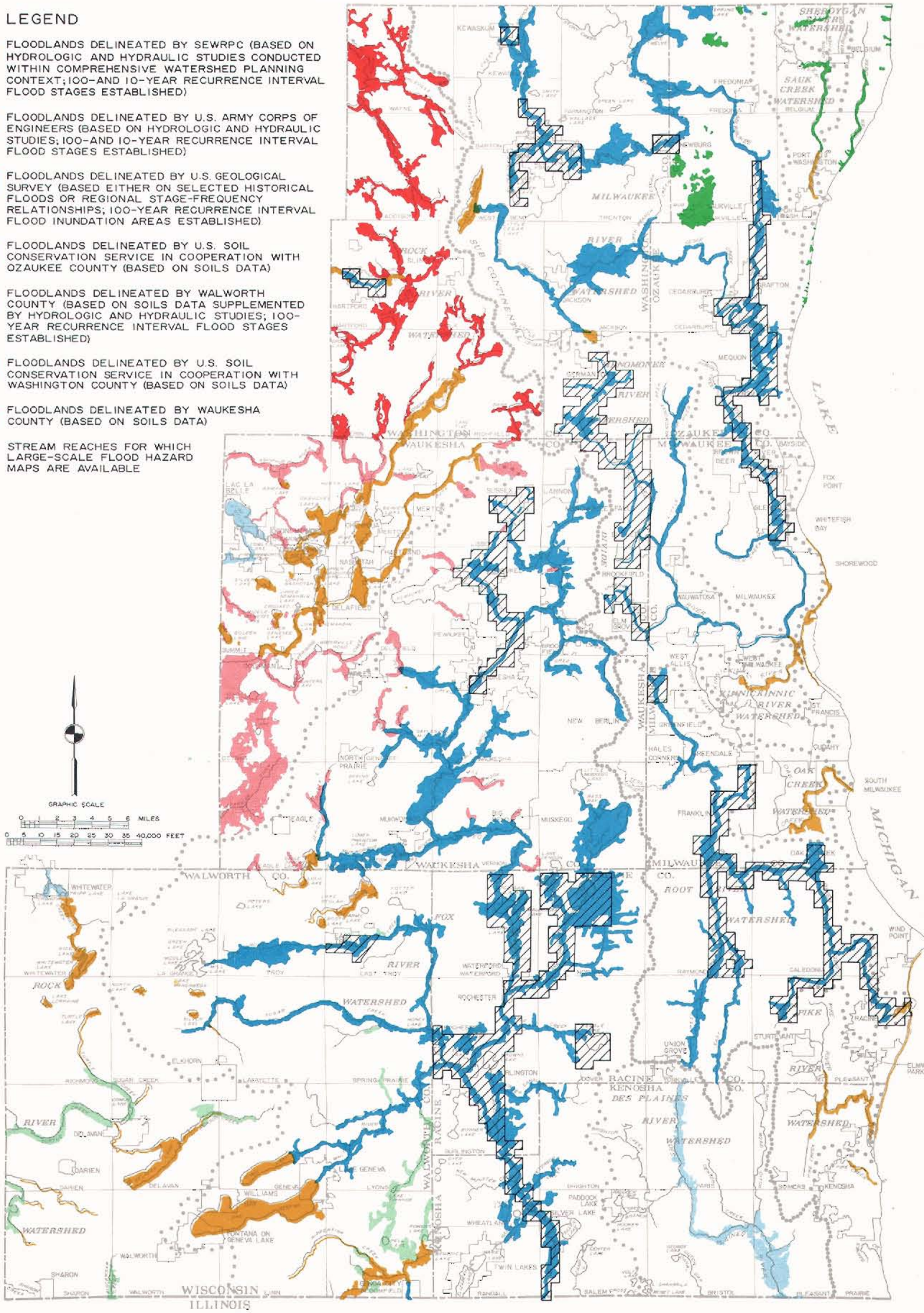
Flood hazard data for the numerous streams of the Southeastern Wisconsin Region, and particularly data on the limits of the natural floodlands of the streams for a flood of a specified recurrence interval, are important inputs to the regional planning process. Due to the importance of floodland data, the Commission, as an integral part of its comprehensive watershed studies, provides definitive data, including a delineation of the limits of the floodplain, on the 10- and 100-year recurrence interval floods for most of the perennial streams in each watershed.

The status of existing flood hazard data in the Region as of January 1, 1977, is summarized on Map 33. The Commission has completed comprehensive watershed studies for the Root, Fox, Milwaukee, and Menomonee River watersheds, resulting in the delineation of floodlands for about 530 miles of major stream channels, not including stream channels in the Milwaukee River watershed lying outside of the Region in Sheboygan and Fond du Lac Counties. Both 10- and 100-year recurrence interval floodplain limits have been established for the indicated stream reaches in these watersheds by the Commission. A specified recurrence interval is necessary so that a sound economic analysis of the benefits and costs and of the advantages and disadvantages of various combinations of land use regulation, public acquisition, and public construction for flood damage abatement and prevention can be conducted.

While the Commission is the only agency which has developed flood hazard data for the Region on the basis of comprehensive watershed studies, other federal and local agencies have developed flood hazard data

Map 33

FLOODLANDS IN THE REGION



Delineation of the floodlands of southeastern Wisconsin is extremely important for sound local as well as regional planning and development. The above map summarizes the status of floodland data in the Region as of the end of 1977. The Commission itself, as an integral part of its comprehensive watershed studies, provides definitive data on the 10- and 100-year recurrence interval floods for most of the perennial streams in each watershed studied. Other agencies which have to date made flood hazard data available for various stream reaches in the Region are the U. S. Army Corps of Engineers, the U. S. Geological Survey, and the U. S. Soil Conservation Service, acting in cooperation with the Commission and with county zoning and planning staffs in Ozaukee, Washington, Waukesha, and Walworth Counties. In addition to identifying the stream reaches for which existing flood hazard data in the Region are available and the agency from which the data are available, the above map shows those stream reaches for which detailed, large-scale flood hazard maps are available from the Commission. These maps are available at scales of 1" = 100' with 2' contour intervals, or 1" = 200' with 2'-4' contour intervals, and enable precise delineations of the floodplains to be accomplished.

Source: SEWRPC.

for additional stream reaches within the Region. For example, the U. S. Army Corps of Engineers has completed detailed floodplain information studies along Whitewater Creek and along the Oconomowoc River at the request of the City of Whitewater and the City of Oconomowoc, respectively. The U. S. Soil Conservation Service has completed detailed floodplain information studies in the Pike River watershed at the request of Racine and Kenosha Counties, and along the Bark River at the request of the Village of Dousman. These are also indicated on Map 33.

Various studies are currently underway to develop additional flood hazard data for stream reaches in the Region. For example, as a result of increased flood insurance activity in the Region, numerous studies are being undertaken by the U. S. Department of Housing and Urban Development to provide supplemental flood hazard data to be used in identifying flood-prone areas for flood insurance purposes. In areas where detailed flood hazard data already exist, these studies utilize the existing data and may include the development of flood hazard data for small, previously unstudied tributaries. In areas where no flood hazard data exist, these studies develop the data necessary for the determination of flood hazard areas.

Groundwater Resources: The groundwater aquifers underlying the Region, together with Lake Michigan, are the major source of water for domestic, municipal, and industrial users. Approximately 235,000 persons, or 13 percent of the total resident population of the Region, utilize a total of about 35 million gallons of groundwater per day. Nearly 71 percent of the publicly owned water utilities within the Region uses groundwater as a source of supply. Groundwater withdrawals increased 67 percent from 1960 to 1970, causing drawdowns (water level lowerings) of up to 350 feet in portions of Waukesha, Brookfield, and New Berlin.

That part of precipitation that infiltrates into the ground and escapes—becoming evapotranspiration or part of the soil moisture—percolates downward until it reaches the zone of saturation and becomes part of the groundwater reservoir. Groundwater in any stratum is subject to a continuous process of natural and artificial discharge into streams, lakes, springs, and wells, and of replenishment through deep percolation of precipitation or recharge from streams, lakes, or wells.

Groundwater in saturated rock occupies the pore spaces and other openings in the rock materials. Similarly, in loose, unconsolidated materials, groundwater in the saturated zone occupies the spaces between individual grains of silt, clay, sand, or gravel. Rock units that yield water in usable amounts to pumped wells and in important amounts to lakes and streams are called aquifers. The aquifers beneath the Region differ widely in water yield capabilities and extend to great depths, probably attaining a thickness in excess of 1,500 feet in portions of the Region. Three major aquifers exist in the Region. These are, in order from land surface downward: 1) the sand and gravel deposits in the glacial drift; 2) the shallow dolomite strata in the underlying bedrock; and 3) the Cambrian and Ordovician strata, composed of sandstone, dolomite, siltstone, and shale. Because of their relative nearness to the land surface and their intimate hydraulic interconnection, the first two aquifers are often considered to be a single aquifer commonly known as the "shallow aquifer." The latter is accordingly commonly known as the "deep aquifer."

As shown on Map 34, the elevation of the potentiometric surface—the elevation to which water would rise in an open well tapping the aquifer—of the groundwater in the Region ranges from a high of more than 1,100 feet above National Geodetic Vertical Datum (mean sea level datum) in northwest portions of the Region to a low of less than 540 feet above National Geodetic Vertical Datum in east-central portions of the Region. The elevation of the potentiometric surface of the groundwater in the shallow dolomite aquifer and glacial deposits is shown on Map 34. The direction of groundwater movement is generally away from the subsurface divide. The subsurface divide approximates the location of the subcontinental divide of the surface waters down the hydraulic gradient toward the points of groundwater discharge or recharge of the deep aquifer. Groundwater discharge is an important factor in the sustenance of the dry-weather flow of streams in the Region.

Map 35 shows the estimated depth to seasonal high groundwater for the Region. Seasonal high groundwater is defined as the average of highest annual groundwater levels over the period of record available. Soils mapping and soils moisture information were used by the U. S. Geological Survey to determine the seasonal high groundwater levels. Seasonal high groundwater in the Region may be expected to be less than 10 feet beneath the land surface for about 12 percent of the Region. The seasonal high groundwater may be expected to be between 10 and 30 feet beneath the land surface for 54 percent of the Region and in excess of 30 feet beneath the land surface for the remaining 34 percent of the Region.

The potential for groundwater pollution is dependent on the depth to groundwater, the depth and type of soils through which precipitation must percolate, the location of groundwater recharge areas, and the subsurface geology. As shown on Map 36, about 18 percent of the Region is noted as having a severe potential for groundwater pollution, and 45 percent as having a moderate potential, whereas about 37 percent of the Region is rated as having a slight potential for groundwater pollution.

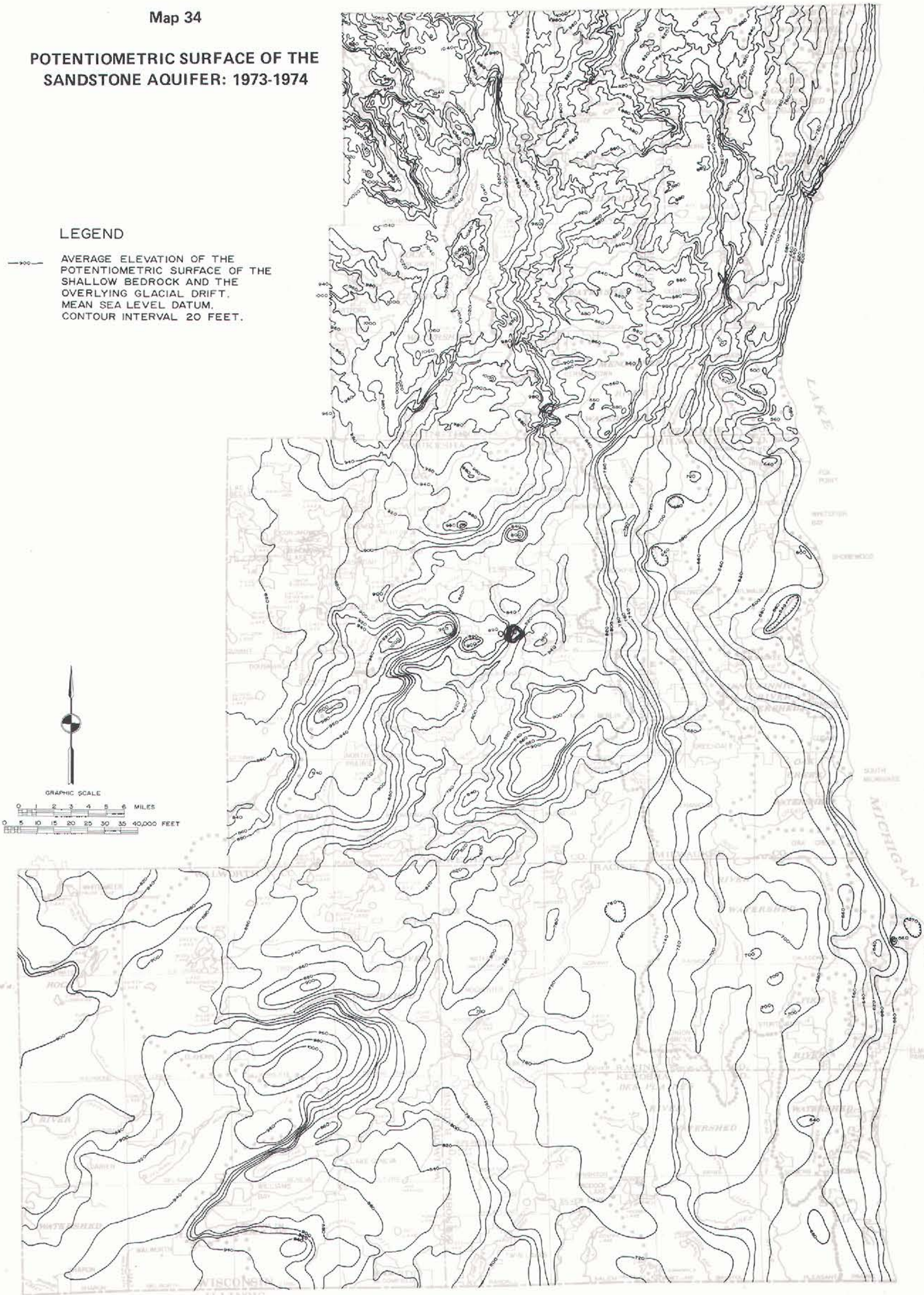
ENVIRONMENTAL CORRIDORS

The Corridor Concept

One of the most important tasks which was completed as part of the regional land use planning effort was the identification and delineation of the environmental corridors within the Region. Such corridors are defined as elongated areas encompassing the best remaining

Map 34

POTENTIOMETRIC SURFACE OF THE SANDSTONE AQUIFER: 1973-1974

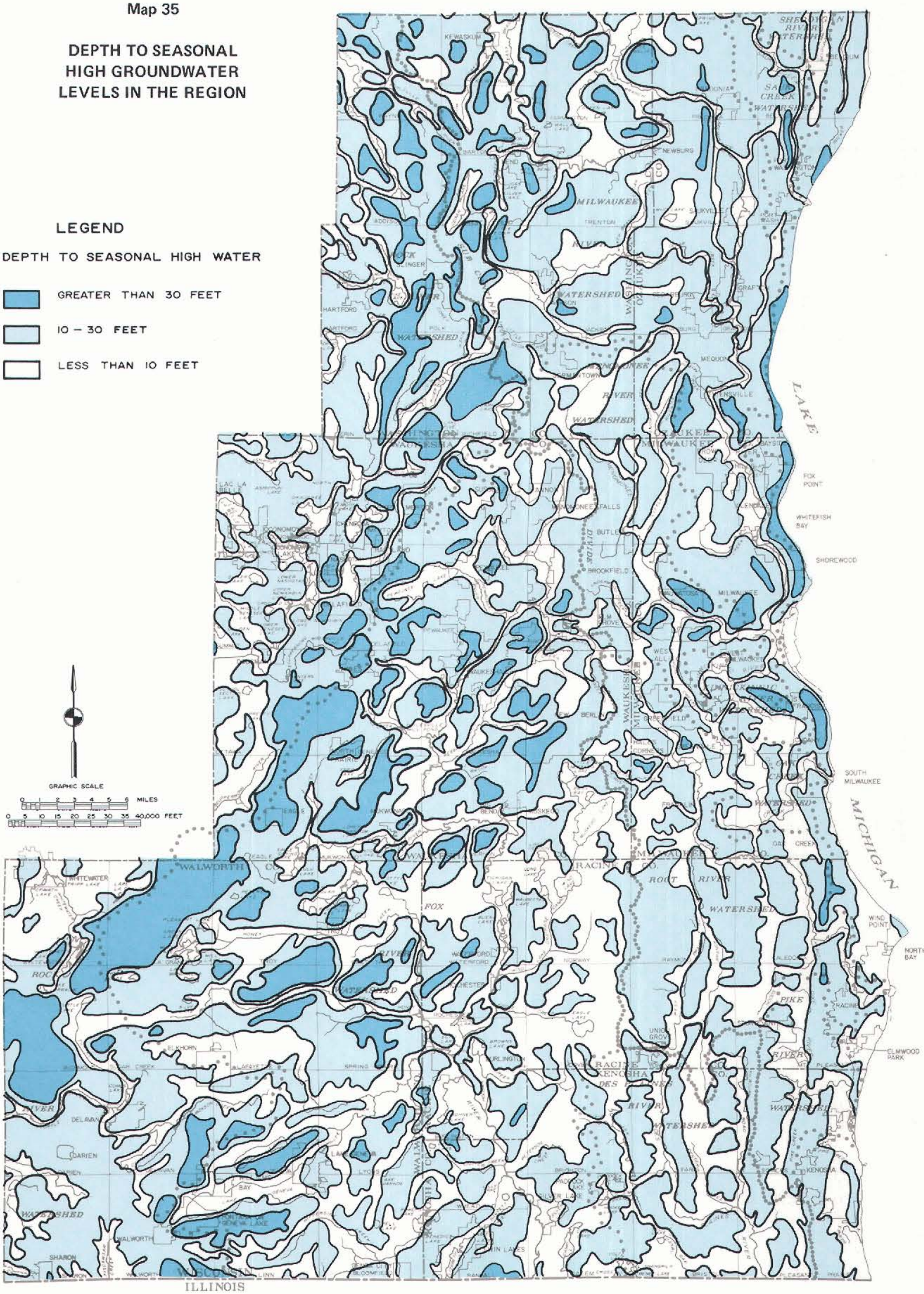


The elevation of the water table—the elevation to which water would rise in an open well which just penetrates the saturated zone—ranges from a high of 1,100 feet above mean sea level datum in the northwestern portion of the Region to a low of 540 feet above mean sea level datum in the east-central portion of the Region. This water table provides a potable water supply for a significant proportion of the resident population, but is of poor quality in localized portions of the Region. This very complex shallow aquifer is locally recharged and can be adversely affected by improper land and wastewater management of the overlying areas unless proper precautions are taken.

Source: U. S. Geological Survey and SEWRPC.

Map 35

DEPTH TO SEASONAL HIGH GROUNDWATER LEVELS IN THE REGION

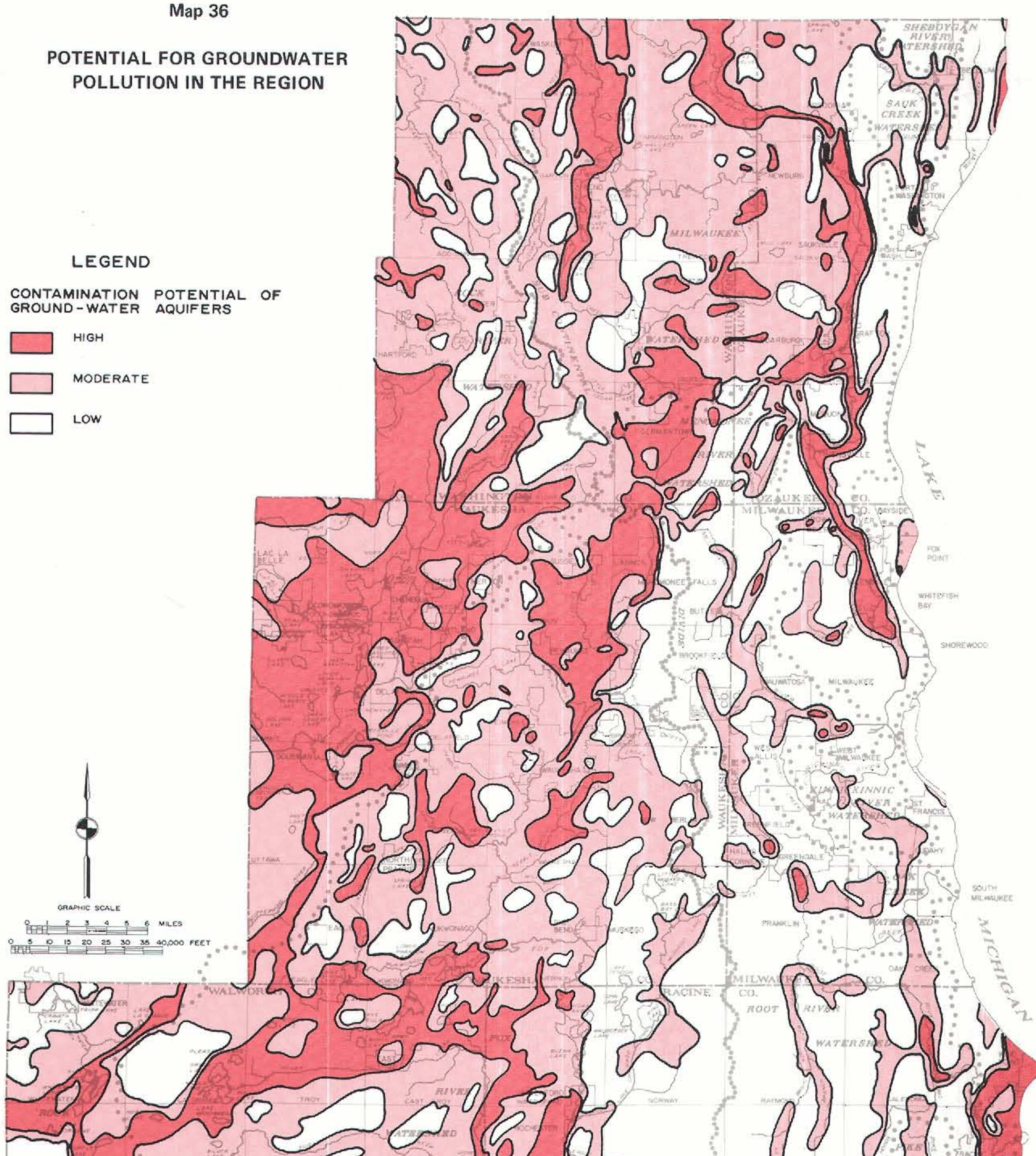


The depth to the seasonally high groundwater in the Region may be expected to be less than 10 feet beneath the land surface for about 33 percent of the Region, between 10 and 30 feet beneath the land surface for 56 percent of the Region, and in excess of 30 feet beneath the surface for the remaining 11 percent of the Region. In addition to the effects on the potential for private water supply from shallow wells, this physical feature has an effect on groundwater quality, and the viability of various liquid and solid waste disposal methods in specific areas of the Region.

Source: U. S. Geological Survey and SEWRPC.

Map 36

POTENTIAL FOR GROUNDWATER POLLUTION IN THE REGION



Areas of the Region may be classified according to their susceptibility to groundwater contamination based upon the depth to bedrock, soil permeability, and depth to water table—all measures of the ability of the unconsolidated glacial drift to serve as a filter to protect groundwater quality. Principal consideration is given to conditions that would affect groundwater contamination in the shallow sand and gravel aquifers and in the dolomite aquifers. About 18 percent of the Region has a high potential for groundwater contamination, 45 percent a moderate potential, and 37 percent a low potential.

Source: U. S. Geological Survey and SEWRPC.

elements of the natural resource base and which should, therefore, be preserved in essentially natural open uses in order to maintain a sound ecological balance, protect the overall quality of the environment, and preserve the unique natural beauty of the Region. The corridors by definition include one or more of the following seven elements of the natural resource base:

1. Lakes, rivers, and streams and their associated undeveloped shorelands and floodlands.

2. Wetlands.

3. Woodlands.

4. Wildlife habitat areas.

5. Rugged terrain and high relief topography.

6. Significant geological formations and physiographic features.

7. Wet or poorly drained soils.

Although the foregoing elements comprise the integral parts of the natural resource base, there are four additional elements which, although not a part of the natural resource base per se, are closely related to, or centered on, that base and are a determining factor in identifying and delineating the environmental corridors. These additional elements are:

1. Existing outdoor recreation and related open space sites.

2. Potential outdoor recreation and related open space sites.

3. Historic sites and structures.

4. Significant scenic areas and vistas.

The delineation of these natural resource and natural resource-related elements on a map of the Region results in an essentially lineal pattern encompassed in narrow, elongated areas which have been termed "environmental corridors" by the Commission. Primary environmental corridors are defined as those areas which encompass three or more of the aforementioned eleven environmental elements, whereas secondary environmental corridors are contiguous areas exhibiting one or two of the eleven necessary elements.

Regional Environmental Corridors

The primary environmental corridors of southeastern Wisconsin as shown on Map 37 are found to occupy approximately 503 square miles of land and inland water area, or about 19 percent of the total area of the Region. Most of the primary environmental corridors lie along major stream valleys, surround major lakes, or are found in the Kettle Moraine area. It is important to note that the primary environmental corridors contain almost all of the remaining high-value woodlands, wetlands, and wildlife habitat areas within the Region in addition to the lakes and streams and associated undeveloped shorelands and floodlands. These corridors also contain many of the best remaining potential park sites. The primary environmental corridors are, in effect, a composite of the best of the individual elements of the natural resource base of southeastern Wisconsin.

Recent trends within southeastern Wisconsin have resulted in the encroachment of urban development into the primary environmental corridors. Unfortunately, unplanned or poorly planned intrusion of urban development into these corridors not only tends to destroy the very resources and related amenities sought by the development, but tends to create severe environmental and developmental problems having areawide effects.

The preservation of the primary environmental corridors from further degradation is one of the principal objectives of the adopted regional land use plan upon which the areawide water quality management plan is based. These corridors should be considered inviolate; their preservation in a natural, open state or in park and related open space uses, including limited agricultural and country estate type uses, will serve to maintain a high level of environmental quality in the Region and protect its unique natural beauty. Secondary environmental corridors, also delineated by the Commission, should be at least partially retained in open space by using them as the basis for, or by integrating them into, greenways, drainageways, storm water retention basins, parks, and open spaces in developing areas of the Region.

SUMMARY

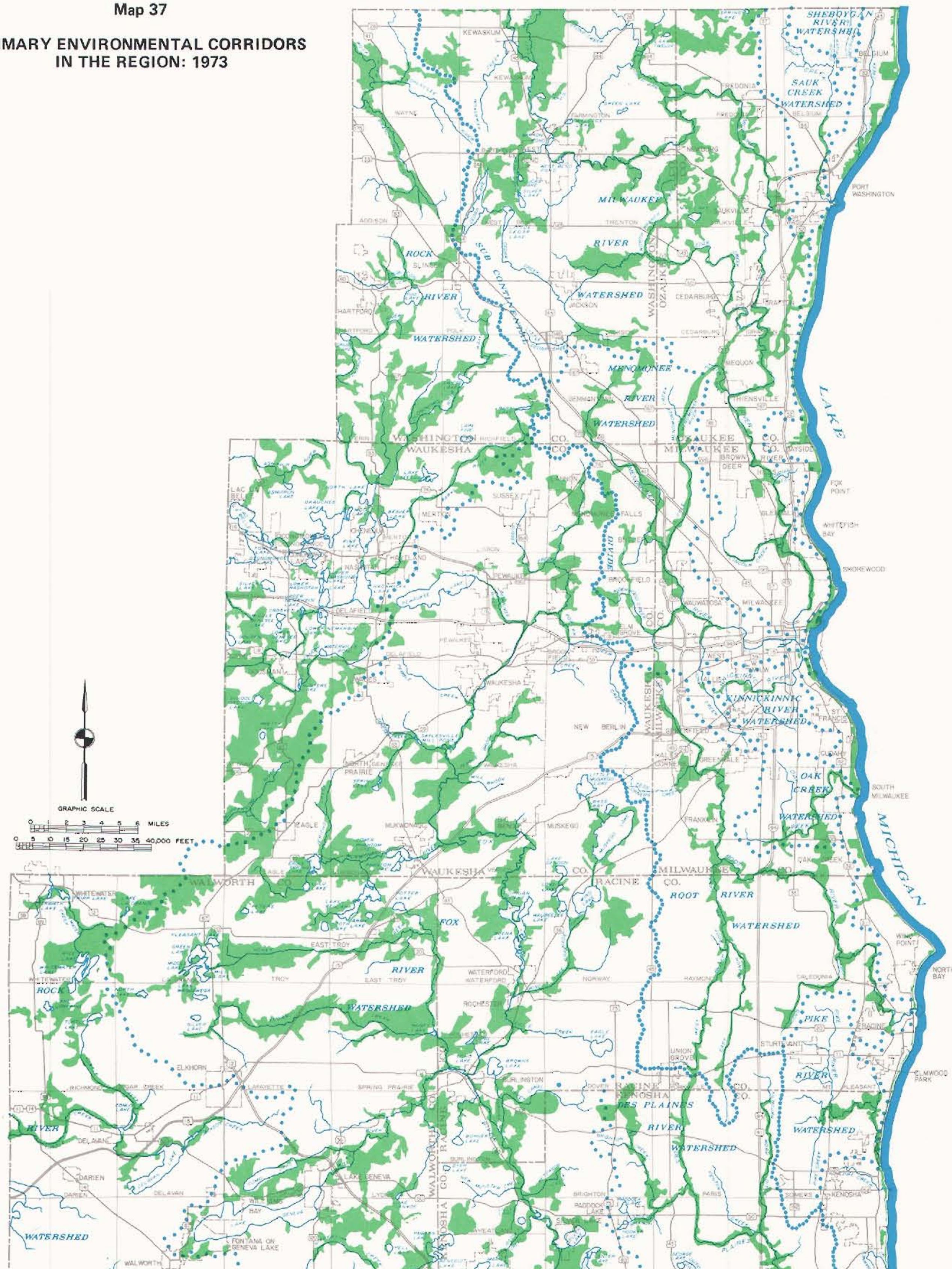
This chapter has described the man-made features and the natural resource base of the seven-county area which comprises the complex and changing environment served by the Southeastern Wisconsin Regional Planning Commission. Each of the significant elements of the man-made and natural resource base has been identified and described, the spatial distribution and extent quantified, the quality characterized, and the relationships to the areawide water quality management planning program identified.

The population of the Region has been increasing at an average rate of about 21,970 persons per year from 1950 to 1975, and as of 1975, totaled 1,789,871 persons. This rate of population growth is higher than state and national growth rates. Population growth within the Region has been occurring primarily in the newer outlying suburban and rural-urban fringe areas of the Region, while the populations of the older central cities and suburbs of the Region have remained relatively stable or have actually declined.

The population growth has been accompanied by marked changes in population characteristics. The composition of the population at the present time is only 12.4 percent rural. Moreover, of the total population, about 11 percent

Map 37

PRIMARY ENVIRONMENTAL CORRIDORS IN THE REGION: 1973



Approximately one-fifth of the Region lies within primary environmental corridors, which encompass almost all of the best remaining woodlands and wetlands, the best remaining wildlife habitat areas, almost all of the streams and lakes and associated undeveloped floodlands and shorelands, and many of the significant topographical, geographical, and historical features remaining in the Region. The preservation of these corridors in compatible open uses is essential to maintaining the overall quality of the environment within the Region. Sanitary sewer service should be planned so as to discourage urban development in these primary environmental corridors.

Source: SEWRPC.

is classed as rural nonfarm and only 1.4 percent as rural farm. Household sizes are declining and personal income has been increasing at a higher rate than has the total population. Thus, per capita and per household incomes have increased markedly over the last two decades, with the areas of highest average household income being located in the most rapidly growing newer suburban and rural-urban fringe areas of the Region.

Employment opportunities have increased at a rate of approximately 9,000 jobs per year since 1950 to a current level of approximately 779,000 jobs within the Region. The economic factors which promote population growth and urbanization in the Region are largely centered in and around the major urban centers of Milwaukee, Racine, and Kenosha, although a diffusion of economic activity into the outlying areas of the Region is occurring.

Land within the Region has been undergoing a particularly rapid conversion from rural to urban use. Recent urban development within the Region has been discontinuous and highly diffused, consisting primarily of many scattered, low-density, isolated enclaves of residential development located away from established urban centers. The highly diffused nature of this recent urban development, along with a sharp decline in urban population density, has intensified many long-standing environmental problems of an unprecedented scale and complexity, including problems of water quality management. The concentration of urban development around the shorelines of many of the inland lakes within the Region has further intensified the need for water quality control measures in order to assure protection and preservation of the natural resource base.

There are a total of 95 centralized public sanitary sewerage systems presently operated by utilities within the Region. These 95 systems serve a total area of about 353 square miles, or about 13 percent of the total area of the Region, and a total population of about 1.54 million persons, or about 86 percent of the total population of the Region. A total of 61 sewage treatment facilities are currently operated by the utilities owning, operating, and maintaining the 95 public sanitary sewerage systems, with many of the utilities contracting with adjacent utilities for sewage treatment purposes. In addition, there are 67 privately owned sewage treatment plants presently in operation within the Region. These generally serve isolated land use enclaves, mainly for industrial, commercial, and recreational enterprises. In all, then, there are 128 sewage treatment facilities within the Region.

The construction of public sanitary sewerage and water supply facilities has not fully kept pace with the rapid urbanization of the Region, necessitating the widespread use of onsite sewage disposal systems. An estimated 246,500 persons, or about 14 percent of the total population of the Region, rely on such septic tank sewage disposal systems. About half of the total area of the Region is covered by soils which are unsuitable for onsite sewage disposal facilities.

There are a total of 55 urban storm water management systems in the Region, of which mapping is available for 48 systems. These 48 systems drain a total area of about 183 square miles, or about 7 percent of the Region, and the 48 civil divisions contain about 1.50 million persons, or about 84 percent of the total regional population.

The Region is unusually rich with respect to water resources. Urban development located east of the subcontinental divide, which traverses the Region, can utilize both Lake Michigan and the two underlying ground aquifers as a source of supply. Urban development west of that divide must depend primarily upon the two groundwater aquifers. The location and timing of public water supply system service has generally followed those of public sanitary sewerage service areas within the Region. Gas and electric power services can be considered readily available throughout the Region, and, therefore, do not constitute a major constraint on the location or intensity of urban development within the Region. Transportation facilities similarly provide a very high level of service throughout the Region, with the extensively developed high-speed, all-weather highway system having had a particularly important influence on the spatial location of urban development within the Region in the recent past, although this influence has been significantly modified by the location within the Region of such natural resource base elements as streams, lakes, woodlands, wetlands, and fertile farmlands.

The Region has a continental type climate characterized primarily by a continuous progression of markedly different seasons and a large range in annual temperature. This climate is distinguished in the Region by frequent distinct changes in weather conditions which, particularly in the winter and spring, normally occur once every two or three days. In addition to marked temporal weather changes, the Region exhibits spatial weather differences, the most significant of which is the summer cooling attributable to Lake Michigan experienced primarily by areas in close proximity to the lake.

The annual temperature range, which is based on monthly means for six geographically representative observation stations, extends from a January low of 20.7^{O}F to a July high of 71.0^{O}F. Precipitation within the planning region occurs as rain, sleet, hail, and snow. Precipitation events range in intensity, duration, and significance from gentle showers to destructive thunderstorms and major rainfall or rainfall-snowmelt events resulting in property and crop damage, inundation of poorly drained areas, and stream flooding. The annual total precipitation is 31.26 inches expressed as water equivalent, with monthly averages ranging from a February low of 1.19 inches to a high of 3.77 inches in June.

Snow is most likely to occur in southeastern Wisconsin during the months of December, January, and February, and averages about 44.5 inches annually. Snow cover is of importance primarily because the insulating capability of accumulated snow significantly influences the depth and duration of frozen ground which, in turn, directly influences agricultural activities and sanitary and storm sewerage system construction and maintenance activities, as well as the ability of sunlight to penetrate below frozen lakes, and thus the production of oxygen by aquatic plants.

The groundwater within the Region provides an abundant source of generally high-quality water supply. The groundwater table lies at elevations of between about 540 feet and 1,100 feet above mean sea level. For about 12 percent of the land surface area of the Region, the vertical distance from the land surface to the seasonal high water table is between 0 and 10 feet, with 34 percent of the land surface area of the Region being more than 30 feet from the water table. The soil characteristics and subsurface geology of the Region cause about 18 percent of the land to be rated as high with regard to the potential for groundwater pollution; about 45 percent to be rated as moderate; and about 37 percent to be rated as low in its potential for groundwater pollution.

The 2,689-square-mile Southeastern Wisconsin Region was once subjected to the influence of several stages of continental glaciation, the last of which, the Wisconsin stage, terminated about 11,000 years ago and largely determined the physiographic and topographic features of the entire Region. That glaciation provided southeastern Wisconsin with an interesting, varied, and attractive landscape exemplified by the Kettle Moraine area that is still very much in evidence because of the predominantly rural as opposed to urban and, therefore, altered nature of the existing land use pattern. Protection of the aesthetic quality as well as the educational and recreational value of the Region's glacial landscape is largely dependent on future public policy with regard to the development and extension of public sanitary sewerage systems and private onsite sewage disposal systems.

Regional surface drainage is characterized by a disordered dendritic pattern, primarily because of the heterogeneous nature of the glacial drift. There is a preponderance of ponds and lakes, and much of the Region is covered by wetlands, with many streams being mere threads of water through those wetlands. A major subcontinental divide, which bisects the Region such that 1,685 square miles, or 63 percent of the Region, drain toward the Mississippi River, while 1,004 square miles, or 37 percent of the Region, are tributary to the Great Lakes-St. Lawrence River drainage basin, determines the gross surface water drainage pattern and also creates certain legal and water use problems.

The surface water drainage pattern of southeastern Wisconsin may be further subdivided so as to identify 11 individual watersheds, of which five—the Root River, Menomonee River, and Kinnickinnic River, Oak Creek, and Pike River watersheds—are wholly contained within the Region. In addition to the 11 watersheds, there are numerous small catchment areas contiguous with Lake Michigan that are drained directly to the lake by local natural streams and artificial drainageways; these areas may be considered as comprising a twelfth watershed. The surface drainage pattern and location of watershed boundaries are pertinent to the areawide water quality management plan since emphasis on in-watershed solutions is one of the five basic principles formulated under the areawide water quality management planning program.

The glacial drift of southeastern Wisconsin is underlain by bedrock formations of the Cambrian through Devonian periods. The formations dip gently down toward the east at a slope on the order of 20 feet per mile, and attain a thickness in excess of 1,500 feet beneath the eastern boundary of the Region. The bedrock of the seven-county Region is, for the most part, covered by unconsolidated glacial deposits that are more than 500 feet thick in some buried preglacial valleys. In contrast, there are approximately 150 square miles of southeastern Wisconsin, generally east of and parallel to the Kettle Moraine area, in which bedrock lies within 20 feet of the ground surface, and a few localized areas exist where bedrock is actually exposed. Outcrop areas and those portions of the Region having less than 20 feet of glacial drift overlying the bedrock constitute an important consideration in the design and construction of private onsite sewage disposal systems and public sanitary sewerage systems, since the operation of the former is dependent on favorable soil characteristics while the latter involves extensive trenching and excavation. Outcrops and shallow drift areas also serve to identify those portions of the Region that are particularly susceptible to pollution of both the sand and gravel aquifer and the underlying dolomite aquifer as a result of malfunctioning septic systems, exfiltration from sanitary sewers, landfill leachates, and other diffuse pollution sources.

The nature of surficial deposits and the characteristics of the bedrock are the two important geologic factors that determine, in conjunction with selected hydrologic and cultural considerations, the potential for land disposal of liquid wastes on a large scale. Geologic conditions within the Region are such that only a relatively small portion of the Region, consisting of the western one-half of Ozaukee County and scattered areas comprising about one-half of Washington County, is well suited for the land disposal of treated sewage effluent.

Sand and gravel, dolomite building stone known locally as lannon stone or limestone, and organic material are the three primary mineral and organic resources of southeastern Wisconsin that have commercial value as a result of their quantity, quality, and location. As a result of its glacial history, the Region has an abundant supply of sand and gravel deposits, the most productive of which are concentrated in the Kettle Moraine area and are important sources of concrete aggregate and of gravel for general construction purposes. Depending on the nature of the deposits, particularly their depth and areal extent and the size of the gravel and rocks, sand and gravel deposits may seriously hamper trenching, excavation, and tunneling work. Niagara dolomite is mined in open quarries, most of which are located in Waukesha

County, and supplies high-quality dimensional building stone and, when crushed, concrete aggregate and gravel for construction purposes. The presence of a quarrying operation in an area indicates relatively thin glacial deposits and close proximity of bedrock to the ground surface and is, therefore, an important consideration in the planning and conduct of construction projects, such as sanitary sewerage systems, that entail extensive trenching and excavation.

Organic deposits are widely distributed throughout the Region in small, scattered, low-lying, poorly drained areas, and form the basis for wildlife, wetland, and recreation areas. Because of the fertilization potential, organic deposits have commercial value in their ability to support certain field and specialized crops as well as sod farming and peat mining. Organic deposits identify areas having severe limitations for development of onsite sewage disposal systems because of poor drainage characteristics and because of potential infiltration problems through sewer pipe joints and cracks. Also, organic deposits complicate the construction of sanitary sewerage systems because of the difficulty of operating heavy equipment on them and of working with them.

A wide variety of soil types have developed in southeastern Wisconsin as a result of the interaction of parent glacial deposits covering the Region; the resulting topography; the climate; the plants and the animals; and time. As a result of a detailed soil survey, all the diverse soil types of a detailed soil survey, all the diverse soil types of southeastern Wisconsin have been mapped; and their physical, chemical, and biological properties have been identified. Also, interpretations have been made for planning purposes. Soil survey data and interpretations reveal that approximately 716 square miles, or about 27 percent of the Region, are covered by soils that are poorly suited for residential development with public sanitary sewer serivce; approximately 1,637 square miles, or about 61 percent of the Region, are poorly suited for residential development without sanitary sewer service on lots smaller than one acre in size; and about 1,181 square miles, or approximately 44 percent of the Region, are poorly suited for residential development without public sanitary sewer service on lots one acre or larger in size.

Historically, vegetational patterns in southeastern Wisconsin were determined by natural factors such as climate, disease, glacial deposits, soil type, fire, topography, and drainage characteristics, but since his settlement of the Region, man has increasingly influenced the quantity and quality of woodlands, wetlands, and aquatic vegetation. In 1970, woodlands comprised 125,300 acres, or approximately 7 percent of the regional land area. In addition to commercial value, woodlands have significant aesthetic value when viewed in conjunction with the beauty of the Region's lakes, streams, and glacial land forms. Wetlands, which covered about 180,800 acres, or about 11 percent of the seven-county Region in 1970, attenuate peak flood flows, protect stream water quality by serving as nutrient and sediment traps, and provide necessary wildlife habitat.

Lakes, streams and their floodlands, and groundwater, which comprise the water resources of southeastern Wisconsin, constitute the most important single natural resource category because of their multifaceted functions including support of numerous, popular water-oriented recreation activities; habitat for fish and wildlife; desirable sites for vacation homes and permanent residential developments; and provision of water for domestic, municipal, and industrial water users. The Region contains 1,148 lineal miles of major streams and 100 major lakes, the latter having a total surface area of 57 square miles, or about 2 percent of the area of the Region. The major lakes provide a total shoreline length of 448 miles.

These surface water resources, in general, and many of the streams in the Region in particular, are vulnerable to pollution because the low flows are small relative to forecast municipal treatment plant discharges.

Commission studies indicate that many of the major lakes and many miles of major streams in the planning Region are being degraded as a result of man's activities to the point where they now have, or will in the future have, little or no value as recreational areas, as desirable locations for controlled water-oriented residential development, or as aesthetic assets of southeastern Wisconsin. In general, the surface waters of the Region may be characterized as being highly polluted. Surface water degradation is primarily attributable to mismanagement of human wastes and poor land management practices. Therefore, the areawide water quality management planning program has the potential to protect the Region's surface water resources.

Approximately 7 to 10 percent, or 188 to 260 square miles, of southeastern Wisconsin is estimated to lie within the inundation limits of a 100-year recurrence interval flood event. The 100-year floodplain has been delineated for approximately 530 lineal miles of major stream channel in the Root, Fox, Menomonee, Milwaukee, and Des Plaines River watersheds within the seven-county Region. This floodplain serves to identify those portions of the Region poorly suited for urban development because of flood hazards, high water tables, inadequate soils, and high cost for public utilities and services such as sanitary sewerage systems. At the same time, this floodplain identifies areas well suited for much needed open space uses. Regional land use policies in general, and areawide water quality management planning and development policies in particular, should direct urban development to more suitable areas outside of the floodplain areas, thereby reserving the floodplain for open space uses consistent with the underlying natural resource base.

Groundwater is the principal source of water supply for about two-thirds of the water utilities operating within the Region, for about 13 percent of the resident population of the Region served by such utilities, and for many industries. Groundwater also sustains lake levels and provides the base flow of streams. The aquifers lying beneath the Region, which attain a combined thickness in excess of 1,500 feet in the east, may be subdivided so as to identify three distinct groundwater sources. In order from the land surface downward they are the sand and gravel deposits in glacial drift, the shallow dolomite strata in the underlying bedrock, and the deeper Cambrian period and Ordovician period strata composed of sandstone, dolomite, siltstone, and shale. Regional groundwater quality is generally good, although it is very hard so that softening is required for most uses. Regional development must be managed to protect the valuable groundwater resources, with particular emphasis on public sanitary sewerage systems, private onsite sewage disposal systems, and sanitary land fills, since these uses may easily contaminate the surficial sand and gravel aquifer and also have the potential to pollute the underlying dolomite aquifer in areas where it is creviced and covered by thin, permeable, glacial deposits.

The lakes and streams within the seven-county Region are capable of supporting a limited fishery relative to the heavy fishing demand that is placed on them. A 1970 wildlife habitat inventory revealed that about 103,000 acres, or 6 percent of the Region, contained high-quality wildlife habitat furnishing food and cover for small upland game, larger predators, game birds, and fish. Wildlife habitat areas constitute both a valuable recreation resource and an aesthetic asset, the protection of which is strongly dependent on rational land use—in particular, policies pertaining to areawide water quality management planning.

The delineation of selected natural resource and natural resource-related elements on a regional map produces an essentially lineal pattern encompassed in narrow, elongated areas which have been termed "environmental corridors" by the Southeastern Wisconsin Regional Planning Commission. Primary environmental corridors occupy approximately 503 square miles, or 19 percent, of the planning Region, and contain almost all of the remaining high-value wildlife habitat areas and woodlands within southeastern Wisconsin; most of the wetlands, lakes and streams, and associated floodlands; as well as many significant physiographic features and historic sites. The primary environmental corridors are a composite of the best of the individual elements comprising the natural resource base of southeastern Wisconsin. The preservation of these primary environmental corridors in a natural state or in park and related open space uses, including limited agricultural and country estate-type use, is essential to the maintenance of a high level of environmental quality in the Region and to the protection of its natural beauty, and as such is one of the principal objectives of the adopted regional land use plan upon which the areawide water quality management plan is based.

Chapter IV

EXISTING AND HISTORICAL WATER QUALITY

INTRODUCTION

The development of areawide water quality management plans requires the collection of definitive data on the existing level of water quality in the streams and lakes of the planning area and an evaluation of the ability of those levels to support existing and proposed water uses. Ideally such data would be collected over a long period. Unfortunately, such long-term historic data are usually unavailable.

An important exception are the data provided by the major benchmark study of surface water quality conducted by the Regional Planning Commission in 1964 and the continuing water quality monitoring program carried out by the Commission since then. Under these Commission programs, an extensive set of water quality data have been obtained at 87 sampling stations located at strategic points on the stream network of the Region. This collection of data on historic streamwater quality conditions in the Region is presented, evaluated in light of established water use objectives and standards, and analyzed in relation to existing sources of pollution in SEWRPC Technical Report No. 17, Water Quality of Lakes and Streams in Southeastern Wisconsin: 1964-1975.

As part of the areawide water quality management planning program, three additional supplementary sets of data have been developed. In special studies of 13 major inland lakes, the Commission has obtained valuable lake water quality data for use in the preparation of special lake water quality management reports to be published separately from this planning report. The lake water quality data, however, were also utilized in the calibration and application of the water quality simulation model, which is an important analytical tool in the areawide water quality management planning program. In order to calibrate the simulation model for the surface water network, the Commission also obtained detailed streamwater quality data during storm runoff events at 36 sampling stations in the Region, including 23 of the 87 Commission streamwater quality sampling stations. A total of 1,067 samples were collected from September 18, 1976 through April 6, 1977 during runoff events. In addition, diurnal sampling was conducted at each of the remaining 64 of the basic 87 Commission sampling stations during the period from September 22, 1976 through November 4, 1976. Although this was a period of relatively little precipitation, the sampling program did obtain samples from at least one storm event at each sampling station. These data are all on file and available at the Commission offices.

In addition to the data on the historical and existing water quality conditions of the streams and major inland lakes of the Region, presented in very brief summary form in this chapter, it should be noted that the Commission has prepared a uniform, areawide characterization of existing surface water quality conditions through the simulation of such conditions as of 1975. This characterization as presented in Volume Two of this report includes an assessment of the probability of achieving the established water use objectives and supporting standards, and provides a more comprehensive assessment of existing water quality conditions, based on simulation modeling, than does the analysis rendered in this chapter, which compares specific instantaneous stream sampling observations to the state and federally adopted standards. The data and analyses presented in this chapter, however, are intended to comprise an important independent check on the simulation modeling study results.

Presettlement Water Quality Conditions

Few documents exist which set forth the condition of the streams and lakes of the Region prior to and immediately after settlement of the Region by Europeans in 1836. The Commission reviewed the few available documents, and the results from some are cited here. Other historical records, such as the notes documenting the original U. S. Public Land Survey, did not contain any specific historic water quality information, although those records do provide an invaluable record of presettlement land cover and other then-existing physiographic features of the landscape.

The surface waters of the streams and lakes of southeastern Wisconsin contain many substances which are not introduced by the activities of man, but are derived instead from natural sources, including soils, underlying bedrock, plants, and animals, which all affect the background levels of water quality. These natural processes were at work prior to human settlement of the Region, but may have been accelerated by human activities.

During the late 1830's and early 1840's, the streams and lakes of the seven-county area had not yet begun to show any visible signs of degradation as a result of man's activities. In 1846, Increase A. Lapham, a prominent early land surveyor, civil engineer, and natural scientist of the Region, thus described the streams and lakes: "Many of them [lakes] are the most beautiful that can be imagined—the water deep and of crystal-clearness and purity surrounded by sloping hills and promontories covered with scattered groves and clumps of trees. All the principal rivers are, however, navigable for canoes. Their waters usually originate in springs and lakes of pure and cold water."[1]

[1] *I. A. Lapham, Wisconsin, Its Geography and Topography, History, Geology, and Minerology, 1846, p. 14-15.*

Similar statements with regard to other major streams and rivers within southeastern Wisconsin have been found: "The early settlers testify that when they first knew Poplar Creek in the Fox River watershed, so named for the poplar trees along the banks, it contained trout."[2] And in 1875, James S. Buck described the lower Milwaukee River as it appeared in 1836 (see Map 38): "While between them [bluffs] ran the river, like a silver thread [not the filthy sewer it is today, but a clear stream] in which the Indian could detect and spear a fish at the depth of 12 and even 18 feet and upon whose surface sparkled the rays of the morning sun as upon a mirror." [3] These comments of 1875 indicate that a distinct decline in water quality occurred over the period 1840-1880.

As the settlements grew rapidly in the early 1840's, aesthetic pollution began to become more noticeable in the major rivers flowing through the larger population concentrations. A foreigner visiting Milwaukee in the early 1840's told how wooden sidewalks lined muddy streets and the gutters—a row of flat stones in the center of the street—ran with "liquid filth" directly into the Milwaukee River. Nobody bothered about providing even an outhouse. Milwaukee citizens just emptied the contents of the chamber pots into the streets each morning. Sometime in the late 1840's, civic-minded citizens became so upset with the resulting filth that the first city sewer was constructed. Built of planks buried under what is now Wisconsin Avenue, it extended from the river to the base of the rise at about what is now N. 6th Street, hiding the sewage from view of visitors to the downtown area. Within 30 years, it had become common knowledge that sewage was a carrier of typhoid and cholera, and the stench on warm summer days was so intense that citizens began to complain about the filthy conditions of the river.[4]

By the 1880's outlying rural areas were still relatively unaffected by water pollution resulting from man's activities. Early newspaper reports indicate the pristine nature of the streams and lakes in Walworth, Waukesha, Washington, Racine, Ozaukee, and Kenosha Counties, with large numbers of ducks and other wildlife and game fish inhabiting the area. Unfortunately, not unlike the rivers near the by-then highly urbanized City of Milwaukee, the rural lakes and streams gradually began to exhibit water quality degradation in the early 1900's as indicated by documented demands for carp eradication on Oconomowoc Lake;[5] dissolved oxygen depletion in the hypolimnion[6] of Okauchee and Pike Lakes; and significant algal growth in the upper and lower depths of Geneva Lake.[7] No longer did the streams and lakes within the major watersheds of the Region flow with pristine waters.

As technology improved and advanced, raw sewage was collected and channeled in underground pipes, out of sight of the city dwellers, to be discharged to the rivers and lakes of the Region, at first untreated; later the sewage was treated by primary sewage treatment plants; and still later it was treated by more advanced secondary treatment plants. Although collection and treatment of the raw sewage in the urbanized areas helped to reduce the degradation of the streams and lakes in that area, pollution from man's activities continued and intensified from the period of the early 1900's through the mid-1970's—leading to the conditions as reported in this chapter.

Impact of Human Activities on Water Quality

Human activities contribute significant amounts of pollutants to the surface waters of the Region, thereby impairing desirable water uses. More specifically, raw sewage discharged from both separate and combined sewer overflow points; sewage treatment plant effluent; industrial wastewaters; quarry discharges; leachate and runoff from poorly designed and managed solid waste disposal sites; runoff from construction sites; fertilizer runoff from lawns and golf courses; stream and lake dredging; rainfall and snowmelt runoff from streets, highways, parking lots, and other urbanized areas; and rainfall and snowmelt runoff from croplands, livestock operations, and other rural land uses all contribute to water quality degradation. Selected examples are illustrated in Figures 17 through 28. These various point and nonpoint sources introduce organic pollutants which consume the oxygen needed by aquatic life; nutrient pollutants which stimulate undesirable plant growth; chemical pollutants which can cause an unhealthy

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[2] *History of Waukesha County, Western Historical Company, 1880, p. 318.*

[3] *History of Milwaukee, Wisconsin, Western Historical Company, 1881, Chapter III, p. 105.*

[4] *Milwaukee Sentinel, "Milwaukee River Remains Just an Ugly Duckling," December 3, 1968.*

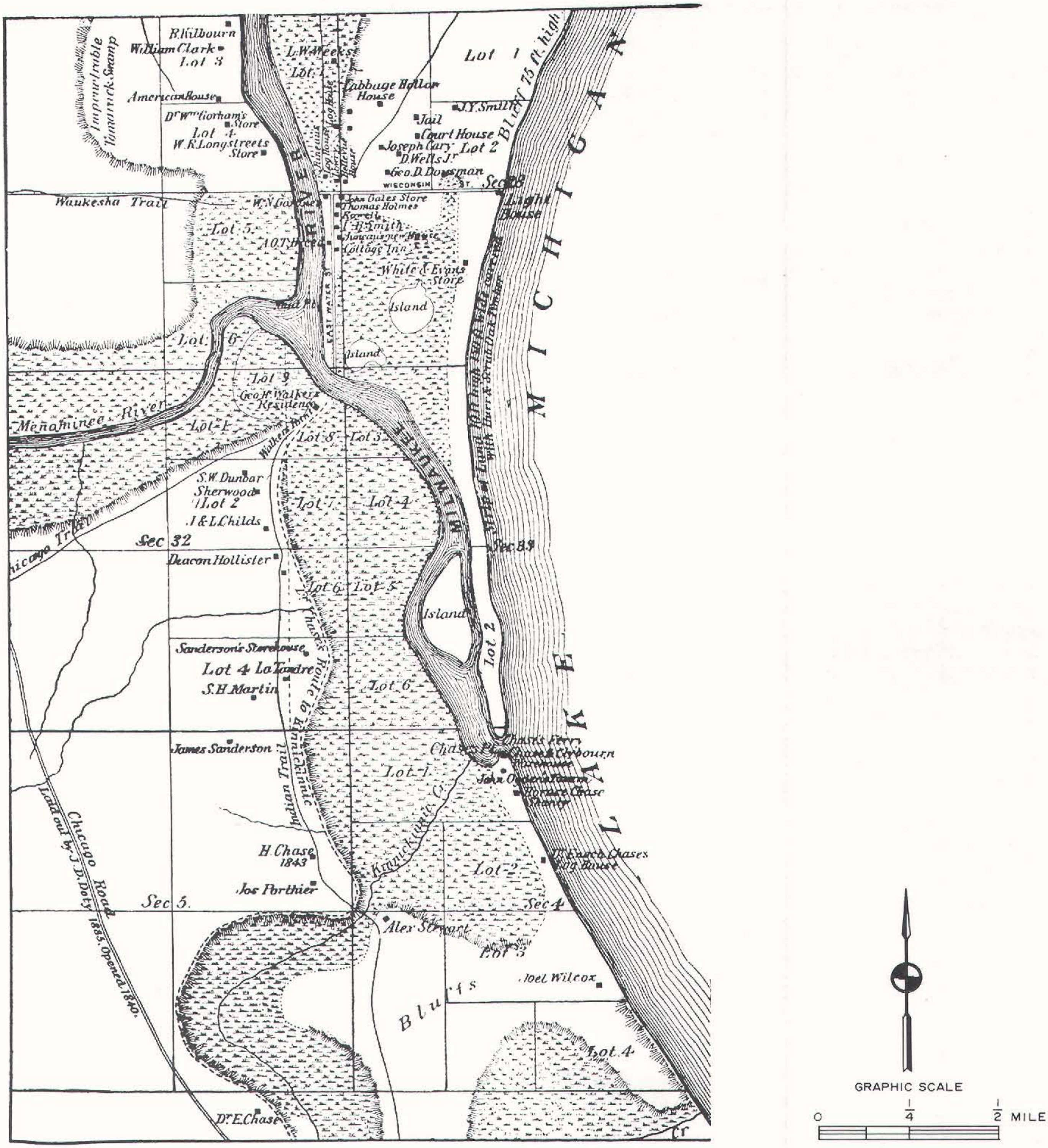
[5] *Oconomowoc Enterprise, "Oconomowoc Yesteryears," January 29, 1970.*

[6] *In lakes deeper than about 20 feet, three separate zones or layers of water tend to develop during the summer months. The upper zone, or epilimnion, consists of a well-mixed layer of relatively warm water of uniform temperature. The bottom zone, or hypolimnion, consists of the densest, coldest water in the lake. These two zones are separated by a layer of water known as the thermocline, in which there is a rapid drop in temperature, with increasing depth. The thermocline acts as a barrier that prevents mixing of the upper layer of water with the bottom layer of water and thus maintains the thermal stratification of the lake during the summer months.*

[7] *Edward A Birge and Chancey Juday, "Inland Lakes of Wisconsin, the Dissolved Gases of Water and Their Biological Significance," Wisconsin Geological and Natural History Survey, Bulletin No. XXII, Scientific Series No. 7, 1911.*

Map 38

DEPICTION OF THE MILWAUKEE, MENOMONEE, AND KINNICKINNIC HARBOR AREAS PRIOR TO EUROPEAN SETTLEMENT



In 1836 the Milwaukee River, as the first European settlers found it, flowed into Lake Michigan through a swampy delta. The wetlands here, as in the rest of the Region, would have protected the flowing streams against the effects of storm water runoff. The outlet of the river then was about a half-mile south of the present outflow through the harbor entrance. Waterway modifications of the sort which occurred in this portion of the Region change the hydrologic, hydraulic, and fish and wildlife habitat conditions so greatly that long-term comparisons are of little value.

Source: Milwaukee County Historical Society.

Figure 17

RESIDENTIAL LAND UNDER DEVELOPMENT

Example of Urban Nonpoint Pollution Source

SEWRPC Photo.

Figure 18

RESIDENTIAL LAND UNDER DEVELOPMENT— RESULTS OF INADEQUATE TOPSOIL COVER

Example of Urban Nonpoint Pollution Source

SEWRPC Photo.

Figure 19

INDUSTRIAL LAND USE

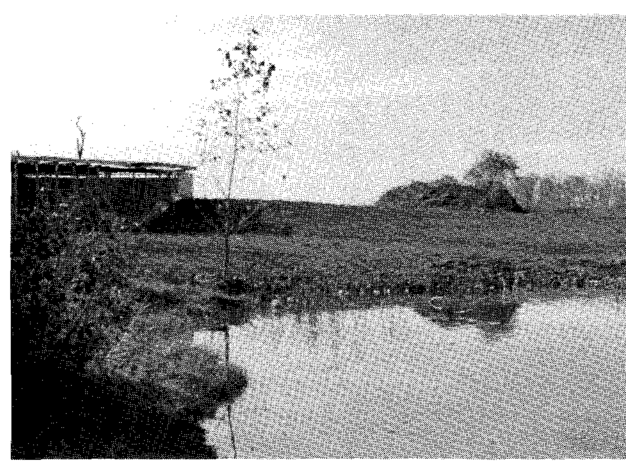
Example of Urban Nonpoint Pollution Source

Photo Courtesy of Milwaukee County Park Commission.

Figure 20

ILLEGAL LAKE FILLING DURING DEVELOPMENT

Example of Rural Nonpoint Pollution Source



SEWRPC Photo.

environment for flora and fauna, and for humans; thermal pollutants which affect the balance and dynamics of natural, chemical, and biological processes; floating trash and debris and other materials which cause aesthetic pollution and interfere with the enjoyment of lakes and streams; and radioactive pollutants which may be hazardous to all forms of life. These forms of pollution produce varying effects upon the streams and lakes of the Region. Because of the lack of data, this chapter and the parent technical report address the radioactive or chemical pollutants only to a very limited degree. A comprehensive inventory of pollution sources was conducted, and the results are reported by watershed in Volume One, Chapter V of this report, and more fully in SEWRPC Technical Report No. 21, Sources of Water Pollution in Southeastern Wisconsin: 1975.

Current Water Quality and Recent Trends

Commission studies have clearly shown that human activities have altered the quality of the surface waters of southeastern Wisconsin to such an extent that in many areas these waters do not meet established water use objectives and standards. In order to reduce the massive amount of water quality data collected and collated

Figure 21

INSTALLATION OF SANITARY SEWER

Example of Urban Nonpoint Pollution Source

SEWRPC Photo.

Figure 22

EROSION ON A SKI HILL

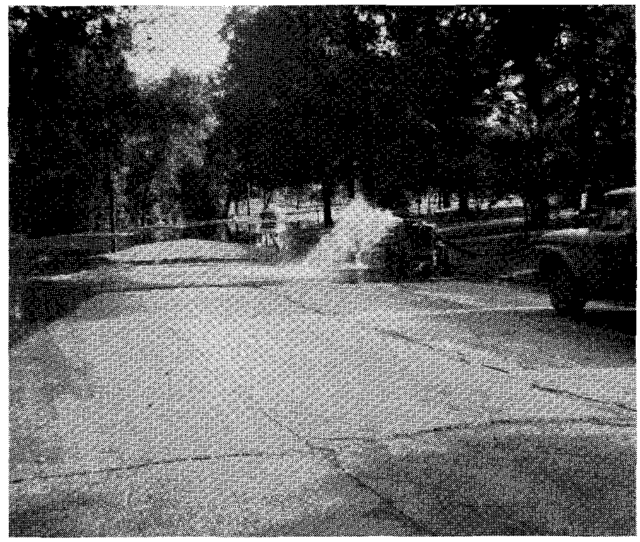
Example of Urban Nonpoint Pollution Source

SEWRPC Photo.

Figure 23

SANITARY SEWER FLOW RELIEF PUMPING STATION

Example of Urban Point Pollution Source

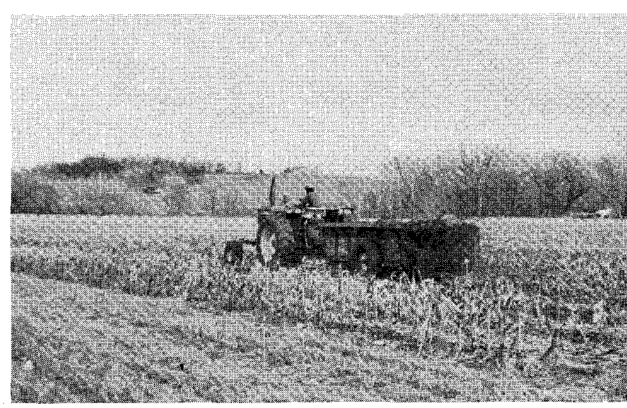


SEWRPC Photo.

Figure 24

MANURE-SPREADING OPERATION

Example of Rural Nonpoint Pollution Source



SEWRPC Photo.

under the Commission water quality monitoring efforts to a more readily understandable summary form, the Commission developed a water quality index based upon the six water quality parameters of dissolved oxygen, fecal coliform, pH, chloride, nitrate-nitrogen, and total phosphorus. For each water quality sample analyzed, the observed level of each of the six selected parameters was assigned a score in the range of from 0 to 100. The parameter scores were then combined to prepare a general water quality index classification for each sampling station. The resulting ratings for 1964 and 1975

Figure 25

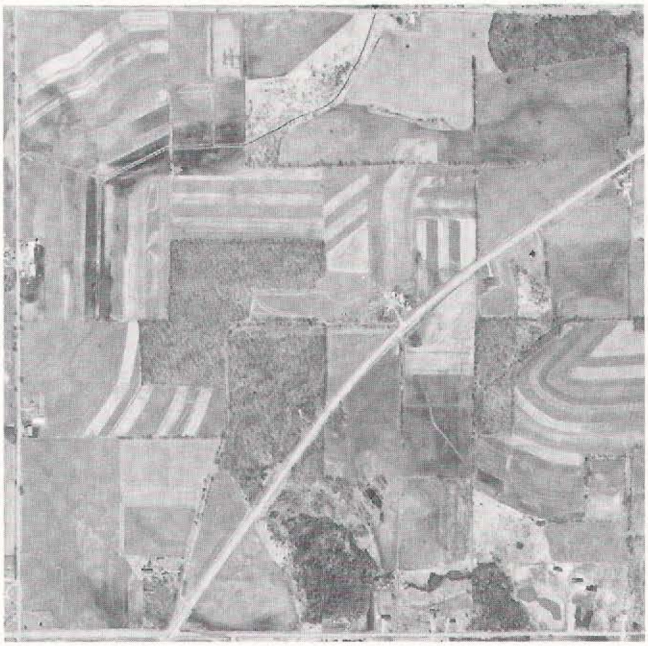
AERIAL PHOTOGRAPH OF AGRICULTURAL LAND ILLUSTRATING NO CONSERVATION PRACTICES

U. S. Public Land Survey
Section 25, Town 12 North, Range 18 East,
Town of Wayne, Washington County, Wisconsin

Figure 25 (continued)

AERIAL PHOTOGRAPH OF AGRICULTURAL LAND ILLUSTRATING GOOD CONSERVATION PRACTICES

U. S. Public Land Survey
Section 17, Town 12 North, Range 20 East,
Town of Farmington, Washington County, Wisconsin



The figure on the left illustrates an agricultural operation within the Region which has not implemented conservation measures to retard soil loss from the land surface. By contrast, the figure on the right shows an exemplary farm on which sound conservation techniques such as strip cropping and bench terracing have been implemented and on which grass waterways have been added. The agricultural operations which do not implement conservation practices are by far more significant sources of sediment and nutrient loading to the lakes and streams of the Region, than are the farms with sound soil and water conservation practices in place.

Source: SEWRPC.

are presented, together with selected sampling data, in the following descriptions of existing water quality conditions and trends in each of the 12 major watersheds of the Region.

The assessment of water quality conditions requires a comparison of observed conditions to desired conditions. Water quality standards as promulgated by the state and federal governments change over time.[8] This was recognized in the preparation of SEWRPC Technical Report No. 17, Water Quality of Lakes and Streams of Southeastern Wisconsin: 1964-1975. During the preparation of that report the State of Wisconsin was in the process of revising the stream water quality standards, and was considering the development of more detailed water quality standards for lakes. Because of the transition then underway, the Commission applied in that technical report the 1973 state standards, at that time the most recent standards formally adopted by the Wisconsin Natural Resources Board. Subsequently, the state standards for stream water quality were modified and, accordingly, in this chapter the observed water quality conditions are compared to the revised stream standards as adopted by the Natural Resources Board in October 1976, and as interpreted for phosphorus by the Commission staff, and to the Commission staff interpretation of existing water use objectives and supporting standards for each of the major lakes of the Region, based on the Wisconsin Administrative Code, Chapters NR 102 through 104. Thus, to provide a complete presentation in this chapter, the Commission compared the observed water quality conditions of streams from the continuing water quality sampling effort and the lake water quality conditions observed since 1970 to the water use objectives and supporting standards as adopted by the State in October 1976. The resulting assessment, summarized on Map 39 in this chapter, serves along with the simulated water quality conditions to be presented in Volume Two of this report as a basis for the evaluation of alternative water pollution control plans for the Region.

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[8] *A more detailed discussion of the function and history of water use objectives and supporting water quality standards will be provided in Volume One, Chapter VI and Volume Two, Chapter II of this report. These chapters will also describe respectively the existing (1976) adopted state and federal water use objectives and supporting standards, as well as the Commission's initial recommended objectives and standards for the year 2000.*

Figure 26

AERIAL PHOTOGRAPH SHOWING INLAND LAKE WITH EXCESSIVE MACROPHYTE AND ALGAE GROWTH

West End of Lake Wandawega, Walworth County, Wisconsin

This figure illustrates an inland lake with large quantities of aquatic vegetation which impair the desirable recreational uses of that portion of the lake due to large quantities of nitrogen and phosphorus entering the lake from upstream pollutant sources such as agricultural runoff and malfunctioning septic tanks, all as a result of human activities.

Photo Courtesy of Wisconsin Department of Natural Resources.

use objectives and supporting standards as will be set forth in Volume Two, Chapter II of this report. The resulting assessment, summarized on Map 39 in this chapter, serves along with the simulated water quality conditions to be presented in Volume Two, Chapter IV of this report as a basis for the evaluation of alternative water pollution control plans for the Region.

In addition, 65 of the 100 major lakes in the Region have been classified and are discussed according to trophic status. The classification was conducted by the University of Wisconsin Water Resources Center and published by the U. S. Environmental Protection Agency (EPA) in June 1975,[9] and considered the dissolved oxygen levels in the hypolimnion, water clarity, the history of fishkills, and the levels of use impairment caused by algae and abundant weed growth. These trophic ratings are also reported in the following descriptions of water quality conditions by watershed, as are the assessments of lake water quality conditions—based on the limited data

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[9] *U. S. Environmental Protection Agency, Lake Classification—A Trophic Characterization of Wisconsin Lakes, EPA Report No. 660/3-75-033, June 1975.*

Figure 27

AERIAL PHOTOGRAPHS OF RESIDENTIAL LAND USES OF VARYING DENSITIES AND ATTENDANT NONPOINT POLLUTION POTENTIAL

HIGH-DENSITY RESIDENTIAL LAND USE

U. S. Public Land Survey
Section 3, Town 7 North, Range 21 East,
City of Milwaukee, Milwaukee County, Wisconsin

LOW-DENSITY RESIDENTIAL LAND USE

U. S. Public Land Survey
Section 21, Town 7 North, Range 20 East,
City of Brookfield, Waukesha County, Wisconsin

MEDIUM-DENSITY RESIDENTIAL LAND USE

U. S. Public Land Survey
Section 35, Town 6 North, Range 21 East,
Village of Greendale, Milwaukee County, Wisconsin

LOW-DENSITY SUBURBAN RESIDENTIAL LAND USE

U. S. Public Land Survey
Section 19, Town 6 North, Range 18 East,
Town of Genesee, Waukesha County, Wisconsin

Contaminated runoff from urban land uses including transportation, industry and commercial, and residential activities all contribute to the surface water degradation within the Region. Oils and greases, chlorides, nutrients and other organics, and sediments add to the pollutant loads from the contaminated runoff already carried within the surface waters from the upstream land uses, such as agricultural, silvicultural, and very low-density suburban residential land uses.

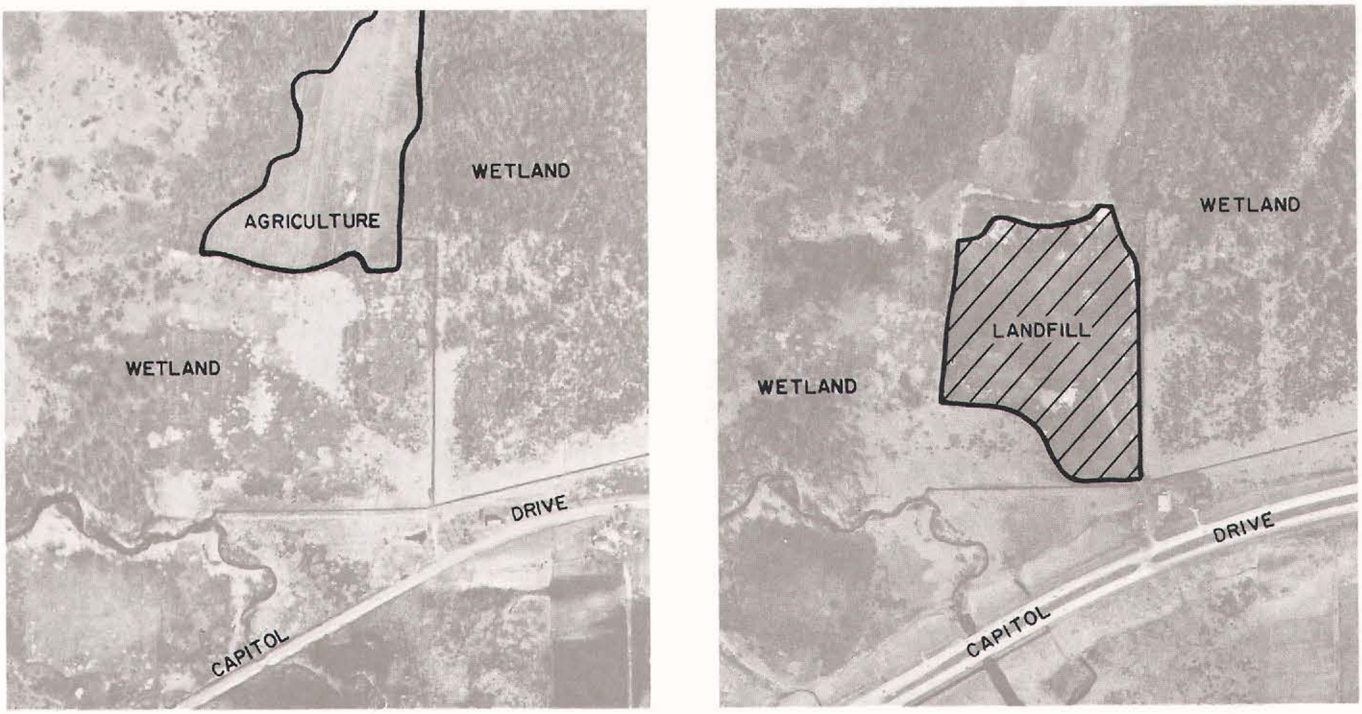
Source: SEWRPC.

Figure 28

AERIAL PHOTOGRAPHS ILLUSTRATING WETLANDS BEFORE AND AFTER FILLING

U. S. Public Land Survey
Section 5, Town 7 North, Range 20 East,
Town of Brookfield, Waukesha County, Wisconsin

Before Filling—March 28, 1963 | After Filling—May 10, 1975



The demand for more land results in encroachment upon marshes and wetlands to provide for additional farmland, transportation routes, or major subdivisions. In addition to the Region losing valuable acreage by reclamation of these marsh and wetland areas by filling in or drainage of these areas each year, the contribution of sediment and nutrients can result in a considerable alteration to the stream and lake water quality, both immediately upstream of the filled and reclaimed area by altering the flow and downstream of the area by the addition of numerous pollutants as shown in the above figure.

Source: SEWRPC.

available—against the Commission staff interpretations of the 1976 adopted water use objectives and supporting standards.[10]

DES PLAINES RIVER WATERSHED

Water Quality Conditions

The Des Plaines River watershed is located in the southeasterly portion of the Region. The watershed is only partly contained within the Region, the Des Plaines River rising in Racine County and flowing approximately 22 miles southerly and easterly in Kenosha County before crossing the state line into Illinois. The geographic, physical, economic, and demographic features of the watershed are described in Volume One, Chapter III of this report.

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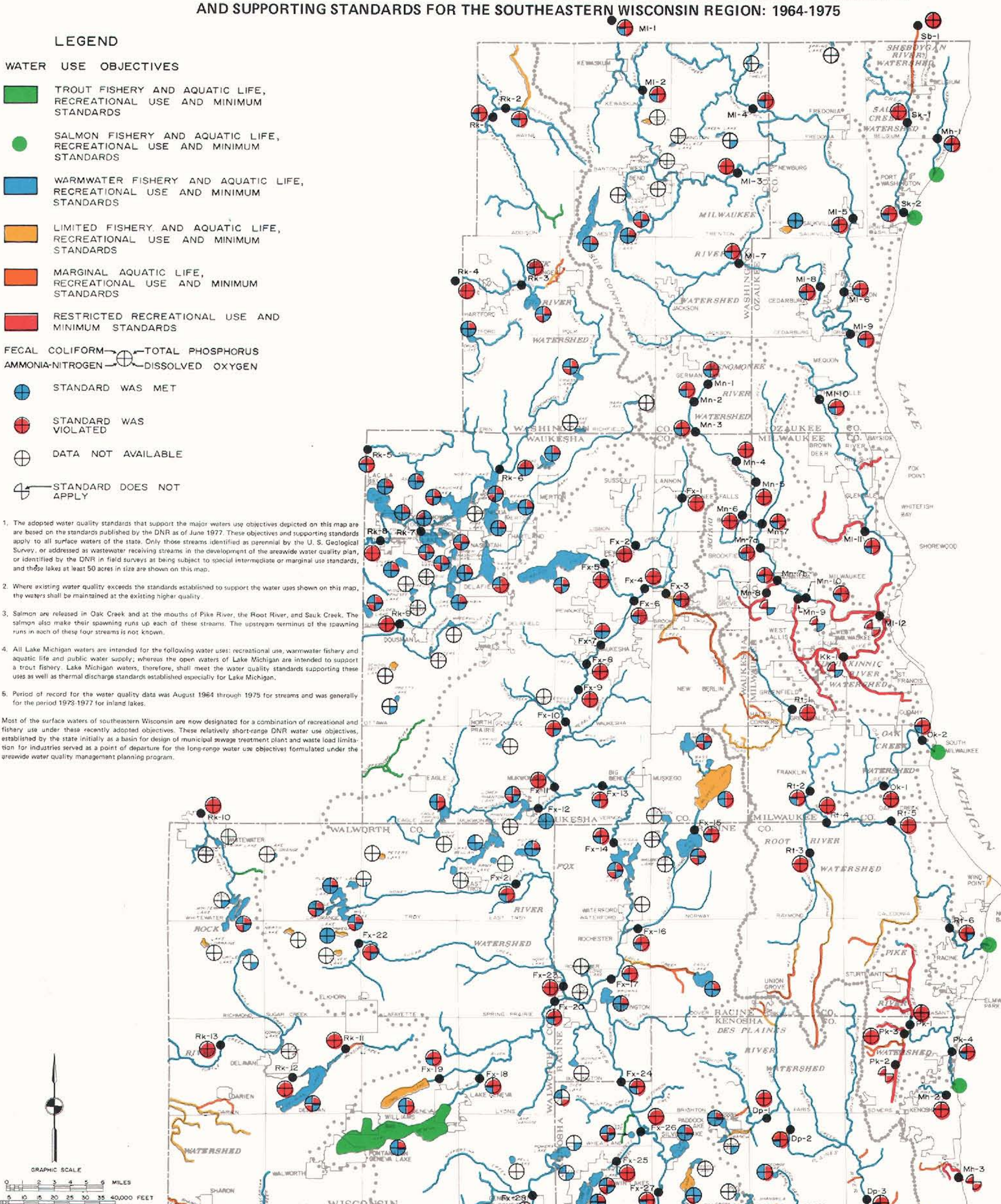
[10] *It should be noted that a new body of scientific knowledge has been evolving in the assessment of the trophic status of inland lakes and associated water quality conditions. Recent research conducted at the University of Wisconsin in Madison indicates that remote sensing using satellite imagery (LANDSAT) can provide extensive and frequent—the satellite overflights occur about every 18 days—survey data for levels of aquatic plant activity for both algae and rooted macrophytes, in Wisconsin lakes. This monitoring technique is rapidly becoming a practical and cost-effective tool in water quality management. Unfortunately, the historic record available at the writing of this report is associated with recent research activities, and the interpretation of the significance of the data has only recently become a routinely operational technique for nonresearch applications.*

Map 39

COMPARISON OF OBSERVED WATER QUALITY CONDITIONS TO THE ADOPTED 1976 WATER USE OBJECTIVES AND SUPPORTING STANDARDS FOR THE SOUTHEASTERN WISCONSIN REGION: 1964-1975



1. The adopted water quality standards that support the major waters use objectives depicted on this map are are based on the standards published by the DNR as of June 1977. These objectives and supporting standards apply to all surface waters of the state. Only those streams identified as perennial by the U. S. Geological Survey, or addressed as wastewater receiving streams in the development of the areawide water quality plan, or identified by the DNR in field surveys as being subject to special intermediate or marginal use standards, and those lakes at least 50 acres in size are shown on this map.

2. Where existing water quality exceeds the standards established to support the water uses shown on this map, the waters shall be maintained at the existing higher quality.

3. Salmon are released in Oak Creek and at the mouths of Pike River, the Root River, and Sauk Creek. The salmon also make their spawning runs up each of these streams. The upstream terminus of the spawning runs in each of these four streams is not known.

4. All Lake Michigan waters are intended for the following water uses: recreational use, warmwater fishery and aquatic life and public water supply; whereas the open waters of Lake Michigan are intended to support a trout fishery. Lake Michigan waters, therefore, shall meet the water quality standards supporting these uses as well as thermal discharge standards established especially for Lake Michigan.

5. Period of record for the water quality data was August 1964 through 1975 for streams and was generally for the period 1973-1977 for inland lakes.

Most of the surface waters of southeastern Wisconsin are now designated for a combination of recreational and fishery use under these recently adopted objectives. These relatively short-range DNR water use objectives, established by the state initially as a basin for design of municipal sewage treatment plant and waste load limitation for industries served as a point of departure for the long-range water use objectives formulated under the areawide water quality management planning program.

Water quality data collected over the 12-year period from 1964 through 1975 for streams and lakes of the Region were compared to the state and federally adopted water use objectives and supporting standards applicable in 1976. The available data for dissolved oxygen, fecal coliform, ammonia-nitrogen, and total phosphorus were utilized to determine the extent to which surface waters of the Region met the requirements for various water uses, including the maintenance of a trout, warmwater, marginal, or intermittent fishery and other aquatic life; recreational use; restricted use; and minimum standards. Of the streams, only the Mukwonago River was found to meet all standards established for full recreational use and the maintenance of a warmwater fishery as well as the recommended phosphorus levels. In addition, sampling stations Mn-8 on Underwood Creek in the Menomonee River watershed and Kk-1 on the Kinnickinnic River met the water quality standards for the established water use objective of restricted recreational use and minimum conditions. Of the 46 major lakes for which complete water quality data were available, two—Mud Lake in Ozaukee County and Lake Wandawega in Walworth County—were found to meet the state standards as interpreted by the Commission.

Source: SEWRPC.

Water Quality Conditions: 1964-1965: The 1964-1965 Commission benchmark streamwater quality study included the operation of three sampling stations in the watershed, one on Brighton Creek and two on the Des Plaines River as shown on Map 40. The chloride concentrations for 1964-1965 at the two sampling stations ranged from 20 to 105 milligrams per liter (mg/l), indicating that the chloride levels were higher than the normal background concentration[11] of 10 mg/l and thereby reflecting a chloride impact upon the stream from human sources. The sampling station situated on Brighton Creek, a first rank tributary to the Des Plaines River, also exhibited chloride concentrations higher than background levels, with ranges of 15 to 30 mg/l. These higher chloride concentrations and loads may be attributed to the effluent from the Village of Paddock Lake sewage treatment plant, the effluent from the Town of Salem Sewer Utility District No. 1 sewage treatment plant, and the runoff of septic tank effluent from unsewered areas such as Montgomery Lake. Chloride concentrations may also be attributed to community and street salting operations during the winter months. The concentration of dissolved oxygen during the 1964-1965 sampling period ranged from 2.1 to 13.9 mg/l. Substandard concentrations of less than 5.0 mg/l of dissolved oxygen were found during the summer months at both sampling station locations on the main stem of the Des Plaines River. High total coliform counts were found at all three sampling station locations and ranged from 100 to 56,000 membrane filter coliform counts per 100 milliliters (MFCC/100 ml). Drainage from agricultural land, wastes from malfunctioning private onsite sewage disposal systems, and wastes from wildlife and domestic animals are some of the probable sources for this indicated contamination. The specific conductance values, which ranged from 430 to 825 micro-mhos per centimeter (umhos/cm) at 25°C, were found to be high at all three sampling locations, with the highest values found at the downstream sampling station located on the Des Plaines River near the state line, indicating higher levels of dissolved solids in the stream flow at that station. Temperature and pH values (hydrogen ion concentrations) showed no appreciable changes during the sampling period.

Water Quality Conditions: 1965-1975: The 1965-1975 Commission stream water quality monitoring effort included continued sampling at the three Commission stations and collecting data available from one Wisconsin Department of Natural Resources (DNR) sampling station established in the watershed as shown on Map 40. A range of 6.0 to 168 mg/l of chloride was observed during the sampling periods with no significant change in water quality conditions at the two main stem stations or the Brighton Creek station. The water quality for dissolved oxygen in the Des Plaines River watershed showed no significant change as compared to the 1964-1965 sampling period and ranged from 1.9 to 13.7 mg/l. Review of the fecal coliform data over the period exhibited ranges of 30 to 7,600 membrane filter fecal coliform counts per 100 milliliters (MFFCC/100 ml) with no significant trends noted. Specific conductance ranged from 430 to 1,026 µmhos/cm at 25°C. No trends were noted as the dissolved solids in a stream are also a function of precipitation. The concentrations for ammonia-nitrogen (NH_3-N) ranged from 0.09 to 0.44 mg/l, with only one recorded value greater than 0.4 mg/l, the level recommended by the Commission to support a warmwater fishery and other aquatic life. Generally, a slight improvement in ammonia-nitrogen levels has been noted at all three stations since sampling for this parameter began in 1972. However, the nutrient concentrations for total phosphorus, which ranged from 0.04 to 2.0 mg/l, have indicated relatively little change since 1964.

The diurnal water quality data for the Des Plaines River and Brighton Creek show a broad range of dissolved oxygen concentrations, from 3.9 to 12.5 mg/l over a 24-hour period, reflecting the dissolved oxygen reductions due to respiration by the aquatic plants and decomposition of organic matter in the stream and dissolved oxygen supersaturation effects of algal photosynthesis. In addition to exhibiting marked diurnal fluctuations, water quality in the Des Plaines River watershed exhibits spatial variation. Overall, the water quality of Brighton Creek remained better than that of the Des Plaines River main stem as measured by dissolved oxygen, chloride, and total phosphorus concentrations. Fecal coliform bacteria and ammonia-nitrogen conditions, however, were poorer. The water quality of the Des Plaines River near the state line was generally better than that in the headwater area as measured by the lower values for specific conductance, chloride concentration, and fecal coliform counts.

Compliance with Water Quality Standards

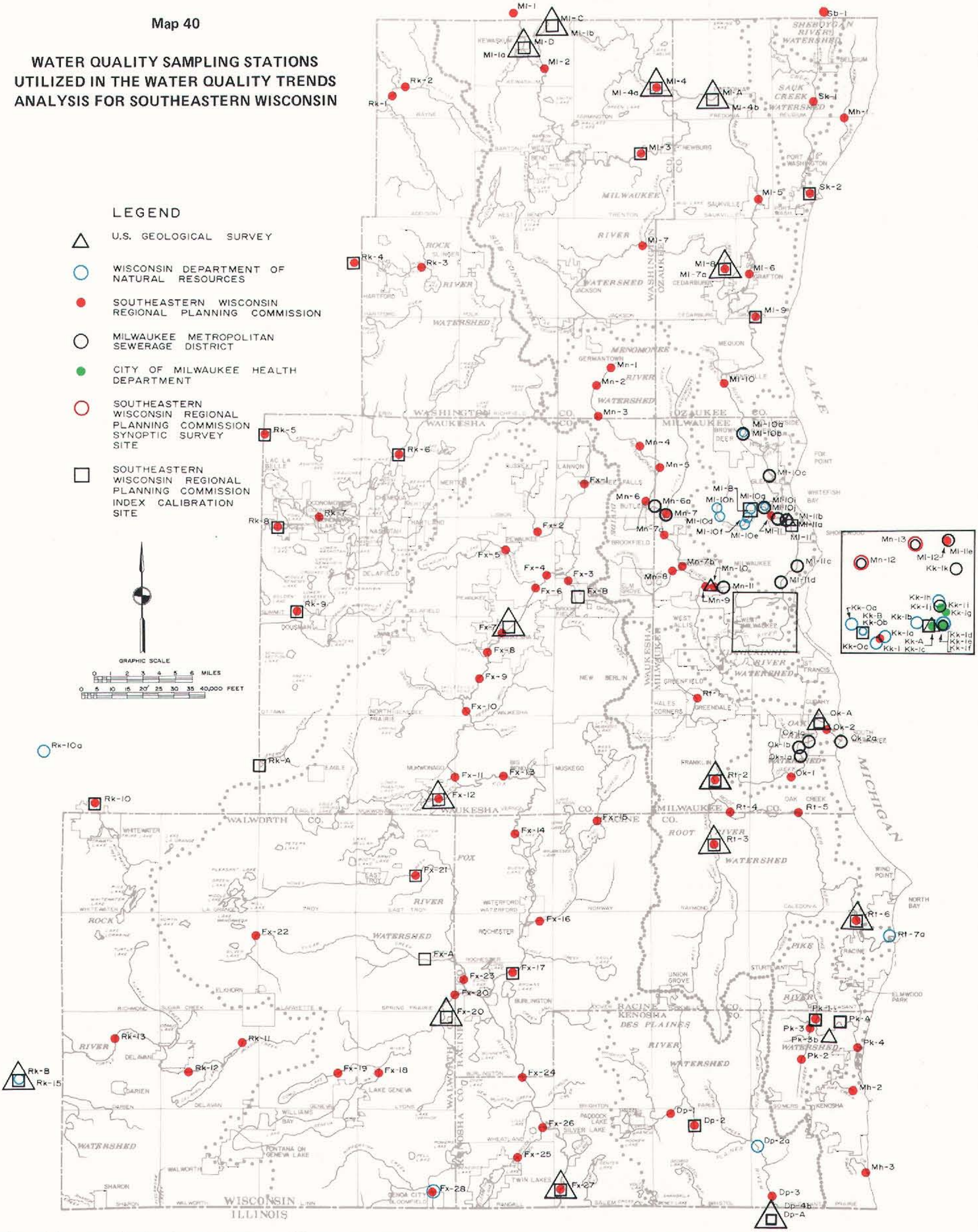
Although remaining generally constant over the decade, the Des Plaines River and Brighton Creek, which are both designated for recreational use and for the maintenance of a warmwater fishery and aquatic life, did not meet the water quality standards adopted by the Wisconsin Department of Natural Resources for dissolved oxygen and fecal coliform counts in 1975. Total phosphorus concentrations were found to be significantly higher than the level of 0.1 mg/l recommended by the Commission. Ammonia-nitrogen met the adopted standard of 0.4 mg/l at all stations in the 1975 sampling analyses.

Lakes George, Hooker, Benet/Shangrila, and Paddock are the major lakes—lakes of 50 acres or more—in the Des Plaines River watershed. Their recommended water use objectives are for recreational use and the maintenance of a warmwater fishery and other aquatic life. Table 27 presents an assessment of the lake water quality standards as applied to the four major lakes. Lakes George and Paddock, for which complete water quality data were

[11] *The background concentrations of chloride cited here and in the following sections of this chapter are based on C.L.R. Holt, Jr. and E.L. Skinner, Groundwater Quality in Wisconsin through 1972, U. S. Geological Survey and University of Wisconsin-Extension, Information Circular No. 22, 1973.*

Map 40

WATER QUALITY SAMPLING STATIONS UTILIZED IN THE WATER QUALITY TRENDS ANALYSIS FOR SOUTHEASTERN WISCONSIN



A substantial water quality data base—dating from 1964—is available from previous Commission work programs and from other water quality sampling efforts in the Region. This data base generally includes information on 13 water quality indicators: temperature, pH, dissolved oxygen, total or fecal coliform organisms, nitrate-nitrogen, nitrite-nitrogen, organic-nitrogen, ammonia-nitrogen, total nitrogen, total phosphorus, dissolved phosphorus, chlorides, and specific conductance. Both Commission 1964 benchmark water quality data—including up to 26 additional parameters—and data from the Commission's continuing water quality sampling program at 87 sites were available to support the analysis of long-term trends and the comparison to water quality standards. In addition, data were available from two sites monitored by the Commission under its Menomonee River watershed study; from 18 sites monitored by the Wisconsin Department of Natural Resources; from 12 sites monitored by the U. S. Geological Survey; from 20 sites monitored by the Milwaukee Metropolitan Sewerage District; and from 4 sites monitored by the City of Milwaukee Health Department. Additional data available from teaching and research projects of universities and colleges and from studies commissioned by lake property owner associations were also reviewed to provide additional checks on the results of the analysis of the primary data sources.

Source: SEWRPC.

available, violated the standard for both inorganic phosphorus (PO_4P) and total phosphorus. In addition, George Lake and Benet/Shangrila Lake violated the dissolved oxygen standard on one occasion.

The three sampling stations operated by the Commission have provided information on water quality in the larger, continuously flowing streams which total 16.3 miles tributary to and inclusive of the Des Plaines River. A comparison of the August 1964 data to the applicable 1976 DNR-adopted water quality standards indicates that 40 percent, or 6.45 miles, of the stream reaches sampled violated the standards for one or more parameters. In August 1975, by comparison, all of the stream reaches sampled—16.3 miles—were in violation of one or more of the identical standards, indicating degradation of water quality in 1975 as compared to 1964. Table 28 indicates the water use objectives and supporting standards violated during the period of 1964 through 1975.

General Water Quality Ratings

Table 29 sets forth the water quality index classifications for the three Commission-operated sampling stations in the watershed. As indicated by the index, the 1964 water quality of the Des Plaines River was generally fair, with Brighton Creek recording excellent water quality. In August of the years 1974 and 1975 all three sampling stations in the Des Plaines River watershed indicated that fair conditions existed. Overall, there was no change in the general watershed rating of fair in 1974-1975 as compared to 1964 conditions.

Of the four major lakes located within the Des Plaines River watershed, three have a maximum depth of 20 feet or greater and are likely to stratify during the summer season. Dissolved oxygen profiles prepared for these four major lakes indicate that two of four lakes exhibit less than 1.0 mg/l dissolved oxygen levels in their lower layers (hypolimnion). Such levels may adversely affect fish and other aquatic life in the lakes. The dissolved oxygen concentrations in the epilimnion are generally above 7.0 mg/l in all four lakes. When assessing the trophic levels for two of four major lakes in the Des Plaines River watershed for which data are available, Paddock Lake is classified as mesotrophic and Benet/Shangrila is classified as very eutrophic as determined by the dissolved oxygen levels in the hypolimnion, water clarity of the lake, history of fishkills, and use impairment caused by algae and weed abundance.[12]

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[12] *U. S. Environmental Protection Agency, Lake Classification—A Trophic Characterization of Wisconsin Lakes, EPA Report No. 660/3-75-033, June 1975. This report and others pertaining to trophic status of lakes generally recognize three classifications of trophic status. These classifications consider water clarity; chemical parameters; biological parameters, including algae and macrophyte growth; physical characteristics; recorded fishkills; or combinations of these. The three classifications are reflective of the natural or human-induced rates of aging or in-filling experienced by the lakes. "Eutrophic" lakes are generally shallower, enriched by nutrients and organic matter, and exhibit low water clarity, "Very eutrophic" or "dystrophic" are terms sometimes used for extreme cases of eutrophic lakes. "Mesotrophic" lakes may be of moderate depth, and exhibit less nutrient and organic enrichment, as well as higher levels of water clarity. "Oligotrophic" lakes are relatively deep, low in nutrient content and organic matter, and exhibit higher levels of water clarity.*

Table 27

COMPARISON OF OBSERVED WATER QUALITY CONDITIONS TO 1976 LAKE WATER USE OBJECTIVES AND SUPPORTING WATER QUALITY STANDARDS IN THE DES PLAINES RIVER WATERSHED

	Recorded Dates of Standard Violations, or Note of Standards Achievement																									
Lake Name	Applicable Objective[a]	Availability of Data	Temperature (°F) Within Total Depth of Lake During Entire Year			pH (standard units) Within Total Depth of Lake During Entire Year			Dissolved Oxygen[c] (mg/l) In Epilimnion During Late July, August, or September			Fecal Coliform (MFFCC/100 ml) Within Total Depth of Lake During Entire Year			Ammonia Nitrogen (mg/l) Within Total Depth of Lake During Mixing (Spring and Fall)			Inorganic Nitrogen—Sum of Nitrite-Nitrogen + Nitrate-Nitrogen + Ammonia-Nitrogen (mg/l) Within Total Depth of Lake During Mixing (Spring and Fall)			Inorganic Phosphorus (mg/l) Within Total Depth of Lake During Mixing (Spring and Fall)			Total Phosphorus (mg/l) Within Total Depth of Lake During Mixing (Spring and Fall)		
			1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
			89°	89°	b	6-9	6-9	6-9	3.0	5.0	6.0	400	400	400	3.5	0.4	0.4	0.9	0.3	0.15	0.03	0.06	0.005	0.06	0.02	0.01
George	2	1976-19777		Yes			Yes			August 17, 1976			Yes			Yes			April 11, 1977			April 6, 1976			April 11, 1977 April 6, 1976	
Hooker.	2	September 13, 1973		Yes			N/A			Yes			N/A			N/A			N/A			N/A			N/A	
Paddock	2	1973-1975		Yes			Yes			Yes			Yes			Yes			April 8, 1974			September 17, 1973 November 27, 1973 April 8, 1974 November 28, 1974 April 28, 1975			September 17, 1973 April 8, 1974 November 22, 1974 April 22, 1975	
Shangrila/Benet . .	2	September 18, 1973		Yes			N/A			September 18, 1973			N/A			N/A			N/A			N/A			N/A	

NOTE: N/A indicates data not available.

[a] There are three categories of initial recommended water use objectives: 1) limited fishery and aquatic life, recreational use; 2) warmwater fishery and aquatic life, recreational use; and 3) trout fishery and aquatic life, recreational use.

[b] The maximum temperature rise at the edge of the mixing zone above the existing natural temperatures shall not exceed 3°F for lakes nor shall there be any significant artificial increases in temperature where natural trout reproduction is to be protected.

[c] The entire depth of shallow lakes (0 to 15 feet) shall be analyzed for dissolved oxygen. However, only the epilimnion of lakes greater than 15 feet shall be analyzed for dissolved oxygen.

Source: SEWRPC.

Table 28

COMPARISON OF OBSERVED WATER QUALITY CONDITIONS TO ADOPTED 1976 STREAM WATER USE OBJECTIVES AND SUPPORTING WATER QUALITY STANDARDS FOR WARMWATER FISHERY AND RECREATIONAL USE IN THE DES PLAINES RIVER WATERSHED

Sampling Stations	Applicable[a] Objective	Adopted Standards[b]						Miles Violated	Miles Meeting All Standards
		Dissolved Oxygen (5.0 mg/l)	Fecal Coliform (400 MFFCC per 100 ml)	Temperature (89°F)	pH (6.0-9.0 standard units)	Ammonia-Nitrogen (0.4 mg/l)	Total Phosphorus (0.1 mg/l)		
Dp-1	4	X	X			X	X		
Dp-2	4	X	X				X		
Dp-3	4	X	X	X			X		
Total								16.3	0.0

NOTE: X indicates violation of water use objectives.

[a] There are five categories of water use objectives:

1) Restricted recreational use and minimum standards.

2) Marginal aquatic life, recreational use, and minimum standards.

3) Limited fishery and aquatic life, recreational use.

4) Warmwater fishery and aquatic life, recreational use.

5) Trout fishery and aquatic life, recreational use.

[b] Includes phosphorus standard as interpreted by SEWRPC.

Source: SEWRPC.

Table 29

WATER QUALITY INDEX CLASSIFICATIONS FOR THE SAMPLING STATIONS OF THE DES PLAINES RIVER WATERSHED 1964 AND 1974-75

Main Stem Stations	July, August, September, and October of 1964	August of the Years 1974-1975
Dp-2.	Fair	Fair
Dp-3.	Fair	Fair
Tributary Station		
Dp-1.	Excellent	Fair
Watershed Average. . . .	Fair	Fair

Source: SEWRPC.

Toxic and Hazardous Substances: Sampling and analysis for pesticides, polychlorinated biphenyls (PCB's), and heavy metals were conducted by the Wisconsin Department of Natural Resources in the Des Plaines River watershed from 1973 through 1977. In the three in-stream water quality samples for which toxic and hazardous substances were tested, recommended levels of heptachlor epoxide, a persistent pesticide, were exceeded only once. Sample analyses for cadmium, chromium, copper, lead, mercury, nickel, zinc, PCB's, DDT, DDE, DDD, aldrin, heptachlor, lindane, dieldrin, methoxychlor, and phthalate uncovered no violations of U. S. Environmental Protection Agency (EPA) recommended levels. [13] No stream bottom sediment analyses were conducted for any of the toxic and hazardous substances.

FOX RIVER WATERSHED

Water Quality Conditions

The Fox River watershed is only partly contained in the Region and is located in the central and south central portion of the Region. The Fox River, which is the main stream of the watershed, rises in Waukesha County and flows 81 miles southward through Racine and Kenosha Counties before crossing the state line into Illinois. The geographic, physical, economic, and demographic features of the watershed are described in Volume One, Chapter III of this report.

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[13] *U. S. Environmental Protection Agency, Quality Criteria for Water, EPA Report No. 440/9-76-023, 1976.*

Water Quality Conditions: 1964-1965: The 1964-1965 benchmark streamwater quality study of the Commission included the operation of 28 sampling stations in the watershed, 12 on the Fox River main stem and 16 on the tributaries of the Fox River as indicated on Map 40. The water quality data for 1964-1965 from the 12 sampling stations on the Fox River indicated that the chloride levels were higher than the normal background concentration of 10 to 20 milligrams per liter (mg/l), reflecting a chloride impact upon the stream from human sources. Recorded levels of chloride concentrations ranged from 5.0 to 445 mg/l on the Fox River main stem during the 1964-1965 sampling period. In the tributaries of the Fox River, with the exception of the Mukwonago River, Como Creek, and Honey Creek, chloride concentrations were relatively high, reflecting the effects of human activities, with ranges of 0 to 120 mg/l. Substandard concentrations of less than 5.0 mg/l of dissolved oxygen were found during the 1964-1965 survey at the headwater area sampling stations on the main stem of the Fox River. The concentrations ranged from 0.3 to 4.4 mg/l. The main stem of the Fox River watershed exhibited dissolved oxygen concentrations ranging from 0.0 to 19.0 mg/l of dissolved oxygen during the 1964-1965 monitoring period, with the tributaries registering from 0.1 to 19.5 mg/l of dissolved oxygen. Among the tributaries, the Pewaukee River, Poplar Creek, Bassett Creek, the Muskego Lake Canal, Sussex Creek, the Wind Lake Drainage Canal, Como Creek, and Honey Creek showed substandard dissolved oxygen levels at one time or another during the 1964-1965 sampling survey. The substandard dissolved oxygen levels observed in the headwaters of the Fox River main stem may be attributed to pollution from both rural and urban runoff, while pollution from agricultural storm water runoff probably depressed the dissolved oxygen levels in the Muskego-Wind Lake Drainage Canal area. During the 1964-1965 monthly sampling survey, high total coliform counts of greater than 2,000 membrane filter coliform counts per 100 milliliters (MFCC/100 ml) were found in many samples at all sampling stations on the Fox River main stem, and at all stations on the tributaries with the exception of the Mukwonago River. The values on the main stem ranged from 100 to 610,000 MFCC/100 ml, while the total coliform levels at the tributary stations varied from 100 to 3,000,000 MFCC/100 ml. Effluent from sewage treatment plants, sanitary sewer overflows, drainage from agricultural land, wastes from malfunctioning private onsite sewage disposal systems, and wastes from domestic livestock are the probable sources for this type of contamination. The specific conductance values were found to be high at all 28 sampling locations, during the 1964-1976 survey, with a range of from 390 to 2,000 micro-mhos per centimeter (μmhos/cm) at 25°C.

Water Quality Conditions: 1965-1975: The 1965-1975 water quality monitoring effort by the Commission included continued sampling at the 28 Commission stations and collecting data available from one Wisconsin Department of Natural Resources (DNR) sampling station established in the watershed as shown on Map 40. The chloride concentrations in the headwaters of the Fox River main stem increased over the period of study and remained constant at sampling stations located downstream from sampling station Fx-9. The concentrations for the 12 main stem stations ranged from 14.0 to 168 mg/l, with a range of from 5.0 to 245 mg/l at the 16 tributary stations in the Fox River watershed. Among the tributaries of the Fox River, there was an increase in chloride concentrations between 1967 and 1975 on the Pewaukee River, Poplar Creek, and the Wind Lake Drainage Canal. The chloride concentrations remained generally stable over the period for the other tributaries.

The observed dissolved oxygen levels indicate that the water quality generally improved in the Fox River main stem except at Commission stations Fx-1, Fx-7, Fx-8, and Fx-14, where the dissolved oxygen concentrations decreased slightly over the decade apparently as a result of increased loadings from municipal sewage treatment plant effluents and increased urbanization. Main stem dissolved oxygen values ranged from 0.3 to a supersaturated level of 26.8 mg/l. Among the tributaries of the Fox River, the dissolved oxygen concentrations increased over the period on Sussex Creek, Poplar Creek, the Muskego Canal, the Wind Lake Drainage Canal, and Bassett Creek and remained essentially unchanged in the Pewaukee River and Como Creek. The dissolved oxygen concentrations of the other tributaries—the Mukwonago River, the White River, Sugar Creek, Honey Creek, and Nippersink Creek—remained at or near saturation in all samples collected over the decade. Concentrations at these 16 tributary stations ranged from 0.4 and 17.0 mg/l.

The fecal coliform counts generally remained low and stable between 1967 and 1975 at the Fox River main stem sampling stations and on Sussex Creek, Poplar Creek, the Mukwonago River, and Nippersink Creek, with ranges of from 5.0 to 420,000 membrane filter fecal coliform counts per 100 milliliter (MFFCC/100 ml). At the 16 tributary stations, fecal coliform counts of 10 to 260,000 MFFCC/100 ml were recorded. Fecal coliform counts declined over the period in the Muskego Canal, the Wind Lake Canal, and Bassett Creek. Fecal coliform counts remained high in the White River over the period. Fecal coliform counts increased in the Pewaukee River, Como Creek, Honey Creek, and Sugar Creek. Concentrations of ammonia-nitrogen (NH_3-N) fluctuated between 0.03 to 5.83 mg/l during the four years of sampling after 1972, with no significant trends noted. Total phosphorus concentrations remained in excess of the recommended water quality level of 0.10 mg/l in most of the samples collected on the Fox River main stem and its tributaries with the exception of the Mukwonago River site over the years of sampling, with concentrations ranging from 0.01 to 2.35 mg/l.

The diurnal water quality data for the Fox River show a broad range of dissolved oxygen concentrations, from 0.5 to 18.5 mg/l over a 24-hour period, reflecting the dissolved oxygen reductions due to respiration by the aquatic plants and decomposition of organic matter in the stream and dissolved oxygen supersaturation effects of algal photosynthesis. The diurnal water quality data for the tributaries of the Fox River showed greater than 5.0 mg/l of dissolved oxygen in all samples collected over a 24-hour period with the exception of samples from Poplar Creek, the Pewaukee River, and Bassett Creek, where the dissolved oxygen concentrations over a 24-hour period ranged as low as 0.5 mg/l on August 2 and 3, 1971.

In addition to exhibiting marked diurnal fluctuations, water quality in the Fox River watershed exhibits spatial variation. The water quality of the Fox River near the state line was generally better than that in the headwaters area as measured by the specific conductance values, chloride concentrations, fecal coliform counts, and dissolved oxygen concentrations.

Compliance with Water Quality Standards

In general, the streamwater of the Fox River watershed did not meet the established water use objectives for recreational use and preservation of a warmwater fishery and other aquatic life in 1975. Supporting standards adopted by the Wisconsin Department of Natural Resources for dissolved oxygen, ammonia-nitrogen, and fecal coliform were generally violated on the Fox River main stem. Among the tributaries of the Fox River, the upstream portions of Poplar Creek in Waukesha County and Eagle Creek in Racine County downstream from CTH J are intended for recreational use and the maintenance of a limited fishery and aquatic life. Deer Creek in Waukesha County and the portion of Eagle Creek upstream from CTH J in Racine County are designated for marginal aquatic life, recreational use, and minimum standards.

Palmer Creek in Kenosha County is recommended for recreational use and for the maintenance of a trout fishery and other aquatic life, and all other tributaries are intended for recreational use and for the maintenance of a warmwater fishery and other aquatic life. The water quality standards for pH and temperature were met at all sampling locations on the Fox River tributaries for which water quality data were available, while dissolved oxygen standards were met only on Sussex Creek, Poplar Creek, the Mukwonago River, Sugar Creek, Honey Creek, Bassett Creek, and Nippersink Creek. The fecal coliform counts were higher than the water quality standards of 400 MFFCC/100 ml at all but the Mukwonago River and the Wind Lake Drainage Canal sampling stations. No SEWRPC water quality data are available for any of the trout streams to compare with the standards set for a trout fishery. Total phosphorus concentrations were found to be higher than the levels recommended by the Commission for the avoidance of nuisance aquatic plant growth in the stream system at all sampling stations except Fx-1 at Mill Road on the Fox River main stem and its tributaries, with the exception of Popular Creek, the Mukwonago River, and Sugar Creek. In addition, ammonia-nitrogen concentrations did not meet the Commission-recommended level of 0.4 mg/l at two locations: the Pewaukee River and the Fox River main stem near Waukesha.

Water use objectives have also been recommended for the 46 major lakes—lakes of 50 acres or more—of the Fox River watershed. Lakes Como, North, Wandawega, Silver, and Peters in Walworth County; Camp Lake in Kenosha County; and Muskego Lake in Waukesha County are designated for a limited fishery and aquatic life. Lake Geneva in Walworth County is designated for recreational use and the maintenance of a trout fishery and aquatic life. The remaining 38 major lakes are designated for recreational use and maintenance of a warmwater fishery and aquatic life. Table 30 presents an assessment of the lake water quality standards as applied to the 46 major lakes, and indicates that of the 22 lakes for which complete water quality data were available, 13 lakes, or 59 percent, did not meet the preliminary recommended standards for one or more of the following parameters: temperature, dissolved oxygen, pH (hydrogen ion concentration), fecal coliform, and ammonianitrogen. Twenty-one of the 22 lakes, all but Lake Wandawega, failed to meet one or more of the preliminary recommendations for inorganic phosphorus (PO_4) and total phosphorus. However, it is important to note that Lake Wandawega is classified for a limited fishery and thus must meet less stringent standards than those for a warmwater fishery.

As noted, over the period since 1964, the 28 sampling stations utilized by the Commission have provided information on water quality in the larger, continuously flowing streams which total 174.9 miles tributary to and inclusive of the Fox River. A comparison of the 1964 data to the applicable 1976 DNR-adopted water quality standards indicates that one-half, or 87.4 miles, of the stream reaches sampled violated the standards for at least one parameter. In 1975, by comparison, 130.2 miles, or 74.4 percent, were in violation of one or more of the identical standards. Table 31 indicates the water use objectives and supporting standards violated during the period of 1964 through 1975.

General Water Quality Ratings

Table 32 sets forth the water quality index ratings for the sampling stations on the major streams of the Fox River watershed. The table indicates that for the months of July through October of 1964, water quality conditions at 10 stations, or about 35.7 percent of the total, were rated as fair; and at seven stations, or about 25 percent of the total, were rated as poor. Water quality conditions at 10 stations, or 35.7 percent of the total, were rated as good; and at one station, or about 3.5 percent of the total, were rated as excellent. In August of the years 1974 and 1975, water quality conditions at 20 stations, or about 71 percent of the total, were rated as fair; and at one station, or about 3.5 percent of the total, were rated as poor. Water quality conditions at six stations, or 22 percent of the total, were rated as good; and at one station, or 3.5 percent of the total, were rated as excellent. Overall, there was no change in the general watershed rating of fair in 1974-1975 as compared to 1964 conditions.

Of the 31 major lakes in the Fox River watershed for which water quality data are available, 19 lakes exhibit less than 1.0 mg/l dissolved oxygen levels in their lower layers (hypolimnion). Such levels may adversely affect fish and other aquatic life in the lakes. The dissolved oxygen concentrations in the epilimnion are generally above 7.0 mg/l. As noted in Table 33, 35 of the 46 major lakes located within the watershed have been classified according to their trophic status. Of the 35 lakes, 4 were rated as eutrophic, 8 as very eutrophic, 21 as mesotrophic, and only 2 as oligotrophic.[14]

Toxic and Hazardous Substances: No known stream water or bottom sediment sampling for toxic and hazardous materials in the form of heavy metals, polychlorinated biphenyls (PCB's) or pesticides has been conducted within the Fox River watershed, and, therefore, no conclusions may be drawn with regard to the presence of these substances.

KINNICKINNIC RIVER WATERSHED

Water Quality Conditions

The Kinnickinnic River watershed is located in the south central portion of Milwaukee County. The Kinnickinnic River, approximately 8.0 miles in length and receiving discharge from approximately 8.2 miles of perennial stream tributaries, discharges into Lake Michigan through the Milwaukee Harbor estuary. The geographic, physical, economic, and demographic features of the watershed are described in Volume One, Chapter III of this report.

Water Quality Conditions: 1964-1965: The 1964-1965 Commission benchmark streamwater quality study included the operation of one sampling station in the watershed located on the main stem of the Kinnickinnic River as shown on Map 40. Chloride concentrations at the sampling station in 1964-1965 ranged from 20 to 115 milligrams per liter (mg/l). The chloride concentrations were highest during April, indicating the probable impact of winter street salting operations and spring runoff. Concentrations of dissolved oxygen at the Kinnickinnic River sampling station ranged from 7.3 to 13.3 mg/l, levels well above the 2.0 mg/l standard established as the water use objective for the Kinnickinnic River. However, data from other sampling programs, provided below, indicate substandard dissolved oxygen concentrations exist downstream in the reaches of the stream affected by combined sewer overflow. High total coliform counts upstream of the combined sewer outfalls at the sampling station existed during spring runoff periods and during and immediately after rainfall events recorded at General Billy Mitchell Field weather station during the period from September 19 through 24, 1964. Fluctuations of 4,000 to 340,000 membrane filter coliform counts per 100 milliliters (MFCC/100 ml) were recorded during the 1964-1965 sampling period. Coliform counts may be presumed to be higher downstream in the reaches of the stream affected by combined sewer overflows. The specific conductance values were found to be highest during the spring runoff period at the sampling station, and thus corresponded to the periods of highest chloride concentrations. Ranges of from 290 to 680 micro-mhos per centimeter (μmhos/cm at 25°C were recorded during the 14 monthly sample collections during 1964 and 1965. The pH values (hydrogen ion concentrations) obtained during the study were found to be within the range of from 6.0 to 9.0 standard units prescribed for rivers and streams designated for restricted use and minimum standards. Temperature variations in sample results reflected only the expected seasonal changes; however, the discharge of cooling waters to the Kinnickinnic River and its tributaries—particularly during warm weather, low flow conditions—may have contributed to localized elevations of the temperature levels.

Water Quality Conditions: 1965-1975: The continuing water quality monitoring program conducted by the Commission during the period from 1965 through 1975 included sampling at the single station established in the watershed. Additional sampling data were available from the three Milwaukee-Metropolitan Sewerage Commission stations, four City of Milwaukee Health Department stations, and seven Wisconsin Department of Natural Resources (DNR) stations, as shown on Map 40. The average chloride concentrations recorded during the August surveys significantly exceeded the expected background concentration of 20 mg/l. Chloride concentrations at Kk-1 generally increased in the samples obtained over the decade, with a range of from 26 to 135 mg/l recorded. The highest chloride concentrations continued to exist during the spring runoff periods as well as during runoff periods at other times of the year. In addition to being attributed to deicing salts, the high chloride levels in the watershed can probably be attributed to sewage discharge from separate sanitary sewer flow relief devices and, in the lower reaches of the watershed, combined sewer overflows. Chloride concentrations recorded by the Milwaukee-Metropolitan Sewerage District and the City of Milwaukee Health Department exhibited spatially decreasing concentrations between S. 6th Street and the Kinnickinnic River flushing tunnel, from which point the concentrations stabilized downstream to the harbor estuary. The magnitude of the dilution effect of the flushing tunnel operation was highlighted by the presence of elevated chloride levels during the 1969 sampling period, when the tunnel was inoperative. The seiche effect of Lake Michigan may also cause localized temporary dilution effects on the chloride concentrations of the Kinnickinnic River at its mouth.

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[14] *U. S. Environmental Protection Agency, Lake Classification—A Trophic Characterization of Wisconsin Lakes, EPA Report No. 660/3-75-033, June 1975. This report and others pertaining to trophic status of lakes generally recognize three classifications of trophic status. These classifications consider water clarity; chemical parameters; biological parameters, including algae and macrophyte growth; physical characteristics; recorded fishkills; or combinations of these. The three classifications are reflective of the natural or human-induced rates of aging or in-filling experienced by the lakes. "Eutrophic" lakes are generally shallower, enriched by nutrients and organic matter, and exhibit low water clarity, "Very eutrophic" or "dystrophic" are terms sometimes used for extreme cases of eutrophic lakes. "Mesotrophic" lakes may be of moderate depth, and exhibit less nutrient and organic enrichment, as well as higher levels of water clarity. "Oligotrophic" lakes are relatively deep, low in nutrient content and organic matter, and exhibit higher levels of water clarity.*

Table 30

COMPARISON OF WATER QUALITY CONDITIONS TO INITIAL RECOMMENDED LAKE WATER USE OBJECTIVES AND SUPPORTING WATER QUALITY STANDARDS IN THE FOX RIVER WATERSHED

Lake Name	Applicable Objective[a]	Availability of Data	Temperature (°F)			pH (standard units)			Dissolved Oxygen[c] (mg/l)			Fecal Coliform (MFFCC/100 ml)			Ammonia-Nitrogen (mg/l)			Inorganic Nitrogen—Sum of Nitrite-Nitrogen + Nitrate-Nitrogen + Ammonia-Nitrogen (mg/l)			Inorganic Phosphorus (mg/l)			Total Phosphorus (mg/l)		
			Within Total Depth of Lake During Entire Year			Within Total Depth of Lake During Entire Year			In Epilimnion During Late July, August, or September			Within Total Depth of Lake During Entire Year			Within Total Depth of Lake During Mixing (Spring and Fall)			Within Total Depth of Lake During Mixing (Spring and Fall)			Within Total Depth of Lake During Mixing (Spring and Fall)			Within Total Depth of Lake During Mixing (Spring and Fall)		
			1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
			89°	89°	b	6-9	6-9	6-9	3.0	5.0	6.0	400	400	400	3.5	0.4	0.4	0.9	0.3	0.15	0.03	0.01	0.005	0.06	0.02	0.01
Army	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Benedict	2	August 10, 1977		Yes			Yes			Yes			Yes			N/A			N/A			N/A			N/A	
Beulah	2	1973-1975		Yes			Yes			Yes			Yes			Yes			November 27, 1973 April 4, 1974 April 28, 1975			November 27, 1973 April 4, 1974 September 18, 1973			November 27, 1973 April 4, 1974 April 29, 1975	
Big Muskego	1	1975-1977	Yes			Yes			August 17, 1976			Yes			Yes			April 25, 1975 April 5, 1976 April 15, 1977			November 21, 1974 November 26, 1973 November 24, 1975 April 5, 1976 April 2, 1974			November 21, 1974 November 24, 1975 April 5, 1976 April 2, 1974		
Bohner	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Booth	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Browns	2	1973-1975		Yes			August 9, 1974			Yes			Yes			Yes			Yes			April 4, 1974 November 27, 1973 November 21, 1974 April 25, 1975			April 4, 1974 November 27, 1973 November 21, 1974 April 25, 1975	
Buena	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Camp	1	1974-1976	Yes			July 19, 1977			Yes			Yes			October 22, 1975			October 22, 1975			Yes			Yes		
Center	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Como	2	1975-1977		Yes			Yes			August 16, 1976			Yes			Yes			Yes			October 22, 1975 April 11, 1977 April 30, 1975			October 22, 1975 April 11, 1977 April 9, 1976 April 30, 1975	
Cross	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Denoon	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Dyer	2	July 20, 1975		Yes			July 20, 1975			July 20, 1975			Yes			N/A			N/A			N/A			N/A	
Eagle	2	1976-1977		Yes			Yes			Yes			Yes			Yes			Yes			September 21, 1976 October 19, 1976			September 21, 1976 October 19, 1976	
Eagle Spring	2	July 1975 October 1975		Yes			Yes			July 3, 1975			Yes			Yes			Yes			October 17, 1975			October 17, 1975	
Echo	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Elizabeth	2	1973-1976		Yes			Yes			Yes			Yes			Yes			April 8, 1974			November 27, 1973 November 22, 1974 September 7, 1973 November 26, 1973 November 18, 1976 April 28, 1975 April 8, 1974			November 27, 1973 November 22, 1974 November 18, 1976 April 11, 1977 April 28, 1975	
Geneva	3	1976-1977			Yes			Yes			Yes			Yes			Yes			Yes			September 18, 1976 October 9, 1976 November 10, 1976			September 18, 1976 October 9, 1976 November 10, 1976
Green	2	1973-1975		Yes			Yes			Yes			Yes				Yes		November 12, 1974 November 26, 1975 April 4, 1974 April 29, 1975			November 26, 1975 November 12, 1974 April 4, 1974			November 12, 1974 April 4, 1974	
Kee Nong Go Mong	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Lilly	2	1975-1977		Yes			July 8, 1975			Yes			Yes			April 28, 1975 April 6, 1976			Yes			November 18, 1976			April 28, 1975 April 6, 1976 October 22, 1975 November 19, 1975	

Table 30 (continued)

Lake Name	Applicable Objective[a]	Availability of Data	Temperature (°F) Within Total Depth of Lake During Entire Year 1	2	3	pH (standard units) Within Total Depth of Lake During Entire Year 1	2	3	Dissolved Oxygen[c] (mg/l) In Epilimnion During Late July, August, or September 1	2	3	Fecal Coliform (MFFCC/100 ml) Within Total Depth of Lake During Entire Year 1	2	3	Ammonia-Nitrogen (mg/l) Within Total Depth of Lake During Mixing (Spring and Fall) 1	2	3	Inorganic Nitrogen—Sum of Nitrite-Nitrogen + Nitrate-Nitrogen + Ammonia-Nitrogen (mg/l) Within Total Depth of Lake During Mixing (Spring and Fall) 1	2	3	Inorganic Phosphorus (mg/l) Within Total Depth of Lake During Mixing (Spring and Fall) 1	2	3	Total Phosphorus (mg/l) Within Total Depth of Lake During Mixing (Spring and Fall) 1	2	3
			89°	89°	b	6-9	6-9	6-9	3.0	5.0	6.0	400	400	400	3.5	0.4	0.4	0.9	0.3	0.15	0.03	0.01	0.005	0.06	0.02	0.01
Little Muskego	2	1973-1977		Yes			Yes			Yes			Yes			April 2, 1974			November 26, 1973 November 21, 1974 November 25, 1975			November 26, 1973 November 21, 1974 November 25, 1975 April 2, 1974			November 26, 1973 November 21, 1974 November 25, 1975 April 2, 1974	
Long	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Lower Phantom	2	July 1975 October 1975		Yes			Yes			Yes			Yes			Yes			October 17, 1975			Yes			October 17, 1975	
Lulu	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Marie	2	1973-1977		Yes			Yes			Yes			Yes			Yes			November 27, 1973 April 8, 1974			November 18, 1976 November 26, 1975 November 22, 1974 November 27, 1973 April 8, 1974 April 11, 1977			November 18, 1976 November 22, 1974 November 27, 1973 April 8, 1974	
Middle	2	1973-1975		Yes			Yes			Yes			Yes			November 12, 1974 November 26, 1975			November 27, 1973 November 12, 1974 April 29, 1975 April 4, 1974			November 12, 1974 November 27, 1973 April 4, 1974			November 12, 1974 November 27, 1973	
Mill	2	1973-1975		Yes			Yes			Yes			Yes			November 26, 1975			November 12, 1974 November 26, 1975 April 4, 1974 April 29, 1975			April 4, 1974 November 27, 1973 November 12, 1974 November 26, 1975			April 4, 1974 November 27, 1973 November 12, 1974 November 26, 1975	
North	1	N/A	N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A		
Pell	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Peters	1	N/A	N/A			N/A			N/A			N/A			NYA			N/A			N/A			N/A		
Pewaukee	2	1976-1977		Yes			Yes			Yes			Yes			November 18, 1976			Yes			September 23, 1976 October 21, 1976 November 18, 1976			September 23, 1976 October 21, 1976 November 18, 1976	
Pleasant	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Potters	2	1975-1976		Yes			Yes			Yes			Yes			Yes			Yes			April 20, 1975			April 29, 1975	
Powers	2	July 20, 1977		Yes			Yes			Yes			N/A			N/A			N/A			N/A			N/A	
Saylesville Mill Pond	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Silver (Kenosha County)	2	1973-1975		Yes			Yes			Yes			Yes			Yes			November 25, 1975 April 8, 1974 April 28, 1975			April 8, 1974 November 22, 1974 November 25, 1975 November 27, 1973			April 8, 1974 November 25, 1975 November 27, 1973	
Silver (Walworth County)	1	N/A	N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A		
Spring	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Tichigan	2	1973-1975 and 1977		Yes			Yes			Yes			Yes			November 21, 1974			November 27, 1973 November 21, 1974 April 4, 1974 April 25, 1975			April 4, 1974 April 25, 1975 November 27, 1973 November 21, 1974 November 25, 1975			April 4, 1974 April 25, 1975 November 27, 1973 November 21, 1974 November 25, 1975	
Upper Phantom	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Voltz	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Wandawega	1	1976-1977	Yes			September 8, 1976			Yes			Yes			Yes			Yes			Yes			Yes		
Waubeesee	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Wind	2	1973-1975		Yes			Yes			Yes			Yes			November 21, 1974			April 4, 1974 April 25, 1974 November 21, 1974 November 27, 1973			April 4, 1974 April 25, 1975 November 25, 1975 November 27, 1973 November 21, 1974			April 4, 1974 April 25, 1975 November 25, 1975 November 27, 1973 November 21, 1974	

NOTE: N/A indicates data not available.

[a] *There are three categories of initial recommended water use objectives: 1) limited fishery and aquatic life, recreational use; 2) warmwater fishery and aquatic life, recreational use; and 3) trout fishery and aquatic life, recreational use.*

[b] *The maximum temperature rise at the edge of the mixing zone above the existing natural temperatures shall not exceed 3°F for lakes nor shall there be any significant artificial increases in temperature where natural trout reproduction is to be protected.*

[c] *The entire depth of shallow lakes (0 to 15 feet) shall be analyzed for dissolved oxygen. However, only the epilimnion of lakes greater than 15 feet shall be analyzed for dissolved oxygen.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 31

COMPARISON OF OBSERVED WATER QUALITY CONDITIONS TO ADOPTED 1976 STREAM WATER USE OBJECTIVES AND SUPPORTING WATER QUALITY STANDARDS FOR WARMWATER FISHERY AND RECREATIONAL USE AND LIMITED FISHERY AND RECREATIONAL USE IN THE FOX RIVER WATERSHED

Sampling Stations	Applicable[a] Objective	Adopted Standards[b]						Miles Violated	Miles Meeting All Standards
		Dissolved Oxygen (5.0 mg/l)	Fecal Coliform (400 MFFCC per 100 ml)	Temperature (89°F)	pH (6.0-9.0 standard units)	Ammonia-Nitrogen (0.4 mg/l)	Total Phosphorus (0.1 mg/l)		
Fx-1	4	X	X			X	X		
Fx-2	4	X	X			X	X		
Fx-3	3	X (3.0 mg/l)[c]	X			(3.5 mg/l)[c]	X		
Fx-4	4	X	X			X	X		
Fx-5	4	X	X			X	X		
Fx-6	4	X	X				X		
Fx-7	4		X				X		
Fx-8	4	X	X			X	X		
Fx-9	4	X	X			X	X		
Fx-10	4		X			X	X		
Fx-11	4	X	X			X	X		
Fx-12	4								
Fx-13	4	X	X				X		
Fx-14	4	X	X		X		X		
Fx-15	4	X	X		X		X		
Fx-16	4	X	X		X		X		
Fx-17	4	X	X		X		X		
Fx-18	4	X	X				X		
Fx-19	4	X	X				X		
Fx-20	4	X	X				X		
Fx-21	4	X	X				X		
Fx-22	4		X			X	X		
Fx-23	4	X	X			X	X		
Fx-24	4	X	X				X		
Fx-25	4	X	X		X		X		
Fx-26	4	X	X			X	X		
Fx-27	4	X	X		X		X		
Fx-28	4		X				X		
Total								172.4	2.5

NOTE: X indicates violation of water use objectives.

[a] *There are five categories of water use objectives:*

1) *Restricted recreational use and minimum standards.*

2) *Marginal aquatic life, recreational use, and minimum standards.*

3) *Limited fishery and aquatic life, recreational use.*

4) *Warmwater fishery and aquatic life, recreational use.*

5) *Trout fishery and aquatic life, recreational use.*

[b] *Includes phosphorus standard as interpreted by SEWRPC.*

[c] *Indicates applicable standard for designated water use objective other than warmwater fishery and recreational use.*

Source: SEWRPC.

The dissolved oxygen concentrations observed during the Commission's continuing water quality monitoring program were well above the established 2.0 mg/l for restricted use at the sampling station and ranged from 3.4 to 14.1 mg/l. The daily average dissolved oxygen concentrations in the August samples collected over the decade remained near saturation levels, but exhibited a distinct decline over the years of sampling. The dissolved oxygen concentrations can be reasonably assumed to decline downstream from the sampling location, as the stream flows through the combined sewer service area. This assumption is supported by the data obtained by the Milwaukee-Metropolitan Sewerage District and the City of Milwaukee Health Department in the lower

Table 32

WATER QUALITY INDEX CLASSIFICATIONS FOR THE SAMPLING STATIONS OF THE FOX RIVER WATERSHED 1964 AND 1974-75

Main Stem Stations	July, August, September, and October of 1964	August of the Years 1974-1975
Fx-1	Fair	Fair
Fx-4	Poor	Fair
Fx-7	Fair	Fair
Fx-8	Poor	Fair
Fx-9	Poor	Fair
Fx-10	Poor	Fair
Fx-11	Fair	Fair
Fx-13	Good	Good
Fx-14	Good	Good
Fx-17	Good	Good
Fx-24	Fair	Fair
Fx-27	Good	Good
Tributary Stations		
Fx-2	Fair	Fair
Fx-3	Fair	Fair
Fx-5	Poor	Poor
Fx-6	Good	Fair
Fx-12	Excellent	Excellent
Fx-15	Poor	Fair
Fx-16	Good	Good
Fx-18	Fair	Fair
Fx-19	Fair	Fair
Fx-20	Fair	Fair
Fx-21	Good	Fair
Fx-22	Good	Good
Fx-23	Good	Fair
Fx-25	Poor	Fair
Fx-26	Fair	Fair
Fx-28	Good	Fair
Watershed Average	Fair	Fair

Source: SEWRPC.

Table 33

TROPHIC CLASSIFICATION OF SELECTED MAJOR LAKES IN THE FOX RIVER WATERSHED: 1975

Major Lake Name	County	Category[a]
Beulah	Walworth	Mesotrophic
Big Muskego	Waukesha	Eutrophic
Bohners	Racine	Mesotrophic
Booth	Walworth	Mesotrophic
Browns	Racine	Mesotrophic
Buena	Racine	Mesotrophic
Camp	Kenosh	Very Eutrophic
Center	Kenosha	Mesotrophic
Como	Walworth	Very Eutrophic
Denoon	Waukesha	Mesotrophic
Eagle	Racine	Very Eutrophic
Eagle Spring	Waukesha	Mesotrophic
Echo	Racine	Mesotrophic
Elizabeth	Kenosha	Mesotrophic
Geneva	Walworth	Mesotrophic
Green	Walworth	Mesotrophic
Little Muskego	Waukesha	Eutrophic
Long	Racine	Very Eutrophic
Lower Phantom	Waukesha	Mesotrophic
Marie	Kenosha	Mesotrophic
Middle	Walworth	Mesotrophic
Mill	Walworth	Mesotrophic
North	Walworth	Very Eutrophic
Pell	Walworth	Eutrophic
Pewaukee	Waukesha	Very Eutrophic
Pleasant	Walworth	Oligotrophic
Potters	Walworth	Eutrophic
Powers	Kenosha	Mesotrophic
Silver	Kenosha	Mesotrophic
Spring	Waukesha	Oligotrophic
Tichigan	Racine	Very Eutrophic
Upper Phantom	Waukesha	Mesotrophic
Wandawega	Walworth	Very Eutrophic
Waubeesee	Racine	Mesotrophic
Wind	Racine	Mesotrophic

[a] *U. S. Environmental Protection Agency, Lake Classification—A Trophic Characterization of Wisconsin Lakes, EPA Report No. 660/3-75-033, June 1975.*

Source: Water Resources Center, University of Wisconsin and SEWRPC.

reaches of the Kinnickinnic River. The dissolved oxygen concentrations were found to decline between S. 6th Street and the harbor estuary.

The average fecal coliform counts recorded at the Kinnickinnic River sampling station generally increased over the decade and generally exceeded the 2,000 membrane filter fecal coliform counts per 100 milliliters (MFFCC/100 ml) maximum standard prescribed for the Kinnickinnic River. The fecal coliform counts ranged from 30 to 72,000 MFFCC/100 ml and may be attributed to the discharge of raw sewage from the sanitary sewer flow relief devices located upstream of the sampling station. High fecal coliform counts may be assumed to be present downstream throughout the combined sewer service area, except perhaps during sustained periods of dry weather. This assumption is supported by the fecal coliform counts recorded by the Milwaukee-Metropolitan Sewerage District and City of Milwaukee Health Department for the lower reaches of the Kinnickinnic River, as the average fecal coliform counts exceeded the 2,000 MFFCC/100 ml standard at all of the sampling stations for the six-year sampling period of record for fecal coliform.

The specific conductance values recorded at the Kinnickinnic River sampling stations ranged from 560 to 962 umhos/cm at 25°C and exhibited a trend toward higher values in the spring samples, corresponding to the trend in chloride concentrations. The higher specific conductance is thought to be attributable to the spring runoff and snowmelt, which have high concentrations of deicing salts. The pH values were found to be within the range of 6.0 to 9.0 standard units established for the Kinnickinnic River with one exception: in one instance the pH fell below 6.0 standard units. This low value is assumed to have resulted from the discharge of acidic substances to the river from industrial wastewater outfalls. Water temperature variations were within normal limits as they fluctuated with the seasonal air temperature patterns.

The diurnal water quality data for the Kinnickinnic River exhibit a broad range of dissolved oxygen concentrations, from 4.5 to 11.7 mg/l over a 24-hour period. These diurnal variations reflect dissolved oxygen reductions from respiration by the aquatic flora and the supersaturation effects of algal photosynthesis.

In addition to exhibiting diurnal fluctuations at the sampling station, the water quality exhibits a predictable pattern of spatial variation. Because of the high fecal coliform counts and low dissolved oxygen concentrations recorded downstream of the sampling station, the water quality is generally better in the reaches upstream from the combined sewer overflow area of the Kinnickinnic River. However, the dilution effects of the flushing tunnel operation on the stream below S. 6th Street and the dilution effects of Lake Michigan and the inner harbor are reflected in enhanced water quality sample results. No sample results are currently available to provide a comparison to other portions of the watershed, where significant industrial wastewater outfalls are located on several tributaries.

Compliance with Water Quality Standards

The Kinnickinnic River, designated for restricted use and minimum standards, met the water quality standards adopted by the Wisconsin Department of Natural Resources for temperature, dissolved oxygen, pH, and fecal coliform counts at the sampling station in 1975. The water quality of the River at the sampling station does, however, exhibit degradation as measured by dissolved oxygen, chlorides, and fecal coliform over the period since 1964. Additional available data from the Milwaukee-Metropolitan Sewerage District and the City of Milwaukee Health Department for the years 1965 through 1970 indicate that the water quality standards were generally met with respect to dissolved oxygen and pH in the lower reaches of the Kinnickinnic River and its tributaries when the flushing tunnel was in operation. However, when the flushing tunnel was inoperative, the water of the lower reaches of the Kinnickinnic River and its tributaries did not meet the water quality standards for dissolved oxygen and fecal coliform.

The sampling station operated by the Commission has provided information on water quality for about 4.0 miles of the continuously flowing reaches of the Kinnickinnic River. A comparison of the 1964 data to the applicable 1976 DNR-adopted water quality standards indicates that all of the parameters met the applicable standards. In 1975, a comparison of the identical standards indicated that the stream reaches sampled remained within the prescribed standards. Table 34 indicates the water use objectives and supporting standards violated during the period of 1964 through 1975.

General Water Quality Ratings

Table 35 sets forth the water quality index classifications for the one Commission-operated sampling station in the watershed. As indicated by the index, the 1964 water quality of the Kinnickinnic River was rated as fair. Fair conditions also existed for August of the years 1974 and 1975.

Toxic and Hazardous Substances: Sampling and analysis for pesticides, polychlorinated biphenyls (PCB's), and heavy metals were conducted by the Wisconsin Department of Natural Resources in the Kinnickinnic River watershed from 1973 through 1977. The analyses indicated that recommended levels of mercury were exceeded in four of 73 samples, and that recommended PCB levels were exceeded in one out of 12 water quality samples. Sample analyses for cadmium, chromium, copper, lead, nickel, zinc, DDT, DDE, DDD, aldrin, heptachlor, heptachlor epoxide, lindane, dieldrin, methoxychlor, and phthalate uncovered no violations of U. S. Environmental Protection Agency (EPA) recommended levels. Sampling and analyses of bottom sediment were conducted on the Kinnickinnic River, and detectable levels of cadmium, chromium, copper, lead, mercury, nickel, zinc, and PCB's were observed; however, no criteria have been established to assess the recorded concentrations.

MENOMONEE RIVER WATERSHED

Water Quality Conditions

The Menomonee River watershed is located in the east central portion of the Region. The Menomonee River originates in southeastern Washington County, and flows approximately 28 miles through the northeastern corner of Waukesha County and through western and central Milwaukee County to its confluence with the Milwaukee River. The geographic, physical, economic, and demographic features of the watershed are described in Volume One, Chapter III of this report.

Water Quality Conditions: 1964-1965: The 1964-1965 benchmark streamwater quality study of the Commission included the operation of 12 sampling stations in the watershed, nine on the Menomonee River main stem and one each on the Little Menomonee River, Underwood Creek, and Honey Creek as shown on Map 40. The water quality data for 1964-1965 from the nine Menomonee River main stem sampling stations indicated chloride concentrations ranging from 15 to 425 milligrams per liter (mg/l), higher than the normal background concentration and reflecting the impact of sewage treatment discharges and malfunctioning domestic onsite sewage disposal systems, and of road deicing activities. Higher levels of chloride concentrations were also found on the three major tributaries of the Menomonee River, where concentrations ranged from 30 to 1,200 mg/l, probably

Table 34

COMPARISON OF OBSERVED WATER QUALITY CONDITIONS TO ADOPTED 1976 STREAM WATER USE OBJECTIVES AND SUPPORTING WATER QUALITY STANDARDS FOR RESTRICTED RECREATIONAL USE AND MINIMUM STANDARDS IN THE KINNICKINNIC RIVER WATERSHED

Sampling Station	Applicable[a] Objective	Adopted Standards[b]						Miles Violated	Miles Meeting All Standards
		Dissolved Oxygen (2.0 mg/l)	Fecal Coliform (2,000 MFFCC per 100 ml)	Temperature (89°F)	pH (6.0-9.0 standard units)	Ammonia-Nitrogen	Total Phosphorus		
Kk-1	1	X	X			N/A	N/A	4.0	0.0
Total								4.0	0.0

NOTES: X indicates violation of water use objectives.
N/A indicates not applicable.

[a] There are five categories of water use objectives:

1) Restricted recreational use and minimum standards.

2) Marginal aquatic life, recreational use, and minimum standards.

3) Limited fishery and aquatic life, recreational use.

4) Warmwater fishery and aquatic life, recreational use.

5) Trout fishery and aquatic life, recreational use.

[b] Includes phosphorus standard as interpreted by SEWRPC.

Source: SEWRPC.

Table 35

WATER QUALITY INDEX CLASSIFICATIONS FOR THE SAMPLING STATION OF THE KINNICKINNIC RIVER WATERSHED 1964 AND 1974-75

Main Stem Station	July, August, September, and October of 1964	August of the Years 1974-1975
Kk-1	Fair	Fair
Watershed Average . . .	Fair	Fair

Source: SEWRPC.

due to malfunctioning private onsite sewage disposal systems, livestock wastes, and road salting operations. Dissolved oxygen levels fluctuated from 0.0 to 18.9 mg/l on the Menomonee River main stem and from 0.2 to 20.4 mg/l in the tributaries during the 1964-1965 sampling period. Substandard concentrations of dissolved oxygen were recorded at four of the nine main stem stations on the Menomonee River during the August sampling period of 1964, and no violations were recorded at the three tributary stations, Mn-7, Mn-8, and Mn-9. High total coliform counts were found at five of the nine Menomonee River sampling stations, with values ranging from 100 to 1,000,000 membrane filter coliform counts per 100 milliliters (MFCC/100 ml). Ranges of from 100 to 430,000 MFCC/100 ml were recorded at the tributary stations. Drainage from agricultural land and wastes from malfunctioning private onsite sewage disposal systems are some of the probable sources of this indicated contamination. The specific conductance values in the Menomonee River watershed were found to be within the expected range of from 345 to 2,460 micro-mhos per centimeter (μmhos/cm) at 25°C. As a result of spring runoff from snowmelt and rainfall events, elevated levels of specific conductance were found to be typical at the middle and downstream sampling stations. The pH values (hydrogen ion concentrations) were within the recommended range of 6.0 to 9.0 standard units with one exception: a reading of 9.2 was recorded in November of 1964 at the S. Muskego Avenue sampling site. All temperature variations were primarily seasonal and not a result of thermal pollution from cooling water discharges.

Water Quality Conditions: 1965-1975: The 1965-1975 water quality monitoring effort by the Commission included continued sampling at the 12 sampling stations in the watershed and collecting data available from five Milwaukee-Metropolitan Sewerage District sampling stations as shown on Map 40. Review of the chloride and fecal coliform data indicated essentially no change in the chloride levels over the period of sampling and generally increased fecal coliform counts throughout the main stem of the Menomonee River after 1968, when the parameter was first measured. Ranges of chloride and stream and the dissolved oxygen supersaturation effects of algal photosynthesis. In addition to exhibiting marked diurnal fluctuations, water quality in the Menomonee River watershed exhibits spatial variation. The water quality of the Menomonee River downstream near 76th Street was generally better than the water quality in the headwater areas of the Menomonee River.

Compliance with Water Quality Standards

Although generally stable over the period, the Upper Menomonee River and the Little Menomonee River, which are intended for recreational use and the maintenance of a warmwater fishery and other aquatic life, did not meet the water quality standards adopted by the Wisconsin Department of Natural Resources (DNR) for fecal coliform and ammonia-nitrogen in 1975. Also, in the extreme upper reaches of the Menomonee River at station Mn-1, the water did not meet the adopted standard for dissolved oxygen in 1975. Finally, total phosphorus concentrations were found to be significantly higher than the recommended level adopted by the Commission. When the water quality of the lower Menomonee River, Underwood Creek, and Honey Creek was assessed against the restricted use standards, violations of fecal coliform persisted.

The 12 sampling stations operated by the Commission have provided information on water quality in the large, continuously flowing streams which total 39.5 miles tributary to and inclusive of the Menomonee River. A comparison of the 1964 data to the applicable 1976 DNR-adopted water quality standards indicates that 33.6 miles, or 85 percent, of the stream reaches sampled violated the standards for one or more parameters. In 1975, by comparison, all of the 39.5 miles of the stream reaches sampled were in violation of one or more of the identical standards, particularly that for fecal coliform, indicating degradation of water quality in 1975 as compared to 1964. Tables 36 and 37 indicate the water use objectives and supporting standards violated furing the period of 1964 through 1975.

General Water Quality Ratings

Table 38 sets forth the water quality index rating for the 12 Commission-operated sampling stations in the watershed. The table indicates that for the months of July through October of 1964, water quality conditions at eight stations, or 66.7 percent of the total, were rated fecal coliform bacteria were from 12 to 341 mg/l and from 10 to 400,000 membrane filter fecal coliform counts per 100 milliliters (MFFCC/100 ml), respectively. On the three major tributary streams, chloride and fecal coliform remained in an essentially stable condition over the decade. The observed dissolved oxygen levels indicate that the water quality at the upstream sampling stations, Mn-1 through Mn-5, has improved since 1964. Water quality conditions have, however, deteriorated at the downstream sampling stations, Mn-6 through Mn-10. There was essentially no trend in dissolved oxygen levels on the tributary streams. Within the watershed, dissolved oxygen concentrations varied from 0.1 to 20.1 mg/l. Specific conductance values ranged from 229 to 1,605 µmhos/cm at 25°C with no specific trends noted. Fluctuations were observed in the concentrations of dissolved solids as a function of runoff from winter salting operations, storm events, and spring snowmelt. The pH values (hydrogen ion concentrations) and temperature remained within the established standards during the sampling period. Ammonianitrogen (NH_3-N) concentrations from 1972 through 1975 ranged from 0.03 to 3.61 mg/l. Excessive levels of ammonia-nitrogen above the 0.4 mg/l recommended standard, which is the level toxic to fish and aquatic life, were recorded at stations Mn-4, Mn-5, and Mn-6, on the main stem. Total phosphorus concentrations remained in excess of the recommended level of 0.10 mg/l in 92 percent of the total phosphorus samples. The range of total phosphorus concentrations varied from 0.03 to 2.82 mg/l. The water quality of the Little Menomonee River remained equal to or better than the water quality of the main stem as measured by dissolved oxygen, chloride, ammonia-nitrogen, and total phosphorus. However, fecal coliform levels on the Little Menomonee River, Honey Creek, and Underwood Creek, were higher in total counts than on the Menomonee River main stem.

The diurnal water quality data for the Menomonee River and its three major tributaries show a broad range of dissolved oxygen concentrations, from 0.6 to 10.7 mg/l over a 24-hour period, reflecting the dissolved oxygen reductions due to respiration by the aquatic plants and decomposition of organic matter in the as fair; at three stations, or 25 percent of the total, were rated as poor; and at one station, or 8.4 percent of the total, were rated as good. No stations were rated as excellent. By comparison, in August of the years 1974 and 1975, water quality conditions at 11 sampling sites, or a total of 91.7 percent, were rated as fair; and at one station, or 8.4 percent, were rated as poor. Although Table 38 indicates that the overall watershed averages in 1974-1975 as compared to 1964 remained fair, the above percentages indicate a decline in water quality since 1964.

Toxic and Hazardous Substances: Sampling and analysis for pesticides, polychlorinated biphenyls (PCB's), and heavy metals were conducted by the Commission and the Wisconsin Department of Natural Resources (DNR) at three sampling stations in the Menomonee River and the results are reported in Chapter VII, Table 55 of Technical Report No. 26, A Comprehensive Plan for the Menomonee River Watershed, Volume One, Inventory Findings and Forecasts. Specifically, 21 of 105, or 20 percent, of the samples collected violated the recommended criteria for lead. Sample analyses for cadmium, cobalt, copper, mercury, nickel, and zinc uncovered no violations of U. S. Environmental Protection Agency (EPA) recommended levels.

MILWAUKEE RIVER WATERSHED

Water Quality Conditions

The Milwaukee River watershed is located in the northeastern and north-central portions of the Southeastern Wisconsin Region. The headwaters portion of the water-

Table 36

COMPARISON OF OBSERVED WATER QUALITY CONDITIONS TO ADOPTED 1976 STREAM WATER USE OBJECTIVES AND SUPPORTING WATER QUALITY STANDARDS FOR WARMWATER FISHERY AND RECREATIONAL USE IN THE MENOMONEE RIVER WATERSHED

Sampling Stations	Applicable[a] Objective	Adopted Standards[b]						Miles Violated	Miles Meeting All Standards
		Dissolved Oxygen (5.0 mg/l)	Fecal Coliform (400 MFFCC per 100 ml)	Temperature (89°F)	pH (6.0-9.0 standard units)	Ammonia-Nitrogen (0.4 mg/l)	Total Phosphorus (0.1 mg/l)		
Mn-1	4	X	X				X		
Mn-2	4	X	X		X		X		
Mn-3	4	X	X		X		X		
Mn-4	4	X	X			X	X		
Mn-5	4	X	X			X	X		
Mn-6	4	X	X			X	X		
Mn-7	4	X	X				X		
Mn-7A	4	X	X				X		
Mn-7B	4	X	X				X		
Mn-10	4	X	X				X		
Total								34.65	0.0

NOTE: X indicates violation of water use objectives.

[a] *There are five categories of water use objectives:*

1) *Restricted recreational use and minimum standards.*
2) *Marginal aquatic life, recreational use, and minimum standards.*
3) *Limited fishery and aquatic life, recreational use.*
4) *Warmwater fishery and aquatic life, recreational use.*
5) *Trout fishery and aquatic life, recreational use.*

[b] *Includes phosphorus standard as interpreted by SEWRPC.*

Source: SEWRPC.

Table 37

COMPARISON OF OBSERVED WATER QUALITY CONDITIONS TO ADOPTED 1976 STREAM WATER USE OBJECTIVES AND SUPPORTING WATER QUALITY STANDARDS FOR RESTRICTED RECREATIONAL USE AND MINIMUM STANDARDS IN THE MENOMONEE RIVER WATERSHED

Sampling Stations	Applicable[a] Objective	Adopted Standards[b]						Miles Violated	Miles Meeting All Standards
		Dissolved Oxygen (2.0 mg/l)	Fecal Coliform (2,000 MFFCC per 100 ml)	Temperature (89°F)	pH (6.0-9.0 standard units)	Ammonia-Nitrogen	Total Phosphorus		
Mn-8	1		X		X	N/A	N/A		
Mn-9	1		X			N/A			
Total								4.85	0.0

NOTES: X indicates violation of water use objectives.
N/A indicates not applicable.

[a] *There are five categories of water use objectives:*

1) *Restricted recreational use and minimum standards.*
2) *Marginal aquatic life, recreational use, and minimum standards.*
3) *Limited fishery and aquatic life, recreational use.*
4) *Warmwater fishery and aquatic life, recreational use.*
5) *Trout fishery and aquatic life, recreational use.*

[b] *Includes phosphorus standard as interpreted by SEWRPC.*

Source: SEWRPC.

Table 38

WATER QUALITY INDEX CLASSIFICATIONS FOR THE SAMPLING STATIONS OF THE MENOMONEE RIVER WATERSHED 1964 AND 1974-1975

Main Stem Stations	July, August, September, and October of 1964	August of the Years 1974-1975
Mn-1.	Fair	Fair
Mn-2.	Poor	Fair
Mn-3.	Good	Fair
Mn-4.	Poor	Fair
Mn-5.	Poor	Poor
Mn-6.	Fair	Fair
Mn-7a	Fair	Fair
Mn-7b.	Fair	Fair
Mn-10.	Fair	Fair
Tributary Stations		
Mn-7.	Fair	Fair
Mn-8.	Fair	Fair
Mn-9.	Fair	Fair
Watershed Average. . . .	Fair	Fair

Source: SEWRPC.

shed lies adjacent to the Region in Dodge, Fond du Lac, and Sheboygan Counties. The geographic, physical, economic, and demographic features of the watershed are described in Volume One, Chapter III of this report.

Water Quality Conditions: 1964-1965: The 1964-1965 benchmark streamwater quality study conducted by the Commission included the operation of 12 sampling stations on the Milwaukee River and its major tributaries as indicated on Map 40. The water quality data from the 12 stations for the 1964-1965 sampling period indicated chloride concentrations ranging from 0 to 120 milligrams per liter (mg/l). The data, moreover, indicated that the chloride concentrations were higher during February, May, and December, probably reflecting the impact of winter street and highway salting operations and spring runoff. The dissolved oxygen concentrations recorded at the Milwaukee River watershed sampling stations during the benchmark survey ranged from 0.0 to 24.2 mg/l and indicated substandard dissolved oxygen concentrations at sampling stations Ml-1 through Ml-8, and at Ml-11 during July 1964. These substandard conditions may be attributed to wastewater treatment plant discharge and sewer overflow as well as to agricultural runoff. Total coliform counts ranged from 100 to 170,000 membrane filter coliform counts per 100 milliliters (MFCC/100 ml). High total coliform counts occurred during the low flow months of July and August and are attributed to sewage effluents and seepage of septic tank effluents. The specific conductance values were highest during the spring runoff period and ranged from 245 to 730 micro-mhos per centimeter (μmhos/cm) at 25°C. The pH values (hydrogen ion concentrations) obtained during the study were within the 6.0 to 9.0 standard units prescribed for rivers and streams designated for warmwater or limited fishery and other aquatic life. Temperature variations reflected the expected seasonal changes. The discharge of cooling waters to the Milwaukee River and its major tributaries apparently did not elevate the natural water temperatures significantly.

Water Quality Conditions: 1965-1975: The 1965-1975 water quality monitoring effort by the Commission included continued sampling at the 12 stations established in the watershed and collecting data from the eight Milwaukee-Metropolitan Sewerage District sampling stations and six Wisconsin Department of Natural Resources (DNR) sampling stations shown on Map 40. Analysis of the average chloride concentrations recorded during the August surveys indicates concentrations which significantly exceeded the expected background concentration of 10 mg/l, except in those areas tributary to the North Branch of the Milwaukee River. The highest chloride concentrations occurred during snowmelt and rainfall runoff events. As well as being associated with deicing salts, chloride levels in the watershed are associated with sewage treatment plant effluent, sewer overflows, industrial discharges, and functioning septic systems and livestock operations. During the sampling period, the chloride concentrations ranged from 15.5 to 131 mg/l. The chloride concentrations increased from 1968 through 1975 at sampling stations Ml-1 and Ml-2 on the main stem of the Milwaukee River. At the same time, chloride concentrations decreased at sampling stations Ml-3 and Ml-9, and remained stable at sampling stations Ml-5, Ml-6, and Ml-10 through Ml-12. The chloride concentrations on the tributary streams of the Milwaukee River ranged from 6.0 to 324 mg/l and generally exhibited a decreasing trend over the decade. The chloride concentrations also declined downstream from the North Avenue dam because of dilution from the Milwaukee River flushing tunnel and the effects of Lake Michigan. The chloride concentrations in this stream reach are affected by the storm water runoff and sanitary sewage discharge from the combined sewer overflows and flow relief devices located in the area.

The recorded levels of dissolved oxygen concentrations from 1964 through 1975 ranged from 0.3 to 21.3 mg/l. Analysis of the average dissolved oxygen concentrations from this period indicates an increasing trend at sampling stations Ml-1, Ml-2, Ml-5, Ml-6, Ml-10, and Ml-12. Decreasing trends in the average dissolved oxygen concentrations were noted at sampling stations Ml-3, Ml-9, and Ml-11. Tributary sampling station Ml-4 on the North Branch of the Milwaukee River and sampling stations Ml-7 and Ml-8 on Cedar Creek exhibited no significant change from 1964 through 1975. Substandard dissolved oxygen concentrations were also recorded by the Milwaukee-Metropolitan Sewerage District at all but one of the eight sample sites located on the Milwaukee River and Lincoln Creek from 1964 to 1968. Downstream from the North Avenue dam, a general decline in the average dissolved oxygen was noted from 1964 to 1968.

Review of the fecal coliform data over the period of sampling indicated a range of from 10 to 40,000 membrane filter fecal coliform counts per 100 milliliters (MFFCC/100 ml). Generally, fecal coliform bacteria increased over the sampling period at the tributary sampling stations and along the main stem with the exception of stations Ml-1, Ml-10, and Ml-11, which registered decreases. The specific conductance values recorded at at the Milwaukee River watershed sampling stations exhibited an increase in the spring samples, which corresponds to the increasing trend in the chloride concentrations. Ranges of specific conductance during the sampling period varied from 510 to 1,550 µmhos/cm at 25°C. Stable pH values were noted in the August samples collected between 1964 and 1975. Temperature variations fluctuated as a result of seasonal changes and were within normal limits. Ammonia-nitrogen (NH_3-N) concentrations exceeded the established standard of 0.4 mg/l for warmwater fishery and aquatic life at only two of the 12 sampling stations in the Milwaukee River watershed between 1972 and 1975. All of the total phosphorus concentrations recorded were in excess of the recommended water quality level of 0.10 mg/l.

The diurnal water quality data for the Milwaukee River exhibited a broad range of dissolved oxygen concentrations—from 3.7 to 11.3 mg/l at sampling station Ml-2, and from 7.3 to 11.5 mg/l at sampling station Ml-11—on the main stem of the Milwaukee River over a 24-hour period. The dissolved oxygen diurnal variations at sampling station Ml-4 located on the North Branch of the Milwaukee River ranged from 4.7 to 9.9 mg/l. At sampling stations Ml-7 and Ml-8, located on Cedar Creek, the dissolved oxygen diurnal variations ranged from 2.5 to 9.5 mg/l and from 4.4 to 9.8 mg/l, respectively. These diurnal variations reflect dissolved oxygen reductions due to respiration by aquatic plants and decomposition of organic matter deposited in the stream, and the dissolved oxygen supersaturation effects of algal photosynthesis.

In addition to exhibiting marked diurnal fluctuations, the water quality at the Milwaukee River sampling stations exhibited a predictable pattern of spatial variation. The water quality, as measured by the dissolved oxygen and fecal coliform counts, are generally better upstream from the sewage treatment facilities, sanitary sewer flow relief devices, and industrial discharges located on the Milwaukee River and its tributaries than downstream from these sources.

Compliance with Water Quality Standards

In general, water quality conditions in the Milwaukee River watershed have deteriorated since 1964, although some water quality parameters have slightly improved. When comparing the 1975 water quality data to the water quality standards adopted by the Wisconsin Department of Natural Resources, dissolved oxygen concentrations and fecal coliform counts violate the standards for recreational use and the maintenance of a warmwater fishery and other aquatic life; the objectives set for the reaches of the Milwaukee River and its tributaries upstream from the North Avenue dam; and the standards for restricted use set for fecal coliform for the reaches of the main stem of the Milwaukee River downstream from the North Avenue dam and for Lincoln Creek. In addition, total phosphorus levels upstream from the North Avenue dam were found to be significantly higher than the recommended level adopted by the Commission.

Water use objectives and supporting water quality standards for lakes have been recommended by the Commission for the 12 major lakes—lakes of 50 acres or more—in the Milwaukee River watershed within the Region. Two—Mud and Smith Lakes—are designated for maintenance of a limited fishery and other aquatic life and recreational use. The remaining lakes are designated to meet recreational use and maintenance of a warmwater fishery and other aquatic life objectives as indicated in Table 39, which also assesses the lakes' compliance with the recommended lake water quality standards. Of the four lakes for which complete water quality data are available, only Mud Lake met the preliminary recommended levels of water quality for all of the parameters. Since 1964 the 12 sampling stations utilized by the Commission have provided information on water quality in the larger, continuously flowing streams which total 99.8 miles tributary to and inclusive of the Milwaukee River. A comparison of the 1964 data to the applicable 1976 DNR-adopted water quality standards indicates that all of the stream reaches sampled violated the standards for at least one parameter. In 1975, by comparison, 78.6 stream miles, or 79 percent, were in violation of one or more of the identical standards. Tables 40 and 41 indicate the water use objectives and supporting standards violated during the period of 1964 through 1975.

General Water Quality Ratings

Table 42 sets forth the water quality index classifications for the 12 Commission-operated sampling stations in the watershed. As indicated by the index, the 1964 water quality of the Milwaukee River main stem was generally fair, and the tributary reaches also recorded fair water quality. In August of the years 1974 and 1975, 10 of the 12 sampling stations in the Milwaukee River watershed were rated as fair. Overall, there was no change in the general watershed rating of fair in 1974-1975 as compared to 1964 conditions.

Table 39

COMPARISON OF WATER QUALITY CONDITIONS TO INITIAL RECOMMENDED LAKE WATER USE OBJECTIVES AND SUPPORTING WATER QUALITY STANDARDS IN THE MILWAUKEE RIVER WATERSHED

			Temperature (^{o}F)			pH (standard units)			Dissolved Oxygen[c] (mg/l)			Fecal Coliform (MFFCC/100 ml)			Ammonia Nitrogen (mg/l)			Inorganic Nitrogen—Sum of Nitrite-Nitrogen + Nitrate-Nitrogen + Ammonia-Nitrogen (mg/l)			Inorganic Phosphorus (mg/l)			Total Phosphorus (mg/l)		
			Within Total Depth of Lake During Entire Year			Within Total Depth of Lake During Entire Year			In Epilimnion During Late July, August, or September			Within Total Depth of Lake During Entire Year			Within Total Depth of Lake During Mixing (Spring and Fall)			Within Total Depth of Lake During Mixing (Spring and Fall)			Within Total Depth of Lake During Mixing (Spring and Fall)			Within Total Depth of Lake During Mixing (Spring and Fall)		
	Applicable	Availability	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Lake Name	Objective[a]	of Data	89°	89°	b	6-9	6-9	6-9	3.0	5.0	6.0	400	400	400	3.5	0.4	0.4	0.9	0.3	0.15	0.03	0.01	0.005	0.06	0.02	0.01
Barton Pond	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Big Cedar.	2	1974-1975		Yes			Yes			Yes			Yes			Yes			April 23, 1975			November 9, 1976 April 8, 1976 April 23, 1975 April 8, 1974 November 18, 1974 November 15, 1973			November 9, 1976 April 8, 1976 April 23, 1975 April 8, 1974 November 18, 1974 November 15, 1973	
Green.	2	September 9, 1974		Yes			N/A			Yes			N/A			N/A			N/A			N/A			N/A	
Little Cedar	2	1973-1977		Yes			Yes			Yes			Yes			Yes			November 18, 1974			November 24, 1975 April 8, 1974 November 9, 1976 November 18, 1974			November 24, 1975 April 8, 1974 November 9, 1976 November 18, 1974	
Lucas.	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Mud[d].	1	1973-1975	Yes			Yes			Yes			Yes			Yes			Yes			Yes			Yes		
Silver	2	1975-1977		Yes			Yes			Yes			Yes			April 8, 1976			November 24, 1975 April 8, 1976 April 23, 1975			November 24, 1975 November 9, 1976 April 23, 1975			November 24, 1975 November 9, 1976 April 23, 1975	
Smith.	1	N/A	N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A		
Spring	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Twelve	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Wallace	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
West Bend Pond. .	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	

NOTE: N/A indicates data not available.

[a] *There are three categories of initial recommended water use objectives: 1) limited fishery and aquatic life, recreational use; 2) warmwater fishery and aquatic life, recreational use; and 3) trout fishery and aquatic life, recreational use.*

[b] *The maximum temperature rise at the edge of the mixing zone above the existing natural temperatures shall not exceed 3°F for lakes nor shall there be any significant artificial increases in temperature where natural trout reproduction is to be protected.*

[c] *The entire depth of shallow lakes (0 to 15 feet) shall be analyzed for dissolved oxygen. However, only the epilimnion of lakes greater than 15 feet shall be analyzed for dissolved oxygen.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Of the 12 major lakes in the Milwaukee River watershed within the Region, seven have a maximum depth greater than 20 feet and therefore are likely to stratify during the summer season. Dissolved oxygen profiles prepared for these seven lakes indicate that all exhibit less than 1.0 mg/l dissolved oxygen levels in the lower lake layers (hypolimnion), and may adversely affect fish and other aquatic life in the lakes. The dissolved oxygen concentrations in the upper layers (epilimnion) are generally above 7.0 mg/l. As noted in Table 43, four of the 12 major lakes located in the watershed have been classified according to their trophic status as determined by the dissolved oxygen levels in the lower layers of the lake, water clarity of the lake, history of fishkills, and use impairment caused by algae and weed abundance. Of the four lakes, one was rated as very eutrophic, two as mesotrophic, and one as oligotrophic.[15]

Toxic and Hazardous Substances: Sampling and analysis for toxic and hazardous substances were conducted by the Wisconsin Department of Natural Resources in the Milwaukee River watershed from 1973 to 1976. In the very limited number of samples of streamflow available, levels for mercury exceeded the recommended criteria

[15] *U. S. Environmental Protection Agency, Lake Classification—A Trophic Characterization of Wisconsin Lakes, EPA Report No. 660/3-75-033, June 1975. This report and others pertaining to trophic status of lakes generally recognize three classifications of trophic status. These classifications consider water clarity; chemical parameters; biological parameters, including algae and macrophyte growth; physical characteristics; recorded fishkills; or combinations of these. The three classifications are reflective of the natural or*

(footnote continued on next page)

Table 40

COMPARISON OF OBSERVED WATER QUALITY CONDITIONS TO ADOPTED 1976 STREAM WATER USE OBJECTIVES AND SUPPORTING WATER QUALITY STANDARDS FOR WARMWATER FISHERY AND RECREATIONAL USE IN THE MILWAUKEE RIVER WATERSHED

Sampling Stations	Applicable[a] Objective	Adopted Standards[b] Dissolved Oxygen (5.0 mg/l)	Fecal Coliform (400 MFFCC per 100 ml)	Temperature (89°F)	pH (6.0-9.0 standard units)	Ammonia-Nitrogen (0.4 mg/l)	Total Phosphorus (0.1 mg/l)	Miles Violated	Miles Meeting All Standards
MI-1	4	X	X				X		
MI-2	4	X	X				X		
MI-3	4	X	X			X	X		
MI-4	4	X	X				X		
MI-5	4	X	X		X		X		
MI-6	4	X	X		X		X		
MI-7	4	X	X				X		
MI-8	4	X	X				X		
MI-9	4	X	X		X		X		
MI-10	4	X	X				X		
MI-11	4	X	X		X		X		
Total								95.69	0.0

NOTE: X indicates violation of water use objectives.

[a] *There are five categories of water use objectives:*

1) Restricted recreational use and minimum standards.

2) Marginal aquatic life, recreational use, and minimum standards.

3) Limited fishery and aquatic life, recreational use.

4) Warmwater fishery and aquatic life, recreational use.

5) Trout fishery and aquatic life, recreational use.

[b] *Includes phosphorus standard as interpreted by SEWRPC.*

Source: SEWRPC.

in 17 of 172 samples, and excessive levels of polychlorinated biphenyls (PCB's) were recorded in eight of 70 samples collected and analyzed. Levels were in excess of recommended criteria in two of 67 analyses for the pesticide known as aldrin, in one out of 73 analyses for both heptachlor and heptachlor epoxide pesticides, and in one out of 51 analyses for phthalate, a pesticide. Sample analyses for cadmium, chromium, copper, lead, nickel, zinc, DDT, DDE, DDD, lindane, dieldrin, and methoxychlor uncovered no violations of U. S. Environmental Protection Agency (EPA) recommended levels. There are some indications that such substances are absorbed in the bottom sediments of the stream network, since detectable levels of cadmium, chromium, copper, lead, mercury, nickel, zinc, and PCB's were observed; however, no criteria have been established to assess the recorded concentrations.

WATERSHED OF MINOR STREAMS TRIBUTARY TO LAKE MICHIGAN

Water Quality Conditions

The composite watershed of the minor streams tributary to Lake Michigan is located in the eastern portion of the

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footnote 15 (continued)

human-induced rates of aging or in-filling experienced by the lakes. "Eutrophic" lakes are generally shallower, enriched by nutrients and organic matter, and exhibit low water clarity, "Very eutrophic" or "dystrophic" are terms sometimes used for extreme cases of eutrophic lakes. "Mesotrophic" lakes may be of moderate depth, and exhibit less nutrient and organic enrichment, as well as higher levels of water clarity. "Oligotrophic" lakes are relatively deep, low in nutrient content and organic matter, and exhibit higher levels of water clarity.

Table 41

COMPARISON OF OBSERVED WATER QUALITY CONDITIONS TO ADOPTED 1976 STREAM WATER USE OBJECTIVES AND SUPPORTING WATER QUALITY STANDARDS FOR RESTRICTED RECREATIONAL USE AND MINIMUM STANDARDS IN THE MILWAUKEE RIVER WATERSHED

Sampling Station	Applicable[a] Objective	Adopted Standards[b]						Miles Violated	Miles Meeting All Standards
		Dissolved Oxygen (2.0 mg/l)	Fecal Coliform (2,000 MFFCC per 100 ml)	Temperature (89°F)	pH (6.0-9.0 standard units)	Ammonia-Nitrogen	Total Phosphorus		
MI-12	1	X	X			N/A	N/A		
Total								4.15	0.0

NOTES: X indicates violation of water use objectives.
N/A indicates not applicable.

[a] *There are five categories of water use objectives:*

1) Restricted recreational use and minimum standards.

2) Marginal aquatic life, recreational use, and minimum standards.

3) Limited fishery and aquatic life, recreational use.

4) Warmwater fishery and aquatic life, recreational use.

5) Trout fishery and aquatic life, recreational use.

[b] *Includes phosphorus standard as interpreted by SEWRPC.*

Source: SEWRPC.

Table 42

WATER QUALITY INDEX CLASSIFICATIONS FOR THE SAMPLING STATIONS OF THE MILWAUKEE RIVER WATERSHED 1964 AND 1974-75

Main Stem Stations	July, August, September, and October of 1964	August of the Years 1974-1975
MI-1	Fair	Fair
MI-2	Fair	Fair
MI-3	Good	Fair
MI-5	Good	Good
MI-6	Good	Fair
MI-9	Good	Fair
MI-10	Fair	Fair
MI-11	Fair	Good
MI-12	Fair	Fair
Tributary Stations		
MI-4	Fair	Fair
MI-7	Fair	Fair
MI-8	Fair	Fair
Watershed Average	Fair	Fair

Source: SEWRPC.

Table 43

TROPHIC CLASSIFICATION OF SELECTED MAJOR LAKES IN THE MILWAUKEE RIVER WATERSHED: 1975

Major Lake Name	County	Category[a]
Big Cedar	Washington	Mesotrophic
Little Cedar	Washington	Mesotrophic
Mud	Ozaukee	Very Eutrophic
Silver	Washington	Oligotrophic

[a] *U. S. Environmental Protection Agency, Lake Classification—A Trophic Characterization of Wisconsin Lakes, EPA Report No. 660/3-75-033, June 1975.*

Source: Water Resources Center—University of Wisconsin and SEWRPC.

Region and on the western shore of Lake Michigan in the eastern parts of Ozaukee, Milwaukee, Racine, and Kenosha Counties. Three perennial streams, Barnes Creek, Pike Creek, and Sucker Creek, drain portions of the composite watershed. The geographic, physical, economic, and demographic features of the watershed are described in Volume One, Chapter III of this report.

Barnes Creek Subwatershed

Water Quality Conditions: 1964-1965: The Barnes Creek drainage area is located in the eastern portion of Kenosha County. The 1964-1965 benchmark streamwater quality study of the Commission included the operation of one sampling station on Barnes Creek, as indicated on Map 40. The water quality data for 1964-1965 indicated chloride levels ranging from 30 to 45 milligrams per liter (mg/l), which are higher than the normal background chloride concentration of area groundwater. These levels reflect a chloride impact upon the stream from cultural sources. Dissolved oxygen concentrations were greater than the recommended minimum of 5.0 mg/l for all samples taken during the one-year survey, with ranges of from 6.7 to 21.7 mg/l. Barnes Creek also exhibited high total coliform counts, which fluctuated from 100 to 88,000 membrane filter coliform counts per 100 milliliters (MFCC/100 ml). The apparent source of this contamination was drainage from malfunctioning septic systems. The specific conductance values ranged from 560 to 585 micro-mhos per centimeter (μmhos/cm at 25°C) and were associated with high calcium, bicarbonate, and sulfate concentrations, indicating that the source of the high specific conductance was probably soil erosion. The pH values (hydrogen ion concentrations) and temperatures were within the adopted standards.

Water Quality Conditions: 1965-1975: The 1965-1975 continuing water quality monitoring effort by the Commission included continued sampling at the single sampling station on Barnes Creek. The observed chloride, dissolved oxygen, and fecal coliform levels remained essentially unchanged in Barnes Creek over the decade, and ranged from 28.0 to 68.0 mg/l, 4.2 to 18.2 mg/l, and 100 to 760 membrane filter fecal coliform counts per 100 milliliters (MFFCC/100 ml), respectively. Specific conductance levels were higher in the 1965-1975 sampling period than in the 1964-1965 period, and ranged from 699 to 960 μmhos/cm at 25°C. Temperature and pH values were within the recommended levels.

Compliance with Water Quality Standards: In 1975 Barnes Creek, designated for restricted use and minimum standards, met the water quality standards adopted by the Wisconsin Department of Natural Resources (DNR) for temperature, pH, dissolved oxygen, and fecal coliform.

The single sampling station operated by the Commission has provided information on water quality in the continuously flowing streams which total 1.4 miles of the Barnes Creek subwatershed. A comparison of the 1964 data to the applicable 1976 DNR-adopted water quality standards indicates that all of the standards were satisfied on the stream reaches sampled. In 1975, the same conditions were found to exist when the identical 1976 standards were applied. Table 44 indicates the water use objectives and supporting standards violated during the period of 1964 through 1975.

Pike Creek Subwatershed

Water Quality Conditions: 1964-1965: The Pike Creek drainage area is located in the eastern portion of Kenosha County and in the City of Kenosha. The 1964-1965 benchmark streamwater quality study of the Commission included the operation of one sampling station on Pike Creek, as indicated on Map 40. The water quality data for 1964-1965 indicated chloride levels ranging from 20 to 285 milligrams per liter (mg/l), which are higher than the normal background chloride concentrations in groundwater. These levels reflect a chloride impact upon the stream from cultural sources. Substandard dissolved oxygen levels and high total coliform counts were found during the summer months at the Pike Creek sampling station, with ranges of from 3.5 to 12.0 mg/l and from 10,000 to 740,000 membrane filter coliform counts per 100 milliliters (MFCC/100 ml), respectively. The specific conductance values, which ranged from 260 to 740 micromhos per centimeter (μmhos/cm) at 25°C, were found Creek than at the sampling stations on Barnes Creek and Sucker Creek. The high specific conductance values were associated with high calcium, bicarbonate, and sulfate concentrations, indicating that the probable source of the high specific conductance was soil erosion. The pH values (hydrogen ion concentrations) and temperatures were within the adopted standards designated for the Pike Creek subwatershed.

Water Quality Conditions: 1965-1975: The 1965-1975 continuing water quality monitoring effort by the Commission included continued sampling at the single station on Pike Creek. Chloride concentrations ranging from 18.0 to 52.0 mg/l were observed, showing a slight decreasing trend. The observed dissolved oxygen levels remained essentially unchanged over the decade with ranges of from 3.2 to 12.2 mg/l. The fecal coliform counts increased, and ranged from 110 to 64,000 membrane filter fecal coliform counts per 100 milliliters (MFFCC/100 ml). Specific conductance exhibited a decreasing trend over the years, with ranges of from 155 to 708 μmhos/cm at 25°C. Temperature, pH, and ammonia-nitrogen were within normal limits of the designated water use objectives for Pike Creek. Total phosphorus ranged from 0.01 to 1.14 mg/l and violated recommended standards in two of 10 samples.

The diurnal water quality data for Pike Creek showed a broad range of dissolved oxygen concentrations—from 1.8 to 11.6 mg/l—over a 24-hour period, reflecting the effects of algal photosynthesis and respiration.

Compliance with Water Quality Standards: In 1975 Pike Creek, which is intended for recreational use and the maintenance of a warmwater fishery, did not meet the water quality standards adopted by the Wisconsin Department of Natural Resources (DNR) for dissolved oxygen and fecal coliform. In addition, total phosphorus levels were in violation of the Commission's recommended standard of 0.1 mg/l.

Table 44

COMPARISON OF OBSERVED WATER QUALITY CONDITIONS TO ADOPTED 1976 STREAM WATER USE OBJECTIVES AND SUPPORTING WATER QUALITY STANDARDS FOR RESTRICTED RECREATIONAL USE AND MINIMUM STANDARDS IN THE BARNES CREEK WATERSHED

Sampling Station	Applicable[a] Objective	Adopted Standards[b]						Miles Violated	Miles Meeting All Standards
		Dissolved Oxygen (2.0 mg/l)	Fecal Coliform (2,000 MFFCC per 100 ml)	Temperature (89°F)	pH (6.0-9.0 standard units)	Ammonia-Nitrogen	Total Phosphorus		
Mh-3	1	X	X			N/A	N/A		
Total								1.4	0.0

NOTES: X indicates violation of water use objectives.
N/A indicates not applicable.

[a] *There are five categories of water use objectives:*

1) Restricted recreational use and minimum standards.

2) Marginal aquatic life, recreational use, and minimum standards.

3) Limited fishery and aquatic life, recreational use.

4) Warmwater fishery and aquatic life, recreational use.

5) Trout fishery and aquatic life, recreational use.

[b] *Includes phosphorus standard as interpreted by SEWRPC.*

Source: SEWRPC.

The sampling station operated by the Commission has provided information on water quality within Pike Creek, which totals 2.0 stream miles. A comparison of the 1964 data to the applicable 1976 DNR-adopted water quality standards indicates that Pike Creek violated the applicable water quality standards. In 1975, the same conditions were found to exist when identical 1976 standards were applied. Table 45 indicates the water use objectives and supporting standards violated during the period of 1964 through 1975.

Sucker Creek Subwatershed

Water Quality Conditions: 1964-1965: The Sucker Creek drainage area is located in the eastern portion of Ozaukee County. The 1964-1965 benchmark streamwater quality study of the Commission included the operation of one sampling station in the Sucker Creek drainage area as indicated on Map 40. The water quality data for 1964-1965 indicated chloride levels of 30 milligrams per liter (mg/l), higher than the normal background chloride concentration in groundwater, and reflective of chloride impacts upon the stream from cultural sources. Substandard concentrations of dissolved oxygen and high total coliform counts were found during the summer months at Sucker Creek and ranged from 0.3 to 10.0 mg/l, and 100 to 140,000 membrane filter coliform counts per 100 milliliters (MFCC/100 ml), respectively. The high specific conductance values found on Sucker Creek were associated with high calcium, bicarbonate, and sulfate concentrations, indicating the probable source was sediment erosion. Ranges of from 725 to 790 micromhos per centimeter (µmhos/cm) at 25°C were reported. Temperature and pH values (hydrogen ion concentrations) were within the designated limits of the standards adopted by the Wisconsin Department of Natural Resources (DNR).

Water Quality Conditions: 1965-1975: The 1965-1975 continuing water quality monitoring effort by the Commission included continued sampling at the single station on Sucker Creek. The observed dissolved oxygen concentrations ranged from 0.8 to 12.5 mg/l, indicating that water quality conditions improved in Sucker Creek over the period. Fecal coliform counts, however, increased and the chloride levels decreased slightly over the period. Ranges of from 140 to 4,300 membrane filter fecal coliform counts per 100 milliliters (MFFCC/100 ml) and from 33 to 92 mg/l of chloride were recorded during the sampling period. Specific conductance values ranged from 543 to 944 µmhos/cm at 25°C and showed a gradual decrease since 1964. Temperature, pH, and ammonia-nitrogen were within the adopted standards for all samples analyzed and ranged from 65 to 89°F, 7.3 to 8.4 standard units,and 0.03 to 0.18 mg/l, respectively. Concentrations of total phosphorus were generally in excess of the recommended level and ranged from 0.05 to 0.16 mg/l.

Compliance with Water Quality Standards: Although generally constant over the decade, the water quality of

Table 45

COMPARISON OF OBSERVED WATER QUALITY CONDITIONS TO ADOPTED 1976 STREAM WATER USE OBJECTIVES AND SUPPORTING WATER QUALITY STANDARDS FOR WARMWATER FISHERY AND RECREATIONAL USE IN THE PIKE CREEK SUBWATERSHED

Sampling Station	Applicable[a] Objective	Adopted Standards[b]: Dissolved Oxygen (5.0 mg/l)	Fecal Coliform (400 MFFCC per 100 ml)	Temperature (89°F)	pH (6.0-9.0 standard units)	Ammonia-Nitrogen (0.4 mg/l)	Total Phosphorus (0.1 mg/l)	Miles Violated	Miles Meeting All Standards
Mh-2	4	X	X			X	X		
Total								2.0	0.0

NOTE: X indicates violation of water use objectives.

[a] *There are five categories of water use objectives:*

1) *Restricted recreational use and minimum standards.*

2) *Marginal aquatic life, recreational use, and minimum standards.*

3) *Limited fishery and aquatic life, recreational use.*

4) *Warmwater fishery and aquatic life, recreational use.*

5) *Trout fishery and aquatic life, recreational use.*

[b] *Includes phosphorus standard as interpreted by SEWRPC.*

Source: SEWRPC.

Sucker Creek, which is intended for recreational use and for the maintenance of a warmwater fishery and other aquatic life, did not meet the water quality standards adopted by the DNR for dissolved oxygen, total phosphorus, and fecal coliform in 1975.

The sampling station operated by the Commission has provided information on the water quality of Sucker Creek, which has a stream length of 3.8 miles. A comparison of the 1964 data to the applicable 1976 DNR-adopted water quality standards indicates that Sucker Creek violated applicable water quality standards. In 1975 the same conditions were found to exist when identical standards were applied. Table 46 indicates the water use objectives and supporting standards violated during the period of 1964 through 1975.

General Water Quality Ratings

Table 47 sets forth the water quality index classifications for the three Commission-operated sampling stations in the watershed. As indicated by the index, the 1964 water quality ratings of Barnes, Pike, and Sucker Creeks were fair. Fair conditions also existed at all three stations in August of the years 1974 and 1975.

Toxic and Hazardous Substances: No known streamwater or bottom sediment sampling for toxic and hazardous materials in the form of heavy metals, polychlorinated biphenyls (PCB's), or pesticides has been conducted within the three subwatersheds, and, therefore, no conclusions may be drawn with regard to the presence of these substances.

OAK CREEK WATERSHED

Water Quality Conditions

The Oak Creek watershed is located in the east central portion of the Region. The main stem of Oak Creek rises and flows easterly and northerly within Milwaukee County for approximately 13 miles before emptying into Lake Michigan on the eastern border of the watershed. The geographic, physical, economic, and demographic features of the watershed are described in Volume One, Chapter III of this report.

Water Quality Conditions: 1964-1965: The 1964-1965 benchmark streamwater quality study of the Commission included the operation of two sampling stations on the Oak Creek main stream as indicated on Map 40. The water quality data for 1964-1965 from the two sampling stations indicated chloride levels were higher than background levels, reflecting a probable chloride impact upon the stream from winter salting operations, urban storm runoff, domestic onsite sewage disposal systems, sewer overflows, and animal feeding operations. The chloride concentrations during the 1964-1965 sampling period ranged from 30 to 135 milligrams per liter (mg/l). High concentrations of dissolved oxygen were noted at both stations, with levels ranging from 6.4 to 13.7 mg/l during the entire 14-month sampling period from January 1964 through February 1965. During this sampling period, total coliform bacteria counts ranged from 500 to 33,000 membrane filter coliform counts per 100 milliliters (MFCC/100 ml), with the higher values being recorded at station Ok-2. These levels indicate the presence of fecal

Table 46

COMPARISON OF OBSERVED WATER QUALITY CONDITIONS TO ADOPTED 1976 STREAM WATER USE OBJECTIVES AND SUPPORTING WATER QUALITY STANDARDS FOR WARMWATER FISHERY AND RECREATIONAL USE IN THE SUCKER CREEK SUBWATERSHED

Sampling Station	Applicable[a] Objective	Adopted Standards[b]						Miles Violated	Miles Meeting All Standards
		Dissolved Oxygen (5.0 mg/l)	Fecal Coliform (400 MFFCC per 100 ml)	Temperature (89°F)	pH (6.0-9.0 standard units)	Ammonia-Nitrogen (0.4 mg/l)	Total Phosphorus (0.1 mg/l)		
Mh-1	4	X	X				X		
Total								3.8	0.0

NOTE: X indicates violation of water use objectives.

[a] *There are five categories of water use objectives:*

1) Restricted recreational use and minimum standards.

2) Marginal aquatic life, recreational use, and minimum standards.

3) Limited fishery and aquatic life, recreational use.

4) Warmwater fishery and aquatic life, recreational use.

5) Trout fishery and aquatic life, recreational use.

[b] *Includes phosphorus standard as interpreted by SEWRPC.*

Source: SEWRPC.

coliform bacteria contamination in Oak Creek from several possible sources, including malfunctioning onsite sewage disposal systems and runoff from animal feeding operations within the watershed. The specific conductance values were found to be moderately high in August 1964 at both sampling stations. Ranges throughout the sampling period varied from 375 to 755 micromhos per centimeter (µmhos/cm) at 25°C. The pH values (hydrogen ion concentrations) and temperature were within the standards established by the Wisconsin Department of Natural Resources (DNR).

Table 47

WATER QUALITY INDEX CLASSIFICATIONS FOR THE SAMPLING STATIONS OF THE MINOR STREAMS TRIBUTARY TO THE LAKE MICHIGAN WATERSHED 1964 AND 1974-75

Main Stem Stations	July, August, September, and October of 1964	August of the Years 1974-1975
Mh-1 (Sucker Creek) . .	Fair	Fair
Mh-2 (Pike Creek). . . .	Fair	Fair
Mh-3 (Barnes Creek) . .	Fair	Fair
Watershed Average.	Fair	Fair

Source: SEWRPC.

Water Quality Conditions: 1965-1975: The 1965-1975 water quality monitoring effort by the Commission included continued sampling at the two stations established in the watershed. In addition, data were collected from four Milwaukee-Metropolitan Sewerage District sampling stations as shown on Map 40. The Commission water quality data for 1965-1975 indicated that chloride concentrations, which ranged from 27 mg/l to 221 mg/l, were higher during the spring snowmelt and runoff months as compared to other sampling periods throughout the year. Dissolved oxygen levels fluctuated from 1.5 to 13.1 mg/l at station Ok-1, with intermediate ranges monitored at station Ok-2. Lower dissolved oxygen levels were observed in 1975 than in any of the prior sampling years, indicating that the water quality conditions had declined during the sampling period. Review of the fecal coliform data indicates a general decline in water quality at sampling station Ok-2 and a general improvement at sampling station Ok-1 between 1967 and 1975. This may be attributable to higher sewage flows and associated sanitary sewage bypassing at the downstream station Ok-2, and to declining livestock numbers within the watershed over the sampling years at the upstream sampling station, Ok-1. The elimination of sanitary sewage flow relief devices may, however, be reflected in lower fecal coliform counts observed in 1975 compared to those of 1974 at station Ok-2. Fecal coliform bacteria counts ranged from 130 to 1,800 membrane filter fecal coliform counts per 100 milliliters (MFFCC/100 ml) during the period of sampling. Specific conductance values ranged from 609 to 1,720 µmhos/cm at 25°C during the 1965-1975 monitoring period. Both stations indicated decreasing dissolved solids in the sampling period after the 1964-1965 benchmark survey. Ammonia-nitrogen (NH_3-N), which is toxic to fish and other aquatic life, exceeded the recommended 0.4 mg/l maximum concentration at sampling station Ok-1 on two occasions during the 1972-1975 period in which ammonia-nitrogen was sampled. The concentrations ranged from 0.03 to 0.44 mg/l. The total phosphorus concentrations ranged from 0.02 to 0.23 mg/l of which approximately 50 percent exceeded the recommended standard.

The diurnal water quality data for Oak Creek show a broad range of dissolved oxygen concentrations, from 4.2 to 13.1 mg/l over a 24-hour period, reflecting the dissolved oxygen reductions due to respiration by the aquatic plants and decomposition of organic matter in the stream, and the dissolved oxygen supersaturation effects of algal photosynthesis. In addition to exhibiting marked diurnal fluctuations, water quality in the Oak Creek watershed exhibited spatial variation. The water quality was generally of a higher quality at the downstream sampling station, Ok-2, than at the upstream station, Ok-1, as measured by fecal coliform, dissolved oxygen, chloride, and specific conductance.

Compliance with Water Quality Standards

In general, water quality conditions in the Oak Creek watershed have deteriorated slightly since 1964, as indicated by the decline in the average dissolved oxygen concentrations from 13.4 mg/l in 1964 to 3.9 mg/l in 1975 at sampling station Ok-1, and from 10.3 mg/l in 1964 to 6.1 mg/l in 1975 at sampling station Ok-2. When comparing the 1975 water quality data to the applicable 1976 DNR-adopted standards, dissolved oxygen concentrations and fecal coliform counts were found not to meet the minimum standards for recreational use and the maintenance of a warmwater fishery and other aquatic life. The level of total phosphorus was higher than the recommended level adopted by the Commission, and the levels of ammonia-nitrogen exceeded the established maximum standard of 0.4 mg/l in streams on two occasions at station Ok-1.

The two sampling stations operated by the Commission have provided information on water quality in the larger, continuously flowing stream reaches which total 10 miles of the Oak Creek main stem. A comparison of the 1964 data to the applicable 1976 DNR-adopted water quality standards indicates that all of the applicable standards were satisfied on the stream reaches sampled. In 1975, by comparison, all 10 miles sampled were in violation of the identical standards, indicating lower water quality in 1975 as compared to 1964. Table 48 indicates the water use objectives and supporting standards violated during the period of 1964 through 1975.

Table 48

COMPARISON OF OBSERVED WATER QUALITY CONDITIONS TO ADOPTED 1976 STREAM WATER USE OBJECTIVES AND SUPPORTING WATER QUALITY STANDARDS FOR WARMWATER FISHERY AND RECREATIONAL USE IN THE OAK CREEK WATERSHED

Sampling Stations	Applicable[a] Objective	Adopted Standards[b]						Miles Violated	Miles Meeting All Standards
		Dissolved Oxygen (5.0 mg/l)	Fecal Coliform (400 MFFCC per 100 ml)	Temperature (89°F)	pH (6.0-9.0 standard units)	Ammonia-Nitrogen (0.4 mg/l)	Total Phosphorus (0.1 mg/l)		
Ok-1	4	X	X			X	X		
Ok-2	4	X	X				X		
Total								10.6	0.0

NOTE: X indicates violation of water use objectives.

[a] *There are five categories of water use objectives:*

1) Restricted recreational use and minimum standards.

2) Marginal aquatic life, recreational use, and minimum standards.

3) Limited fishery and aquatic life, recreational use.

4) Warmwater fishery and aquatic life, recreational use.

5) Trout fishery and aquatic life, recreational use.

[b] *Includes phosphorus standard as interpreted by SEWRPC.*

Source: SEWRPC.

General Water Quality Ratings

Table 49 sets forth the water quality index classifications for the two Commission-operated sampling stations in the watershed. As indicated by the index, the 1964 water quality of Oak Creek was good. Fair conditions existed at both stations in August of the years 1974 and 1975.

Toxic and Hazardous Substances: Sampling and analysis for pesticides, polychlorinated biphenyls (PCB's), and heavy metals were conducted by the Wisconsin Department of Natural Resources in the Oak Creek watershed from 1975 through 1976. In the in-stream water quality samples for which toxic and hazardous substances were tested, recommended levels of mercury were exceeded in two out of a total of 48 samples collected and recommended levels of PCB's were exceeded in one out of 10 samples collected. Sample analyses for cadmium, chromium, copper, lead, nickel, zinc, DDT, DDE, DDD, aldrin, heptachlor, heptachlor epoxide, lindane, dieldrin methoxychlor, and phthalate uncovered no violations of U. S. Environmental Protection Agency (EPA) recommended levels. Sampling and analysis of bottom sediment was conducted for Oak Creek, and detectable levels of cadmium, chromium, copper, lead, mercury, nickel, zinc, and PCB's were observed; however, no criteria have been established to assess the recorded concentrations.

PIKE RIVER WATERSHED

Water Quality Conditions

The Pike River watershed is located in the southeast portion of the Region, rising in Racine County and flowing 16.6 miles south and east to enter Lake Michigan in the City of Kenosha in Kenosha County. The geographic, physical, economic, and demographic features of the watershed are described in Volume One, Chapter III of this report.

Water Quality Conditions: 1964-1965: The 1964-1965 benchmark streamwater quality study included the operation of four sampling stations in the Pike River watershed—two on the Pike River and two on Pike Creek—as indicated on Map 40. The water quality data for 1964-1965 from the two sampling stations on the Pike River showed that chloride levels were higher than the normal background concentration, reflecting an impact from human sources. Chloride concentrations ranged from 35 to 90 milligrams per liter (mg/l). The two sampling stations situated on Pike Creek also exhibited chloride concentrations higher than the background levels with ranges of from 35 to 90 mg/l over the 14-month sampling period. These higher chloride concentrations are attributed to the effluent from the Town of Somers Sanitary District No. 2 and from the American Motors Corporation waste treatment facility. Dissolved oxygen levels at Pk-2 and Pk-3 on Pike Creek varied from 0.4 to 13.2 mg/l. High total coliform counts were found at all four sampling locations and ranged from 1,200 to 1,800,000 membrane filter coliform counts per 100 milliliters (MFCC/100 ml). The specific conductance values were high at all four locations, ranging from 380 to 905 micro-mhos per centimeter (µmhos/cm) at 25°C, with the highest values recorded at the Pike River sampling stations during the winter months. The pH values (hydrogen ion concentrations) were within the normal range of 6.0 to 9.0 standard units and the temperature did not exceed the prescribed standard of 89°F in any of the samples.

Water Quality Conditions: 1965-1975: The water quality monitoring survey carried out by the Commission from 1965 through 1975 included continued sampling at the four stations in the Pike River watershed. The chloride and fecal coliform levels showed a decrease over the period at all four locations, with the exception of the samples collected in 1968, 1969, and 1972, which were preceded by rain according to precipitation records of the Racine Department of Air Pollution Control. Chloride concentrations ranged from 16.0 to 90.0 mg/l and fecal coliform counts ranged from 10 to 12,000 membrane filter fecal coliform counts per 100 milliliters (MFFCC/100 ml). The dissolved oxygen content of the samples collected at the Pike River stations indicated that the water quality improved slightly over the decade, probably reflecting improved operation and maintenance at the Village of Sturtevant sewage treatment facilities. The applicable dissolved oxygen standard, however, was still not met. Concentrations at the four stations within the watershed ranged from 1.5 to 16.1 mg/l. In Pike Creek, near its confluence with Pike River, the dissolved oxygen concentrations remained fairly stable. However, significant fluctuations in the recorded values of dissolved oxygen concentrations were observed near the source of Pike Creek. The observed variation in the water quality at Pike Creek as measured by the dissolved oxygen is attributable to the variation in the flow of Pike Creek which is dependent on precipitation and flow from the industrial and municipal treatment facilities located in

Table 49

WATER QUALITY INDEX CLASSIFICATIONS FOR THE SAMPLING STATIONS OF THE OAK CREEK WATERSHED !964 AND 1974-75

Main Stem Stations	July, August, September, and October of 1964	August of the Years 1974-1975
Ok-1	Good	Fair
Ok-2	Good	Fair
Watershed Average	Good	Fair

Source: SEWRPC.

the subwatershed. Specific conductance concentrations exhibited higher values in the 1965-1975 sampling period than in the 1964-1965 sampling period with ranges of from 313 to 1,455 μmhos/cm at 25°C. These increases were due in part to increased rainfall amounts recorded during the period of sampling. The pH values (hydrogen ion concentrations) met the applicable standards, and ranged from 7.5 to 9.0 standard units, and temperature readings fluctuated with seasonal air temperatures. Ammonia-nitrogen (NH_3-N) levels varied throughout the watershed and ranged from 0.03 to 1.49 mg/l; however, values in excess of 0.4 mg/l occurred only at Pk-1 on the main stem of the Pike River. Total phosphorus concentrations were in excess of the recommended level of 0.10 mg/l on the Pike River in all the samples collected—samples were collected between 1972 and 1975—with two exceptions: the samples collected at station Pk-4 in August of 1974 and August of 1975. The concentrations ranged from 0.05 to 0.8 mg/l.

The diurnal water quality data in the Pike River and Pike Creek indicated a broad range of dissolved oxygen concentrations, from 1.5 to 14.5 mg/l over a 24-hour period, reflecting the effects of photosynthesis and respiration by aquatic plants. In addition to exhibiting marked diurnal fluctuations, Pike River water quality is characterized by spatial variations. The water quality improved slightly from the headwaters areas of the Pike River to downstream near the mouth of the river at Lake Michigan as measured by the decrease in fecal coliform, total nitrogen, and total phosphorus and the increase in the dissolved oxygen concentration. Similarly, the water quality improved in the downstream portions of Pike Creek (Pk-3) when compared to the upstream location (Pk-2).

Compliance with Water Quality Standards

The water quality of the Pike River in Kenosha County is designated for recreational use and for the maintenance of a warmwater fishery and other aquatic life. Although the quality was fairly constant between 1965 and 1975, it did not meet the water quality standards adopted by the Wisconsin Department of Natural Resources (DNR) for dissolved oxygen, fecal coliform, and ammonia-nitrogen. Total phosphorus concentrations were also found to be higher than the recommended level adopted by the Commission except for the level recorded at sampling station Pk-4, which was 0.05 mg/l. With respect to the Pike River in Racine County, which is designated for restricted use and minimum standards, no water quality data are available for comparison to the established standards. With regard to station Pk-2 on Pike Creek upstream from the confluence with the Somers Branch tributary and designated for restricted use and minimum standards, the water quality levels measured in 1975 did meet the adopted standards for pH, temperature, dissolved oxygen, and fecal coliform. Station Pk-3 on that portion of Pike Creek designated for a limited fishery and aquatic life was also in compliance with the adopted stream standards.

The four sampling stations operated by the Commission have provided information on water quality in the larger, continuously flowing streams which total 12.6 miles tributary to and inclusive of the Pike River. A comparison of the 1964 data to the applicable 1976 DNR-adopted water quality standards indicates that violations of the standards for one or more parameters occurred on 6.6 miles, or 52 percent, of the stream reaches sampled. In 1975, the same conditions were found to exist when identical standards were applied. Tables 50 and 51 indicate the water use objectives and supporting standards violated during the period of 1964 through 1975.

General Water Quality Ratings

Table 52 sets forth the water quality index classifications for the four Commission-operated sampling stations in the watershed. As indicated by the index, the 1964 water quality of the Pike River watershed was generally poor, with station Pk-4 recording fair water quality. In August of the years 1974 and 1975 all four sampling stations in the Pike watershed exhibited fair conditions.

Toxic and Hazardous Substances: Sampling and analysis for pesticides, polychlorinated biphenyls (PCB's), and heavy metals were conducted by the Wisconsin Department of Natural Resources in the Pike River watershed in 1973. In the in-stream water quality samples for which toxic and hazardous substances were tested, recommended levels of mercury were exceeded in one of five samples analyzed. For the persistent pesticides of DDT, heptachlor epoxide, lindane, and dieldrin, recommended criteria were exceeded in one of nine, two of nine, one and three of eight samples collected, respectively. Sample analyses for cadmium, chromium, copper, lead, nickel, zinc, PCB's, DDE, DDD, aldrin, heptachlor, methoxychlor, and phthalate uncovered no violations of U. S. Environmental Protection Agency (EPA) recommended levels. No stream bottom sediment analyses were conducted for any of the toxic and hazardous substances.

ROCK RIVER WATERSHED

Water Quality Conditions

The Rock River watershed is located in the westerly portion of the Region and is only partially contained in the Region, with the Rock River main stem itself arising and flowing outside of the Region. Seventeen tributaries of the Rock River originate in the Region. The geographic, physical, economic, and demographic features of the watershed are described in Volume One, Chapter III of this report.

Water Quality Conditions: 1964-1965: The 1964-1965 benchmark stream water quality study of the Commission included the operation of 13 sampling stations in the watershed within the Region, eight on the Upper Rock and five on the lower Rock River watershed, as indicated on Map 40. The water quality data for 1964-1965 from the 13 sampling stations on the Rock River tributaries indicated that the chloride levels were generally higher than the normal background concentration, reflecting an impact upon the stream from human sources. The exceptions were the sampling stations on the Ashippun River and the Bark River, at which the chloride concentrations were found to be less than 10 milligrams

Table 50

COMPARISON OF OBSERVED WATER QUALITY CONDITIONS TO ADOPTED 1976 STREAM WATER USE OBJECTIVES AND SUPPORTING WATER QUALITY STANDARDS FOR WARMWATER FISHERY AND RECREATIONAL USE AND FOR LIMITED FISHERY AND RECREATIONAL USE IN THE PIKE RIVER WATERSHED

Sampling Stations	Applicable[a] Objective	Adopted Standards[b]						Miles Violated	Miles Meeting All Standards
		Dissolved Oxygen (5.0 mg/l)	Fecal Coliform (400 MFFCC per 100 ml)	Temperature (89°F)	pH (6.0-9.0 standard units)	Ammonia-Nitrogen (0.4 mg/l)	Total Phosphorus (0.1 mg/l)		
Pk-1	4	X	X		X	X	X		
Pk-3	3	X (3.0 mg/l)[c]	X			X (3.5 mg/l)[c]	X		
Pk-4	4	X	X				X		
Total								7.4	0.0

NOTE: X indicates violation of water use objectives.

[a] *There are five categories of water use objectives:*

1) *Restricted recreational use and minimum standards.*

2) *Marginal aquatic life, recreational use, and minimum standards.*

3) *Limited fishery and aquatic life, recreational use.*

4) *Warmwater fishery and aquatic life, recreational use.*

5) *Trout fishery and aquatic life, recreational use.*

[b] *Includes phosphorus standard as interpreted by SEWRPC.*

[c] *Indicates applicable standard for designated water use objective other than warmwater fishery and recreational use.*

Source: SEWRPC.

per liter (mg/l). The concentrations ranged from 0.0 to 850 mg/l. The high chloride concentrations at certain rural locations may be attributed to malfunctioning septic systems and animal feedlot runoff. In more urbanized areas, chloride concentrations may be attributed to sewage treatment plant effluent, urban runoff, and loadings during snowmelt and spring runoff periods.

Substandard concentrations of dissolved oxygen were detected at stations Rk-4 and Rk-8 on the Rubicon River and Oconomowoc River, respectively. In addition, extremely low values, below 2.0 mg/l, were consistently recorded at the Jackson Creek site, Rk-11, as a result of the City of Elkhorn sewage treatment plant. Ranges of dissolved oxygen concentrations at the 13 sites within the watershed during the 1964-1965 sampling period varied from 0.0 to 17.1 mg/l.

During the sampling period, total coliform counts were found to vary from less than 100 to 2,300,000 membrane filter coliform counts per 100 milliliters (MFCC/100 ml). The higher levels of total coliform were detected at those sampling sites with sewage treatment plants upstream. Specific conductance values ranged from 376 to 3,390 micro-mhos per centimeters (μmhos/cm) at 25°C, with the highest values being found in the Rubicon River, sites Rk-3 and Rk-4, and the lowest values being recorded at the three Oconomowoc River sites. At no location within the watershed was the pH value (hydrogen ion concentration) found to be outside the range of 6.0 to 9.0 standard units prescribed for recreational use and the maintenance of a warmwater fishery and aquatic life—the water use objectives prescribed for all the streams in the watershed for which data were available with the exception of site Rk-11 on Jackson Creek, which is classified for marginal aquatic life and recreational use.

During the 1964-1965 sampling period temperatures ranged from 32° to 48°F between December and May and from 36° to 80°F between May and November. The temperature variations, threfore, can be attributed to diurnal or seasonal changes.

Water Quality Conditions: 1965-1975: The 1965-1975 water quality monitoring effort by the Commission included continued sampling at the 13 stations in the watershed.

Table 51

COMPARISON OF OBSERVED WATER QUALITY CONDITIONS TO ADOPTED 1976 STREAM WATER USE OBJECTIVES AND SUPPORTING WATER QUALITY STANDARDS FOR RESTRICTED RECREATIONAL USE AND MINIMUM STANDARDS IN THE PIKE RIVER WATERSHED

Sampling Station	Applicable[a] Objective	Adopted Standards[b]						Miles Violated	Miles Meeting All Standards
		Dissolved Oxygen (2.0 mg/l)	Fecal Coliform (2,000 MFFCC per 100 ml)	Temperature (89°F)	pH (6.0-9.0 standard units)	Ammonia-Nitrogen	Total Phosphorus		
Pk-2	1	X	X			N/A	N/A		
Total								5.2	0.0

NOTES: X indicates violation of water use objectives.
N/A indicates not applicable.

[a] *There are five categories of water use objectives:*

1) *Restricted recreational use and minimum standards.*
2) *Marginal aquatic life, recreational use, and minimum standards.*
3) *Limited fishery and aquatic life, recreational use.*
4) *Warmwater fishery and aquatic life, recreational use.*
5) *Trout fishery and aquatic life, recreational use.*

[b] *Includes phosphorus standard as interpreted by SEWRPC.*

Source: SEWRPC.

The chloride concentration data indicated essentially stable conditions over the decade at all the sampling stations with the exception of Rk-4 on the Rubicon River, where a significant decrease in chloride levels was observed. The concentrations ranged from 3.0 to 897 mg/l over the 10-year sampling period.

The observed dissolved oxygen levels indicate that the water quality remained essentially stable at all sampling station locations with the exception of stations Rk-1 on the East Branch of the Rock River, Rk-4 on the Rubicon River, and Rk-8 on the Oconomowoc River. A slight decrease in the dissolved oxygen content over the decade was observed at stations Rk-1 and Rk-8. The dissolved oxygen content showed an increase over the decade at sampling station Rk-4 on the Rubicon River. Ranges of dissolved oxygen varied from 0.3 to 25.1 mg/l during the 1965 to 1975 sampling period.

Fecal coliform bacteria counts were found to be in excess of 2,000 membrane filter fecal coliform counts per 100 milliliters (MFFCC/100 ml) at stations Rk-1, Rk-4, Rk-8, Rk-10, Rk-11, and Rk-13. The range of fecal coliform at the 13 sampling stations varied from less than 10 to 60,000 MFFCC/100 ml. Excessive counts of fecal coliform bacteria may be attributed to effluent discharges from the City of Hartford, City of Oconomowoc, City of Whitewater, City of Elkhorn, and City of Delavan sewage treatment plants located just upstream from sampling stations Rk-4, Rk-8, Rk-10, Rk-11, and Rk-13, respectively. Fecal coliform loadings elsewhere in the watershed may be attributed to malfunctioning septic tanks and animal waste runoff.

Table 52

WATER QUALITY INDEX CLASSIFICATIONS FOR THE SAMPLING STATIONS OF THE PIKE RIVER WATERSHED 1964 AND 1974-75

Main Stem Stations	July, August, September, and October of 1964	August of the Years 1974-1975
Pk-1	Poor	Fair
Pk-4	Fair	Fair
Tributary Stations		
Pk-2	Poor	Fair
Pk-3	Poor	Fair
Watershed Average	Poor	Fair

Source: SEWRPC.

The fecal coliform counts remained essentially unchanged between 1967 and 1975 at sampling stations Rk-1 on the East Branch of the Rock River, Rk-3 on the Rubicon River, Rk-7 on the Oconomowoc River, Rk-9 on the Bark River, and Rk-12 on the Delavan Lake Outlet. However, the fecal coliform counts decreased at sampling stations Rk-5 on the Ashippun River, Rk-6 on the

Oconomowoc River, and Rk-10 on Whitewater Creek. At the other five locations, no trends in fecal coliform counts were observed.

Specific conductance values ranged from 210 to 3,000 μmhos/cm at 25°C at the 13 stations during the period of sampling. Concentrations were lowest at station Rk-7 on the Oconomowoc River and highest at station Rk-4 on the Rubicon River. Temperature was within normal ranges, and pH values exceeded the adopted maximum standard of 9.0 standard units at stations Rk-8 and Rk-11 on one occasion each during the sampling period.

Ammonia-nitrogen (NH_3-N) levels exceeded the adopted standard of 0.4 mg/l for recreational use and the maintenance of a warmwater fishery and other aquatic life at stations Rk-4, Rk-8, Rk-9, and Rk-12.

Total phosphorus was in excess of the recommended level of 0.10 mg/l in all of the samples collected at all of the sampling stations—samples were collected between 1967 and 1975—with the exception of samples from sampling station Rk-7 on the Oconomowoc River downstream from Oconomowoc Lake and Rk-11 on Jackson Creek just upstream from Delavan Lake. The range of total phosphorus concentrations varied from 0.1 to 9.36 mg/l.

The diurnal water quality data for the Rock River tributaries show a broach range of dissolved oxygen concentrations, from 0.8 to 15.8 mg/l over a 24-hour period, reflecting the dissolved oxygen reductions due to respiration by aquatic plants and decomposition of organic matter in the stream, and the production of dissolved oxygen by algal photosynthesis. In addition to exhibiting marked diurnal fluctuations, water quality in the Rubicon and Oconomowoc Rivers and in Jackson Creek, the Delavan Lake outlet, and Turtle Creek showed spatial variation. The water quality of the Rubicon River generally declined from sampling station Rk-3 to sampling station Rk-4, located downstream from the City of Hartford sewage treatment plant.

Significant decreases in the fecal coliform, chloride, specific conductance, total nitrogen, and total phosphorus concentrations at sampling station Rk-12 on the Delavan Lake outlet were observed when compared with the water quality of Jackson Creek at sampling station Rk-11. The better water quality at sampling station Rk-12 can probably be attributed to the effects of Lake Delavan.

When the water quality at sampling station Rk-12 on the Delavan Lake outlet and that at sampling station Rk-13 on Turtle Creek were compared, no definite change was observed. The chloride concentrations in 75 percent of the samples collected at station Rk-13 were the same as those in 75 percent of the samples collected at station Rk-12. There were slight increases observed in specific conductance values, total phosphorus concentrations, and total nitrogen concentrations and a very significant increase in the fecal coliform counts at station Rk-13 when compared to the fecal coliform counts obtained at station Rk-12. A general increasing trend in the water quality as measured by a decrease in the fecal coliform counts, chloride concentrations, specific conductance values, total nitrogen concentrations, and total phosphorus concentrations and an increase in the dissolved oxygen concentrations was observed from sampling station Rk-6 to sampling station Rk-7 on the Oconomowoc River. Water quality conditions showed a declining trend from station Rk-7 to station Rk-8 as measured by a decrease in dissolved oxygen concentrations and increases in chloride concentrations, specific conductance values, total nitrogen concentrations, total phosphorus concentrations, and fecal coliform counts. This trend is due to the discharge of effluent from the City of Oconomowoc sewage treatment plant upstream from sampling station Rk-8.

Compliance with Water Quality Standards

Although remaining generally stable over the decade, the water quality of the major Rock River tributaries within the Region for which data are available and which are designated for recreational use and for the maintenance of a warmwater fishery and aquatic life did not meet the water quality standards adopted by the Wisconsin Department of Natural Resources (DNR) for dissolved oxygen, fecal coliform, and ammonia-nitrogen in 1975. Also, part of Jackson Creek, which is designated for marginal aquatic life, recreational use, and minimum standards, failed to meet the DNR standards for dissolved oxygen, fecal coliform counts, and ammonia-nitrogen in 1975. In addition, at many locations total phosphorus concentrations were found to be significantly higher than the recommended level adopted by the Commission. When considering all of the major streams within the Rock River watershed which have been designated for water use objectives other than that for a warmwater fishery and aquatic life and recreational use, three are designated for recreational use and for the maintenance of a limited fishery, three are designated for recreational use and for the maintenance of a trout fishery and other aquatic life, and two are designated for marginal aquatic life, recreational use, and minimum standards. No Commission water quality data are available for any of these streams to assess existing water quality conditions and compliance with the adopted standards and recommended limits with the exception of that portion of Jackson Creek which is just above the Delavan Lake inlet.

Water use objectives have also been recommended for the 38 major lakes—lakes of 50 acres or more—in the Rock River watershed. Lakes Loraine and La Grange in Walworth County and School Section Lake in Waukesha County have been recommended by the Commission for recreational use and the maintenance of a limited fishery and aquatic life. The remaining 35 major lakes have been recommended by the Commission for recreational use and the maintenance of a warmwater fishery and aquatic life. Table 53 presents an assessment of the lake water quality standards as applied to the 38 major

Table 53

COMPARISON OF WATER QUALITY CONDITIONS TO INITIAL RECOMMENDED LAKE WATER USE OBJECTIVES AND SUPPORTING WATER QUALITY STANDARDS IN THE ROCK RIVER WATERSHED

Lake Name	Applicable Objective[a]	Availability of Data	Temperature (°F) Within Total Depth of Lake During Entire Year			pH (standard units) Within Total Depth of Lake During Entire Year			Dissolved Oxygen[c] (mg/l) In Epilimnion During Late July, August, or September			Fecal Coliform (MFFCC/100 ml) Within Total Depth of Lake During Entire Year			Ammonia-Nitrogen (mg/l) Within Total Depth of Lake During Mixing (Spring and Fall)			Inorganic Nitrogen—Sum of Nitrite-Nitrogen + Nitrate-Nitrogen + Ammonia-Nitrogen (mg/l) Within Total Depth of Lake During Mixing (Spring and Fall)			Inorganic Phosphorus (mg/l) Within Total Depth of Lake During Mixing (Spring and Fall)			Total Phosphorus (mg/l) Within Total Depth of Lake During Mixing (Spring and Fall)		
			1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
			89°	89°	b	6-9	6-9	6-9	3.0	5.0	6.0	400	400	400	3.5	0.4	0.4	0.9	0.3	0.15	0.03	0.01	0.005	0.06	0.02	0.01
Ashippun	2	1975-1976		Yes			Yes			Yes			Yes			Yes			Yes			Yes			April 15, 1977	
Bark	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Beaver	2	1973-1975		Yes			Yes			Yes			Yes			Yes			April 2, 1974 April 23, 1975 November 5, 1975 November 20, 1974 November 21, 1973			April 2, 1974 April 23, 1975			November 21, 1973 November 20, 1974 November 5, 1975 April 12, 1974 April 23, 1975	
Comus	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Cravath	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Crooked	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Delavan	2	1970-1975		Yes			Yes			Yes			Yes			November 11, 1970 November 3, 1971 April 26, 1972 November 21, 1972			May 10, 1973			November 11, 1970 September 1, 1971 November 3, 1971 April 26, 1972 November 21, 1972			November 11, 1970 September 1, 1971 November 3, 1971 April 26, 1972 November 21, 1972	
Druid	2	1973-1975		Yes			Yes			Yes			Yes			Yes			November 15, 1973 November 18, 1974 April 9, 1974			November 15, 1973 April 9, 1974 November 18, 1974 March 28, 1975 April 24, 1975			November 15, 1973 April 9, 1974 November 18, 1974 March 28, 1975 April 24, 1975	
Five	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Fowler	2	1973-1975		Yes			Yes			Yes			Yes			Yes			April 3, 1974			September 18, 1973 November 21, 1973 April 3, 1974 November 19, 1974 April 22, 1975 November 26, 1975			November 21, 1973 April 3, 1974 November 19, 1974 April 22, 1975 November 26, 1975	
Friess	2	1976-1977		Yes			Yes			Yes			Yes			October 20, 1976			October 20, 1976 August 11, 1976 April 13, 1977 April 27, 1977			September 22, 1976 October 20, 1976 April 13, 1977 April 27, 1977			September 22, 1976 October 20, 1976 April 13, 1977 April 27, 1977	
Golden	2	1973-1975		Yes			Yes			Yes			Yes			April 1, 1974 November 19, 1973			April 1, 1974 November 19, 1973 November 18, 1974			November 19, 1973 November 18, 1974 April 1, 1974			November 19, 1973 November 18, 1974 November 4, 1975 April 1, 1974 April 21, 1975	
Hunters	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Keesus	2	1973-1975		Yes			Yes			Yes			Yes			Yes			April 5, 1974 April 24, 1975 November 21, 1973 November 20, 1974			April 5, 1974 April 24, 1975 November 21, 1973 November 20, 1974			April 5, 1974 April 24, 1975 November 21, 1973 November 20, 1974	
LaGrange	1	N/A	N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A		
Lac La Belle	2	1976-1977		Yes			Yes			Yes			Yes			Yes			April 14, 1977 April 29, 1977			April 14, 1977 April 29, 1977 September 23, 1976 October 23, 1976			April 14, 1977 April 29, 1977 September 23, 1976 October 22, 1976	
Loraine	1	N/A	N/A			N/A			N/A			N/A			N/A			N/A			N/A				N/A	
Lower Genesee	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Lower Nashotah	2	1973-1975		Yes			Yes			Yes			Yes			April 1, 1974 November 19, 1973			April 1, 1974 November 19, 1973			April 1, 1974 November 19, 1973 November 18, 1974			April 1, 1974 November 19, 1973 November 18, 1974 November 4, 1975	

Table 53 (continued)

Lake Name	Applicable Objective[a]	Availability of Data	Temperature (°F)			pH (standard units)			Dissolved Oxygen[c] (mg/l)			Fecal Coliform (MFFCC/100 ml)			Ammonia-Nitrogen (mg/l)			Inorganic Nitrogen—Sum of Nitrite-Nitrogen + Nitrate-Nitrogen + Ammonia-Nitrogen (mg/l)			Inorganic Phosphorus (mg/l)			Total Phosphorus (mg/l)		
			Within Total Depth of Lake During Entire Year			Within Total Depth of Lake During Entire Year			In Epilimnion During Late July, August, or September			Within Total Depth of Lake During Entire Year			Within Total Depth of Lake During Mixing (Spring and Fall)			Within Total Depth of Lake During Mixing (Spring and Fall)			Within Total Depth of Lake During Mixing (Spring and Fall)			Within Total Depth of Lake During Mixing (Spring and Fall)		
			1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
			89°	89°	b	6-9	6-9	6-9	3.0	5.0	6.0	400	400	400	3.5	0.4	0.4	0.9	0.3	0.15	0.03	0.01	0.005	0.06	0.02	0.01
Lower Nemahbin	2	1973-1975		Yes			Yes			Yes			Yes			Yes			April 1, 1974 April 21, 1975 November 4, 1975 November 18, 1974 November 19, 1973			November 18, 1974 November 19, 1973 November 4, 1975 April 1, 1974 April 21, 1975			November 19, 1973 November 18, 1974 November 4, 1975 April 1, 1974 April 21, 1975	
Middle Genesee	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Moose	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Nagawicka	2	1973-1977		Yes			Yes			July 16, 1976			Yes			November 19, 1974			April 3, 1974 April 9, 1976 November 19, 1974 November 21, 1973			April 3, 1974 November 19, 1974 November 21, 1973 April 9, 1976			April 3, 1974 November 19, 1974 November 21, 1973 April 9, 1976	
North	2	1976-1977		Yes			Yes			Yes			Yes			September 9, 1976 September 22, 1976			April 13, 1977 April 26, 1977 September 22, 1976			October 20, 1976 November 16, 1976 April 13, 1977 April 26, 1977			October 20, 1976 November 16, 1976 April 13, 1977 April 26, 1977	
Oconomowoc	2	1976-1977		Yes			Yes			Yes			Yes			November 18, 1976 April 29, 1977			November 18, 1976 April 14, 1977 April 29, 1977			November 18, 1976 October 22, 1976 April 29, 1977			October 22, 1976 November 18, 1976	
Okauchee	2	1973-1977		Yes			Yes			Yes			Yes			April 5, 1976			April 5, 1976 April 24, 1975 April 3, 1974 November 19, 1974			April 23, 1975 April 3, 1974 April 5, 1976 November 26, 1973 November 19, 1974 July 16, 1976			April 3, 1974 April 23, 1975 April 5, 1976 November 26, 1973 November 19, 1974 July 16, 1976	
Pike	2	1976-1977		Ye			Yes			Yes			Yes			April 13, 1977			April 13, 1977 April 27, 1977 November 18, 1974			October 20, 1976 April 13, 1977 April 26, 1977			October 20, 1976 April 13, 1977 April 26, 1977	
Pine	2	1973-1975		Yes			Yes			Yes			Yes			Yes			Yes			April 3, 1974 April 23, 1975 November 20, 1974 November 21, 1973			April 3, 1974 April 23, 1975 November 21, 1973 November 20, 1974	
Pretty	2	September 3, 1974		Yes			N/A			Yes			N/A			N/A			N/A			N/A			N/A	
Rice	2	August 28, 1974		Yes			N/A			Yes			N/A			N/A			N/A			N/A			N/A	
School Section	1	N/A	N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A		
Silver	2	1973-1975		Yes			Yes			Yes			Yes			Yes			April 1, 1974 November 19, 1973 November 4, 1975			November 19, 1973 November 15, 1974 April 1, 1974			November 19, 1973 November 15, 1974 November 4, 1975 April 1, 1974	
Tripp	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Turtle	2	August 28, 1974		Yes			N/A			Yes			N/A			N/A			N/A			N/A			N/A	
Upper Nashotah	2	1973-1975		Yes			Yes			Yes			Yes			April 22, 1975			April 22, 1975 November 26, 1975 November 18, 1974			November 19, 1973 November 18, 1974 April 1, 1974 April 22, 1975			April 1, 1974 April 22, 1975 November 19, 1973 November 18, 1974 November 26, 1975	
Upper Nemahbin	2	1973-1975		Yes			Yes			Yes			Yes			Yes			April 1, 1974 April 21, 1974 November 26, 1975 November 18, 1974 November 19, 1973 September 17, 1973			April 1, 1974 April 21, 1975 November 26, 1975 November 18, 1974 November 19, 1973 September 17, 1973			April 1, 1974 April 21, 1975 November 19, 1973 November 18, 1974 November 26, 1975	
Waterville Pond	2	N/A		N/A			N/A			N/A			N/A			N/A			N/A			N/A			N/A	
Whitewater	2	1973-1975		Yes			Yes			Yes			Yes			April 4, 1974			April 4, 1974 April 30, 1975 November 26, 1975 November 28, 1973 September 18, 1973			April 4, 1974 April 30, 1975 November 28, 1973 November 12, 1974 November 26, 1975			April 4, 1974 April 30, 1975 November 28, 1973 November 12, 1974 November 26, 1975	

NOTE: N/A indicates data not available.

[a] *There are three categories of initial recommended water use objectives: 1) limited fishery and aquatic life, recreational use; 2) warmwater fishery and aquatic life, recreational use; and 3) trout fishery and aquatic life, recreational use.*

[b] *The maximum temperature rise at the edge of the mixing zone above the existing natural temperatures shall not exceed 3°F for lakes nor shall there be any significant artificial increases in temperature where natural trout reproduction is to be protected.*

[c] *The entire depth of shallow lakes (0 to 15 feet) shall be analyzed for dissolved oxygen. However, only the epilimnion of lakes greater than 15 feet shall be analyzed for dissolved oxygen.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

lakes. The data indicate that all 21 lakes for which complete water quality data are available violated the preliminary recommended levels of water quality for one or more parameters.

The 13 sampling stations operated by the Commission have provided information on water quality in the larger, continuously flowing streams which total 44.3 miles tributary to and inclusive of the Rock River. A comparison of the 1964 data to the applicable 1976 DNR-adopted water quality standards indicates that violations of the standards for one or more parameters occurred on 26 miles, or 59 percent, of the stream reaches sampled. In 1975, by comparison, 33.3 miles, or 75 percent of the stream reaches sampled, were in violation of the identical standards indicating substantial degradation of water quality between 1964 and 1975. Tables 54 and 55 indicate the water use objectives and supporting standards violated during the period of 1964 through 1975.

General Water Quality Ratings

Table 56 sets forth the water quality index classifications for the 13 Commission-operated sampling stations in the watershed. As indicated by the index, the 1964 water quality of the Upper Rock River watershed has degraded substantially since 1964, whereas the Middle Rock and Lower Rock subwatersheds have shown little change in water quality.

More specifically, the water quality of the Oconomowoc River improved from sampling station Rk-6 to sampling station Rk-7 located downstream from the three major

Table 54

COMPARISON OF OBSERVED WATER QUALITY CONDITIONS TO ADOPTED 1976 STREAM WATER USE OBJECTIVES AND SUPPORTING WATER QUALITY STANDARDS FOR WARMWATER FISHERY AND RECREATIONAL USE IN THE ROCK RIVER WATERSHED

Sampling Stations	Applicable[a] Objective	Adopted Standards[b]						Miles Violated	Miles Meeting All Standards
		Dissolved Oxygen (5.0 mg/l)	Fecal Coliform (400 MFFCC per 100 ml)	Temperature (89°F)	pH (6.0-9.0 standard units)	Ammonia-Nitrogen (0.4 mg/l)	Total Phosphorus (0.1 mg/l)		
Rk-1	4	X	X				X		
Rk-2	4	X	X				X		
Rk-3	4	X	X				X		
Rk-4	4	X	X				X		
Rk-5	4	X	X				X		
Rk-6	4		X				X		
Rk-7	4		X						
Rk-8	4	X	X			X	X		
Rk-9	4	X	X			X	X		
Rk-10	4	X	X			X	X		
Rk-12	4	X	X		X	X	X		
Rk-13	4	X	X			X	X		
Total								41.8	0.0

NOTE: X indicates violation of water use objectives.

[a] There are five categories of water use objectives:

1) Restricted recreational use and minimum standards.

2) Marginal aquatic life, recreational use, and minimum standards.

3) Limited fishery and aquatic life, recreational use.

4) Warmwater fishery and aquatic life, recreational use.

5) Trout fishery and aquatic life, recreational use.

[b] Includes phosphorus standard as interpreted by SEWRPC.

Source: SEWRPC.

Table 55

COMPARISON OF OBSERVED WATER QUALITY CONDITIONS TO ADOPTED 1976 STREAM WATER USE OBJECTIVES AND SUPPORTING WATER QUALITY STANDARDS FOR MARGINAL AQUATIC LIFE AND RECREATIONAL USE IN THE ROCK RIVER WATERSHED

Sampling Station	Applicable[a] Objective	Adopted Standards[b]						Miles Violated	Miles Meeting All Standards
		Dissolved Oxygen (3.0 mg/l)	Fecal Coliform (2,000 MFFCC per 100 ml)	Temperature (89°F)	pH (6.0-9.0 standard units)	Ammonia-Nitrogen (3.5 mg/l)	Total Phosphorus (0.1 mg/l)		
Rk-11	2	X	X		X	X	X		
Total								2.5	0.0

NOTE: X indicates violation of water use objectives.

[a] *There are five categories of water use objectives:*

1) *Restricted recreational use and minimum standards.*
2) *Marginal aquatic life, recreational use, and minimum standards.*
3) *Limited fishery and aquatic life, recreational use.*
4) *Warmwater fishery and aquatic life, recreational use.*
5) *Trout fishery and aquatic life, recreational use.*

[b] *Includes phosphorus standard as interpreted by SEWRPC.*

Source: SEWRPC.

lakes—North, Okauchee, and Oconomowoc Lakes. At sampling station Rk-8, located downstream from sampling stations Rk-6 and Rk-7 and the old City of Oconomowoc sewage treatment plant, the water quality declined as compared to that at sampling stations Rk-6 and Rk-7. The water quality of Jackson Creek improved as the water passed through Delavan Lake but deteriorated at sampling station Rk-13 on Turtle Creek, located downstream from the City of Delavan sewage treatment plant.

Of the 38 major lakes in the Rock River watershed, Okauchee Lake in Waukesha County is the deepest with a maximum depth of 94 feet. All major lakes showed 1.0 mg/l or less of dissolved oxygen in the lower layers (hypolimnion) indicating that anaerobic conditions probably occur during summer, with resulting adverse effects on the fish habitat of these lakes. The trophic status of 24 of the 38 major lakes has been evaluated on the basis dissolved oxygen levels in the hypolimnion, water clarity of the lake, history of fishkills, and use impairment caused by algae and weed abundance, and is rated accordingly in Table 57. Comus, Delavan, and Nagawicka Lakes are classified as "very eutrophic"; Lac La Belle and Lake Loraine are classified as "eutrophic"; Beaver, Druid, Fowler, Golden, Keesus, Lower Nemahbin, North Oconomowoc, Pine, Silver (in Waukesha County), Tripp, Turtle, Upper Nemahbin, and Whitewater Lakes are classified as "mesotrophic" lakes; and Pike, Friess, Middle Genesee, Okauchee, and Upper Nashotah Lakes are classified as "oligotrophic" lakes.[16]

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[16] *U. S. Environmental Protection Agency, Lake Classification—A Trophic Characterization of Wisconsin Lakes, EPA Report No. 660/3-75-033, June 1975. This report and others pertaining to trophic status of lakes generally recognize three classifications of trophic status. These classifications consider water clarity; chemical parameters; biological parameters, including algae and macrophyte growth; physical characteristics; recorded fishkills; or combinations of these. The three classifications are reflective of the natural or human-induced rates of aging or in-filling experienced by the lakes. "Eutrophic" lakes are generally shallower, enriched by nutrients and organic matter, and exhibit low water clarity, "Very eutrophic" or "dystrophic" are terms sometimes used for extreme cases of eutrophic lakes. "Mesotrophic" lakes may be of moderate depth, and exhibit less nutrient and organic enrichment, as well as higher levels of water clarity. "Oligotrophic" lakes are relatively deep, low in nutrient content and organic matter, and exhibit higher levels of water clarity.*

Table 56

WATER QUALITY INDEX CLASSIFICATIONS FOR THE SAMPLING STATIONS OF THE ROCK RIVER WATERSHED 1964 AND 1974-75

Upper Rock River Subwatershed Stations	July, August, September, and October of 1964	August of the Years 1974-1975
Rk-1	Excellent	Fair
Rk-2	Excellent	Fair
Rk-3	Excellent	Fair
Rk-4	Fair	Fair
Upper Rock Subwatershed Average.	Good	Fair
Middle Rock River Subwatershed Stations		
Rk-5	Good	Fair
Rk-6	Excellent	Fair
Rk-7	Good	Excellent
Rk-8	Fair	Fair
Rk-9	Good	Fair
Middle Rock Subwatershed Average.	Good	Good
Lower Rock River Subwatershed Stations		
Rk-10.	Fair	Fair
Rk-11.	Poor	Poor
Rk-12.	Good	Fair
Rk-13.	Fair	Fair
Lower Rock Subwatershed Average.	Fair	Fair

Source: SEWRPC.

Table 57

TROPHIC CLASSIFICATION OF SELECTED MAJOR LAKES IN THE ROCK RIVER WATERSHED: 1975

Major Lake Name	County	Category[a]
Beaver	Waukesha	Mesotrophic
Comus	Walworth	Very Eutrophic
Delavan	Walworth	Very Eutrophic
Druid	Washington	Mesotrophic
Five	Washington	Eutrophic
Friess	Washington	Oligotrophic
Golden	Waukesha	Mesotrophic
Keesus	Waukesha	Mesotrophic
Lac La Belle	Waukesha	Eutrophic
Loraine	Walworth	Eutrophic
Lower Nemahbin	Waukesha	Mesotrophic
Lower Whitewater	Walworth	Very Eutrophic
Middle Genesee	Waukesha	Oligotrophic
Nagawicka	Waukesha	Very Eutrophic
North	Waukesha	Mesotrophic
Oconomowoc	Waukesha	Mesotrophic
Okauchee	Waukesha	Oligotrophic
Pike	Washington	Oligotrophic
Pine	Waukesha	Mesotrophic
Silver	Waukesha	Mesotrophic
Trapp	Walworth	Mesotrophic
Turtle	Walworth	Mesotrophic
Upper Nashotah	Waukesha	Oligotrophic
Upper Nemahbin	Waukesha	Mesotrophic
Whitewater	Walworth	Mesotrophic

[a] *U. S. Environmental Protection Agency, Lake Classification—A Trophic Characterization of Wisconsin Lakes, EPA Report No. 660/3-75-033, June 1975.*

Source: Water Resources Center, University of Wisconsin and SEWRPC.

Toxic and Hazardous Substances: Sampling and analysis for pesticides, polychlorinated biphenyls (PCB's), and heavy metals were conducted by the Wisconsin Department of Natural Resources in the Rock River watershed between 1973 and 1978. In the in-stream water quality samples for which toxic and hazardous substances were tested, recommended levels of mercury were exceeded in approximately four of 78 samples, and for the persistent pesticides of heptachlor, heptachlor epoxide, lindane, methoxychlor, and phthalate recommended levels were exceeded in one of 77, one of 76, one of 76, and three of 62 samples collected, respectively. Sample analyses for cadmium, chromium, copper, lead, nickel, zinc, PCB's, DDT, DDE, DDD, aldrin, and dieldrin uncovered no violations of U. S. Environmental Protection Agency (EPA) recommended levels. No analyses were conducted for toxic and hazardous substances in the bottom sediments of the Rock River watershed.

ROOT RIVER WATERSHED

Water Quality Conditions

The Root River watershed is located in the east-central portion of the Region rising in the rapidly expanding Milwaukee urbanized area and following 44.8 miles southward and then eastward, and eventually discharging into Lake Michigan in the City of Racine. The geographic, physical, economic, and demographic features of the watershed are described in Volume One, Chapter III of this report.

Water Quality Conditions: 1964-1965: The 1964-1965 Commission streamwater quality benchmark study included the operation of six sampling stations on the Root River watershed as shown on Map 40. The chloride concentrations observed for 1964-1965 at the five sampling stations on the main stem and station Rt-3 on the Root River Canal ranged from 30 to 240 milligrams per liter (mg/l) and 45 to 170 mg/l, respectively. Normal background levels of 20 to 50 mg/l were present in the groundwater, thereby indicating that chloride contaminants were entering the surface water from diffuse pollution sources. Malfunctioning septic tanks, agricultural runoff, and winter salting operations are all likely sources of chloride to the Root River watershed. Substandard dissolved oxygen levels of less than 5.0 mg/l were reported at various locations, and ranged from 0.0 to 14.6 mg/l. The organic load for the Cooper-Dixon (C&D) Duck Farms and the Union Grove sewage treatment plant were probable sources of the dissolved oxygen content in the Root River Canal, with dissolved oxygen ranging from 0.0 to 9.2 mg/l. Total coliform counts in the Root River and its tributaries ranged from less than 100 to 1,700,000 membrane filter coliform counts per 100 milliliters (MFCC/100 ml), with the higher values being apparent during the spring runoff months, indicating pollution from diffuse sources associated with storm water runoff.

Similarly, specific conductance values were consistently higher during the spring snowmelt and runoff periods and ranged from 390 to 955 micro-mhos per centimeter (µmhos/cm) at 25°C. At no location within the watershed were the pH values (hydrogen ion concentrations) found to be outside the range of 6.0 to 9.0 standard units. Temperature was within normal ranges and fluctuated according to diurnal and seasonal air temperature changes.

Water Quality Conditions: 1965-1975: The 1965-1975 Commission streamwater quality monitoring effort included continued sampling at the six Commission stations. In addition, data were collected from one Wisconsin Department of Natural Resources (DNR) station established in the watershed as shown on Map 40. A range of 38 to 395 mg/l of chloride was observed during the decade of sampling. As in several other watersheds, the chloride concentrations exhibited higher levels during the spring snowmelt and runoff period as compared to other times of the year, resulting from winter salting operations. This chloride increase is typically more pronounced at the sampling stations located near urbanized areas. Chloride levels in the summer, fall, and winter seasons were higher than the normal 20-50 mg/l groundwater concentrations, indicating an additional impact of human activities. For the watershed as a whole, the dissolved oxygen on the Root River stream system ranged from 0.2 to 23.0 mg/l. The data collected during the sampling period by the Commission and by the DNR indicated lower dissolved oxygen levels during the summer months than at other times during the year. A decreasing trend in dissolved oxygen was noted at the upstream sampling stations, Rt-1 and Rt-2, while generally higher levels, indicating improved water quality, were detected at the lower reaches of the Root River main stem stations, Rt-4, Rt-5, and Rt.6.

A reduction in fecal coliform levels was observed at stations Rt-1 through Rt-4 and Rt-6. Improved levels at stations Rt-4 and Rt-6, located in the middle reaches of the watershed, can be attributed to the abandonment of four sewage treatment facilities previously discharging to the streams of the watershed, following the start of fecal coliform sampling in 1968. Fecal coliform bacteria ranged from 30 to 36,000 membrane filter fecal coliform counts per 100 milliliters (MFFCC/100 ml), with a stabilized count of about 500 MFFCC/100 ml being recorded between 1972 and 1975 at all stations but Rt-5. At this location, a general increasing trend is attributed to the sewage effluent discharge of the Caddy Vista sewage treatment plant and to livestock waste runoff. Specific conductance values observed were consistent with the chloride trends and ranged from 464 to 1,733 µmhos/cm at 25°C. Water temperature fluctuated with the seasonal air temperature variations and was well below the 89°F maximum adopted standard. The pH values were within 6.0 to 9.0 standard units for all samples with the exception of four readings ranging from 9.1 to 9.3 at station Rt-5 in August of 1971.

Ammonia-nitrogen (NH_3-N) levels varied from 0.0 to 4.1 mg/l and exceeded the recommended standard of 0.4 mg/l at all sampling stations except Rt-2 during the years of sampling, 1972 to 1975. Total phosphorus concentrations exceeded the recommended standard of 0.1 mg/l at all six Commission sampling stations in the watershed, with excessively high concentrations of total phosphorus recorded at the Root River Canal site, Rt-3.

The diurnal water quality data for the Root River and Root River Canal show a broad range of dissolved oxygen concentrations, from 0.5 to 23.0 mg/l over a 24-hour period, and reflect the dissolved oxygen reductions due to respiration by aquatic plants and decomposition of organic matter in the stream, and the supersaturation effects of algal photosynthesis. In addition to exhibiting marked diurnal fluctuations, water quality in the Root River watershed exhibits spatial variation. The water quality of the Root River downstream was generally better than that in the headwaters area as measured by the specific conductance values, chloride concentrations, and fecal coliform counts, with the exception of the fecal coliform count at station Rt-5.

Compliance with Water Quality Standards

Although remaining generally stable over the decade, the water quality of the Root River and Root River Canal, which are designated for recreational use and for the maintenance of a warmwater fishery and other aquatic life, did not meet the standards adopted by the Wisconsin Department of Natural Resources for dissolved oxygen, fecal coliform counts, and ammonia-nitrogen in 1975. Total phosphorus concentrations were also found to be significantly higher than the level recommended by the Commission. However, temperature was well within the adopted limit of 89°F, and pH was within the 6.0 to 9.0 standard level at all stations in 1975. The upstream portions of the east and west branches of the Root River Canal are designated for limited fishery and aquatic life and recreational use, and the headwater portions of these canals are designated for marginal aquatic life and recreational use objectives; however, no water quality data are available to assess the existing water quality conditions in these reaches.

The six sampling stations operated by the Commission have provided information on water quality in the larger, continuously flowing streams which total 37.5 miles tributary to and inclusive of the Root River. A comparison of the 1964 data to the applicable 1976 DNR-adopted water quality standards indicates that violations of the standards for one or more parameters occurred on 24.3 miles, or 65 percent, of the stream reaches sampled. In 1975, by comparison, all of the stream reaches sampled were in violation of the identical standards, indicating substantial degradation of water quality in 1975 as compared to 1964. Table 58 indicates the water use objectives and supporting standards violated during the period of 1964 through 1975.

General Water Quality Ratings

Table 59 sets forth the water quality index classifications for the six Commission-operated sampling stations in the watershed. As indicated by the index, the 1964 water quality of the Root River was generally fair, with the Root River Canal recording poor water quality. In August of the years 1974 and 1975, three of five sampling stations on the Root River indicated poor conditions, and the Root River Canal exhibited poor conditions, even though conditions had improved slightly due to improved wastewater management practices at the duck farms. Overall there was no change in the general watershed rating of fair in 1975 as compared to 1964 conditions.

Toxic and Hazardous Substances: Sampling and analysis for pesticides, polychlorinated biphenyls (PCB's), and heavy metals were conducted by the Wisconsin Department of Natural Resources in the Root River watershed in 1973. The analyses indicated that recommended levels of heptachlor epoxide, a persistent pesticide, were exceeded in one out of 11 samples. No stream bottom sediment analyses were conducted for any of the toxic and hazardous substances. Sample analyses for cadmium, chromium, copper, lead, mercury, nickel, zinc, DDT, DDE, DDD, aldrin, heptachlor, lindane, dieldrin, methoxychlor, and phthalate uncovered no violations of U. S. Environmental Protection Agency (EPA) recommended levels.

Table 58

COMPARISON OF OBSERVED WATER QUALITY CONDITIONS TO ADOPTED 1976 STREAM WATER USE OBJECTIVES AND SUPPORTING WATER QUALITY STANDARDS FOR WARMWATER FISHERY AND RECREATIONAL USE IN THE ROOT RIVER WATERSHED

Sampling Stations	Applicable Objective[a]	Adopted Standards[b]						Miles Violated	Miles Meeting All Standards
		Dissolved Oxygen (5.0 mg/l)	Fecal Coliform (400 MFFCC per 100 ml)	Temperature ($89^{o}F$)	pH (6.0-9.0 standard units)	Ammonia-Nitrogen (0.4 mg/l)	Total Phosphorus (0.1 mg/l)		
Rt-1	4	X	X			X	X		
Rt-2	4	X	X				X		
Rt-3	4	X	X			X	X		
Rt-4	4	X	X		X	X	X		
Rt-5	4	X	X		X	X	X		
Rt-6	4		X			X	X		
Total								37.5	0.0

NOTE: X indicates violation of water use objectives.

[a] *There are five categories of water use objectives:*

1) Restricted recreational use and minimum standards.

2) Marginal aquatic life, recreational use, and minimum standards.

3) Limited fishery and aquatic life, recreational use.

4) Warmwater fishery and aquatic life, recreational use.

5) Trout fishery and aquatic life, recreational use.

[b] *Includes phosphorus standard as interpreted by SEWRPC.*

Source: SEWRPC.

SAUK CREEK WATERSHED

Water Quality Conditions

The Sauk Creek watershed is located in the northeast portion of the Region and all but about 0.9 square mile of the 34.5-square-mile area of the watershed lies within the Region. Sauk Creek, the main stem draining the watershed, rises within the Region in Ozaukee County, and flows 12.9 miles southerly and easterly to discharge into Lake Michigan in the City of Port Washington. The geographic, physical, economic, and demographic features of the watershed are described in Volume One, Chapter III of this report.

Water Quality Conditions: 1964-1965: The 1964-1965 Commission streamwater quality benchmark study included the operation of two sampling stations in the Sauk Creek watershed as indicated on Map 40. The water quality data for 1964-1965 from these two sampling stations indicated that chloride levels were higher than the normal background concentration, reflecting an impact from human sources. Chloride concentrations measured during the sampling period ranged from 20 to 55 milligrams per liter (mg/l). Dissolved oxygen concentrations were found to exceed 5.0 mg/l during the summer months at both the stations, located on the main stem of Sauk Creek, and ranged from 0.1 to 19.3 mg/l during the 14-month sampling period. Total coliform bacteria ranged from 400 to 200,000 membrane filter coliform counts per 100 milliliters (MFCC/100 ml). The specific conductance values, which ranged from 200 to 770 micro-mhos per centimeter (µmhos/cm) at 25°C, were found to be high at both stations, with the highest values recorded at the sampling station located near the headwaters area. The pH values (hydrogen ion concentrations) were found to be within the normal range of 6.0 to 9.0 standard units, and the temperature never exceeded the prescribed standard of 89°F. In general, water quality conditions in Sauk Creek were better at sampling station Sk-2 located in Port Washington than at sampling station Sk-1, which is located in the rural portion of the watershed and approximately 6.6 miles upstream from station Sk-2.

Water Quality Conditions: 1965-1975: The water quality monitoring survey carried out by the Commission from 1965 through 1975 included continued sampling at the two stations in the Sauk Creek watershed. The dissolved oxygen content declined from 1965 to 1971, with stabilization occurring from 1971 through 1975. Dissolved oxygen ranged from 0.3 to 14.6 mg/l during the sampling period. The chloride concentrations decreased over the period, and no significant trend in fecal coliform counts was observed at the two stations. Chloride and fecal coliform ranged from 33 to 230 mg/l and from 10 to 54,000 membrane filter fecal coliform counts per 100 milliliters (MFFCC/100 ml), respectively. Specific conductance values were higher at the upstream station, Sk-2, than at Sk-1 and ranged from 522 to 1,460 µmhos/cm at 25°C. The pH values were within the recommended range of 6.0 to 9.0 standard units, and temperature, although fluctuating with diurnal and seasonal air temperatures, remained below the 89°F adopted standard. Ammonia-nitrogen (NH_3-N) levels ranged from 0.03 to 0.45 mg/l, and exceeded the adopted standard of 0.4 mg/l at the upstream station, Sk-1.

Total phosphorus concentrations remained high, being in excess of the recommended level of 0.10 mg/l in all but two of the samples collected between 1967 and 1975, and ranged from 0.05 to 1.25 mg/l. The diurnal water quality data available for Sauk Creek indicate that dissolved oxygen concentrations ranged from 2.1 to 8.4 mg/l over a 24-hour period. In addition to exhibiting marked diurnal fluctuations, water quality in Sauk Creek exhibits spatial variation. Water quality conditions generally improved from sampling station Sk-1 to Sk-2, as measured by the specific conductance, chloride, nutrients, fecal coliform, and dissolved oxygen.

Compliance with Water Quality Standards

The water quality of Sauk Creek, designated for recreational use and for the maintenance of a warmwater fishery and other aquatic life, did not meet the water quality standards set by the Wisconsin Department of Natural Resources (DNR) for dissolved oxygen and fecal coliform counts in 1975. Total phosphorus concentrations were also found to be higher than the level recommended by the Commission. The ammonia-nitrogen concentrations generally did not meet the recommended level of 0.4 mg/l. The more severe water quality problems were indicated in sampling station Sk-1, in the rural headwaters area of the watershed that is dominated by the effects of agricultural land use.

The two sampling stations operated by the Commission have provided information on water quality in the

Table 59

WATER QUALITY INDEX CLASSIFICATIONS FOR THE SAMPLING STATIONS OF THE ROOT RIVER WATERSHED 1964 AND 1974-75

Main Stem Stations	July, August, September, and October of 1964	August of the Years 1974-1975
Rt-1	Fair	Poor
Rt-2	Poor	Poor
Rt-4	Fair	Fair
Rt-5	Fair	Poor
Rt-6	Fair	Fair
Tributary Station		
Rt-3	Poor	Poor
Watershed Average	Fair	Fair

Source: SEWRPC.

continuously flowing stream which totals 9.0 miles of Sauk Creek. A comparison of the 1964 data to the applicable 1976 DNR-adopted water quality standards indicates that violations of the standards for one or more parameters occurred on 5.3 miles, or 59 percent, of the stream reaches sampled. In 1975, by comparison, all of the stream reaches sampled were in violation of the identical standards, indicating substantial degradation of water quality in 1975 as compared to 1964. Table 60 indicates the water use objectives and supporting standards violated during the period 1964 through 1975.

General Water Quality Ratings

Table 61 sets forth the water quality index classifications for the two Commission-operated sampling stations in the watershed. As indicated by the index, the 1964 water quality of Sauk Creek was generally fair. In August of the years 1974 and 1975, poor conditions existed at sampling station Sk-1, and at station Sk-2 fair conditions prevailed. Overall, there was no change in the general watershed rating of fair in 1974-1975 as compared to 1964 conditions.

Toxic and Hazardous Substances: No known stream water or bottom sediment sampling for toxic and hazardous materials in the form of heavy metals, polychlorinated biphenyls (PCB's), or pesticides has been conducted within the Sauk Creek watershed and, therefore, no conclusions may be drawn with regard to the presence of these substances.

SHEBOYGAN RIVER WATERSHED

Water Quality Conditions

The Sheboygan River watershed is located in the northern portion of Ozaukee County. The watershed is only partly contained in the Region, the major portion of the watershed being located in Sheboygan County. The only perennial stream of the Sheboygan River watershed within the Region is Belgium Creek, and the watershed within the Region does not include any lakes. The geographic, physical, economic, and demographic features of the watershed are described in Volume One, Chapter III of this report.

Table 60

COMPARISON OF OBSERVED WATER QUALITY CONDITIONS TO ADOPTED 1976 STREAM WATER USE OBJECTIVES AND SUPPORTING WATER QUALITY STANDARDS FOR WARMWATER FISHERY AND RECREATIONAL USE IN THE SAUK CREEK WATERSHED

Sampling Stations	Applicable[a] Objective	Adopted Standards[b]						Miles Violated	Miles Meeting All Standards
		Dissolved Oxygen (5.0 mg/l)	Fecal Coliform (400 MFFCC per 100 ml)	Temperature (89°F)	pH (6.0-9.0 standard units)	Ammonia-Nitrogen (0.4 mg/l)	Total Phosphorus (0.1 mg/l)		
Sk-1	4	X	X		X	X	X		
Sk-2	4	X	X				X		
Total								9.0	0.0

NOTE: X indicates violation of water use objectives.

[a] *There are five categories of water use objectives:*

1) *Restricted recreational use and minimum standards.*
2) *Marginal aquatic life, recreational use, and minimum standards.*
3) *Limited fishery and aquatic life, recreational use.*
4) *Warmwater fishery and aquatic life, recreational use.*
5) *Trout fishery and aquatic life, recreational use.*

[b] *Includes phosphorus standard as interpreted by SEWRPC.*

Source: SEWRPC.

Table 61

WATER QUALITY INDEX CLASSIFICATIONS FOR THE SAMPLING STATIONS OF THE SAUK CREEK WATERSHED 1964 AND 1974-75

Main Stem Stations	July, August, September, and October of 1964	August of the Years 1974-1975
Sk-1	Poor	Poor
Sk-2	Good	Fair
Watershed Average	Fair	Fair

Source: SEWRPC.

Water Quality Conditions: 1964-1965: The 1964-1965 benchmark streamwater quality study conducted by the Commission included the operation of one sampling station located on Belgium Creek as shown on Map 40. The water quality data for 1964-1965 from the sampling station indicated that the chloride levels during April were higher than the normal background concentrations, presumably reflected an impact from sewage treatment plant effluent. Chloride concentrations during the sampling period ranged from 20 to 30 milligrams per liter (mg/l). One substandard level of less than 3.0 mg/l of dissolved oxygen was recorded at Belgium Creek in September 1964. The remainder of the 14-month sampling levels ranged from 7.6 to 16.5 mg/l. At no time during the sampling period were total coliform bacteria levels below 2,000 membrane filter coliform counts per 100 milliliters (MFCC/100 ml). Fecal coliform counts for this period ranged from 2,000 to 200,000 MFCC/100 ml. The two specific conductance values obtained were 756 and 800 micro-mhos per centimeter (μmhos/cm) at 25°C. The pH values (hydrogen ion concentrations) obtained were within the prescribed range of 6.0 to 9.0 standard units. Temperature variations were in accordance with expected seasonal changes.

Water Quality Conditions: 1965-1975: The 1965-1975 water quality monitoring effort by the Commission included continued sampling at the single station on Belgium Creek. The average chloride concentrations recorded during the August surveys indicated levels significantly exceeding the background concentration of 10 mg/l and varied from 9.0 to 63 mg/l throughout the sampling period. High chloride concentrations were found in the 1972 and 1975 samples collected after a heavy rain. The dissolved oxygen concentrations remained higher than 3.0 mg/l in all the samples collected over the decade with the exception of four of the six samples collected in 1970 and one sample collected in 1973. The range of dissolved oxygen values varied from 1.1 to 13.6 mg/l during the sampling period. Fecal coliform counts ranged from 180 to 21,000 membrane filter fecal coliform counts per 100 milliliters (MFFCC/100 ml). The specific conductance values exhibited a trend toward higher values in the samples collected after storm events—a pattern which corresponds to the pattern for chloride concentrations—and ranged from 569 to 1,041 μmhos/cm at 25°C. The pH values were found to be within the applicable standard of 6.0 to 9.0 standard units and exhibited no discernible trend. Temperatures were well below the adopted standard of 89°F.

Ammonia-nitrogen (NH_3-N) levels were well below the recommended 3.5 mg/l, with levels ranging from 0.03 to 1.12 mg/l. The diurnal water quality data for Belgium Creek exhibit a broad range of dissolved oxygen concentrations, from 1.1 to 10.4 mg/l over a 24-hour period.

Compliance with Water Quality Standards

The water quality of Belgium Creek, designated for marginal aquatic life, recreational use, and minimum standards, remained stable over the decade, but did not meet the water quality standards adopted by the Wisconsin Department of Natural Resources (DNR) for fecal coliform in 1975. Adverse water quality effects of treated sewage discharges and livestock wastes appear to be exhibited in the available data.

The sampling station operated by the Commission has provided information on water quality in the continuously flowing stream, Belgium Creek, which totals 4.0 miles tributary to the Sheboygan River. A comparison of the 1964 data to the applicable 1976 DNR-adopted water quality standards indicates that all of the applicable standards were met at station Sb-1. In 1975, by comparison, station Sb-1 was in violation of the fecal coliform standard, indicating degradation of water quality in 1975 as compared to 1964. Table 62 indicates the water use objectives and supporting standards violated during the period of 1964 through 1975.

General Water Quality Ratings

Table 63 sets forth the water quality index classifications for the one Commission-operated sampling station in the watershed. As indicated by the index, the 1964 water quality of Belgium Creek was fair. Sampling station Sb-1 also exhibited fair conditions in August of the years 1974 and 1975.

Toxic and Hazardous Substances: No known stream water or bottom sediment sampling for toxic and hazardous material in the form of heavy metals, polychlorinated biphenyls (PCB's), or pesticides has been conducted within the portion of the Sheboygan River watershed within the Region and, therefore, no conclusions may be drawn with regard to the presence of these substances.

SUMMARY

Since the late 1840's in the densely populated areas of Milwaukee, and since the 1880's in selected rural-agricultural areas of southeastern Wisconsin, stream and

Table 62

COMPARISON OF OBSERVED WATER QUALITY CONDITIONS TO ADOPTED 1976 STREAM WATER USE OBJECTIVES AND SUPPORTING WATER QUALITY STANDARDS FOR MARGINAL AQUATIC LIFE AND RECREATIONAL USE IN THE SHEBOYGAN RIVER WATERSHED

Sampling Station	Applicable[a] Objective	Adopted Standards[b]						Miles Violated	Miles Meeting All Standards
		Dissolved Oxygen (3.0 mg/l)	Fecal Coliform (2,000 MFFCC per 100 ml)	Temperature (89°F)	pH (6.0-9.0 standard units)	Ammonia-Nitrogen (3.5 mg/l)	Total Phosphorus (0.1 mg/l)		
Sb-1	2	X	X				X		
Total								4.0	0.0

NOTE: X indicates violation of water use objectives.

[a] *There are five categories of water use objectives:*

1) *Restricted recreational use and minimum standards.*
2) *Marginal aquatic life, recreational use, and minimum standards.*
3) *Limited fishery and aquatic life, recreational use.*
4) *Warmwater fishery and aquatic life, recreational use.*
5) *Trout fishery and aquatic life, recreational use.*

[b] *Includes phosphorus standard as interpreted by SEWRPC.*

Source: SEWRPC.

Table 63

WATER QUALITY INDEX CLASSIFICATIONS FOR THE SAMPLING STATION OF THE SHEBOYGAN RIVER WATERSHED 1964 AND 1974-75

Main Stem Station	July, August, September, and October of 1964	August of the Years 1974-1975
Sb-1	Fair	Fair
Watershed Average	Fair	Fair

Source: SEWRPC.

lake water quality conditions have exhibited visual signs of declining water quality. No longer was their pristine beauty untouched by man's activities. Raw sewage flowed freely into numerous streams in the more populated areas and construction of new residential, commercial, and industrial buildings along with the streets needed to accommodate this additional urbanization occurred very rapidly, resulting in ever-increasing pollutant loads to the surface water network. Significant but temporary water quality improvement was observed during the periods following the initial stages of construction of primary and secondary wastewater treatment facilities until the facilities became overloaded and could no longer adequately and efficiently treat the sewage wastes.

The water quality conditions and long-term trends in those declining conditions were analyzed from data available for the period from 1964-1975 for each of the 12 major watersheds in the Region in order to identify instances in which such pollution abatement programs had been fully successful, or had been frustrated by increased pollutant loads from other sources.

Map 39 presents the adopted 1976 water use objectives for the major surface water systems studied under the areawide water quality management planning program for southeastern Wisconsin and evaluates whether water quality conditions for 1964-1975 meet these initial recommended water use objectives for the 100 major lakes and the 1976 adopted standards for the perennial streams within the 12 watersheds of the Region.

Des Plaines River Watershed

In the Des Plaines River watershed surface water quality conditions were found to be essentially unchanged over the decade. However, the water quality of the Des Plaines River and Brighton Creek, both intended for recreational use and the maintenance of a warmwater fishery and other aquatic life, did not meet the water quality standards adopted by the Wisconsin Department of Natural Resources in 1975 for dissolved oxygen and fecal coliform bacteria. In addition, total phosphorus concentrations were found to be higher than the recommended level adopted by the Commission.

Two of the four lakes in the watershed experienced less than 1.0 mg/l dissolved oxygen concentrations in the hypolimnion during summer stratification. For Lakes George and Paddock, for which complete chemical water quality data were available, the recommended levels of water quality were not achieved for one or more parameters, based on samples available from the Wisconsin Department of Natural Resources and the Commission.

Fox River Watershed

In the Fox River watershed, surface water quality conditions as measured at 12 sampling stations along the Fox River main stem were found to be slightly improved between 1965 and 1975. Streamwater quality conditions of the Fox River watershed as a whole did not meet the established water use objectives for recreational use and the maintenance of a warmwater fishery and other aquatic life in 1975. Supporting standards for dissolved oxygen, ammonia-nitrogen, and fecal coliform, and the recommended level for total phosphorus were generally not met.

Of the 31 major lakes in the watershed for which water quality data are available, 19 exhibit potentially anaerobic conditions in the hypolimnion in the summer. Thirty-five of the major lakes in the watershed were classified for their trophic status: eight were classified as very eutrophic and two lakes in the watershed were considered to be oligotrophic, with the remaining 25 being classified as mesotrophic. Of the 22 lakes for which complete chemical water quality data are available, 13 lakes, or 59 percent, did not meet the recommended water quality levels for one or more parameters, based on sampling data collected by the Wisconsin Department of Natural Resources and the Commission.

Kinnickinnic River Watershed

In the Kinnickinnic River watershed, surface water quality as measured at a single Commission sampling station was found to be essentially unchanged over the decade and met the applicable water quality standards for restricted use and minimum standards as established by the Department of Natural Resources.

Menomonee River Watershed

Although remaining generally constant over the decade, the water quality of the Menomonee River upstream from the confluence with Honey Creek designated for recreational use and maintenance of a warmwater fishery and other aquatic life did not meet the established water quality standards for fecal coliform, dissolved oxygen, and ammonia-nitrogen, nor the recommended level for total phosphorus in 1975. Honey Creek and Underwood Creek tributaries showed no significant change over the decade. Both reaches, which are designated for restricted use and minimum standards, exhibited violations of fecal coliform counts, with Honey Creek recording excessive levels during the 1975 sampling period despite the industrial use standards applicable to these stream reaches which drain generally urban, commercial, and industrial land uses.

Milwaukee River Watershed

Although for specific parameters the water quality of the Milwaukee River and its major tributaries fluctuated between slightly improved, no change, or slightly worse, the overall quality has slightly declined since 1964. When comparing the 1975 water quality data to the water quality standards adopted by the Wisconsin Department of Natural Resources, dissolved oxygen, and fecal coliform are found not to satisfy the minimum standards for recreational use and the maintenance of a warmwater fishery and other aquatic life set for the reaches of the Milwaukee River and its tributaries upstream from the North Avenue dam, nor the standards for restricted use set for fecal coliform for the reaches of the main stem of the Milwaukee River downstream from the North Avenue dam and for Lincoln Creek. In addition, total phosphorus levels were generally found to be significantly higher than the recommended level adopted by the Commission.

Of the 12 major lakes located within the Milwaukee River watershed within the Region, dissolved oxygen profiles were available for seven. All of these exhibit potentially anaerobic conditions in the hypolimnion in the summer. Four of the major lakes have been classified according to their trophic status; Silver as oligotrophic, Big and Little Cedar as mesotrophic, and Mud as very eutrophic. Of the four major lakes within the watershed for which complete water quality data are available, only Mud Lake exhibited conditions which conformed to the recommended water quality standards to be set forth in Volume Two, Chapter II of this report.

Minor Streams Directly Tributary to Lake Michigan

The largest of the minor streams draining directly to Lake Michigan include Barnes Creek, Pike Creek, and Sucker Creek. In the Barnes Creek subwatershed, water quality conditions were found to be essentially unchanged between 1965 and 1975. The 1975 water quality conditions in the Creek, which is intended for restricted use and minimum standards, met the water quality standards for temperature, pH, dissolved oxygen, and fecal coliform.

In the Pike Creek subwatershed, the observed dissolved oxygen levels at the single sampling station indicate essentially unchanged water quality conditions over the decade; however, chloride levels showed slight decreases and fecal coliform counts increased during the sampling period. Although the water quality did not change significantly over the decade, the applicable standards for recreational use and the maintenance of a warmwater fishery and aquatic life were not met with respect to fecal coliform counts and dissolved oxygen in 1975. In addition, total phosphorus values were in violation of the Commission's recommended standard of 0.1 mg/l.

Improvements were noted over the decade at the sampling station in the Sucker Creek subwatershed for dissolved oxygen and chloride levels, indicating improvements in water quality conditions over the decade. Fecal coliform counts on the other hand were found to have increased, although phosphorus levels remained in excess of the recommended levels. Despite the improvements, Sucker Creek exhibits water quality conditions which do not meet the applicable water quality standards for recreational use and the maintenance of a warmwater fishery and aquatic life with respect to fecal coliform counts, dissolved oxygen, and total phosphorus.

Oak Creek Watershed

In the Oak Creek watershed, surface water quality conditions were measured at two sampling stations on the Oak Creek main stem, and were found to be slightly degraded in general. However, fecal coliform counts improved somewhat in 1975. The total phosphorus levels observed during the 1975 sampling period were found to be in excess of the recommended level, and the dissolved oxygen, ammonia-nitrogen, and fecal coliform levels did not meet the applicable water quality standards for recreation and the maintenance of a warmwater fishery and other aquatic life. The downstream sampling station generally exhibited better water quality than that of the upstream station.

Pike River Watershed

Two sampling stations on the Pike River and two sampling stations on Pike Creek of the Pike River watershed were monitored as part of the Commission continuing water quality monitoring program. The sampling on Pike Creek indicated that in 1975, fecal coliform, pH, temperature, and dissolved oxygen levels did not meet the restricted use and minimum standards. However, dissolved oxygen sample results indicated that the water quality of the Pike River had improved slightly over the decade. The chloride and fecal coliform levels showed general improvement over the decade at both sampling stations on the main stem in the watershed, except during sampling periods which followed significant precipitation events. The main stem of the Pike River, which is designated for recreational use and the maintenance of a warmwater fishery and aquatic life, exceeded the standards for dissolved oxygen, ammonia-nitrogen, fecal coliform, and total phosphorus. Generally, high levels of total phosphorus were recorded at all stations in 1975.

Rock River Watershed

Water quality conditions in the major tributaries of the Rock River within the Region were monitored under the Commission continuing water quality monitoring effort at 13 sampling stations, eight in the Upper Rock River subwatershed and five in the Lower Rock River subwatershed. The Bark and Ashippun Rivers showed no significant change in water quality over the decade. No significant change was observed in the water quality of the Rubicon River, except at the sampling station located downstream from the City of Hartford sewage treatment plant, where the sewage treatment plant improvements completed in the summer of 1973 were reflected in improved dissolved oxygen levels. Water quality conditions in the Oconomowoc River showed no change except at the sampling station located downstream from the City of Oconomowoc's old sewage treatment plant, where increased loadings from the plant were reflected in decreased water quality conditions. Whitewater Creek showed a slight improvement in fecal coliform counts over the decade. At the same time, the water quality of Jackson Creek and Turtle Creek deteriorated somewhat as measured at the sampling stations located downstream from the City of Elkhorn and the City of Delavan sewage treatment plants. In general, the water quality of the Rock River tributaries lying within the Southeastern Wisconsin Region, all designated for recreational use and for the maintenance of a warmwater fishery and other aquatic life—with the exception of portions of Jackson Creek—meet the water quality standards for dissolved oxygen, ammonia-nitrogen, and fecal coliform and frequently exhibits concentrations of total phosphorus which are significantly higher than the recommended level. That portion of Jackson Creek, one mile upstream from sampling station Rk-11, which is designated for marginal aquatic life, recreational use, and minimum standards was not in compliance with the prescribed dissolved oxygen and fecal coliform standards. In addition, high concentrations of ammonia-nitrogen at stations on Jackson Creek and at the Delavan Lake outlet were recorded.

All 38 major lakes in the Rock River watershed for which water quality data are available exhibited the potential for anaerobic conditions in the hypolimnion during the summer and the resulting adverse effects on fish and other aquatic life within these lakes. Of the 24 lakes which have been rated for their trophic status, 5 were rated as oligotrophic lakes, 14 as mesotrophic, 2 as eutrophic, and 3 as very eutrophic. All 21 major lakes for which complete chemical sampling is available failed to meet the recommended levels of water quality for one or more parameters.

Root River Watershed

In the Root River watershed, the Commission continuing water quality monitoring program included sampling at six stations. Water quality conditions as measured by fecal coliform within the middle reaches of the watershed exhibited improvement as a result of the abandonment of four sewage treatment facilities previously discharging to the streams of the watershed. Water quality conditions as measured by chloride loadings and dissolved oxygen levels in the upper reaches of the Root River, however, exhibited some decline. This decline may be attributed to the increased urbanization of the tributary area. The improved wastewater management practices instituted at the Cooper-Dixon (C&D) Duck Farm are manifested in improved water quality conditions in the Root River Canal. Despite these improvements, the water quality of the streams of the Root River watershed does not meet the applicable water quality standards for recreational use and maintenance of a warmwater fishery and other aquatic life with regard to dissolved oxygen, ammonia-nitrogen, and fecal coliform, and the total phosphorus levels in all of the streams were also found to be higher than the recommended level.

Sauk Creek Watershed

In the Sauk Creek watershed, the continuing water quality monitoring program of the Commission included the collection of samples from two stations. A slight decline in dissolved oxygen and chloride levels over the decade, and generally stable fecal coliform counts were recorded over the decade, as well as high total phosphorus concentrations. Although water quality conditions were generally stable over the decade, the water quality standards applicable for recreational use and the maintenance of a warmwater fishery and other aquatic life were not met within this watershed, with regard to dissolved oxygen, ammonia-nitrogen, fecal coliform, and total phosphorus.

Sheboygan River Watershed

Water quality conditions in Belgium Creek in the Sheboygan River watershed remained essentially unchanged over the decade, but did not meet the initial recommended water use objectives and supporting standards for marginal aquatic life, recreational use, and minimum standards for fecal coliform.

General Water Quality in the Region

When assessing the average of the water quality index ratings for all samples within the Region, no major shift in water quality over the 1965-1975 decade is indicated, although a subtle decline is observed overall in the levels of some parameters at some stations; this, despite observed improvements at 26 stations downstream from points of improved wastewater treatment plants or reduced effluent discharges. In addition, of the total 458.6 miles of perennial streams within the Region for which 10 years of water quality data are available, only 52.1 miles, or 11.4 percent, met the water quality standards adopted by the Wisconsin Department of Natural Resources in 1976, and when the Commission-recommended levels for total phosphorus are applied only 2.5 miles, or 0.5 percent, met existing water quality standards during the period 1964 through 1975.

When evaluating the 65 major lakes for which trophic status ratings are available, 8 lakes, or 12.3 percent and 7 percent of the rated average, are rated as oligotrophic; 38 lakes, or 58.5 percent and 52 percent of the rated acreage, are rated as mesotrophic; 6 lakes, or 9.2 percent and 12 percent of the rated average, are rated as eutrophic; and 13 lakes, or 20 percent and 29 percent of the rated acreage, are rated as very eutrophic. Only about 2 percent of the total of 49 lakes for which complete water quality data are available, 7 percent of the lake acreage for which data are available, met the initial recommended water use objectives, primarily due to high levels of inorganic nitrogen and inorganic phosphorus. The 100 major lakes within the seven-county area also show visual scars of degraded water quality. Although natural eutrophication has done its part, the increased demands and loadings placed on the lakes in the Region due to urbanization and increased recreational pressure are limiting the recreational and aesthetic values of the lakes.

Based on 12 years of water quality data collected from 1964 through 1975, degradation of southeastern Wisconsin's lakes and streams continues. Unfortunately, improved techniques of wastewater treatment coupled with more stringent regulations governing the discharge of effluents into the surface waters over the past several years have resulted in only localized or marginal improvements on certain reaches of streams. By contrast, the majority of streams have progressively declined in quality because of diffuse as well as point source pollution, and because of extensive violations of the established stream water quality standards since 1964, when the Commission benchmark survey of streamwater quality was conducted.

Chapter V

SOURCES OF WATER POLLUTION IN THE REGION

INTRODUCTION

A complete analysis of water pollution problems must include not only the identification of the location of the pollution sources, but an estimate of the type, quantity, and characteristics of the pollutants contributed and of the probable effects of those pollutants on the quality of the receiving waters. The quantity and character of the pollutants released must, moreover, be related to the natural waste assimilation capacity of the receiving lakes and streams if the water quality effects are to be understood. This chapter is accordingly intended to identify the water pollution sources within the Region as of 1975, and to present estimates of the character and quantity of pollutants contributed by those sources. This chapter constitutes a summary of the more detailed analysis of pollution sources, documented in SEWRPC Technical Report No. 21, Sources of Water Pollution in Southeastern Wisconsin: 1975.

For systems planning purposes, the most important characteristics of pollution sources are the amount and type of the specific pollutants discharged; the locations of the sources with respect to the surface water system; and the timing or conditions under which the pollutants are discharged to the waterways and thereby released into the aquatic environment. The rate at which a waste stream flows; the size, shape, and slope of the surface over which it flows; the characteristics of the material—soil, vegetation, or synthetic surface—upon or through which it flows; the spatial separation of the pollution source from the nearest body of surface water; the physical or chemical stability of the waste stream as it degrades in the natural environment; and the moisture conditions in the tributary drainage basin prior to a rainfall or snowmelt event all serve to complicate any attempt to precisely define these characteristics. Each unique combination of pollutant loading and attendant condition of the receiving water body is a function of the events during and preceding the specific discharge period involved. A clear example of this is the dependence of the concentration of pollutants in a storm washoff event upon the length of time since the last such event. The longer the time period during which the pollutant was able to build up on the earth's surface as a result of dry fallout and of deposition resulting from cultural processes, the more polluted will be the initial flush of storm water runoff. In other words, the occurrence of pollutants and their movement through natural systems, when considered in light of the numerous factors which affect those pollutants within the environment, are not simple deterministic processes which can be readily measured, calculated, and predicted. Rather, such occurrences and movements are highly variable, characterized by probabilities of occurrence and by expected values as associated with other random processes. In recognition of this fact, the Commission, in the formulation and evaluation of alternative pollution abatement plans in this report, has related the effects of water pollution sources presented in this chapter to the probability of achieving the recommended water use objectives and supporting standards.

POLLUTION SOURCE CATEGORIES

Presentation of information relating to such a pervasive phenomenon as water pollution is difficult because of the many interrelated factors which determine the nature and severity of pollution. More specifically, a clear and useful presentation of the sources of water pollution, the amounts of pollutants they contribute, and their relative importance is complicated by three factors: 1) the pollution sources are difficult to categorize; 2) the geographic area of presentation may not correlate readily to the affected hydrologic unit; and 3) meteorological processes may have an effect on the transport and delivery of pollutants to the streams and lakes. With regard to the first factor, streets and highways are an integral part of any urban development pattern, but exist in rural areas as well. Pollutants in storm water are contributed by diffuse sources, but may be released to the waterways at a single point, through a storm sewer outfall. Storm water may infiltrate sanitary sewers as groundwater, or may enter directly as inflow from roof drains or flooded manhole covers, surcharging such sewers and causing them to overflow through various kinds of flow relief devices. Sanitary sewage may flow into storm sewers if cross-connections have been constructed to relieve excess flow and avoid sanitary sewer surcharging and the attendant health hazard associated with basement flooding. Some residential, commercial, and industrial areas may be drained by storm sewers, while others may be drained by roadside ditches, and interconnected natural swales and watercourses. Because of the problems inherent in categorizing pollution sources, it is imperative to avoid double-accounting of the various sources, and to carefully explain what is and what is not included within each pollutant category. Accordingly, this chapter addresses pollution from sanitary sewers, storm sewers, and combined storm and sanitary sewers as separate categories. Storm sewer systems are defined as including not only the systems of subsurface conduits, which have been constructed to drain urban areas, but also any major surface drainageways which may interconnect such subsurface conduits as part of a larger system or drain them to the nearest receiving natural watercourse. The pollution contributions from storm sewer discharges are presented in association with urban land runoff.

URBAN AND RURAL POLLUTION SOURCES

For purposes of this report, the major distinction to be made in the categories of pollution sources is the predominantly urban or rural character of each source. This distinction is particularly important in relating pollution problems to alternative solutions and implementation responsibilities. Urban pollution sources are herein defined as those associated with residential land uses regardless of density, and the associated land uses which serve and support the residential uses.[1] These urban land uses are identified in Figure 29 and include, in addition to residential land uses, industrial and commercial land uses, transportation land uses, recreational land uses, and certain activities related to the modification of the land surface such as earth moving, grading, trenching, clearing, grubbing, dredging, or channelization. In addition to storm runoff, urban water pollution sources include sanitary sewage, combined storm and sanitary sewage, effluent from onsite sewage disposal systems, and industrial wastewaters. Rural land uses are herein defined as all of the residual nonurban land uses, including agriculture, silviculture, and natural areas of the Region. The rural water pollution sources include the runoff from livestock operations, croplands, pasturelands, unused or open lands, orchards, woodlands, and wetlands.

Because of the complex mix of rural and urban land uses found in the rapidly urbanizing Region, it has been necessary to make somewhat arbitrary distinctions between rural and urban uses for some pollution sources which may relate to both types of land uses. It is believed, however, that neither the areal extent nor the pollutant loadings associated with these sources represent a significant proportion of the regional totals. These pollution sources include direct air pollution fallout to water bodies, which—because most of the acreage of lakes and streams is located in rural areas of the Region—is considered herein as a predominantly rural source. Included as urban sources are all known residential onsite sewage disposal systems—including those serving rural farmsteads and isolated homesites of less than five acres in extent, sand and gravel pits and stone quarries, solid waste disposal operations, and parks including golf courses. Freeways and other arterial highways are considered as urban sources, but local collector and land access streets serving adjacent land uses are classified with the adjacent urban or rural land uses.

Figure 29 presents a summary diagram of the interrelationships of diffuse sources of pollution and the points at which pollutants are contributed to natural water bodies, as well as major functional routes of the wastewater discharged from municipal and industrial outfalls, combined storm and sanitary sewers, and storm sewers.

POINT AND NONPOINT POLLUTION SOURCES

Two other general categories of pollution sources which are sometimes used in the consideration of the effects of human activities on surface water quality are point sources and nonpoint sources. These pollution source categories do not coincide with the urban-rural dichotomy discussed above. Point sources of pollution are defined as concentrated discharges of wastewater emanating from a specific, discrete site. Because point sources discharge collected wastewaters to surface water bodies through a pipe or other identifiable conduit, point sources generally can be more readily eliminated or abated than nonpoint sources. Examples of such discernible confined and discrete sources of pollution include sewerage system flow relief device outfalls, sewage treatment plant outfalls, and industrial waste outfalls.

Nonpoint sources of pollution are frequently defined as diffuse discharges of wastewater which cannot be identified as a point source. Most commonly, these consist of storm water runoff and snowmelt discharges carrying sediment and chemical substances which act as water pollutants. The distinction between point and nonpoint sources of pollution is, however, also somewhat arbitrary since diffuse pollution sources associated with urban and rural runoff can be collected, channelized, and conveyed to identifiable points of discharge, such as storm sewer outfalls.

WATERSHED AND GOVERNMENTAL UNITS

As already mentioned, another factor complicating the presentation of inventory data pertaining to pollution sources is the geographic area of presentation. The area relevant to a specific pollution source may not correlate readily to the affected hydrologic unit—the watershed and subdivisions thereof, such as subwatershed or subbasin—within the Region. For example, the storm water runoff from an urban area may be carried by a storm sewer system which serves an area at least roughly congruent with the original natural catchment area, while the sanitary sewage discharges may be carried through a more extensive system of subsurface conduits crossing low-relief natural watershed boundaries several times before draining to the ultimate site of wastewater treatment. A related problem exists when the data related to a diffuse source of pollution are available only by civil division—as opposed to the sanitary sewerage service area or the hydrologic unit.

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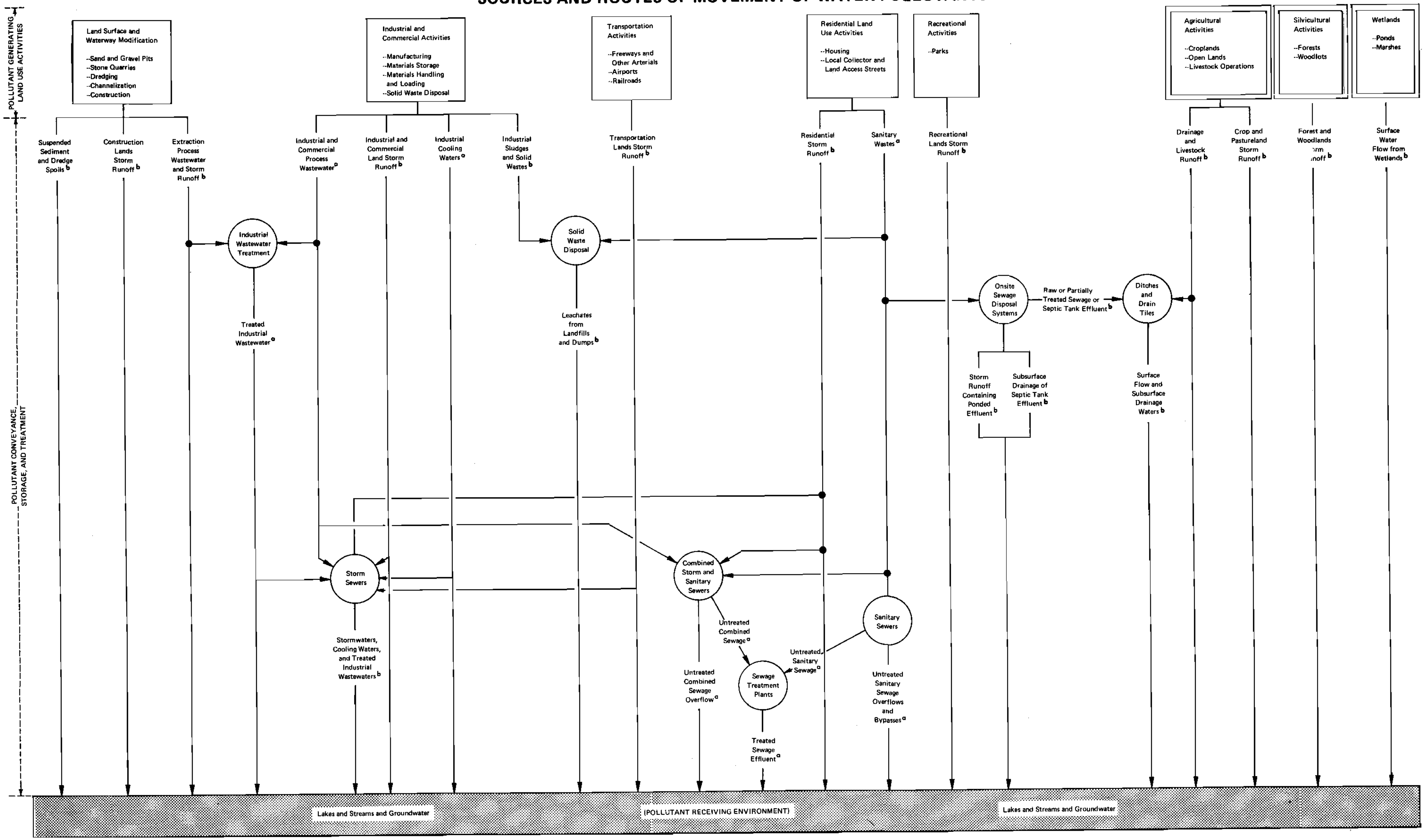
[1] *It should be noted that the pollutional effects of rural farmsteads and isolated, individual rural homesites were considered in two components. The runoff of storm waters from the lawns, gardens, driveways, and buildings was considered along with the contributions from adjoining land uses, since these residential land surfaces comprise a very small proportion of the rural land uses. The diffuse pollution associated with onsite sewage disposal systems was considered separately from the land surface runoff, but along with the other onsite systems estimated to be located within each watershed, and with due regard to the estimated proportion of malfunctioning or improperly installed systems.*

Figure 29

SOURCES AND ROUTES OF MOVEMENT OF WATER POLLUTANTS



LEGEND

PREDOMINANTLY URBAN LAND USE ACTIVITIES

PREDOMINANTLY RURAL LAND USE ACTIVITIES

MAN-MADE STRUCTURAL CONTROLS

ROUTES OF POLLUTANTS

[a] *Routes of pollutant-bearing substances predominantly point in nature.*

[b] *Routes of pollutant-bearing substances predominantly nonpoint or diffuse in nature.*

Source: SEWRPC.

In order to be useful in subsequent analyses, all of the water pollution sources data must be related to the hydrologic watershed to which they are tributary. Accordingly, the several inventories of pollution sources were conducted in such a manner that the resulting data could always be related to the natural watershed, and, therefore, the inventory findings are presented in this chapter only by watershed. The pertinent data on urban storm sewer systems and on land cover in rural areas are readily presented by watershed. For convenience, however, the pertinent data on sanitary and combined sewerage systems were presented in the SEWRPC Technical Report No. 21 by subregional areas initially delineated under the regional sanitary sewerage system planning program. These subregional areas have proven to be sound for sanitary sewerage system planning purposes, and can be related to the hydrologic watersheds within which the effluents are ultimately released. The boundaries of these subregional areas were delineated on the basis of the location of major watershed divides, the existing and potential service areas of existing centralized sanitary sewerage systems, and existing and probable future areas of urban development. Because of their past and continuing value for sanitary sewerage system planning, these areas provided the best available basis for assembling and reporting the sanitary and combined sewerage system inventory data required for the areawide water quality management planning effort and were utilized in SEWRPC Technical Report No. 21. For purposes of analysis of water pollution control alternatives, however, such data are reported in this chapter by hydrologic watershed.

The pollution source inventory data presented in this chapter and in the more detailed technical report cited above were reorganized and presented in appendices to that report according to other appropriate geographic units to facilitate the review and use of the data not only in the areawide planning process but in plan implementation as well. More specifically, pertinent data on the existing sanitary and combined sewerage systems were summarized in appendices by civil division; data on the sanitary sewer flow relief devices and combined sewer outfalls are presented by watershed and civil division; data on the storm sewer systems are presented by civil division; and data on the diffuse sources of pollution are presented by county.

With regard to the third factor which complicates the presentation of data on pollution sources in the Region—the effect of meteorological processes on the transport and delivery of pollutants to the streams and lakes—the water quality conditions of the surface waters are a function of their capacity to assimilate the amounts of pollutants actually reaching the stream. These pollutants may be due to storm water flows which carry pollutants from the land surface to the waterways, to heavy pollutant buildup washed from the land surface after a long period without precipitation or snowmelt, or to a combination of these occurrences. The relative importance of the different types of pollution sources and their associated pollutant transport and delivery mechanisms varies with these factors. Because the relationship between precipitation events and pollutant buildup is a random one, except when characterized for many such events and over a long period of time, it is difficult to present a single and universal depiction of the relative importance of the different pollution sources. Therefore, the Commission utilized a hydrologic-hydraulic-water quality simulation model for the analysis of plan alternatives and applied the findings of this chapter as an independent check of the modeling results, which are presented in Volume Two, Chapter IV of this report.

EFFECTS OF WATER POLLUTANTS

Table 64 sets forth the types of pollutants associated with each of the major categories of pollution sources. Regardless of source, the pollutants listed in Table 64 may be expected to have the same general effects on the water quality of a stream or lake. The specific effects of the existing and anticipated future pollution sources will be considered in Volume Two, Chapter IV and Volume Three, Chapter II of this report. However, it is possible to characterize the effects of these pollutants on the quality of the streams and lakes in a general way. Accordingly, the following comments discuss the general physical, chemical, and biological effects on surface water quality of selected pollutants; the current understanding of the potential for disease associated with the pollutants; and the degree to which the general levels of the pollutants meet the currently adopted water quality standards for waters intended for the maintenance of fish and aquatic life and for recreational use—the Congressionally mandated national water use objectives.

The various pollution source categories listed in Table 64 may contribute a total of 17 major pollutants including: suspended solids; dissolved solids; oxygen-demanding, rapidly degrading organic substances; slowly degrading or nondegrading organic substances; nitrogen; phosphorus; pathogenic organisms; toxic and hazardous substances; corrosives; grease and oil; dissolved organic substances; detergents; heat; heavy metals; and pesticides. Some of these pollutants can and do interact, thereby causing additional environmental hazards; for example, oxygen-demanding substances exert their influence more quickly at higher temperatures, while warmer water holds less dissolved oxygen than does cooler water. Other pollutants are sensitive to the pH (hydrogen ion concentration) of the aquatic environment. The following descriptions of the effects of the various kinds of pollutants—except as noted—assume a typical water quality condition in which the subject pollutant is the principal cause of degradation beyond natural conditions and is not affected by the other pollutants present.

Of the plethora of pollutants, a select few have been historically identified and studied both as predominant pollutants and as principal indicators of the presence of other more specific polluting substances. The specific water chemistry indicators which are utilized in this chapter include total nitrogen, total phosphorus, five-day biochemical oxygen demand, suspended solids, and

Table 64

POLLUTANTS ASSOCIATED WITH CATEGORIES OF POLLUTION SOURCES FOUND IN THE REGION

Category of Pollution Source	Principal Associated Substances Containing Pollutants	Specific Pollutants Contributed to Watercourses
Urban Categories:		
Publicly or privately owned sanitary sewerage system discharges and overflows	Treated and untreated sanitary sewage or combined storm and sanitary sewage	Suspended solids, degradable organic (oxygen-demanding) substances; phosphorus; nitrogen; slowly or nondegradable organic substances; bacteria; viruses; toxic and hazardous substances
Privately owned onsite sewage disposal systems (septic tanks, mound systems)	Surface runoff of effluent from malfunctioning or improperly designed systems	Viruses; bacteria; degradable organic (oxygen-demanding) substances; nitrogen; phosphorus, dissolved organic substances; suspended solids
Holding tanks	Groundwater discharge of effluent (holding tank wastes, including sanitary and household wastes improperly disposed on land)	Viruses; bacteria; degradable organic (oxygen-demanding) substances; nitrogen; phosphorus; dissolved organic substances; suspended solids
Industrial wastewater outfalls	Process waters, including wash waters, rinse water, organic wastewaters, chemical wastes, cooling waters	Oxygen-demanding substances; dissolved solids; suspended solids; toxic and hazardous substances; corrosives; oil; grease; detergents; heat
Storm sewerage systems	Street litter and runoff, pet litter, lawn runoff, and rooftop and parking lot runoff	Oil; grease; suspended solids; dissolved solids; oxygen-demanding substances; phosphorus; nitrogen; pesticides; toxic and hazardous substances; bacteria; viruses
Storm runoff from residential areas	Lawn runoff, street litter, pet litter, rooftop and parking lot runoff, garbage, degraded surface coatings, vegetation	Oil; grease; suspended solids; dissolved solids; oxygen-demanding substances; phosphorus; nitrogen; pesticides; toxic and hazardous substances; bacteria; viruses
Storm runoff from commercial areas	Loading dock and work area litter, parking lot runoff, refuse litter, fuels	Suspended solids; dissolved solids; oxygen-demanding substances; toxic and hazardous substances; phosphorus; nitrogen; bacteria; viruses; grease and oil
Storm runoff from industrial areas	Loading dock and work area litter, runoff from materials storage, parking lot runoff, refuse litter, fuels, wood, virgin and scrap metals, paper, plastics, salt, sand and gravel, organic deposits, fly ash, petroleum and chemical products, corrosives, waste chemicals, brush, garbage, rubber, acids, glass, ceramics, paint, glue, solvents	Suspended solids; dissolved solids; oxygen-demanding substances; toxic and hazardous substances; phosphorus; nitrogen; bacteria; viruses; grease and oil
Storm runoff from mining areas	Sand, gravel, quarried stone, dust, chemicals, petroleum products	Suspended solids; dissolved solids; grease; oil
Storm runoff from construction areas	Building materials, pesticides, fertilizers, cement, fuels, petroleum products, soil particles, garbage, litter, chemicals (paints, glues, solvents, acids, concrete curing compounds, lime, fly ash, salt)	Eroded soil particles; nitrogen; phosphorus; oxygen-demanding substances; toxic and hazardous substances; grease and oil
Storm runoff from transportation areas	Fuel, oil, grease, hydraulic fluids, coolants, engine emission particles, rubber particles, litter, brake linings, pavement particles, paints, vegetation, deicing salts, cinders, spilled materials, chemicals, pesticides, carrion, soil particles	Eroded soil particles; nitrogen; phosphorus; oxygen-demanding substances; toxic and hazardous substances; grease and oil; dissolved solids; suspended solids
Runoff from dredging and channelization areas	Soil particles, vegetation, sediments, petroleum products, organic deposits	Eroded soil particles; nitrogen; phosphorus; grease and oil; oxygen-demanding substances
Storm runoff from recreational areas	Vegetation, fertilizers, pesticides, garbage, litter, eroded soil particles, disturbed stream or lake sediments, petroleum products	Suspended solids; dissolved solids; nitrogen; phosphorus; grease and oil; oxygen-demanding substances

Table 64 (continued)

Category of Pollution Source	Principal Associated Substances Containing Pollutants	Specific Pollutants Contributed to Watercourses
Rural Categories:		
Storm runoff and direct drainage from livestock operations	Manure, bedding, eroded soil particles, pesticides	Suspended solids; dissolved solids; nitrogen; phosphorus; oxygen-demanding substances; pesticides; bacteria; viruses
Storm runoff from croplands and pasture lands	Eroded soil particles, fertilizers, pesticides, manure, crop residue	Suspended solids; dissolved solids; nitrogen; phosphorus; pesticides; bacteria; viruses
Storm runoff from orchards	Eroded soil particles, vegetation, prunings, pesticides, fertilizers, mulch	Suspended solids; dissolved solids; pesticides; nitrogen; phosphorus
Storm runoff from woodlands	Vegetation, pesticides, slashings and logging debris, wood chips, bark, eroded soil particles, leaf leachate, detritus livestock manure, wildlife droppings	Nitrogen; phosphorus; eroded soil particles; oxygen-demanding substances; pesticides; bacteria; viruses
Direct fallout of air contaminants and storm runoff from wetlands and surface waters	Air contaminants, nitrogen-oxides (NO_x), hydrocarbons, sulfur oxides, lead, particulates, organic carbon), smoke, dust, soot, fly ash, seeds, fumes, mists, odors, contaminated precipitation, dry fallout, wind-carried soil particles, wildlife droppings, aquatic vegetation, disturbed sediments	Nitrogen; phosphorus; oxygen-demanding substances; heavy metals; inorganic solids

Source: SEWRPC.

fecal coliform. The discussion below addresses nitrogen and its various forms; phosphorus; oxygen-demanding substances; pathogenic organisms, including the indicator organism fecal coliform; and suspended solids, since these are the basic parameters for which pollutant loads are estimated in the watershed discussions which will follow. A parallel discussion of the other pollutants and their effects can be found in Chapter II of Technical Report No. 21.

Nitrogen

Nitrogen is a nutrient essential for plant growth and, along with phosphorus, is often cited as causing problems of overfertilization in surface waters. The various chemical compounds of nitrogen are important water quality parameters because of the significance of nitrogen as a nutrient in the life processes of all plants and animals. The amount of growth of plants may be limited by the nitrogen concentration, provided all other required nutrients are present and above the critical concentrations.

Nitrogen may occur in water and wastewater in the form of nitrates, nitrites, ammonia, and organic nitrogen. Excessive growth of algae and other aquatic plants may occur from excessive discharges of nitrates to the streams and lakes of the Region, giving rise to unsightly scum and unpleasant odors when nitrate is present along with phosphate and other growth factors above a minimum level. In spite of having many sources, nitrates are seldom abundant in natural surface waters, for they serve as an essential nutrient for all types of plants, from phytoplankton to trees. Photosynthetic action constantly utilizes nitrates and converts them to organic nitrogen in plant cells. Methemoglobinemia, a serious or even fatal disease in infants under three months of age characterized by displacement of oxygen by nitrite in the hemoglobin in blood, is generally held to be a hazard of nitrate concentrations in excess of 45 milligrams per liter (mg/l) in drinking water, a level corresponding to about 10 mg/l of nitrate-nitrogen.

Nitrite occurs in nature as a chemically unstable substance readily oxidized to nitrate, and for this reason is normally present in very low concentrations in surface waters. Nitrites are often byproducts of bacteriological action upon ammonia and nitrogenous substances. Nitrites are toxic, but rarely occur in large enough concentrations to cause a health hazard. The brewing and dairy industries require that water contain no nitrites. In association with ammonia and nitrate, nitrites in water are often indicative of pollution.

Ammonia is the chief decomposition product from plant and animal proteins and is used as chemical evidence of pollution by sanitary wastes. In the presence of oxygen, however, ammonia is transformed by the nitrifying bacteria into nitrate. Ammonia may also result from the discharge of industrial wastes or from scouring and cleaning operations where ammonia water is used. Streams and lakes known to be unpolluted have very low ammonia concentrations, generally less than 0.2 mg/l expressed as nitrogen. In groundwater, however, ammonia generally occurs in higher concentrations as a result of natural reduction processes. High concentrations of ammonia, particularly in the presence of high pH levels, can be toxic to aquatic animals. Algae which live on high nitrate concentrations appear to be harmed or inhibited when the nitrogen is in the form of ammonia.

The organic nitrogen content of a water is contributed by amino acids, proteins, and polypeptides—all products of biological processes. An increase in the organic nitrogen content may often be related to the sewage or industrial waste pollution of a given water supply. In water treatment plants practicing chlorination, the presence of organic nitrogen and ammonia increases the amount of chlorine required since additional chlorine is utilized in the chemical formation of chloramines by the reaction of chlorine with the organic nitrogen or ammonia. Organic nitrogen also exerts a certain amount of chemical oxygen demand, since oxygen present in the surface water is utilized in the oxidation of organic nitrogen, reducing the dissolved oxygen concentrations vital for aquatic life.

For ammonia, concentrations of 0.02 mg/l as un-ionized ammonia is the EPA-recommended level in freshwater streams to avoid conditions toxic to warmwater fish. There are no state or federally recommended levels for concentrations of nitrate, nitrite, or organic nitrogen forms in lakes or streams, since the hazardous or toxic levels are very unlikely to occur. Studies[2] have indicated that the approximate threshold concentration for algae growth in lakes is 0.1 mg/l[3] nitrate-nitrogen. Nitrate-nitrogen concentrations below 0.1 mg/l, however, can be supplemented by nitrogen fixation from atmospheric sources which occurs in blue-green algae.[4,5] Blooms by nonnitrogen-fixing algae can be anticipated in lakes when the inorganic nitrogen[6] concentrations exceed 0.3 mg/l,[7] providing the phosphate-phosphorus level exceeds 0.01 mg/l. Given the potential natural sources of nitrogen forms and the difficulty of controlling such sources—which may include atmospheric fallout and washout—nitrogen standards for surface waters appear impractical.

[2] *State of California Publication No. 34, Eutrophication—A Review, State Water Quality Control Board, 1967, p. 30.*

[3] *P. Fay et al, "Is the Heterocyst the Site of Nitrogen-Fixation in Blue-Green Algae?" Nature, 220:810, 1968.*

[4] *Ibid.*

[5] *W.G.W. Kurz and T.A. LaRue, "Nitrogenase in Anabaera flos-aquae Filaments Lacking Heterocysts," Naturwissenschatten, 58:417, 1971.*

[6] *Inorganic nitrogen includes the nitrate-nitrogen, nitrite-nitrogen, and ammonia-nitrogen concentrations collectively.*

[7] *C. N. Sawyer, "Fertilization of Lakes by Agricultural and Urban Drainage," Journal New England Water Works Association, Volume 61, 1947.*

Phosphorus

To control algae and aquatic plant growths in surface waters due the influx of a critical nutrient, contemporary water resources management practice places emphasis on phosphorus control rather than on the control of nitrogen or the other necessary elements which are generally more readily available in the natural environment.

High phosphate concentrations in water are associated with excessive algae or other aquatic plants growths. Algae have been frequently cited as responsible for unpleasant taste and odor in drinking water supplies. Algae growths can impart color and turbidity to water. Algae also interfere with the water treatment processes of filtration and disinfection and reduce the useful capacity of reservoirs by concentrating at certain depths in the water or along the shallow margins or bottom. Other problems caused by algae in domestic water supplies include clogging of intake screens and reduction of flow capacity. Algae are also undesirable in water for a variety of industrial uses, including cooling towers, paper manufacture, laundry, photography, and chemical industries. Algae can cause heavy fish mortality through direct poisoning or by the depletion of oxygen as a result of the death and decay of excessive growths. Algae, both fresh and decaying, have also been reported to be toxic to livestock and wildlife. Deaths of a variety of animals, after drinking water containing high concentrations of blue-green algae such as Aphanizomenon, Anabaena, and Anacystis, have been reported from many parts of the world if not specifically from southeastern Wisconsin. Excessive growths of algae destroy recreational and aesthetic values of lakes and also cause inconvenience to the recreational users. Wave action may concentrate a large amount of algae on shore, which, if not removed immediately, will cause foul odors and an offensive appearance during decomposition.

Aquatic fertilization can also induce heavy growth of large, rooted, aquatic plants or macrophytes. The aesthetic and chemical hazards of plant overgrowth from macrophytes is similar to that associated with algae, although macrophytes pose no health hazards. Although macrophytes may provide some aquatic wildlife habitat, in extremely heavy growths they may reduce shore erosion from wave action, and have even been suggested to improve water quality by nutrient uptake or by encouraging the settling of suspended solids. The largest and most hardy macrophytes, however, do present a structural impediment to desirable water use because of the strength and durability of certain of their specialized, fibrous tissues. The snarling of boat propellers, water skis, and fishing tackle and documented cases of entanglement and resultant drowning of swimmers have caused public objection to the presence of macrophytes. The ameliorative measures of chemical treatment and weed harvesting have resulted in increasing levels of local expenditures to control this water quality problem.

Studies[8] have indicated that 0.01 mg/l phosphate-phosphorus is the approximate threshold concentration for algae growth in lakes if sufficient nitrogen is also available, along with other necessary conditions such as temperature, incident sunlight, or the presence of essential elements like boron. Federal reports on water quality criteria[9,10] contain guideline values of a maximum of 0.10 mg/l total phosphorus in flowing streams and 0.05 mg/l in streams entering lakes or reservoirs to prevent nuisance growth of aquatic plants in streams and lakes.

Oxygen-Demanding (Degradable Organic) Substances

One especially offensive type of pollution occurs when relatively large amounts of putrescible organic materials, which require oxygen for their decomposition, are introduced into waters. The biodegradation, or oxidation, of carbonaceous or nitrogenous materials by bacteria and microorganisms depends on the dissolved oxygen already present in the receiving waters, oxygen entering from the atmosphere, and oxygen released by photosynthetic processes. When the rate of oxidation is greater than the rate of oxygen replenishment, the concentration of dissolved oxygen in receiving waters declines. In addition, algae and other aquatic plants may cause large daily fluctuations in the dissolved oxygen concentrations of surface waters, as these plants produce oxygen through photosynthesis during the daylight hours and consume oxygen by respiration at night. Such diurnal dissolved oxygen variations often produce unfavorable conditions for the maintenance of desirable forms of aquatic animal life during the low phase of the daily cycle. Low dissolved oxygen concentrations in surface waters create an unsuitable environment for fish and other desirable forms of aquatic life, and the absence of dissolved oxygen leads to a septic or anaerobic condition with its associated foul odors and unpleasant appearance. Anaerobic conditions also affect the release rate of toxic materials and nutrients from sediments and increase denitrification rates. The state and federally adopted water quality standards call for 5.0 mg/l of dissolved oxygen for the protection and propagation of fish and other aquatic life. However, a 6.0 mg/l concentration is recommended for trout streams, with 7.0 mg/l specified for trout spawning periods.

The five-day biochemical oxygen demand (BOD_5) is a measure of the oxygen used over a five-day period at 20°C in the aerobic bacterial decomposition of the organic wastes in a water sample. Thus, BOD_5 is a frequently used measure of the concentration of decomposable organic substances. It should be noted that BOD_5 is not a pollutant, since it is not a specific chemical substance, physical property, organism, or group of organisms; and it is measurable only in the presence of aerobic decay bacteria under a set of controlled test conditions that do not prevail in nature. BOD_5 determinations are important in water quality studies because they indicate levels of organic pollution and the attendant potential decrease in dissolved oxygen concentration. Without the knowledge of the reaeration characteristics of a stream, BOD_5 values cannot be used except in a very general way to determine where dissolved oxygen concentrations may reach critically low levels for the preservation of fish life. However, in this report BOD_5 is regarded as a pollutant and as an aid to prediction, analysis, and planning.

Pathogenic Organisms

Because they can cause serious illness in animals and in man, bacteria and viruses are among the most important of the pollutants which can impair water use in southeastern Wisconsin. These are insidious pollutants because they can be detected only through the application of sophisticated laboratory procedures. However, the bacteriological safety of water can be determined in the test for "coliform bacteria," which refers to a group of bacteria which are rod shaped, aerobic, facultative anaerobic, gram-negative, and nonsporeforming, and which ferment lactose with gas formation within 48 hours after incubation at 35°C. This combination of structural and physiological characters exists in the genera Escherichia, Erwinia, Salmonella, Shigella, Serratia, and Enterobacter, a large and ecologically somewhat diverse group.

The number of coliform bacteria per unit volume of water is the most widely used indicator of the possible presence of disease-producing organisms. Coliform bacteria are easily detected and apparently harmless microorganisms which occur in extremely large concentrations in the intestinal tracts of man and warm-blooded animals, along with the pathogenic—or disease-producing—bacteria. Therefore, the presence of large numbers of coliform bacteria in a water is used as an indicator of the possible presence of enteric pathogens in that water, while the absence of coliform bacteria is used as an indicator of the probable absence of pathogenic bacteria. Coliform bacteria are also present in the soil, however, and therefore may originate from sources other than the human intestinal tract, so that a high coliform count is not necessarily indicative of fecal pollution. Tests have been developed to determine the number of actual fecal coliform organisms present in water, and such tests are considered a better indicator of the probable presence of disease-producing organisms than total coliform tests.

The genera Salmonella and Shigella include most of the important causative agents of intestinal disease in man—the agents of bacillary dysentery, infectious hepatitis, typhoid and paratyphoid fevers, and one of the most

[8] *State of California Publication No. 34, Eutrophication—A Review, State Water Quality Control Board, 1967, p. 30.*

[9] *Water Quality Criteria, Report of the National Technical Advisory Committee, p. 34.*

[10] *U. S. Environmental Protection Agency, Water Quality Criteria, Ecological Research Series, March 1973, p. 81.*

common and serious kinds of food poisoning. These pathogens are transmitted almost exclusively by the fecal contamination of water, food, and milk. Transmission through water is by far the greatest means of infection and has been the source of mass epidemics. Today, typhoid fever is a very rare disease in most civilized countries, and its disappearance has been achieved largely by the sanitary control of water supplies. It is seldom possible to isolate intestinal pathogens directly from water that has undergone fecal contamination unless the water has been recently and massively contaminated. However, any water supply that is contaminated with fecal matter is a potential source of disease, and thus the recognition of such contamination is essential to sanitary control.

The drinking water standards established in 1974 by the Wisconsin Department of Natural Resources limit the mean total coliform concentration in treated drinking water to one colony per 100 milliliters (ml) by the membrane filter coliform count (MFCC) method. In water used for the maintenance of fish and other aquatic life and for recreational purposes, State of Wisconsin standards specify a monthly geometric mean membrane filter fecal coliform count (MFFCC) based on a minimum of five samples per month of not more than 200 colonies per 100 ml, and a maximum count not exceeding 400 colonies per 100 ml for more than 10 percent of the samples during any month.

Viruses can be transmitted to water and infect human populations by contaminating the drinking water, food, milk, and swimming areas. Although enteric viruses are found in relatively small numbers in polluted waters, their occurrence could be hazardous since the minimum infective dose for humans has not been firmly established.[11] Viruses are submicroscopic infective agents so small as to be regarded either as the simplest of microorganisms or as extremely complex molecules containing a protein coat surrounding a core of genetic material and being capable of growth and multiplication only within living cells. Viruses are the causes of various important diseases in man, lower plants, and animals. Viruses can be transmitted by water and infect human populations by contaminating drinking water, food and milk, swimming areas, or other media to which humans are exposed. Although there are means of immobilizing or inactivating viruses, there is no consistently and predictably effective general virucidal technique available. Although some viruses have been found to be more susceptible to inactivation by chlorine, others are typically more resistant to chlorine than are coliform bacteria. Standard analyses for bacteria cannot satisfactorily predict the presence of viruses, since viral bodies are significantly smaller than bacteria and their survival and growth rates differ widely within as well as between the two categories. No single indicator organism has found favor or primary use in the water chemistry profession to identify or indicate the presence of viruses. To a large degree, the sanitary engineering profession has relied upon the use of fecal coliform bacteria and other bacterial indicators as surrogates for the presence of human waste and potential viral contamination.

In addition to a wide range of moderately hazardous or disabling diseases such as influenza or measles, viruses have also been shown to be responsible for such diseases as viral carditis, chicken pox, hemorrhagic fever, infectious and serum hepatitus, infectious mononucleosis, mumps, rabies, rubella, smallpox, and poliomyelitis.[12] Accordingly, there is no single or generally recommended level of a single indicator virus for utilization in the analysis of the potential viral health hazards, and indeed little or no viral sampling is available for the natural waters of the lakes and streams of southeastern Wisconsin.

Suspended Solids

Soil erosion by wind, rain, or other mechanical means destroys the microstructure of the soil, removing organic, microbial, and inorganic particles which may range in size from very fine clay particles to coarse sand particles. The size and density of the particles, as well as the natural chemical content, determine the pollution effects since the smaller particles present a larger proportion of surface area upon which nutrients and pesticides may be absorbed. The eroded soil particles may carry with them nitrogen, phosphorus, pesticides, heavy metals, oxygen-demanding substances, and pathogenic organisms. Therefore, eroded soil particles are important transport mechanisms by which pollutants may be moved into and through a stream system. Once they are within an aqueous environment, the soil particles may either be dissolved or suspended in the overland (sheet) flow of water to the nearest stream. The dissolved solids contribute to the hardness of natural waters. The dissolved and suspended solids both may adversely affect fish and aquatic life by reducing oxygen levels and by adding color and otherwise decreasing the water clarity, thereby interfering with natural feeding patterns. A decrease in clarity can be measured directly by the turbidity of the water, or can be inferred from the levels of total dissolved and suspended solids.

The volatile or organic component of the suspended solids discharged from a sewage treatment plant may produce excessive oxygen demand on the receiving waters, thereby producing fishkills, odors, and generally noxious conditions. Suspended solids in sewage treatment plant effluent and land surface washoff may result in excessive color and turbidity in the receiving stream and may be detrimental to fish by causing abrasive injuries, obstructing respiratory passages, and covering and thereby damaging or destroying eggs in spawning areas.

[11] *U. S. Environmental Protection Agency, Quality Criteria for Water, 1976 Ecological Research Series.*

[12] *Bella G. Liptak, ed., Environmental Engineers Handbook, Volume 1, Water Pollution, Chilton Book Company, 1974, pp. 427-430.*

In streams, the suspended solids drop out of the streamflow when the velocity of movement is reduced sufficiently and settle to the bed of the stream. This process, referred to as sedimentation, may impair the use of the watercourse by the physical displacement of water. Sediment may plug culverts and road ditches, cause localized flooding as the surface drainage patterns are changed, and interfere with commercial and recreational navigation. Deposited on the bed of a stream or lake, the particles create an aesthetic nuisance and may cover benthic organisms, thus shutting off the supplies of light and flowing water needed for life and making these organisms inaccessible as food sources for the other, more mobile creatures in the aquatic system.

As sediment, the soil particles also function as a storage site for the chemical pollutants they carry with them. Nitrogen, phosphorus, pesticides, heavy metals, and some organic matter and pathogenic organisms may be present. Such pollutants may be released by desorption under various conditions not well understood at the present time. It is known that the phosphorus in the sediment is more readily released under anaerobic conditions, under which ferric iron may be changed to ferrous iron and form ferrous phosphate, which is highly soluble. Similarly, it is known that changes in the pH of water can affect the solubility of phosphorus compounds with calcium, magnesium, iron, and aluminum. Temperature is also thought to be an important variable in these processes. As noted below, nitrogen, phosphorus, pesticides, heavy metals, and organic substances all constitute water pollutants with their own attendant hazards and adverse effects.

Federal recommendations relating to the preservation of fish and other aquatic life seek to limit the presence of suspended solids in natural waters to levels which will not reduce by more than 10 percent the seasonal depth of the effective limits of photosynthetic activity. Localized concentrations of 80 mg/l of inert suspended solids have been shown to cause 60 percent density reductions in the populations of macroinvertebrates, while sediment accumulation as a result of any significant concentration in the overlying waters has been shown to cause a 60 percent reduction in benthic invertebrate populations.

DATA SOURCES

The Commission has assembled the known information on the loading rates of the predominant pollutants associated with each of the various sources of pollution and has summarized the relative magnitude of the pollution sources within each of the 12 major watersheds of the Region. The data utilized for the inventory of pollution sources were assembled from many informational sources including:

1. The special inventory of agricultural land management and cropping practices conducted within the Region by the Commission with the assistance of the local soil and water conservation districts and knowledgeable local residents of each civil town of the Region, as well as the U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service, and the University of Wisconsin-Extension Service. This specialized inventory identified, in addition to the types and locations of agricultural land management practices and cropping practices within each watershed, the locations, types, and numbers of all livestock herds in excess of 25 head and the locations of the known sites of severe soil erosion.

2. The Commission 1970 land use inventory and a specialized interpretation and inventory of the land cover characteristics of the 1975 land use delineations, including the identification of areas of new urban development and construction activity on lands under development.

3. A specialized inventory of sanitary sewerage systems utilizing local mapping and building on the inventory of such systems by the Commission in 1972 under the regional sanitary sewerage system planning program and in 1964 under the initial regional planning efforts, as well as the facility plans prepared by local communities under the provisions of Section 201 of the 1972 Federal Water Pollution Control Act.

4. A specialized inventory of storm water management systems utilizing local mapping and building on the inventory conducted by the Commission in 1964 of public utility systems under its initial planning efforts.

5. Industrial discharge data from the regional sanitary sewerage system plan, the Wisconsin Administrative Code monitoring and surveillance program as established under Wisconsin Administrative Code Chapter NR 101, the Wisconsin Pollutant Discharge Elimination System records of the Department of Natural Resources, and data developed as part of the user charge/industrial cost recovery project under the Milwaukee-Metropolitan Sewerage District facility planning effort.

6. Annual public works reports of cities and villages.

7. Specialized Commission inventories of urban land management practices and pollution sources, including salting, sanding, plowing and snow hauling, street sweeping, and landfilling.

8. Specialized Commission inventories of other sources of diffuse pollution, including quarries, gravel pits, lake and stream dredging, channelization, and holding tanks and mound systems used for onsite sewage disposal.

Given the information from the above-cited major inventories and the available data on pollutant loading rates as obtained from technical literature, a set of annual loading rates for the major pollution sources was identified which was internally consistent—as opposed to the widely ranging and sometimes inconsistent values reported in the technical literature—and judged sound in their depiction of the relative water quality effects of various human activities occurring within the Region. In the selection of loading rates, information was accumulated from the SEWRPC Technical Report No. 18, State of the Art of Water Pollution Control for Southeastern Wisconsin, as well as from technical literature and special local studies. The latter included the results of studies conducted under the Washington County Sediment and Erosion Control Project and the International Joint Commission Pilot Study of the Menomonee River watershed, and fields studies conducted by the Wisconsin Department of Natural Resources. The selection of these channel loading rates is discussed in SEWRPC Technical Report No. 21, Sources of Water Pollution in Southeastern Wisconsin: 1975.

This chapter sets forth estimates of the pollutant channel loads from the various pollution sources as a basis for the development of an effective areawide water quality management plan which concentrates initial control measures on the most severe pollution sources. Table 65

Table 65

SUMMARY OF REPORTED POLLUTANT LOADING RATES FROM DIFFUSE SOURCES

	Rate of Pollution Loading[a] (given in pounds per acre per year except for MFFCC given in counts per acre per year)				
Category of Diffuse Pollution Sources	Total Nitrogen	Total Phosphorus	Biochemical Oxygen Demand	Membrane Filter Fecal Coliform Counts	Sediment
Urban					
Residential Land Use	4.0	0.32	24.3	1.6×10^{10}	545
	(1.9-11.5)	(0.32-7.3)	(10.2-95.9)		(356-7,360)
Commercial Land Use	9.0	0.75	97.6	3.3×10^{10}	745
	(9.0-77.4)	(0.75-4.1)	(16-168)		
Industrial Land Use	8.4	0.70	36.9	6.2×10^{10}	977
	(8.4-76.4)	(0.82-9.4)	(16-188)		
Construction Activities	60.0	45.0	120.0	Negligible	150,000
	(60-150)	(45-120)	(120-4,500)		(3,000-380,000)
Extractive Activities	60.0	45.0	120.0	Negligible	150,000
	(60-150)	(45-120)	(120-4,500)		(3,000-380,000)
Transportation—					
Freeways and Highways	23.4	1.4	159.0	6.7×10^{10}	42,600
Airports—Mitchell Field	13.5	2.6	73.0	Negligible	2,900
—Other	12.0	2.7	17.6	Negligible	3,200
Recreation—Parks	2.3	0.06	1.3	3.6×10^{9}	420
	(2.3-26.1)	(0.06-1.53)			(420-750)
Recreation—Golf Courses	4.4	0.20	1.3	Negligible	420
	(4.4-26.1)	(0.20-1.53)			(420-750)
Onsite Sewage Disposal Systems (load per capita per year)	1.4-5.7	2.33-1.32	20.4-81.6	2.5×10^{10} - 1.0×10^{11}	7-28
Rural					
Livestock Operations (load per animal unit per year)	28.4	6.6	111.2	6.4×10^{11}	700
Orchards	2.3	0.14	4.6	6.6×10^{8}	251
	(0.7-9.1)	(0.01-0.80)	(3.6-6.3)		(45-389)
Pastures	4.6	0.29	9.7	Included in Livestock Load	420
	(1.0-7.6)	(0.22-0.57)	(5.4-15.4)		(12-828)
Woodlands	2.3	0.14	4.6	6.6×10^{8}	251
	(0.7-9.1)	(0.01-0.80)	(3.6-6.3)		(45-389)
Air Pollution to Surface Waters	8.9	0.5	162.0	Negligible	665
	(4.4-39.4)	(0.045-1.60)	(153-162)		(614-1,500)
Croplands	0.9-23.1	0.09-0.64	2.1-30.0	Included in Livestock Load	700-10,000
General Agricultural Land	(0.03-23.1)	(0.09-2.59)	(Not Available)	Included in Livestock Load	(680-51,400)

[b] *The single numbers shown represent the chosen channel loading rate taken as representative of the average rate of pollutant loading into a drainageway, even though the drainage channel may flow intermittently—only during storm event or snowmelt conditions—and all of the pollutant may not be transported downstream to the discharge point of a watershed.*

Source: SEWRPC.

summarizes the pollutant loading rates utilized in order to estimate the average loadings from the nonpoint sources. A discussion of the means used to develop these loading rates is set forth in SEWRPC Technical Report No. 21. It should be noted, however, that the general loading rates utilized in the development of the data presented in this chapter have been further refined under the water quality simulation modeling, reported in Volume Two, Chapter IV of this report, through the incorporation in the modeling of the specific meteorological conditions within a given watershed or portion of a watershed as depicted by: the long-term weather records at 17 in-Region and 13 out-of-Region weather bureau stations; soil types and slopes; size and configuration of the tributary drainage areas; size and configuration of the drainage network itself; channel, floodplain slopes, and other hydraulic characteristics of the stream networks; and most importantly, in-stream water quality measurements as determined by sampling during both dry weather, low-flow conditions, and wet weather or storm-related conditions. Such in-stream measurements were taken at 87 Commission sites within the Region during the period from 1964 through 1975; at an additional 36 special sampling stations operated during 1976 for the explicit purpose of calibrating the water quality simulation model; and at 198 water quality sampling stations on 13 major lakes and influent streams thereto monitored as part of the Commission inland lake water quality studies. The inland lakes selected for study were carefully chosen with regard to their size, depth, tributary land uses, trophic status, and hydrologic characteristics to provide a full cross-section of the different types of lakes within the Region and to thus support extension of the lake water quality analyses to the remaining major lakes in the Region.

DES PLAINES RIVER WATERSHED

The Des Plaines River watershed within southeastern Wisconsin is a natural surface water drainage area, 134.0 square miles in areal extent located in the southeastern portion of the Region. The boundaries of the basin, together with the locations of the main channels of the Des Plaines River and its principal tributaries, are shown on Map 41, along with the locations of the known point sources of pollution and the generalized land uses as of 1975. The main stem of the Des Plaines River rises south of Union Grove near the Racine-Kenosha County line and flows in a general southeasterly course for 20.7 river miles, leaving the State about 1.5 miles east of Interstate Highway 94. About 93 percent of the total area of the watershed is still in rural land uses, with about 77 percent of this rural area in agricultural use. Most of the urban-related land use is located in the western portions of the watershed around Lakes Paddock, George, Hooker, Montgomery, and Benet/Shangrila, and within the corporate limits of Union Grove and Kenosha. Table 66 sets forth the extent and proportion of the major land cover categories within the watershed as they relate to water quality conditions in 1975.

The soils within the Des Plaines River watershed consist of deep to moderately deep silt loams. Most of the soils are relatively fertile and produce high crop yields if managed correctly. Sediment discharges from these soils may result in high levels of nutrients in stream waters.

Particularly important to comprehensive water quality management planning are the soil suitability interpretations for specified types of urban development. Based upon the interpretations of the soil properties, about 35 percent of the watershed is covered by soils that have severe or very severe limitations for residential development with public sanitary sewer services as shown on Map 42; virtually the entire watershed, or about 98 percent, is covered by soils that have severe or very severe limitations for small lot (less than one acre in size) residential development without public sanitary sewer, as shown on Map 43; and about 58 percent of the watershed is covered by soils that have severe or very severe limitations for large lot (one acre or larger in size) residential development, as shown on Map 44.

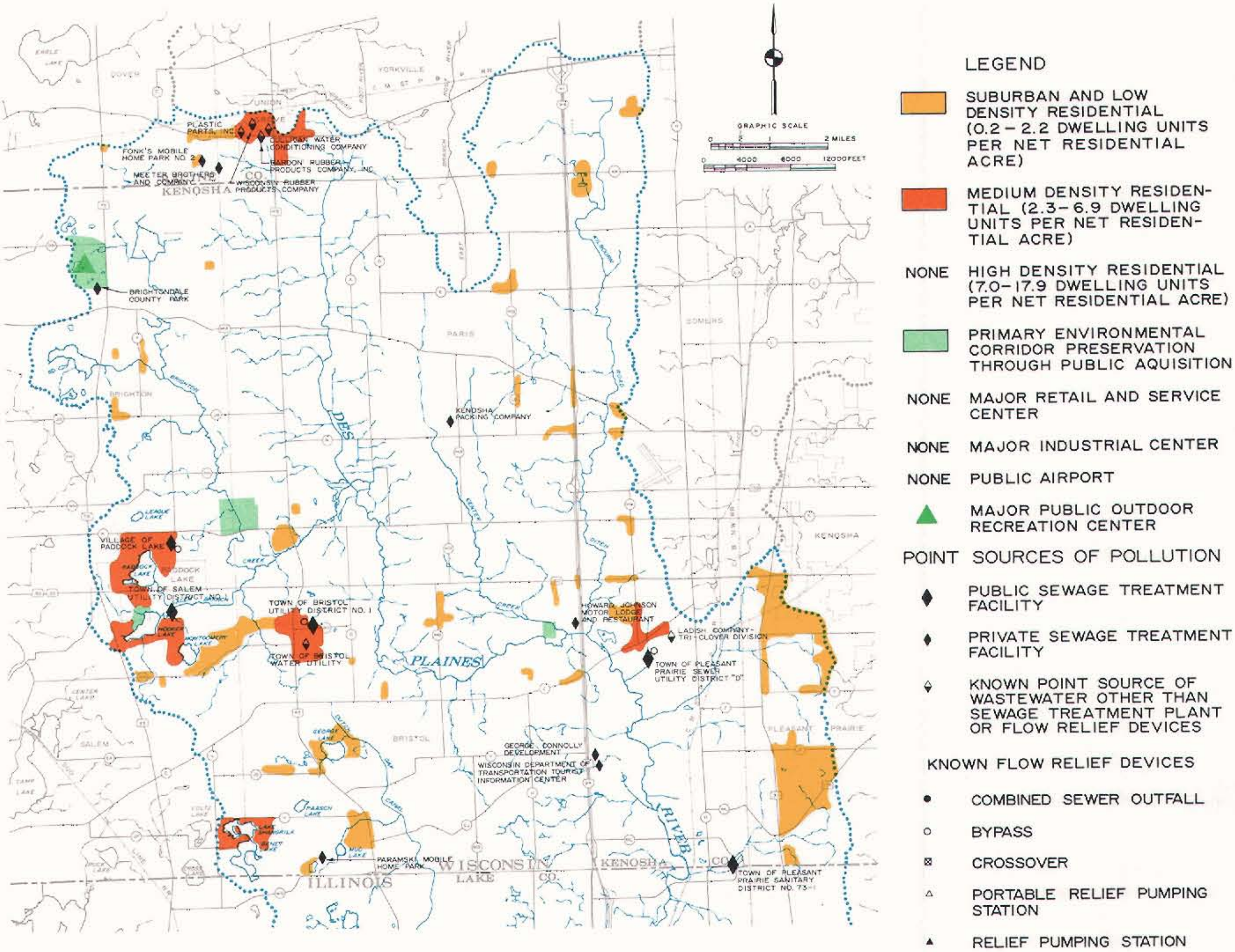
Municipal and Private Sewage Treatment Facilities

In 1975, a total of seven sanitary sewerage systems or portions thereof served a total area of about 9.96 square miles within the watershed, or about 7 percent of the total area of the watershed, and a total population of about 6,300 persons, or approximately 40 percent of the total resident population of the watershed.

Five municipally owned sewage treatment plants are located in the Des Plaines River watershed. The two plants which serve the Town of Pleasant Prairie Utility District "D" and the Town of Pleasant Prairie Sanitary District No. 73-1 discharge treated effluents directly to the main stem of the Des Plaines River; the two plants which serve the Village of Paddock Lake and the Town of Salem discharge indirectly to Brighton Creek, and directly to the Salem Branch of Brighton Creek, respectively; and the plant which serves the Town of Bristol discharges treated effluent directly to a tributary of the Des Plaines River. Selected information for these municipal sewage treatment plants is set forth in Table 67, and the plant locations are shown on Map 41. In addition to the publicly owned sewage treatment facilities, eight private wastewater treatment facilities exist in the Des Plaines River watershed owned and operated by: Fonk's Mobile Home Park No. 2 in Racine County; and Brightondale County Park, George Connolly Development, Howard Johnson Motor Lodge, Kenosha Packing Company, Meeter Brothers Company, Wisconsin Tourist Information Center, and Paramski Mobile Home Park in Kenosha County. Selected data on these eight privately owned wastewater treatment facilities are presented in Table 68 and the locations of these facilities are shown on Map 41. Of the five publicly and eight privately operated sewage treatment facilities, one facility discharges effluent directly to the main stem of the Des Plaines River, one discharges indirectly to the main stem of the Des Plaines River, six to unnamed tributaries of the Des Plaines River, and one to Mud Lake. Of the

Map 41

THE LOCATION, BOUNDARIES, MAJOR STREAMS, AND LAKES OF THE DES PLAINES RIVER WATERSHED—SHOWING POINT SOURCES OF POLLUTION AND GENERALIZED LAND USES: 1975



The Des Plaines River watershed is about 134 square miles in areal extent, or about 5 percent of the total area of the Region. The water quality in the watershed is affected by the various land uses as well as by the five public wastewater treatment plants, eight private wastewater treatment plants, three flow relief devices, and six other point sources of wastewater as shown.

Source: SEWRPC.

remaining four facilities, one discharges indirectly to Brighton Creek, one discharges to the Salem Branch of Brighton Creek, and two utilize soil absorption systems.

Sanitary Sewerage System Flow Relief Points

In 1975, there were three known sanitary sewer flow relief devices in the watershed, as listed in Table 69 and shown on Map 41. All three were sanitary sewerage system bypasses. Of the three devices, two discharge directly to the main stem of the Des Plaines River and one discharges directly to Brighton Creek.

Other Known Point Sources

A total of six other known point sources of pollution were identified in the watershed in 1975. These other point sources consisted primarily of six outfalls through which industrial cooling, process, rinse, wash waters, and filter backwash waters were discharged directly or

Table 66

AREAL EXTENT OF THE WATER QUALITY-RELATED LAND COVER IN THE DES PLAINES RIVER WATERSHED: 1975

Land Cover[a]	Square Miles	Acres	Percent
Urban			
Residential	4.84	3,096	3.66
Commercial[b]	0.59	380	0.45
Industrial			
Manufacturing	0.22	143	0.17
Landfills and Dumps	0.22	143	0.17
Extractive	0.27	170	0.20
Transportation			
Streets and Highways	1.23	787	0.93
Airfields	0.07	45	0.06
Railroad Yards and Terminals	--	--	--
Recreation			
Golf Courses	0.57	367	0.43
Parks and Other Recreation	0.41	261	0.31
Land Under Development			
Residential[c]	1.19	764	0.90
Commercial	--	--	--
Industrial	0.14	88	0.10
Transportation	--	--	--
Recreation	--	--	--
Rural			
Agricultural			
Small Grains	6.87	4,396	5.19
Hay	10.45	6,689	7.90
Row Crops	69.60	44,543	52.63
Specialty Crops	1.60	1,026	1.21
Sod Farm	0.03	22	0.03
Other Open Space[d]	13.85	8,864	10.48
Silvicultural			
Woodlands	7.13	4,560	5.39
Orchards and Nurseries	0.18	115	0.14
Natural and Man-Made Water Areas—Subject to Atmospheric Pollutant Contributions			
Ponds, Lakes, and Streams	1.76	1,127	1.33
Wetlands, Swamps, and Marshes	11.00	7,041	8.32
Total	132.22	84,627	100.00

[a] These special land cover categories, defined primarily according to their imperviousness and vegetative cover characteristics and effects on the quality of storm water runoff, were delineated at a scale of 1" = 400' on aerial photographs taken in May 1975 and were measured to the nearest full acre, using dot-counting overlays. The total acreages measured within hydrologic subbasins were then adjusted to the control totals measured by digitizer from base maps of hydrologic subbasins at a scale of 1" = 2000'. Both the "square miles" and the "percent" shown above were then computed and rounded to the nearest hundredth (0.01) of a percent.

[b] Includes: retail, communication, utilities, administrative, and institutional land uses.

[c] Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.

[d] Includes: pasture, unused urban and rural lands.

[e] The total area of the Des Plaines River watershed represented in this table is different than the total area of the Des Plaines River watershed identified in the text and on Map 41. This is due to the fact that the area set forth on Map 41 includes only that portion of the Des Plaines River watershed lying within the civil boundaries that comprise the Southeastern Wisconsin Region. The area of the Des Plaines River watershed represented in this table represents an aggregation of subbasins, the boundaries of which do not always coincide with the civil boundaries of the Region.

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service; County Soil and Water Conservation Districts; University of Wisconsin-Extension Service; and SEWRPC.

indirectly to the surface water system. Of these, three were identified as discharging only cooling water. The remaining three were discharging other types of wastewaters. Industrial wastewater enters the Des Plaines River and its major tributaries directly through industrial waste outfalls or indirectly through drainage ditches and storm sewers. Table 70 summarizes by receiving stream and civil division the characteristics of these other point sources and Map 41 shows their locations. Two of these other point source outfalls discharge to an unnamed tributary of the Des Plaines River main stem via storm sewers, three industrial outfalls discharge to unnamed tributaries of the Des Plaines River, and one point source outfall discharges to an unnamed tributary of Salem Branch Creek.

Privately Owned Onsite Sanitary Wastewater Treatment

In addition to being provided through centralized sanitary sewerage service within the watershed, sanitary wastewater treatment and disposal is provided through approximately 2,716 privately owned onsite sewage disposal systems consisting of 2,697 septic tanks, 12 holding tanks, and 7 mound systems. These systems serve a total resident population of about 9,500 persons, or 60 percent of the total resident population of the watershed. Of this total, about 2,000 persons, or about 21 percent, resided in concentrated areas of urban development having at least 32 housing units in a U. S. Public Land Survey quarter section. These scattered quarter sections of urban land use concentration totaled about 2.3 square miles of urban land use, or slightly less than 2 percent of the total area of the watershed.

Urban Storm Water Management Systems

As noted in Table 66, land cover categories associated with urban land uses as of 1975 comprised about 6,200 acres, or about 7 percent of the Des Plaines River watershed. The most important urban land cover category was residential land, with about 4 percent.

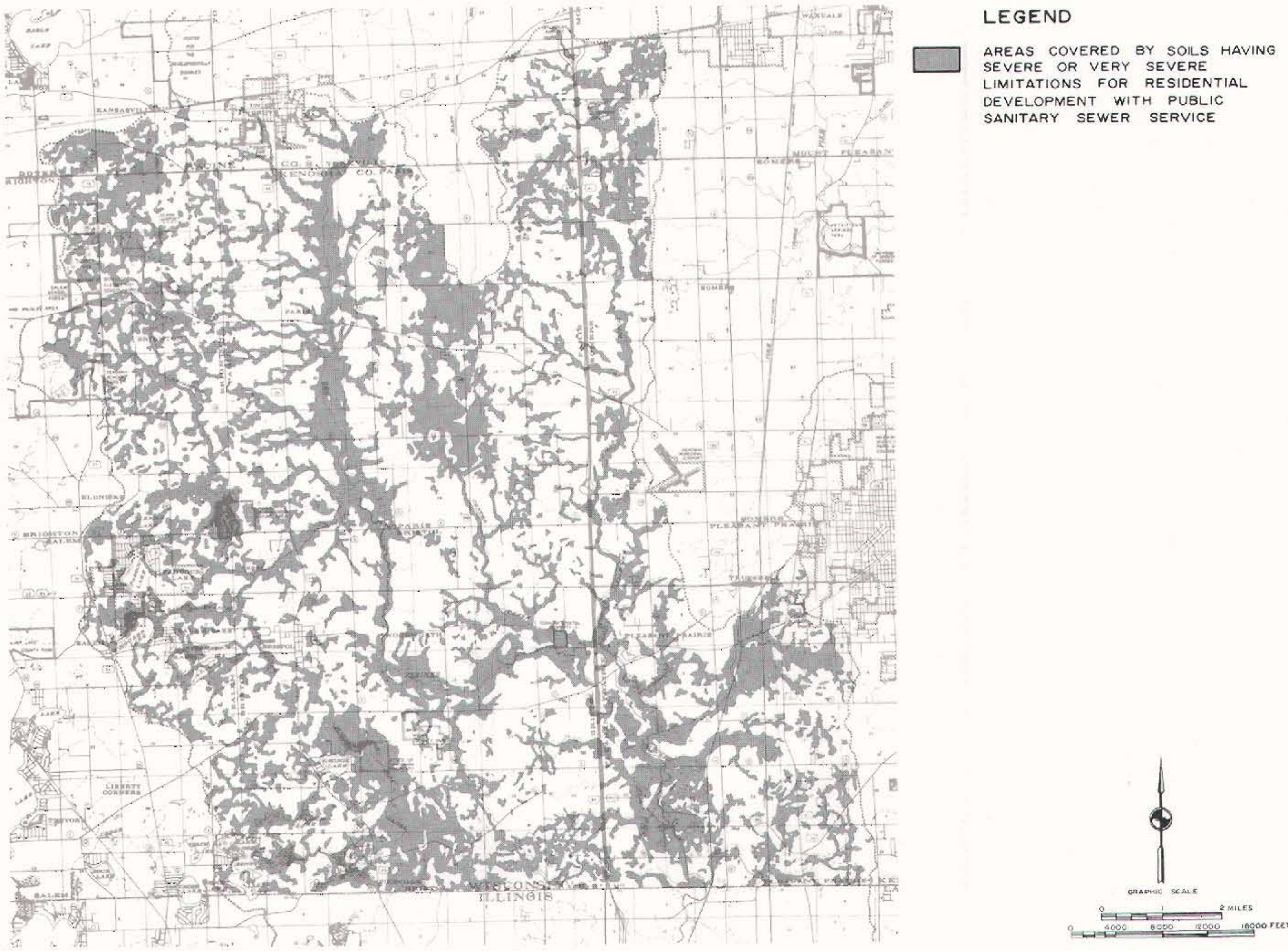
There is one known urban storm water drainage system that provided service to the subareas of the Des Plaines River watershed within the Region in 1975—the system operated by the Village of Union Grove. This storm water drainage system has a tributary drainage area of about 0.3 square mile, or about 0.2 percent of the total area of the watershed. Included within this storm water drainage area are a total of two known storm water outfalls which are 24 inches and 36 inches in diameter. The total annual average discharge from these outfalls is estimated to be about 62 million gallons per year occurring on the average in 65 events. There were no known storm water pumping facilities or storm water storage facilities in the watershed.

Rural Storm Water Runoff

About 78,400 acres, or about 93 percent of the total area of the watershed, are devoted to rural land use activities. The most important rural land cover categories were row crops with 53 percent, hay with 8 percent, other open space with 10 percent, small grains with 5 percent, woodlands with 5 percent, and wetlands, swamps, and marshes with 8 percent of the watershed. As of May 1975, there were an estimated 133 domestic livestock operations—operations of 25 or more equivalent animal units—having a total of 12,340 equivalent animal units within the watershed. Of the 133 operations, 35, or 26 percent,

Map 42

SUITABILITY OF SOILS FOR RESIDENTIAL DEVELOPMENT WITH PUBLIC SANITARY SEWER SERVICE IN THE DES PLAINES RIVER WATERSHED



Of particular importance in comprehensive water quality planning is the recognition of the limitations inherent in the soil resource base. About 35 percent of the area of the Des Plaines River watershed is covered with soils which are poorly suited for residential development with public sanitary sewer service or, more precisely, residential development of any kind. These soils, which include wet soils having a high water table or poor drainage, organic soils which are poorly drained and provide poor foundation support, and soils which have a flood hazard, are especially prevalent in the riverine areas of the watershed.

Source: U. S. Soil Conservation Service and SEWRPC.

were located within 500 feet of the surface water system of the watershed.

Pollution Loadings

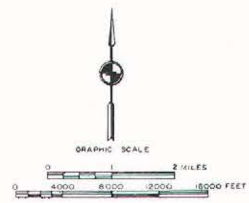
A summary of the estimated average annual pollution loadings in the Des Plaines River watershed is presented in Table 71 and depicted in Figure 30. Urban sources of pollution are estimated to contribute 11 percent of the nitrogen, 38 percent of the phosphorus, 30 percent of the biochemical oxygen demand, 12 percent of the fecal coliform, and 33 percent of the sediment which occur as water pollutants to the Des Plaines River watershed. Of the urban contribution, point sources of pollution are estimated to contribute 11 percent of the nitrogen, 13 percent of the phosphorus, 2 percent of the biochemical oxygen demand, 1 percent of the fecal coliform,

Map 43

SUITABILITY OF SOILS FOR SMALL LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE IN THE DES PLAINES RIVER WATERSHED

LEGEND

AREAS COVERED BY SOILS HAVING SEVERE OR VERY SEVERE LIMITATIONS FOR RESIDENTIAL DEVELOPMENT WITH SEPTIC TANK SEWAGE DISPOSAL ON LOTS LESS THAN ONE ACRE IN SIZE



Approximately 98 percent of the area of the Des Plaines River watershed is covered by soils poorly suited for residential development on lots having an area smaller than one acre and not served by public sanitary sewerage facilities. Reliance on septic tank sewage disposal systems in these areas, which are covered by relatively impervious soils or are subject to seasonally high water tables, can only result in eventual malfunctioning of such systems and the consequent intensification of water pollution and public health problems in the watershed.

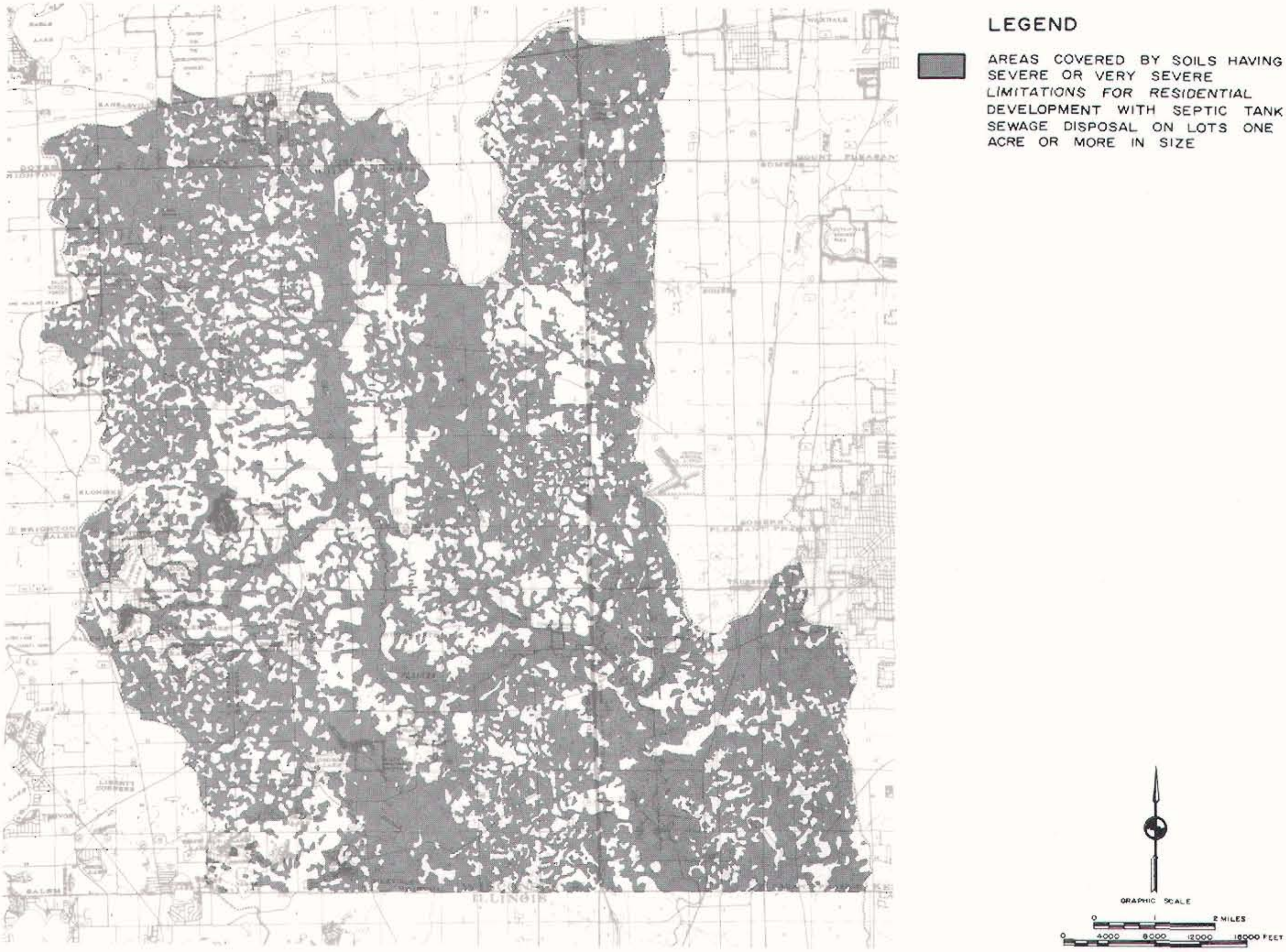
Source: U. S. Soil Conservation Service and SEWRPC.

and almost no sediment. Diffuse sources—including the estimated septic tank and construction-related contributions in the drainage area—account for the remaining 89 percent of the nitrogen, 87 percent of the phosphorus, 98 percent of the biochemical oxygen demand, 99 percent of the fecal coliform, and almost all of the sediment contributed from urban sources.

Of the total pollutant loads, rural pollution sources are estimated to contribute the remaining 89 percent of the nitrogen, 62 percent of the phosphorus, 70 percent of the biochemical oxygen demand, 88 percent of the fecal coliform, and 67 percent of the sediment which occur as water pollutants in the watershed. Livestock feeding operations—inclusive of the disposal of manure on

Map 44

SUITABILITY OF SOILS FOR LARGE LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE IN THE DES PLAINES RIVER WATERSHED



Approximately 58 percent of the area of the Des Plaines River watershed is covered by soils poorly suited for residential development on lots having an area of one acre or more and not served by public sanitary sewerage facilities. The inherent limitations of these soils for septic tank sewage disposal systems cannot be overcome simply by the provision of larger lots, and the use of such systems on these soils, which cannot absorb the sewage effluent, ultimately results in surface ponding and runoff of partially treated wastes into nearby watercourses.

Source: U. S. Soil Conservation Service and SEWRPC.

croplands—are estimated to contribute 24 percent of the nitrogen, 71 percent of the phosphorus, 50 percent of the biochemical oxygen demand, 100 percent of the fecal coliform, and 2 percent of the sediment from rural sources. The remainder of the estimated rural pollution load, or 76 percent of the nitrogen, 29 percent of the phosphorus, 50 percent of the biochemical oxygen demand, and 98 percent of the sediment, is contributed by other rural diffuse sources, namely storm water runoff from rural land uses and atmospheric loadings to surface waters.

Table 67

SELECTED CHARACTERISTICS OF MUNICIPAL SEWAGE TREATMENT PLANTS IN THE DES PLAINES RIVER WATERSHED: 1975

Name	Total Area Served (square miles)	Estimated Total Population Served	Date of Construction and Major Modification	Type of Treatment[a]	Level of Treatment Provided[a]	Disposal of Effluent	Design Capacity					Existing Load	
							Population[b]	Average Hydraulic (mgd)	Peak Hydraulic (mgd)	Average Organic (pounds of BOD_5 per day)	Population[b] Equivalent	Average Hydraulic (mgd)	Average Per Capita (gpd)
Village of Paddock Lake	0.79	1,900	1958, 1967	Activated Sludge	Secondary	Marsh Drained by Brighton Creek	3,200	0.32	0.64	544	2,600	0.17	89
Town of Bristol Utility District No. 1	0.72	800	1965, 1971	Activated Sludge	Secondary	Tributary of Des Plaines River	1,600	0.16	0.27	270	1,290	0.07	87
Town of Pleasant Prairie Sewer Utility District "D"	0.68	1,000	1966	Activated Sludge	Secondary	Des Plaines River	1,200	0.13	0.25	213	1,000	0.10	102
Town of Salem Sewer Utility District No. 1	0.37	1,000	1970	Activated Sludge	Secondary	Salem Branch of Brighton Creek	3,000	0.30	0.60	510	2,430	0.08	80
Town of Pleasant Prairie Sanitary District No. 73-1	0.09	100	1975	Activated Sludge Filter	Secondary	Des Plaines River via Drainage Ditch	4,000	0.40	0.80	800	3,800	0.03	300

[a] *Auxiliary waste treatment for disinfection is provided at all municipal sewage treatment plants.*

[b] *The population design capacity for a given sewage treatment facility was obtained directly from engineering reports prepared by or for the local unit of government operating the facility and reflects assumptions made by the design engineer. The population equivalent design capacity was estimated by the Commission staff by dividing the design BOD_5 loading in pounds per day, as set forth in the engineering reports, by an estimated per capita contribution of 0.21 pound of BOD_5 per day. If the design engineer assumed a different daily per capita contribution of BOD_5, the population equivalent design capacity will differ from the population design capacity shown in the table.*

Source: SEWRPC.

Table 68

SELECTED CHARACTERISTICS OF PRIVATELY OWNED WASTEWATER TREATMENT FACILITIES IN THE DES PLAINES RIVER WATERSHED: 1975

Name	Civil Division Location	Type of Land Use Served	Type of Wastewater	Type of Treatment Provided	Disposal of Effluent	Reported Average Annual Hydraulic Discharge Rate (gallons per day)[a]	Average Hydraulic Design Capacity (gallons per day)	Reported Maximum Monthly Hydraulic Discharge Rate (gallons per day)[a]
Brightondale County Park	Town of Brighton	Recreational	Sanitary	Activated Sludge and Lagoon	Soil Absorption	9,700 (May through September)	10,000	N/A
George Connolly Development	Town of Pleasant Prairie	Residential	Sanitary	Extended Aeration and Sand Filter	Tributary of the Des Plaines River	N/A	34,000	N/A
Howard Johnson Motor Lodge and Restaurant	Town of Bristol	Commercial	Sanitary	Activated Sludge and Lagoon	Des Plaines River	49,000	18,300	77,000
Kenosha Packing Company	Town of Paris	Industrial	Process Cooling, and Sanitary	Ridge and Furrow	Soil Absorption	23,200	N/A	23,700
Meeter Brothers Company	Town of Dover	Industrial	Process and Cooling	Lagoon	Tributary of the Des Plaines River via Storm Sewer	66,500	N/A	71,200
Paramski Mobile Home Park	Town of Bristol	Residential	Sanitary	Extended Aeration and Lagoon	Marsh Tributary to Mud Lake	11,500	40,000	N/A
Wisconsin Department of Transportation Tourist Information Center	Town of Pleasant Prairie	Governmental	Sanitary	Septic Tank, Sand Filter, and Lagoon	Tributary of the Des Plaines River	4,500	9,250	5,800
Fonk's Mobile Home Park No. 2	Town of Dover	Residential	Sanitary	Extended Aeration and Lagoon	Tributary of the Des Plaines River	3,500[b]	15,000[b]	N/A

NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data were obtained, in order of priority, from: quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System or under Section 101 of the Wisconsin Administrative Code or from the Wisconsin Pollutant Discharge Elimination System permit itself. In some cases when 12 months of flow data were not reported, the average annual and maximum monthly hydraulic discharge rates were estimated from the available monthly discharge data or from the flow data as reported in the permit.*

[b] *Data obtained from a Department of Natural Resources compliance monitoring survey conducted on October 29 and 30, 1975.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 69

KNOWN SANITARY SEWERAGE SYSTEM FLOW RELIEF DEVICES IN THE DES PLAINES RIVER WATERSHED BY RECEIVING STREAM AND CIVIL DIVISION: 1975

Receiving Stream	Civil Division	Combined Sewer Outfalls	Other Flow Relief Devices				Total
			Bypasses	Relief Pumping Stations	Portable Pumping Stations	Crossovers	
Brighton Creek	Village of Paddock Lake . . .	0	1	0	0	0	1
Des Plaines River	Town of Bristol.	0	1	0	0	0	1
	Town of Pleasant Prairie . . .	0	1	0	0	0	1
Total		0	3	0	0	0	3

Source: SEWRPC.

Table 70

CHARACTERISTICS OF OTHER KNOWN POINT SOURCES OF WATER POLLUTION IN THE DES PLAINES RIVER WATERSHED: 1975

Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average Annual Hydraulic Discharge Rate (gallons per day)[a]	Reported Maximum Monthly Hydraulic Discharge Rate (gallons per day)[a]
KENOSHA COUNTY								
Ladish Company-Tri-Clover Division	3551	Town of Pleasant Prairie	Process and Cooling	Neutralization Filtration and Lagoon	1	Tributary of the Des Plaines River	94,800	105,300
Town of Bristol Water Utility	4952	Town of Bristol	Filter Backwash	N/A	1	Tributary of Salem Branch Creek	Intermittent	Intermittent
RACINE COUNTY								
Bardon Rubber Products Company, Inc.	3069	Village of Union Grove	Cooling	N/A	1	Tributary of the Des Plaines River	64,700	86,000
Culligan Water Conditioning Company	7399	Village of Union Grove	Filter Backwash	N/A	1	Tributary of the Des Plaines River via Storm Sewer	1,100	1,300
Plastic Parts, Inc.	3079	Village of Union Grove	Cooling	N/A	1	Tributary of the Des Plaines River via Storm Sewer	192,000	214,500
Wisconsin Rubber Products Company	3069	Village of Union Grove	Cooling	N/A	1	Tributary of the Des Plaines River via Storm Sewer	130,000	173,000

NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data were obtained, in order of priority, from: quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System or under Section 101 of the Wisconsin Administrative Code or from the Wisconsin Pollutant Discharge Elimination System permit itself. In some cases when 12 months of flow data were not reported, the average annual and maximum monthly hydraulic discharge rates were estimated from the available monthly discharge data or from the flow data as reported in the permit.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 71

SUMMARY OF ESTIMATED AVERAGE ANNUAL POLLUTANT LOADINGS IN THE DES PLAINES RIVER WATERSHED: 1975

Source	Extent[b]	Parameter	Loads[a] Average Year Total Estimated Loading	Percent
Urban Point Sources				
Municipal Sewage Treatment Plants . .	5	Total Nitrogen	16,110.0	1.0
	5	Total Phosphorus	5,880.0	3.2
	5	Biochemical Oxygen Demand	13,580.0	0.3
	5	Fecal Coliform	10,000.0	0.0
	5	Sediment	15.0	0.0
Private Sewage Treatment Plants	6	Total Nitrogen	2,780.0	0.2
	6	Total Phosphorus	2,600.0	1.4
	6	Biochemical Oxygen Demand	11,070.0	0.3
	6	Fecal Coliform	32,000.0	0.0
	6	Sediment	15.0	0.0
Combined Sewer Overflow	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Industrial Discharges	6	Total Nitrogen	970.0	0.1
	6	Total Phosphorus	640.0	0.3
	6	Biochemical Oxygen Demand	780.0	0.0
	6	Fecal Coliform	0.0	0.0
	6	Sediment	0.0	0.0
Sanitary Sewer Flow Relief Devices . .	3	Total Nitrogen	50.0	0.0
	3	Total Phosphorus	20.0	0.0
	3	Biochemical Oxygen Demand	500.0	0.0
	3	Fecal Coliform	76,000.0	0.1
	3	Sediment	0.0	0.0
Urban Point Source Totals		Total Nitrogen	19,910.0	1.2
		Total Phosphorus	9,140.0	4.9
		Biochemical Oxygen Demand	25,930.0	0.7
		Fecal Coliform	118,000.0	0.1
		Sediment	30.0	0.0
Urban Diffuse Sources				
Residential	3096	Total Nitrogen	12,380.0	0.7
	3096	Total Phosphorus	990.0	0.5
	3096	Biochemical Oxygen Demand	75,230.0	1.9
	3096	Fecal Coliform	495,360.0	0.6
	3096	Sediment	845.0	0.3
Commercial	380	Total Nitrogen	3,420.0	0.2
	380	Total Phosphorus	290.0	0.2
	380	Biochemical Oxygen Demand	37,090.0	0.9
	380	Fecal Coliform	125,400.0	0.1
	380	Sediment	140.0	0.0
Industrial	286	Total Nitrogen	2,400.0	0.1
	286	Total Phosphorus	200.0	0.1
	286	Biochemical Oxygen Demand	10,550.0	0.3
	286	Fecal Coliform	177,320.0	0.2
	286	Sediment	140.0	0.0
Extractive	170	Total Nitrogen	10,200.0	0.6
	170	Total Phosphorus	7,650.0	4.1
	170	Biochemical Oxygen Demand	20,400.0	0.5
	170	Fecal Coliform	0.0	0.0
	170	Sediment	12,750.0	4.5
Transportation	832	Total Nitrogen	18,960.0	1.1
	832	Total Phosphorus	1,220.0	0.7
	832	Biochemical Oxygen Demand	125,930.0	3.2
	832	Fecal Coliform	527,290.0	0.6
	832	Sediment	16,835.0	5.9
Recreation	628	Total Nitrogen	2,220.0	0.1
	628	Total Phosphorus	90.0	0.0
	628	Biochemical Oxygen Demand	820.0	0.0
	628	Fecal Coliform	9,396.0	0.0
	628	Sediment	130.0	0.0
Construction	852	Total Nitrogen	51,120.0	3.1
	852	Total Phosphorus	38,340.0	20.6
	852	Biochemical Oxygen Demand	102,240.0	2.6
	852	Fecal Coliform	0.0	0.0
	852	Sediment	63,900.0	22.4
Septic Systems	9535	Total Nitrogen	54,350	3.3
	9535	Total Phosphorus	12,590	6.8
	9535	Biochemical Oxygen Demand	778,060	19.8
	9535	Fecal Coliform	9,535,000	10.6
	9535	Sediment	135	0.0
Urban Diffuse Source Totals		Total Nitrogen	155,050.0	9.3
		Total Phosphorus	61,370.0	33.0
		Biochemical Oxygen Demand	1,150,320.0	29.2
		Fecal Coliform	10,869,766.0	12.1
		Sediment	94,875.0	33.3
Urban Source Totals		Total Nitrogen	174,960.0	10.5
		Total Phosphorus	70,510.0	37.9
		Biochemical Oxygen Demand	1,176,250.0	29.9
		Fecal Coliform	10,387,766.0	12.2
		Sediment	94,905.0	33.3
Rural Diffuse Sources				
Livestock Operations	12340	Total Nitrogen	350,460.0	21.0
	12340	Total Phosphorus	81,440.0	43.8
	12340	Biochemical Oxygen Demand	1,372,210.0	34.8
	12340	Fecal Coliform	78,976,000.0	87.8
	12340	Sediment	4,320.0	1.5
Cropland, Pasture, and Unused Rural Land	65540	Total Nitrogen	1,120,120.0	67.2
	65540	Total Phosphorus	32,910.0	17.7
	65540	Biochemical Oxygen Demand	1,185,350.0	30.1
	65540	Fecal Coliform	0.0	0.0
	65540	Sediment	185,090.0	64.9
Silvicultural	4675	Total Nitrogen	10,750.0	0.6
	4675	Total Phosphorus	650.0	0.3
	4675	Biochemical Oxygen Demand	21,510.0	0.5
	4675	Fecal Coliform	30,855.0	0.0
	4675	Sediment	585.0	0.2
Air Pollution to Surface Water	1127	Total Nitrogen	10,030.0	0.6
	1127	Total Phosphorus	560.0	0.3
	1127	Biochemical Oxygen Demand	182,570.0	4.6
	1127	Fecal Coliform	0.0	0.0
	1127	Sediment	375.0	0.1
Rural Diffuse Source Totals		Total Nitrogen	1,491,360.0	89.5
		Total Phosphorus	115,560.0	62.1
		Biochemical Oxygen Demand	2,761,640.0	70.1
		Fecal Coliform	79,006,855.0	87.8
		Sediment	190,370.0	66.7
Diffuse Source Totals		Total Nitrogen	1,646,410.0	98.8
		Total Phosphorus	176,930.0	95.1
		Biochemical Oxygen Demand	3,911,960.0	99.3
		Fecal Coliform	89,876,621.0	99.9
		Sediment	285,245.0	100.0
Total Sources		Total Nitrogen	1,666,320.0	100.0
		Total Phosphorus	186,070.0	100.0
		Biochemical Oxygen Demand	3,937,890.0	100.0
		Fecal Coliform	89,994,621.0	100.0
		Sediment	285,275.0	100.0

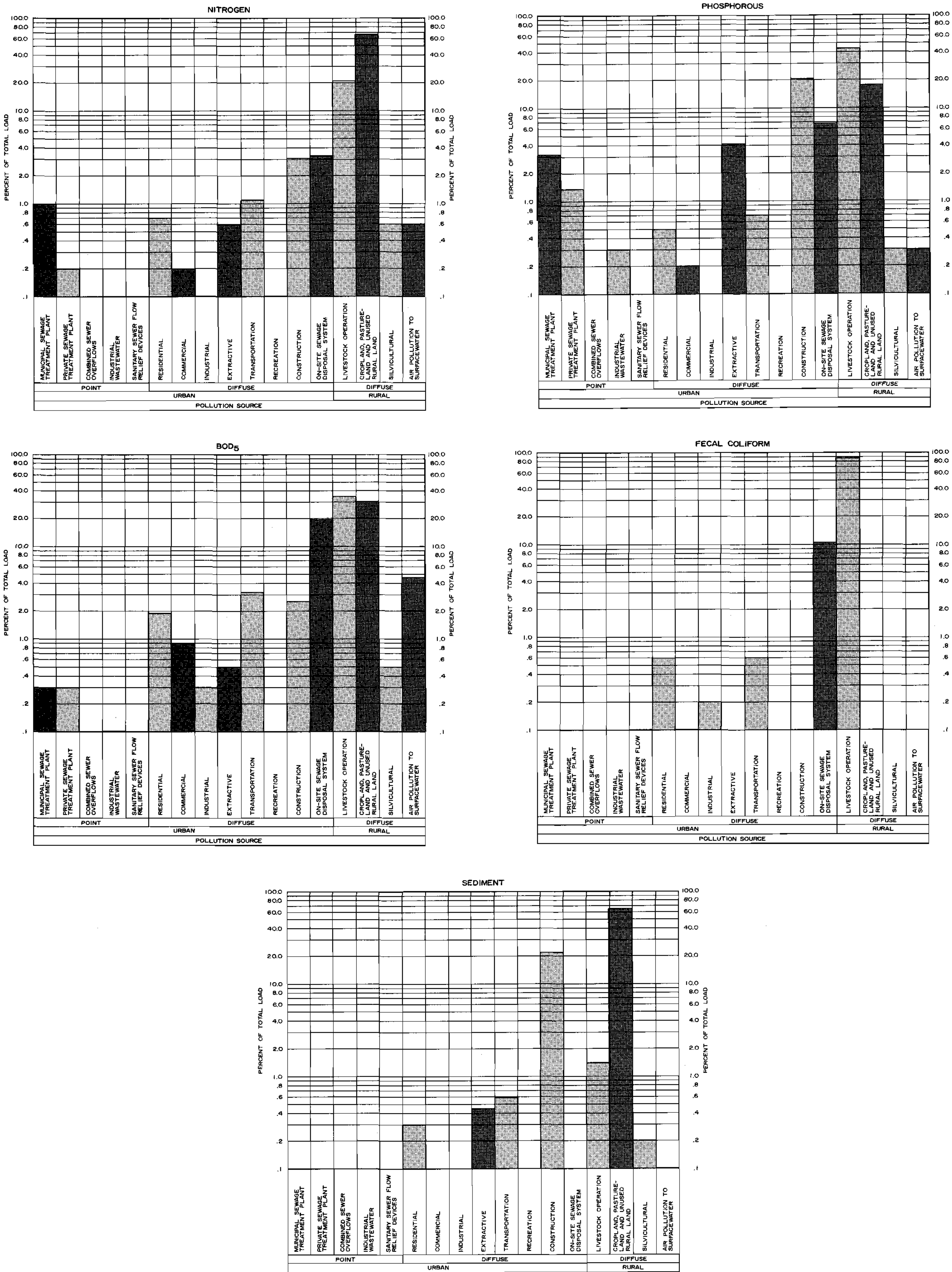
[a] Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.

[b] Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year.

Source: SEWRPC.

Figure 30

SUMMARY OF ESTIMATED AVERAGE ANNUAL POLLUTANT LOADINGS IN THE DES PLAINES RIVER WATERSHED: 1975



Source: SEWRPC.

FOX RIVER WATERSHED

The Fox River watershed within southeastern Wisconsin is a natural surface water drainage unit 934.3 square miles in areal extent located in the central and south-central portions of the Region. The boundaries of the watershed, together with the locations of the main channels of the Fox River and its principal tributaries, are shown on Map 45, along with the locations of the known point sources of pollution and the generalized land uses as of 1975. The main stem of the Fox River originates near the Village of Lannon in northeastern Waukesha County and discharges at the Wisconsin-Illinois state line near Wilmot, Wisconsin. About 83 percent of the total area of the watershed is still in rural land uses, with about 77 percent of this rural area in agricultural use. Most of the agricultural-related land uses are located in the southern and central portions of the watershed. Table 72 sets forth the extent and proportion of the major land cover categories within the watershed as they relate to water quality conditions in 1975.

The soils within the Fox River watershed are deep to moderately deep silt loams in the eastern portions of Walworth County and the western portions of Racine and Kenosha Counties, and are noted primarily for their excellent productivity. Waukesha County generally has rolling silt loams or gravelly loams as the primary soil types. Most of the soils are relatively fertile and produce high crop yields if managed correctly. Sediment discharges from these soils may result in high levels of nutrients in stream waters.

Particularly important to comprehensive water quality management planning are the soil suitability interpretations for specified types of urban development. Based upon the interpretations of the soil properties, about 30 percent of the watershed is covered by soils that have severe or very severe limitations for residential development with public sanitary sewer service, as shown on Map 46; about 56 percent of the watershed is covered by soils that have severe or very severe limitations for small lot (less than one acre in size) residential development without public sanitary sewer, as shown on Map 47; and about 45 percent of the watershed is covered by soils that have severe or very severe limitations for large lot (one acre or larger in size) residential development, as shown on Map 48.

Municipal and Private Sewage Treatment Facilities

In 1975, a total of 23 sanitary sewerage systems or portions thereof served a total area of about 45.4 square miles within the watershed, or about 5 percent of the total area of the watershed, and a total population of about 127,500 persons, or approximately 57 percent of the total resident population of the watershed.

Sixteen municipally owned sewage treatment plants are located in the Fox River watershed. The five plants which serve the Cities of Waukesha, Burlington, and Brookfield, the Village of Silver Lake, and the Western Racine County Sewerage District discharge treated effluents directly to the main stem of the Fox River; the two plants which serve the Villages of Fontana-on-Geneva Lake and Williams Bay discharge treated effluents

Table 72

AREAL EXTENT OF LAND COVER IN THE FOX RIVER WATERSHED: 1975

Land Cover[a]	Square Miles	Acres	Percent
Urban			
Residential	62.80	40,192	6.62
Commercial[b]	7.69	4,924	0.81
Industrial			
Manufacturing	4.78	3,056	0.50
Landfills and Dumps	0.81	518	0.09
Extractive	6.58	4,212	0.69
Transportation			
Streets and Highways	5.58	3,569	0.59
Airfields	1.28	817	0.13
Railroad Yards and Terminals	0.00	1	0.00
Recreation			
Golf Courses	6.42	4,110	0.68
Parks and Other Recreation	9.77	6,251	1.03
Land Under Development			
Residential[c]	16.95	10,846	1.79
Commercial	0.02	13	0.00
Industrial	0.38	245	0.04
Transportation	0.05	29	0.01
Recreation	0.15	96	0.02
Rural			
Agricultural			
Small Grains	14.02	8,970	1.48
Hay	80.31	51,396	8.47
Row Crops	357.44	228,761	37.69
Specialty Crops	9.27	5,934	0.98
Sod Farm	6.47	4,139	0.68
Other Open Space[d]	135.82	86,927	14.32
Silvicultural			
Woodlands	95.75	61,282	10.10
Orchards and Nurseries	2.48	1,584	0.26
Natural and Man-Made Water Areas—Subject to Atmospheric Pollutant Contributions			
Ponds, Lakes, and Streams	41.41	26,500	4.37
Wetlands, Swamps, and Marshes	82.11	52,548	8.66
Total	948.34[e]	606,920	100.00

[a] *These special land cover categories, defined primarily according to their imperviousness and vegetative cover characteristics and effects on the quality of storm water runoff, were delineated at a scale of 1" = 400' on aerial photographs taken in May 1975 and were measured to the nearest full acre, using dot-counting overlays. The total acreages measured within hydrologic subbasins were then adjusted to the control totals measured by digitizer from base maps of hydrologic subbasins at a scale of 1" = 2000'. Both the "square miles" and the "percent" shown above were then computed and rounded to the nearest hundredth (0.01) of a percent.*

[b] *Includes: retail, communication, utilities, administrative, and institutional land uses.*

[c] *Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.*

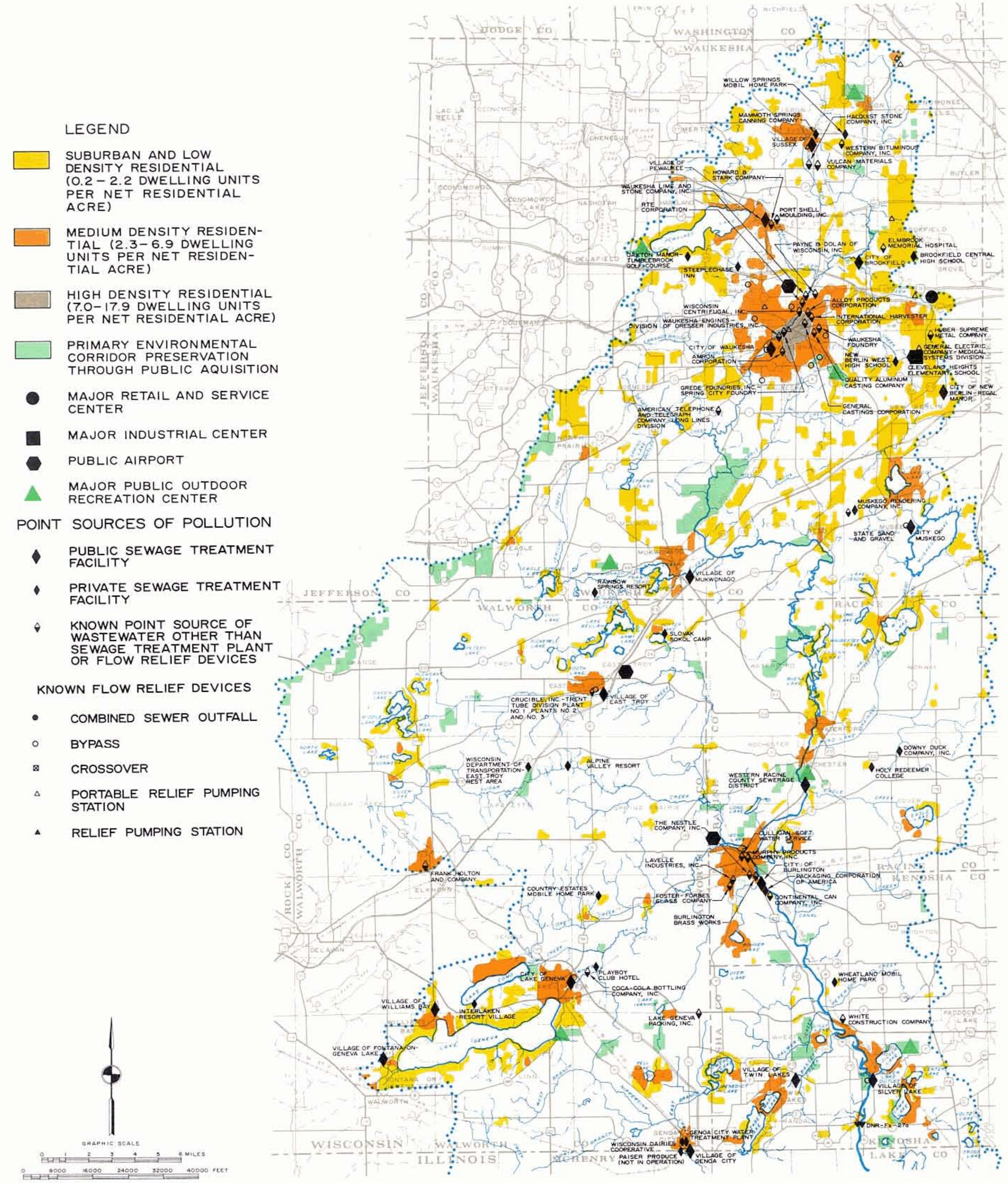
[d] *Includes: pasture, unused urban and rural lands.*

[e] *The total area of the Fox River watershed represented in this table is different than the total area of the Fox River watershed identified in the text and on Map 45. This is due to the fact that the area set forth on Map 45 includes only that portion of the Fox River watershed lying within the civil boundaries that comprise the Southeastern Wisconsin Region. The area of the Fox River watershed represented in this table represents an aggregation of subbasins, the boundaries of which do not always coincide with the civil boundaries of the Region.*

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service; County Soil and Water Conservation Districts; University of Wisconsin-Extension Service; and SEWRPC.

Map 45

THE LOCATION, BOUNDARIES, MAJOR STREAMS, AND LAKES OF THE FOX RIVER WATERSHED— SHOWING POINT SOURCES OF POLLUTION AND GENERALIZED LAND USES: 1975

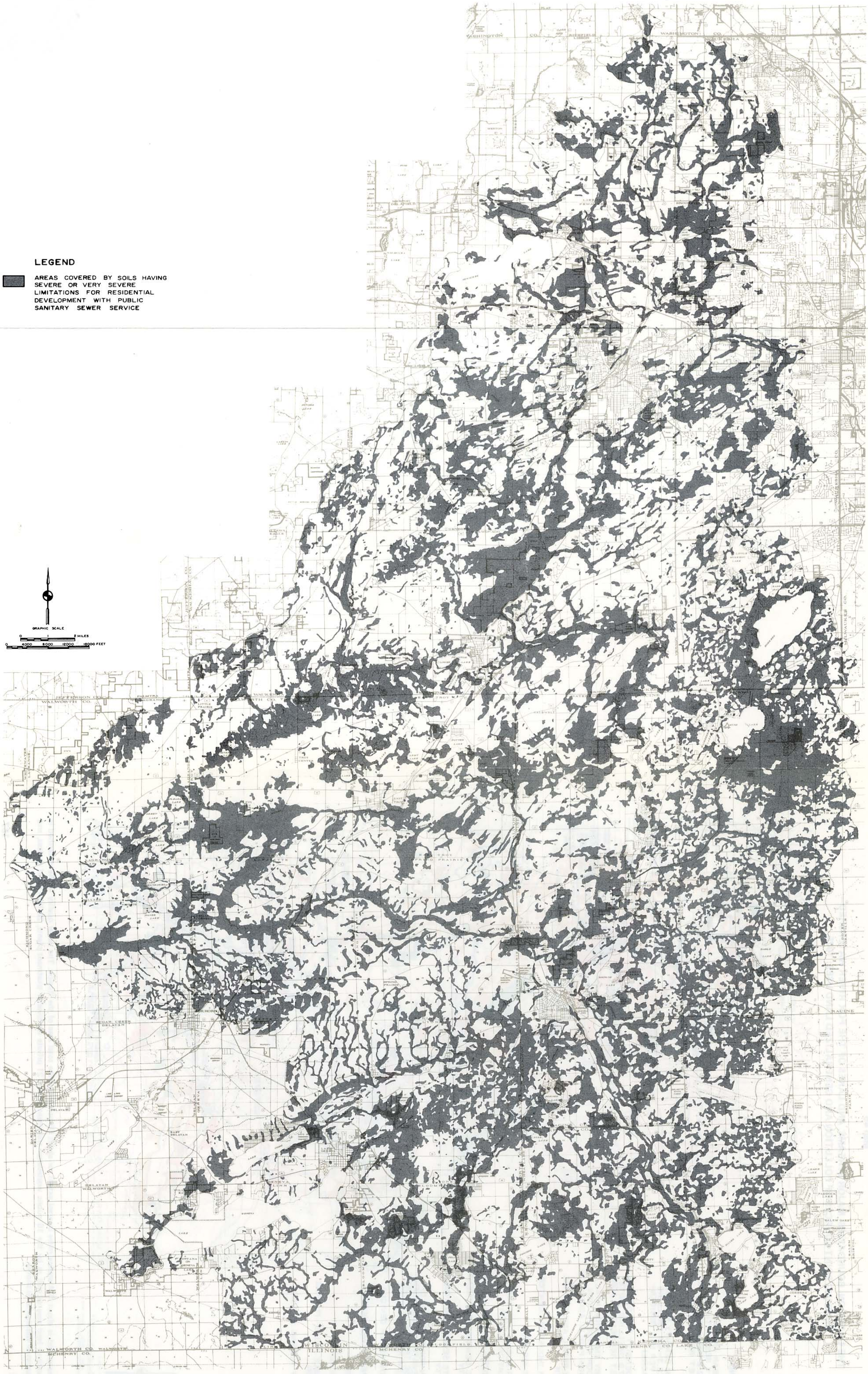


The Fox River watershed is about 934 square miles in areal extent, or about 35 percent of the total area of the Region. The water quality in the watershed is affected by the various land uses as well as by the 16 public wastewater treatment plants, 21 private wastewater treatment plants, 20 flow relief devices, and 38 other point sources of wastewater as shown.

Source: SEWRPC.

Map 46

SUITABILITY OF SOILS FOR RESIDENTIAL DEVELOPMENT WITH PUBLIC SANITARY SEWER SERVICE IN THE FOX RIVER WATERSHED

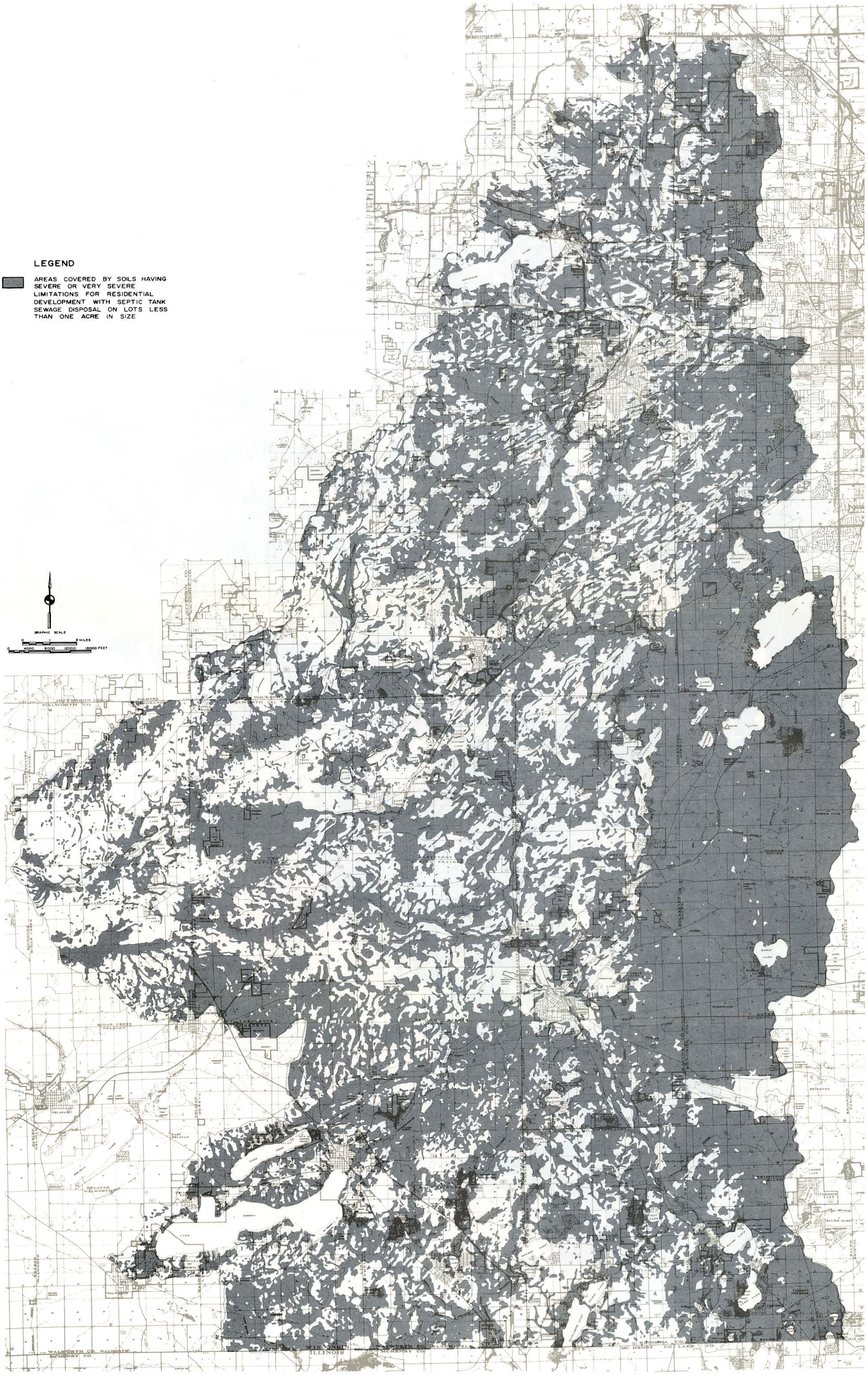


Of particular importance in comprehensive water quality planning is the recognition of the limitations inherent in the soil resource base. About 30 percent of the area of the Fox River watershed is covered with soils which are poorly suited for residential development with public sanitary sewer service or, more precisely, residential development of any kind. These soils, which include wet soils having a high water table or poor drainage, organic soils which are poorly drained and provide poor foundation support, and soils which have a flood hazard, are especially prevalent in the riverine areas of the watershed.

Source: U. S. Soil Conservation Service and SEWRPC.

Map 47

SUITABILITY OF SOILS FOR SMALL LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE IN THE FOX RIVER WATERSHED

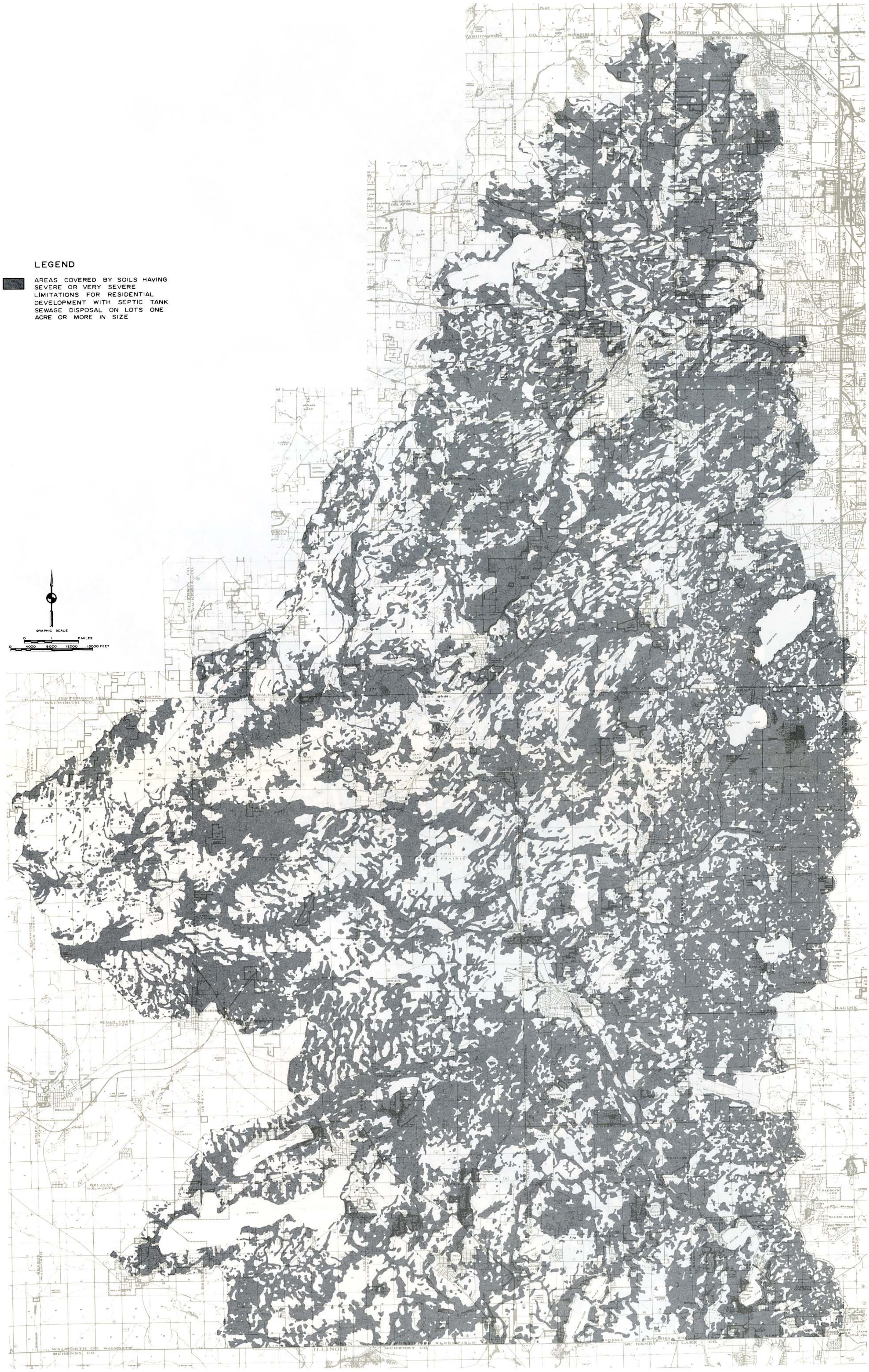


Approximately 56 percent of the area of the Fox River watershed is covered by soils poorly suited for residential development on lots having an area smaller than one acre and not served by public sanitary sewerage facilities. Reliance on septic tank sewage disposal systems in these areas, which are covered by relatively impervious soils or are subject to seasonally high water tables, can only result in eventual malfunctioning of such systems and the consequent intensification of water pollution and public health problems in the watershed.

Source: U. S. Soil Conservation Service and SEWRPC.

Map 48

SUITABILITY OF LARGE LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE IN THE FOX RIVER WATERSHED



Approximately 45 percent of the area of the Fox River watershed is covered by soils poorly suited for residential development on lots having an area of one acre or more and not served by public sanitary sewerage facilities. The inherent limitations of these soils for septic tank sewage disposal systems cannot be overcome simply by the provision of larger lots, and the use of such systems on these soils, which cannot absorb the sewage effluent, ultimately results in surface ponding and runoff of partially treated wastes into nearby watercourses.

Source: U. S. Soil Conservation Service and SEWRPC.

Table 73

SELECTED CHARACTERISTICS OF MUNICIPAL SEWAGE TREATMENT PLANTS IN THE FOX RIVER WATERSHED: 1975

Name	Total Area Served (square miles)	Estimated Total Population Served	Date of Construction and Major Modification	Type of Treatment[a]	Level of Treatment Provided[a]	Disposal of Effluent	Design Capacity					Existing Loading	
							Population[b]	Average Hydraulic (mgd)	Peak Hydraulic (mgd)	Average Organic (pounds of BOD_5 per day)	Population[b] Equivalent	Average Hydraulic (mgd)	Average Per Capita (gpd)
Village of Silver Lake	0.47	1,300	1966	Activated Sludge	Secondary	Fox River	3,000	0.30	0.50	510	2,429	0.15	115
Village of Twin Lakes	2.31	3,400	1958, 1970	Trickling Filter and Activated Sludge Phosphorus Removal	Secondary Advanced	Bassett Creek	8,200	0.82	1.64	1,390	6,619	0.41	121
City of Burlington	2.27	10,800	1934, 1938 1962	Activated Sludge Phosphorus Removal	Secondary Advanced	Fox River	N/A	2.50	3.00	5,000	23,809	1.48	137
Western Racine County Sewerage District (includes Rochester and Waterford)	0.94	3,400	1970,1975 1969, 1976	Activated Sludge Phosphorus Removal	Secondary Advanced	Fox River	5,000	0.50	1.00	850	4,000	0.24	72
City of Lake Geneva	1.96	5,700	1930, 1966	Trickling Filter Phosphorus Removal	Secondary Advanced	White River	9,750	1.1	N/A	1,890	9,000	0.74	129
Village of East Troy	0.82	2,200	1960	Trickling Filter	Secondary	Honey Creek	3,200	0.32	0.64	417	2,000	0.25	112
Village of Fontana-on-Geneva Lake	1.42	1,800	1957,1963	Trickling Filter Activated Sludge	Secondary	Seepage Lagoon and Lake Geneva	4,000	0.90	1.80	N/A	N/A	0.52	289
Village of Genoa City	0.27	1,100	1923, 1959	Trickling Filter	Secondary	Nippersink Creek	N/A	0.12	0.24	200	952	0.07	65
Village of Williams Bay	0.12	1,700	1931, 1968	Activated Sludge	Secondary	Seepage Lagoon	6,500	0.80	1.2	1,100	5,238	0.20	118
City of Waukesha	13.59	51,300	1949, 1967	Trickling Filter Phosphorus Removal	Secondary Advanced	Fox River	50,000	8.50	12.00	11,500	54,762	9.90	193
Village of Mukwonago	1.26	3,400	1950, 1975	Trickling Filter Phosphorus Removal	Secondary Advanced	Mukwonago River	1,500	0.22	0.56	485	2,800	0.44	128
Village of Pewaukee	1.31	4,800	1950, 1971	Trickling Filter and rotating biological disc	Secondary	Pewaukee River	7,500	0.80	1.20	1,595	7,595	0.48	100
Village of Sussex	1.06	4,000	1960, 1975	Trickling Filter	Secondary	Sussex Creek	3,000	0.30	0.5	510	2,429	0.47	118
City of Brookfield	8.50	16,200	1973	Activated Sludge Phosphorus Removal	Secondary Advanced	Fox River	22,000	5.0	7.50	3,665	17,452	2.49	147
City of Muskego	4.75	4,200	1967, 1970	Disinfection through Lagoons	Secondary	Big Muskego Lake	6,000	0.70	1.30	1,400	6,667	0.58	138
City of New Berlin Regal Manor	0.54	1,100	1970	Activated Sludge	Secondary	Deer Creek	N/A	0.30	N/A	500	2,381	0.12	109

[a] *Auxiliary waste treatment for disinfection is provided at all municipal sewage treatment plants except the one operated by the Village of East Troy.*

[b] *The population design capacity for a given sewage treatment facility was obtained directly from engineering reports prepared by or for the local unit of government operating the facility and reflects assumptions made by the design engineer. The population equivalent design capacity was estimated by the Commission staff by dividing the design BOD_5 loading in pounds per day, as set forth in the engineering reports, by an estimated per capita contribution of 0.21 pound of BOD_5 per day. If the design engineer assumed a different daily per capita contribution of BOD_5, the population equivalent design capacity will differ from the population design capacity shown in the table.*

Source: SEWRPC.

to seepage lagoons and thereby to the groundwaters; and the plant which serves the Village of Twin Lakes discharges treated effluents directly to Bassett Creek. The remaining eight municipally owned sewage treatment plants which serve the Cities of Lake Geneva and Muskego; the New Berlin-Regal Manor Subdivision; and the Villages of East Troy, Genoa City, Mukwonago, Pewaukee, and Sussex discharge treated effluents to the White River, Big Muskego Lake, Deer Creek, Honey Creek, Nippersink Creek, Mukwonago River, Pewaukee River, and Sussex Creek, respectively. Selected information for these municipal sewage treatment plants is set forth in Table 73, and the plant locations are shown on Map 45. In addition to the publicly owned sewage treatment facilities, 21 private wastewater treatment facilities exist in the Fox River watershed, owned and operated by: Wheatland Mobile Home Park in Kenosha County; Downey Duck Company, Inc., Holy Redeemer College, and Packaging Corporation of America in Racine County; Alpine Valley Resort, Inc., Country Estates Mobile Home Park, Interlaken Resort Village, Paiser Produce Company (not in operation), Playboy Club Hotel, Slovak Sokol Camp, Wisconsin Dairies Cooperative, and Wisconsin Department of Transportation-East Troy Rest Area in Walworth County; and Brookfield Central High School, Cleveland Heights Elementary School, Mammoth Springs Canning Corporation, Muskego Rendering Company, Inc., New Berlin West High School, Oakton Manor-Tumblebrook Golf Course, Rainbow Springs Resort (not in operation), Steeplechase Inn, and Willow Springs Mobile Home Park in Waukesha County. Selected data on these 21 privately owned wastewater treatment facilities are presented in Table 74, and the locations of these facilities are shown on Map 45. Of the 16 publicly and 21 privately operated sewage treatment facilities, a total of five facilities discharge effluent directly to the main stem of the Fox River, and 11 facilities discharge to seepage lagoon and soil absorption systems. The remaining 21 facilities discharge effluent to various tributaries of the Fox River or into lakes within the watershed.

Sanitary Sewerage System Flow Relief Points

In 1975, there were 20 known sanitary sewer flow relief devices in the watershed, as listed in Table 75 and shown on Map 45. Thirteen of the devices were sanitary sewerage system bypasses, and 7 were portable pumping stations. Of the 20 devices, 14 discharge directly to the main stem of the Fox River and the remaining 6 discharge directly to the White River, Honey Creek, Nippersink Creek, Silver Lake Outlet, Big Muskego Lake, and Deer Creek.

Other Known Point Sources

A total of 37 other known point sources of pollution were identified in the watershed in 1975. These other point sources consisted primarily of 54 outfalls through which industrial cooling, process, rinse, and wash waters were discharged directly or indirectly to the surface water system. Of these, 32 were identified as discharging only

Table 74
SELECTED CHARACTERISTICS OF PRIVATELY OWNED WASTEWATER TREATMENT FACILITIES IN THE FOX RIVER WATERSHED: 1975

Name	Civil Division Location	Type of Land Use Served	Type of Wastewater	Type of Treatment Provided	Disposal of Effluent	Reported Average Annual Hydraulic Discharge Rate (gallons per day)[a]	Average Hydraulic Design Capacity (gallons per day)	Reported Maximum Monthly Hydraulic Discharge Rate (gallons per day)[a]
KENOSHA COUNTY								
Wheatland Mobile Home Park	Town of Wheatland	Residential	Sanitary	Contact Stabilization and Lagoon	Tributary of Fox River	37,000[b]	39,000	N/A
RACINE COUNTY								
Downey Duck Company, Inc.	Town of Dover	Industrial	Process and Sanitary	Lagoon and Spray Irrigation	Soil Absorption	45,000	200,000	125,000
Holy Redeemer College	Town of Dover	Institutional	Sanitary	Extended Aeration and Lagoon	Dover Ditch	8,000	15,000	13,000
Packaging Corporation of America	Town of Burlington	Industrial	Process and Sanitary	Extended Aeration and Sand Filter	Tributary of Fox River	7,500	10,000	11,600
WALWORTH COUNTY								
Alpine Valley Resort, Inc.	Town of LaFayette	Recreational	Sanitary	Activated Sludge and Lagoon	Soil Absorption	N/A	40,000	N/A
Country Estates Mobile Home Park	Town of Lyons	Residential	Sanitary	Extended Aeration and Lagoon	Tributary of Ore Creek	15,000	N/A	23,000
Interlaken Resort Village	Town of Geneva	Recreational	Sanitary	Contact Stabilization, Sand Filter, and Lagoon	Soil Absorption	27,000	125,000	72,000
Paiser Produce Company (not in operation)	Village of Genoa City	Industrial	Process	Lagoon	Soil Absorption	N/A	N/A	N/A
Playboy Club Hotel	Town of Lyons	Recreational	Sanitary	Contact Stabilization and Lagoon	White River	120,000	500,000	278,000
Slovak Sokol Camp	Town of East Troy	Recreational	Sanitary	Activated Sludge	Potters Lake	20,000	N/A	N/A
Wisconsin Dairies Cooperative	Village of Genoa City	Industrial	Process	Activated Sludge	Nippersink Creek	6,200	N/A	N/A
Wisconsin Department of Transportation—East Troy Rest Area	Town of LaFayette	Recreational	Sanitary	Contact Stabilization and Sand Filter	Tributary of Sugar Creek	N/A	18,000	N/A
WAUKESHA COUNTY								
Brookfield Central High School	City of Brookfield	Institutional	Sanitary	Septic Tank, Sand Filter, and Lagoon	Soil Absorption	N/A	N/A	N/A
Cleveland Heights Elementary School	City of New Berlin	Institutional	Sanitary	Septic Tank, Sand Filter, and Lagoon	Tributary of Poplar Creek	5,000	N/A	7,000
Mammoth Springs Canning Corporation	Town of Lisbon	Industrial	Process	Screening and Spray Irrigation	Soil Absorption	200,000	N/A	250,000
Muskego Rendering Company, Inc.	City of Muskego	Industrial	Process	Trap, Skimmer, Aeration and Lagoon	Soil Absorption	N/A	N/A	10,000
New Berlin West High School	City of New Berlin	Institutional	Sanitary	Septic Tank, Sand Filter, and Lagoon	Tributary of Poplar Creek	18,000	24,000	23,000
Oakton Manor—Tumblebrook Golf Course	Town of Delafield	Recreational	Sanitary	Activated Sludge and Lagoon	Tributary of Pewaukee Lake	800[c]	36,000	2,000[c]
Rainbow Springs Resort (not in operation)	Town of Mukwonago	Recreational	Sanitary	Activated Sludge	Tributary of Mukwonago River	N/A	160,000	N/A
Steeplechase Inn	Town of Pewaukee	Commercial	Sanitary	Extended Aeration and Lagoon	Soil Absorption	N/A	25,000	N/A
Willow Springs Mobile Home Park	Town of Lisbon	Residential	Sanitary	Soil Absorption System	Soil Absorption	N/A	N/A	36,000

NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data were obtained, in order of priority, from: quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System or under Section 101 of the Wisconsin Administrative Code or from the Wisconsin Pollutant Discharge Elimination System permit itself. In some cases when 12 months of flow data were not reported, the average annual and maximum monthly hydraulic discharge rates were estimated from the available monthly discharge data or from the flow data as reported in the permit.*

[b] *Data obtained from a Department of Natural Resources compliance monitoring survey conducted on July 9, 1975.*

[c] *Data obtained from a Department of Natural Resources compliance monitoring survey conducted in 1976.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 75

KNOWN COMBINED SEWER OUTFALLS AND OTHER FLOW RELIEF DEVICES
IN THE FOX RIVER WATERSHED BY RECEIVING STREAM AND CIVIL DIVISION: 1975

Receiving Stream	Civil Division	Combined Sewer Outfalls	Other Flow Relief Devices				Total
			Crossovers	Bypasses	Relief Pumping Stations	Portable Pumping Stations	
White River	City of Lake Geneva	0	0	1	0	0	1
Honey Creek	Village of East Troy	0	0	1	0	0	1
Nippersink Creek	Village of Genoa City	0	0	1	0	0	1
Silver Lake Outlet	Village of Silver Lake	0	0	1	0	0	1
Fox River	City of Waukesha	0	0	8	0	2	10
Big Muskego Lake	City of Muskego	0	0	1	0	0	1
Deer Creek	City of Brookfield	0	0	0	0	1	1
Fox River	City of Brookfield	0	0	0	0	1	1
Sussex Creek	Village of Sussex	0	0	0	0	1	1
Fox River	Village of Menomonee Falls	0	0	0	0	2	2
Total	--	0	0	13	0	7	20

Source: SEWRPC.

cooling water. The remaining 22 were discharging other types of wastewaters. Industrial wastewater enters the Fox River and its major tributaries directly through industrial waste outfalls or indirectly through drainage ditches and storm sewers. Table 76 summarizes by receiving stream and civil division the characteristics of these other point sources, and Map 45 shows their locations. Four of these other point source outfalls discharge the wastes directly to the Fox River main stem, 22 industrial outfalls discharge indirectly to the Fox River, 22 discharge to the various tributaries of the Fox River, and six utilize soil absorption systems.

Privately Owned Onsite Sanitary Wastewater Treatment

In addition to being provided through centralized sanitary sewerage service within the watershed, sanitary wastewater treatment and disposal is provided through approximately 28,266 privately owned onsite sewage disposal systems consisting of 28,106 septic tanks, 145 holding tanks, and 15 mound systems. These systems serve a total resident population of about 97,600 persons, or about 43 percent of the total resident population of the watershed. Of this total, about 52,800 persons, or about 56 percent, resided in concentrated areas of urban development having at least 32 housing units in a U. S. Public Land Survey quarter section. These scattered quarter sections of urban land use concentration totaled about 72 square miles of urban land use, or slightly more than 8 percent of the total area of the watershed.

Urban Storm Water Management Systems

As noted in Table 72, land cover categories associated with urban land uses as of 1975 comprised 78,900 acres, or about 13 percent of the Fox River watershed. The most important urban land cover category was residential land, with about 7 percent.

There were a total of 16 known urban storm water drainage systems providing service to the subareas of the Fox River watershed within the Region in 1975. These include the systems operated by the Cities of Brookfield, Burlington, Elkhorn, Lake Geneva, Muskego, New Berlin, and Waukesha, and the Villages of East Troy, Menomonee Falls, Mukwonago, Pewaukee, Rochester, Sussex, Twin Lakes, Wales, and Waterford. The Cities of Lake Geneva and Muskego and the Village of East Troy were unable to provide a copy of a map of their systems. Together, the 13 storm water drainage systems for which mapping was available have a tributary drainage area of about 19.4 square miles, or about 2 percent of the total area of the watershed. Included within this storm water drainage area are a total of 212 known storm water outfalls ranging in size from 8 to 78 inches in diameter. There were no known storm water pumping facilities and three known storm water storage facilities in the watershed. The total annual average discharge from these outfalls is estimated to be about 1,125 million gallons per year occurring on the average in 65 events.

Rural Storm Water Runoff

About 528,000 acres, or 87 percent, of the total area of the watershed, are devoted to rural land use activities. The most important rural land cover categories were row crops with 38 percent, hay with 8 percent, other open space with 14 percent, woodlands with 10 percent, and wetlands, swamps, and marshes with 9 percent of the watershed. As of May 1975 there were an estimated

Table 76

CHARACTERISTICS OF OTHER KNOWN POINT SOURCES OF WATER POLLUTION IN THE FOX RIVER WATERSHED: 1975

Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average Annual Hydraulic Discharge Rate (gallons per day)[a]	Reported Maximum Monthly Hydraulic Discharge Rate (gallons per day)[a]
KENOSHA COUNTY								
White Construction Company	1500	Town of Wheatland	Groundwater Seepage	None	1	Tributary of Fox River	N/A	N/A
RACINE COUNTY								
Burlington Brass Works	3432	City of Burlington	Process and Sanitary	None	2	Fox River via Storm Sewer	1,700	N/A
Continental Can Company, Inc.	3411	City of Burlington	Process	None	1	Soil Absorption	N/A	N/A
Culligan Soft Water Service	7399	City of Burlington	Process	None	1	Fox River via Storm Sewer	1,100	1,300
Foster-Forbes Glass Company	3221	Town of Burlington	Cooling	Lagoon and Oil Separator	1	Fox River via Storm Sewer	212,000	370,000
			Cooling	None	2	Fox River via Storm Sewer	141,000	173,000
			Cooling	None	3	Fox River via Storm Sewer	228,000	294,000
Lavelle Industries, Inc.	3069	City of Burlington	Process and Cooling	None	1	Fox River via Storm Sewer	55,000	60,000
Murphy Products Company, Inc.	2048	City of Burlington	Cooling	None	3	Fox River via Storm Sewer	3,000	3,600
The Nestle Company, Inc.	2066	City of Burlington	Cooling	None	2	Fox River via Storm Sewer	12,000	16,000
WALWORTH COUNTY								
Coca-Cola Bottling Company, Inc.	2086	Town of Lyons	Washwater	None	1	White River via Drainage Ditch	7,000	10,000
Crucible, Inc.—Trent Tube Division Plant No. 1	3317	Village of East Troy	Process and Cooling	Lagoon	1	Honey Creek	480,000	520,000
Crucible, Inc.—Trent Tube Division Plants No. 2 and No. 3	3317	Village of East Troy	Process and Cooling	N/A	1	Honey Creek	64,000	104,000
Genoa City Water Treatment Plant	4952	Village of Genoa City	Filter Backwash	None	1	Nippersink Creek	Intermittent	Intermittent
Lake Geneva Packaging, Inc.	2011	Town of Lyons	Process	None	1	Soil Absorption	N/A	1,000
Wisconsin Dairies Cooperative	2026	Village of Genoa City	Cooling	None	2	Nippersink Creek	3,600	N/A
WAUKESHA COUNTY								
Alloy Products Corporation	3494	City of Waukesha	Process and Cooling	Lagoon	1	Soil Absorption	34,000	46,000
			Process and Cooling	Lagoon	2	Soil Absorption	34,000	46,000
American Telephone and Telegraph Company—Long Lines Division	4811	Town of Waukesha	Cooling, Tower Blowdown and Groundwater Seepage	None	1	Tributary of the Fox River	28,000	28,000
Amron Corporation	3489	City of Waukesha	Cooling	N/A	1	Fox River via Storm Sewer	1,000	7,000
			Process and Cooling	N/A	2	Fox River via Storm Sewer	1,000	1,000
			Process and Cooling	N/A	3	Fox River via Storm Sewer	1,000	1,000
			Cooling	N/A	4	Fox River via Storm Sewer	72,000	288,000
Elmbrook Memorial Hospital	8062	City of Brookfield	Cooling	None	1	Fox River	8,000	N/A
General Casting Corporation	3321	City of Waukesha	Cooling	None	1	Fox River via Storm Sewer	227,000	270,000
			Cooling	None	2	Fox River via Storm Sewer	42,000	N/A
			Cooling	None	3	Fox River via Storm Sewer	180,000	N/A

Table 76 (continued)

Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average Annual Hydraulic Discharge Rate (gallons per day)[a]	Reported Maximum Monthly Hydraulic Discharge Rate (gallons per day)[a]
General Electric Company—Medical Systems Division	--	City of New Berlin	Cooling	None	1	Deer Creek via Storm Sewer	2,400	N/A
Grede Foundries, Inc.—Spring City Foundry	3321	City of Waukesha	Cooling	None	1	Fox River via Storm Sewer	70,000	80,000
			Cooling	None	2	Fox River via Storm Sewer	158,000	179,000
Halquist Stone Company, Inc.	1429	Town of Lisbon	Washwater	Lagoon	1	Sussex Creek	1,035,000	1,186,000
Howard B. Stark Company	2065	Village of Pewaukee	Cooling	Lagoon	1	Pewaukee River	55,000	88,000
Huber Supreme Metal Treating Company	3471	City of New Berlin	Cooling	Oil Separator	1	Deer Creek via Drainage Ditch	58,000	84,000
International Harvester Company	3321	City of Waukesha	Cooling	None	1	Tributary of the Fox River via Storm Sewer	8,900	14,900
			Cooling	None	2	Tributary of the Fox River via Storm Sewer	18,000	32,000
			Cooling	None	3	Tributary of the Fox River via Storm Sewer	26,000	72,000
			Cooling	None	5	Tributary of the Fox River via Storm Sewer	112,000	154,000
			Cooling	None	6	Tributary of the Fox River via Storm Sewer	174,000	198,000
Mammoth Springs Canning Company	2033	Town of Lisbon	Cooling	Lagoon	1	Sussex Creek	6,000	9,000
			Cooling	N/A	2	Soil Absorption	40,000	46,000
Payne & Dolan of Wisconsin, Inc.	2951	Town of Pewaukee	Washwater	Lagoon	1	Fox River	95,000	168,000
			Washwater	Lagoon	2	Fox River	922,000	1,723,000
Port Shell Moulding, Inc.	3369	Town of Pewaukee	Cooling	None	1	Pewaukee River	2,700	N/A
RTE Corporation	3612	City of Waukesha	Cooling	Oil Separator	1	Fox River via Storm Sewer	46,000	52,000
			Cooling	None	2	Fox River via Storm Sewer	60,000	60,000
Quality Aluminum Casting Company	3341	City of Waukesha	Cooling	None	1	Fox River via Storm Sewer	2,300	2,400
State Sand & Gravel Company	--	Town of Muskego	Process	Seepage Lagoon	1	Soil Absorption	N/A	N/A
Vulcan Materials Company	1442	Town of Lisbon	Groundwater	None	1	Tributary of the Fox River via Drainage Ditch	496,000	1,468,000
Waukesha Engine—Division of Dresser Industries, Inc.	3519	City of Waukesha	Cooling	N/A	1	Swamp Adjacent to the Fox River	418,000	900,000
Waukesha Foundry	3321	City of Waukesha	Cooling	None	1	Fox River via Drainage Ditch and Storm Sewer	272,000	272,000
Waukesha Lime & Stone Company, Inc.	1411	Town of Pewaukee	Groundwater	Lagoon	1	Fox River	120,000	N/A
Western Bituminous Company, Inc.	2891	Town of Lisbon	Process	Lagoon	1	Tributary of the Fox River	1,500	N/A
Wisconsin Centrifugal, Inc.	3382	City of Waukesha	Cooling	None	1	Fox River via Storm Sewer	80,000	102,000
			Cooling	None	2	Fox River via Storm Sewer	16,000	60,000

NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data were obtained, in order of priority, from: quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System or under Section 101 of the Wisconsin Administrative Code or from the Wisconsin Pollutant Discharge Elimination System permit itself. In some cases when 12 months of flow data were not reported, the average annual and maximum monthly hydraulic discharge rates were estimated from the available monthly discharge data or from the flow data as reported in the permit.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

698 domestic livestock operations—operations of 25 or more equivalent animal units—having a total of 77,420 equivalent animal units within the watershed. This figure does not include the Downey Duck Farm with about 82,600 ducks, or 826 equivalent animal units which are noted above as a point source of wastewater. Of the 698 operations, 299, or 43 percent, were located within 500 feet of the surface water system of the watershed.

Pollution Loadings

A summary of the estimated average annual pollution loadings in the Fox River watershed is presented in Table 77 and depicted in Figure 31. Urban sources of pollution are estimated to contribute 23 percent of the nitrogen, 58 percent of the phosphorus, 32 percent of the biochemical oxygen demand, 11 percent of the fecal coliform, and 57 percent of the sediment which occur as water pollutants in the Fox River watershed. Of the urban contribution, point sources of pollution are estimated to contribute 36 percent of the nitrogen, 21 percent of the phosphorus, 9 percent of the biochemical oxygen demand, 3 percent of the fecal coliform, and almost none of the sediment. Diffuse sources—including the estimated septic tank and construction-related contributions in the drainage area—account for the remaining 64 percent of the nitrogen, 79 percent of the phosphorus, 91 percent of the biochemical oxygen demand, 97 percent of the fecal coliform, and almost all of the sediment contributed from urban sources.

Of the total pollutant loads, rural pollution sources are estimated to contribute the remaining 77 percent of the nitrogen, 42 percent of the phosphorus, 68 percent of the biochemical oxygen demand, 89 percent of the fecal coliform, and 43 percent of the sediment which occur as water pollutants in the watershed. Livestock feeding operations—inclusive of the disposal of manure on croplands—are estimated to contribute 26 percent of the nitrogen, 72 percent of the phosphorus, 45 percent of the biochemical oxygen demand, almost all of the fecal coliform, and 3 percent of the sediment from rural sources. The remainder of the estimated rural pollution load, or 74 percent of the nitrogen, 28 percent of the phosphorus, 55 percent of the biochemical oxygen demand, almost none of the fecal coliform, and 97 percent of the sediment, are contributed by other rural diffuse sources, namely storm water runoff from rural land uses and atmospheric loadings to surface waters.

KINNICKINNIC RIVER WATERSHED

The Kinnickinnic River watershed is a natural surface water drainage unit 24.9 square miles in areal extent located in the east-central portion of the Region. The boundaries of the basin, together with the locations of the main channels of the Kinnickinnic River and its principal tributaries, are shown on Map 49, along with the locations of known point sources of pollution and the generalized land uses as of 1975. The entire watershed is included in the Milwaukee urbanized area and discharges to Lake Michigan through the Milwaukee Harbor. The watershed is highly urbanized, with about 86 percent of the land devoted to urban uses. The rural land use is primarily devoted to open lands, generally located in the southern portions of the watershed. Table 78 sets forth the extent and proportion of the major land cover categories within the watershed as they relate to water quality conditions in 1975.

Presently there is no available mapping to indicate the predominate soil types within the majority (about 75 percent) of the Kinnickinnic River watershed, due to the highly urbanized characteristics of the land surface, which includes artificial fill materials and paved surfaces over much of the area. However, knowledge of the area soils indicates that the basic soil types are of a heavy, claylike character.

Particularly important to comprehensive water quality management planning are the soil suitability interpretations for specified types of urban development. Based upon the interpretations of the soil properties, for those areas of the watershed for which soils data are available almost all of the known portion of the watershed is covered by soils that meet the soils requirements for residential development with public sanitary sewer service, as shown on Map 50. Most of the known portion of the watershed is covered by soils that have severe or very severe limitations for small lot (less than one acre in size) residential development without public sanitary sewer, as shown on Map 51. Part of the known portion of the watershed is covered by soils that meet the soils requirements for large lot (one acre or larger in size) residential development, as shown on Map 52.

Municipal and Private Sewage Treatment Facilities

In 1975, a total of five sanitary sewerage systems or portions thereof served the entire watershed area of 24.9 square miles, and the entire resident population of the watershed of 165,100 persons. Included in this total are a total area of about 3.9 square miles, or about 16 percent of the watershed area, and an estimated population of about 56,000 persons, or about 34 percent of the resident population of the watershed, which were served by combined storm and sanitary sewers. There are no publicly or privately owned sewage treatment plants discharging to the stream system of the Kinnickinnic River watershed.

Sanitary Sewerage System Flow Relief Points

In 1975, there were 23 combined sewer outfalls and 29 known sanitary sewer flow relief devices in the watershed, as listed in Table 79 and shown on Map 49. Of the latter, four were sanitary sewerage system bypasses; two were relief pumping stations; four were portable pumping stations; and the remaining nineteen were crossovers. Of the total 52 flow relief devices and combined sewer outfalls, 40 discharge directly to the main stem of the Kinnickinnic River; 7 discharge directly to Wilson Park Creek; 2 discharge directly to the S. 43rd Street ditch; 2 discharge directly to Lyons Park Creek; and 1 discharges directly to Cherokee Park Creek.

Table 77

SUMMARY OF ESTIMATED AVERAGE ANNUAL POLLUTANT LOADINGS IN THE FOX RIVER WATERSHED: 1975

Source	Extent[a]	Parameter	Loads[b] Average Year	
			Total Estimated Loading	Percent
Urban Point Sources				
Municipal Sewage Treatment Plants . .	15	Total Nitrogen	875,730.0	8.0
	15	Total Phosphorus	204,520.0	11.9
	15	Biochemical Oxygen Demand	723,920.0	2.6
	15	Fecal Coliform	790,000.0	0.1
	15	Sediment	680.0	0.0
Private Sewage Treatment Plants	12	Total Nitrogen	9,380.0	0.1
	12	Total Phosphorus	2,860.0	0.2
	12	Biochemical Oxygen Demand	11,100.0	0.0
	12	Fecal Coliform	6,400.0	0.0
	12	Sediment	5.0	0.0
Combined Sewer Overflow	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Industrial Discharges	33	Total Nitrogen	8,460.0	0.1
	33	Total Phosphorus	3,330.0	0.2
	33	Biochemical Oxygen Demand	14,650.0	0.1
	33	Fecal Coliform	0.0	0.0
	33	Sediment	435.0	0.0
Sanitary Sewer Flow Relief Devices . .	20	Total Nitrogen	930.0	0.0
	20	Total Phosphorus	310.0	0.0
	20	Biochemical Oxygen Demand	9,260.0	0.0
	20	Fecal Coliform	1,400,000.0	0.3
	20	Sediment	5.0	0.0
Urban Point Source Totals		Total Nitrogen	894,500.0	8.2
		Total Phosphorus	211,020	12.3
		Biochemical Oxygen Demand	758,930.0	2.7
		Fecal Coliform	2,196,400.0	0.4
		Sediment	1,125.0	0.1
Urban Diffuse Sources				
Residential	40192	Total Nitrogen	160,770.0	1.5
	40192	Total Phosphorus	12,860.0	0.8
	40192	Biochemical Oxygen Demand	976,670.0	3.5
	40192	Fecal Coliform	6,430,720.0	1.1
	40192	Sediment	10,950.0	0.5
Commercial	4924	Total Nitrogen	44,320.0	0.4
	4924	Total Phosphorus	3,690.0	0.2
	4924	Biochemical Oxygen Demand	480,580.0	1.7
	4924	Fecal Coliform	1,624,920.0	0.3
	4924	Sediment	1,835.0	0.1
Industrial	3574	Total Nitrogen	30,020.0	0.3
	3574	Total Phosphorus	2,500.0	0.1
	3574	Biochemical Oxygen Demand	131,880.0	0.5
	3574	Fecal Coliform	2,215,880.0	0.4
	3574	Sediment	1,745.0	0.1
Extractive	4212	Total Nitrogen	252,720.0	2.3
	4212	Total Phosphorus	189,540.0	11.1
	4212	Biochemical Oxygen Demand	505,440.0	1.8
	4212	Fecal Coliform	0.0	0.0
	4212	Sediment	315,900.0	14.4
Transportation	4387	Total Nitrogen	93,330.0	0.9
	4387	Total Phosphorus	7,200.0	0.4
	4387	Biochemical Oxygen Demand	581,890.0	2.1
	4387	Fecal Coliform	2,391,850.0	0.4
	4387	Sediment	77,325.0	3.5
Recreation	10361	Total Nitrogen	32,460.0	0.3
	10361	Total Phosphorus	1,200.0	0.1
	10361	Biochemical Oxygen Demand	13,470.0	0.0
	10361	Fecal Coliform	225,036.0	0.0
	10361	Sediment	2,175.0	0.1
Construction	11229	Total Nitrogen	673,740.0	6.1
	11229	Total Phosphorus	505,310.0	29.5
	11229	Biochemical Oxygen Demand	1,347,480.0	4.8
	11229	Fecal Coliform	0.0	0.0
	11229	Sediment	842,185.0	38.3
Septic Systems	97594	Total Nitrogen	283,020.0	2.6
	97594	Total Phosphorus	64,410.0	3.8
	97594	Biochemical Oxygen Demand	3,981,840.0	14.2
	97594	Fecal Coliform	48,797,000.0	8.7
	97594	Sediment	685.0	0.0
Urban Diffuse Source Totals		Total Nitrogen	1,570,380.0	14.3
		Total Phosphorus	786,710.0	45.9
		Biochemical Oxygen Demand	8,019,250.0	28.5
		Fecal Coliform	61,685,406.0	11.0
		Sediment	1,252,790.0	57.0
Urban Source Totals		Total Nitrogen	2,464,880.0	22.5
		Total Phosphorus	997,730.0	58.3
		Biochemical Oxygen Demand	8,778,180.0	31.2
		Fecal Coliform	63,881,806.0	11.4
		Sediment	1,253,915.0	57.0
Rural Diffuse Sources				
Livestock Operations	77420	Total Nitrogen	2,198,730.0	20.1
	77420	Total Phosphorus	510,970.0	29.8
	77420	Biochemical Oxygen Demand	8,609,100.0	30.6
	77420	Fecal Coliform	495,488,000.0	88.5
	77420	Sediment	27,095.0	1.2
Cropland, Pasture and Unused Rural Land	386127	Total Nitrogen	5,913,460.0	54.0
	386127	Total Phosphorus	181,580.0	10.6
	386127	Biochemical Oxygen Demand	6,161,760.0	21.9
	386127	Fecal Coliform	0.0	0.0
	386127	Sediment	900,870.0	41.0
Silvicultural	62866	Total Nitrogen	144,590.0	1.3
	62866	Total Phosphorus	8,800.0	0.5
	62866	Biochemical Oxygen Demand	289,180.0	1.0
	62866	Fecal Coliform	414,915.6	0.1
	62866	Sediment	7,890.0	0.4
Air Pollution to Surface Water	26500	Total Nitrogen	235,850.0	2.2
	26500	Total Phosphorus	13,250.0	0.8
	26500	Biochemical Oxygen Demand	4,293,000.0	15.3
	26500	Fecal Coliform	0.0	0.0
	26500	Sediment	8,810.0	0.4
Rural Diffuse Source Totals		Total Nitrogen	8,492,630.0	77.5
		Total Phosphorus	714,600.0	41.7
		Biochemical Oxygen Demand	19,353,040.0	68.8
		Fecal Coliform	495,902,915.6	88.6
		Sediment	944,665.0	43.0
Diffuse Source Totals		Total Nitrogen	10,063,010.0	91.8
		Total Phosphorus	1,501,310.0	87.7
		Biochemical Oxygen Demand	27,372,290.0	97.3
		Fecal Coliform	557,588,321.6	99.6
		Sediment	2,197,455.0	99.9
Total Sources		Total Nitrogen	10,957,510.0	100.0
		Total Phosphorus	1,712,330.0	100.0
		Biochemical Oxygen Demand	28,131,220.0	100.0
		Fecal Coliform	559,784,721.6	100.0
		Sediment	2,198,580.0	100.0

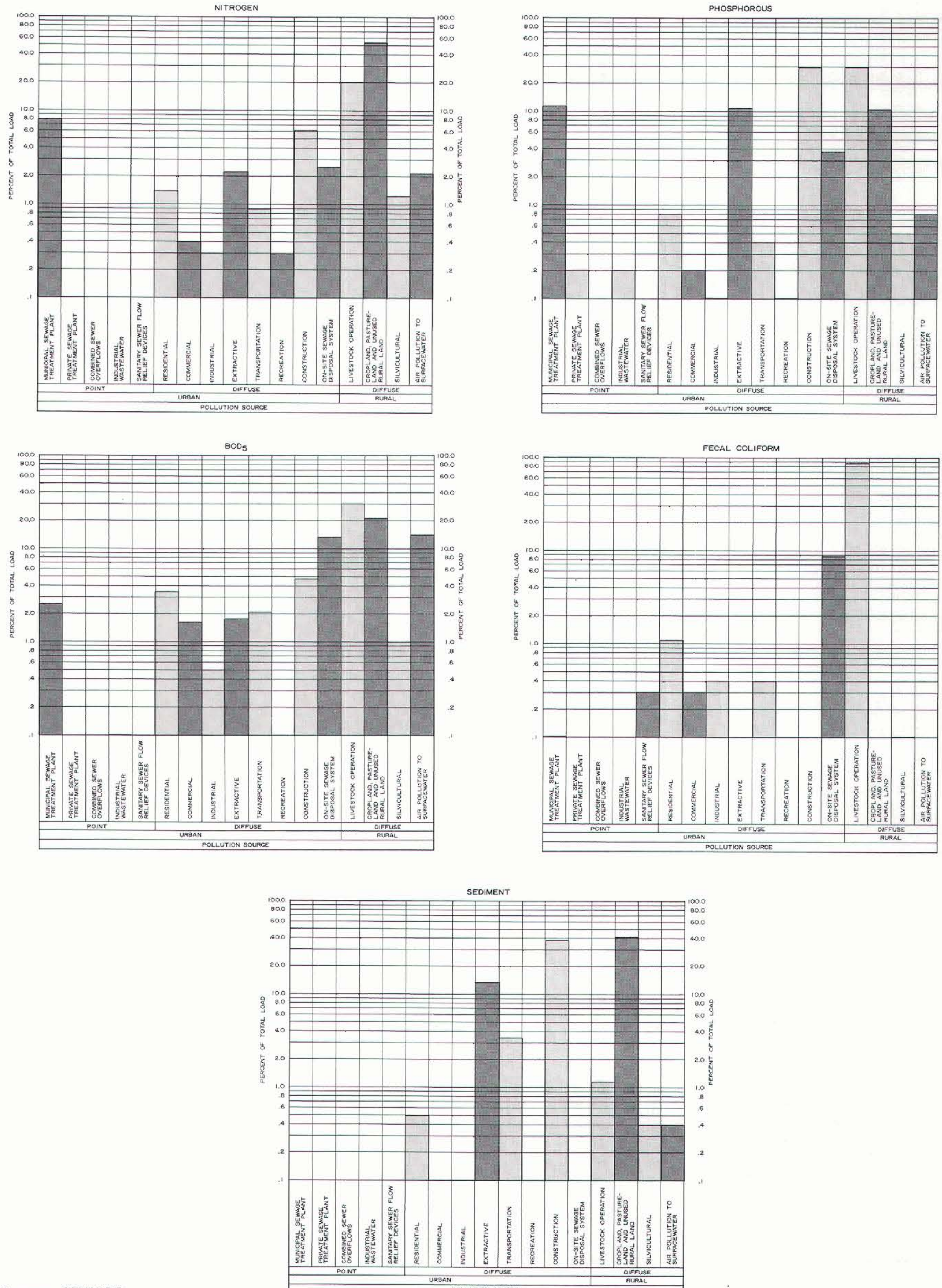
[a] *Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.*

[b] *Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year.*

Source: SEWRPC.

Figure 31

SUMMARY OF ESTIMATED AVERAGE ANNUAL POLLUTANT LOADINGS IN THE FOX RIVER WATERSHED: 1975



Source: SEWRPC.

Table 78

AREAL EXTENT OF WATER QUALITY-RELATED LAND COVER IN THE KINNICKINNIC RIVER WATERSHED: 1975

Land Cover[a]	Square Miles	Acres	Percent
Urban			
Residential	11.81	7,559	50.65
Commercial[b]	1.94	1,239	8.30
Industrial			
Manufacturing	2.12	1,354	9.07
Landfills and Dumps	0.04	27	0.18
Extractive	0.02	15	0.10
Transportation			
Streets and Highways	0.88	563	3.77
Airfields	1.77	1,130	7.57
Railroad Yards and Terminals	0.03	16	0.11
Recreation			
Golf Courses	0.05	32	0.21
Parks and Other Recreation	1.31	839	5.62
Land Under Development			
Residential[c]	0.42	266	1.78
Commercial	--	--	--
Industrial	0.00	1	0.01
Transportation	--	--	--
Recreation	--	--	--
Rural			
Agricultural			
Small Grains	--	--	--
Hay	--	--	--
Row Crops	--	--	--
Specialty Crops	0.15	94	0.63
Sod Farm	--	--	--
Other Open Space[d]	2.66	1,703	11.41
Silvicultural			
Woodlands	0.03	20	0.13
Orchards and Nurseries	--	--	--
Natural and Man-Made Water Areas—Subject to Atmospheric Pollutant Contributions			
Ponds, Lakes, and Streams	0.05	31	0.21
Wetlands, Swamps, and Marshes	0.06	36	0.24
Total	23.34	14,925	100.00

[a] *These special land cover categories, defined primarily according to their imperviousness and vegetative cover characteristics and effects on the quality of storm water runoff, were delineated at a scale of 1" = 400' on aerial photographs taken in May 1975 and were measured to the nearest full acre, using dot-counting overlays. The total acreages measured within hydrologic subbasins were then adjusted to the preliminary control totals measured by digitizer from base maps of hydrologic subbasins at a scale of 1" = 2000'. Both the "square miles" and the "percent" shown above were then computed and rounded to the nearest hundredth (0.01) of a percent. The final control total for the Kinnickinnic River watershed is indicated on Map 49.*

[b] *Includes: retail, communication, utilities, administrative, and institutional land uses.*

[c] *Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.*

[d] *Includes: pasture, unused urban and rural lands.*

Source: *U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service; County Soil and Water Conservation Districts; University of Wisconsin-Extension Service; and SEWRPC.*

Other Known Point Sources

A total of 30 other known point sources of pollution were identified in the watershed in 1975. These other point sources consisted primarily of 60 outfalls through which industrial cooling, process, rinse, and wash waters were discharged directly or indirectly to the surface water system. Of these, 30 were identified as discharging only cooling water. The remaining 30 were discharging other types of wastewaters. Industrial wastewater enters the Kinnickinnic River and its major tributaries directly through industrial waste outfalls or indirectly through drainage ditches and storm sewers. Table 80 summarizes by receiving stream and civil division the characteristics of these other point sources, and Map 49 shows their locations. Six of these other point source outfalls discharge the wastes directly to the Kinnickinnic River main stem, 19 outfalls discharge to the Kinnickinnic River indirectly, and the remaining 35 outfalls discharge to the Kinnickinnic River via tributaries.

Privately Owned Onsite Sanitary Wastewater Treatment

No onsite sewage disposal systems are known to exist in the watershed, since it is fully within areas served by a centralized sanitary sewerage system.

Urban Storm Water Management Systems

As noted in Table 78, land cover categories associated with urban land uses as of 1975 comprised about 13,000 acres, or about 87 percent, of the Kinnickinnic River watershed. The most important urban land cover categories were residential land with about 51 percent, commercial land with about 8 percent, manufacturing land with 9 percent, airfields with 8 percent, and parks and other recreation land with 6 percent.

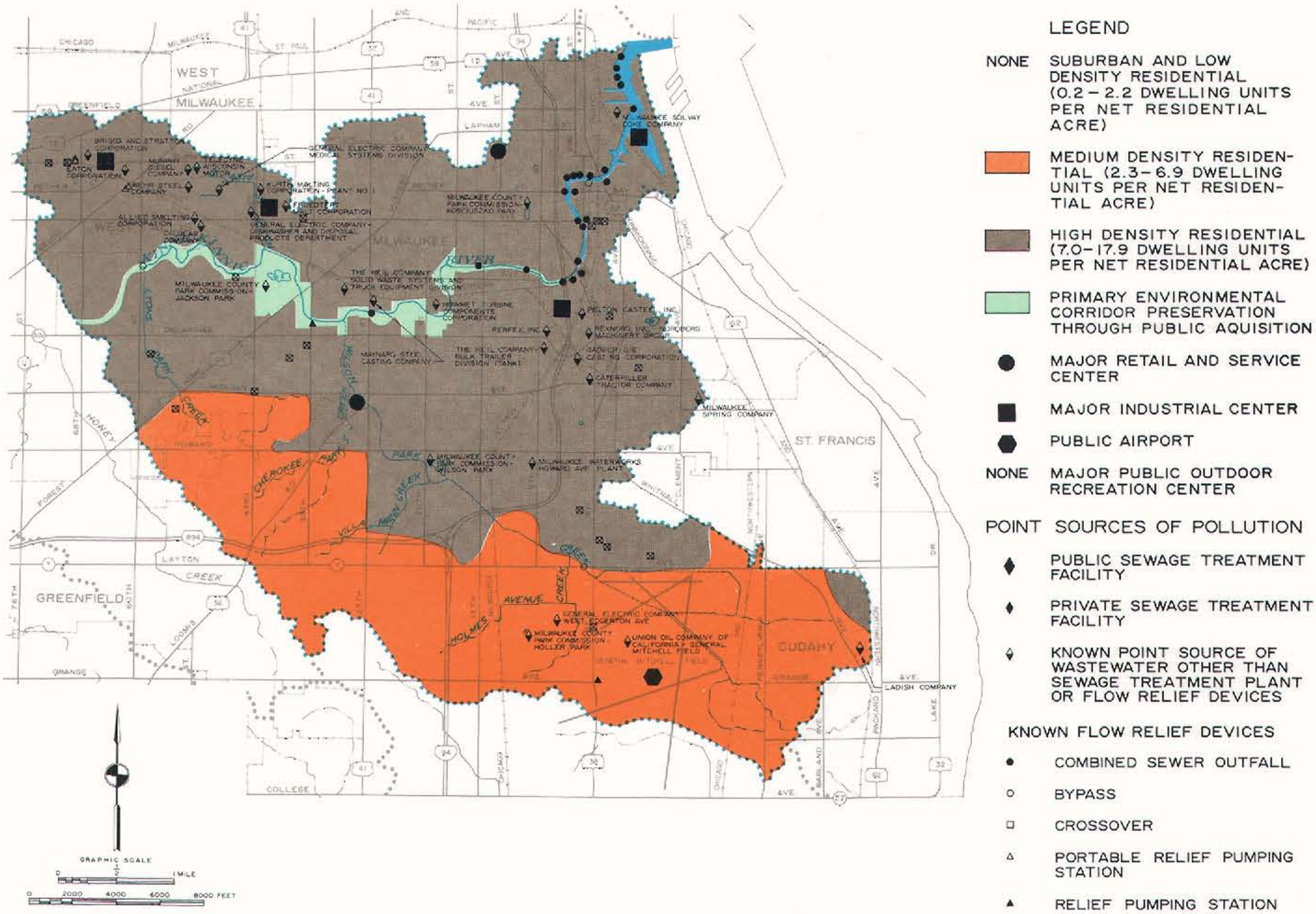
There were a total of six known urban storm water drainage systems providing service to the subareas of the Kinnickinnic River watershed within the Region in 1975. These include the systems operated by the Cities of Cudahy, Greenfield, Milwaukee, St. Francis, and West Allis, and the Village of West Milwaukee. Together, these storm water drainage systems have a tributary drainage area of about 16.6 square miles, or about 67 percent of the total area of the watershed. About 17 percent of the total area of the watershed is served by combined sanitary and storm sewers as noted above. Included within this storm water drainage area are a total of 94 known storm water outfalls ranging in size from 12 inches in diameter to a 142 by 89-inch box culvert. There were no known storm water pumping facilities or storm water storage facilities in the watershed. The total annual average discharge from these outfalls is estimated to be about 2,768 million gallons per year occurring on the average in 70 events.

Rural Storm Water Runoff

About 1,900 acres, or 13 percent of the total area of the watershed, are devoted to rural land use activities. The most important rural land cover category was other open space, with 11 percent. No domestic livestock feeding operations are known to exist in the Kinnickinnic River watershed.

Map 49

THE LOCATION, BOUNDARIES, AND MAJOR STREAMS OF THE KINNICKINNIC RIVER WATERSHED— SHOWING POINT SOURCES OF POLLUTION AND GENERALIZED LAND USES: 1975



The Kinnickinnic River watershed is about 25 square miles in areal extent, or about 0.9 percent of the total area of the Region. The water quality in the watershed is affected by the various land uses as well as by the 29 flow relief devices and 30 other point sources of wastewater as shown.

Source: SEWRPC.

Table 79

KNOWN COMBINED SEWER OUTFALLS AND OTHER FLOW RELIEF DEVICES IN THE KINNICKINNIC RIVER WATERSHED BY RECEIVING STREAM AND CIVIL DIVISION: 1975

Receiving Stream	Civil Division	Combined Sewer Outfalls	Other Flow Relief Devices				Total
			Bypasses	Relief Pumping Stations	Portable Pumping Stations	Crossovers	
Kinnickinnic River	City of Milwaukee	23	2	1	0	8	34
Kinnickinnic River	City of West Allis	0	0	0	4	2	6
Wilson Park Creek	City of Milwaukee	0	1	1	0	5	7
Cherokee Park Creek	City of Milwaukee	0	0	0	0	1	1
South 43rd Street Ditch	City of Milwaukee	0	1	0	0	1	2
Lyons Park Creek	City of Milwaukee	0	0	0	0	2	2
	Totals	23	4	2	4	19	52

Source: SEWRPC.

Table 80

CHARACTERISTICS OF OTHER KNOWN POINT SOURCES OF WATER POLLUTION IN THE KINNICKINNIC RIVER WATERSHED: 1975

Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average Annual Hydraulic Discharge Rate (gallons per day)[a]	Reported Maximum Monthly Hydraulic Discharge Rate (gallons per day)[a]
MILWAUKEE COUNTY								
Allied Smelting Corporation	3341	City of West Allis	Process and Cooling	pH Adjustment	1	S. 43rd Street Ditch via Storm Sewer	121,000	144,000
Badger Die Casting Corporation	3369	City of Milwaukee	Cooling	None	1	Kinnickinnic River via Storm Sewer	43,500	N/A
Briggs & Stratton Corporation	3714	City of West Allis	Cooling	N/A	1	S. 43rd Street Ditch via Storm Sewer	1,026,000	1,026,000
			Cooling	N/A	3	S. 43rd Street Ditch via Storm Sewer	308,000	308,000
			Cooling	N/A	4	S. 43rd Street Ditch via Storm Sewer	20,000	108,000
			Cooling	N/A	5	S. 43rd Street Ditch via Storm Sewer	25,000	25,000
			Cooling	N/A	6	S. 43rd Street Ditch via Storm Sewer	99,000	99,000
Caterpillar Tractor Company	3531	City of Milwaukee	Cooling	N/A	5	Kinnickinnic River via Storm Sewer	1,000	2,400
			Process	N/A	6	Kinnickinnic River via Storm Sewer	1,900	4,800
			Cooling	N/A	13	Kinnickinnic River via Storm Sewer	4,300	5,300
			Process	N/A	16	Kinnickinnic River via Storm Sewer	600	1,200
Eaton Corporation	3462	City of West Allis	Process, Cooling, and Boiler Blowdown	Oil Separator	1	S. 43rd Street Ditch via Storm Sewer	128,800	233,500
			Process, Cooling and Boiler Blowdown	N/A	2	S. 43rd Street Ditch via Storm Sewer	2,800	3,200
Froedtert Malt Corporation	2083	Village of West Milwaukee	Cooling	None	1	S. 43rd Street Ditch via Storm Sewer	19,900	36,200
General Electric Company– Dishwasher and Disposal Products Department	3639	Village of West Milwaukee	Cooling	N/A	1	S. 43rd Street Ditch via Storm Sewer	72,000	N/A
			Cooling	N/A	2	S. 43rd Street Ditch via Storm Sewer	34,000	N/A
			Cooling	N/A	3	S. 43rd Street Ditch via Storm Sewer	2,000	N/A
			Cooling	N/A	4	S. 43rd Street Ditch via Storm Sewer	1,000	N/A
General Electric Company– Medical Systems Division	3829	City of Milwaukee	Cooling and Cooling Tower Blowdown	None	1	S. 43rd Street Ditch via Storm Sewer	475,700	967,600
General Electric Company– West Edgerton Avenue	--	City of Milwaukee	Cooling	None	1	Holmes Avenue Creek via Storm Sewer	300	N/A
The Heil Company– Bulk Trailer Division (Tank)	3713	City of Milwaukee	Test and Cooling	N/A	1	Kinnickinnic River via Storm Sewer	10,800	20,400
			Test and Cooling	N/A	2	Kinnickinnic River via Storm Sewer	300	300
The Heil Company– Solid Waste Systems and Truck Equipment Division	3713	City of Milwaukee	Cooling	None	1	Kinnickinnic River	82,400	120,500
			Cooling	N/A	14	Kinnickinnic River	1,000	5,000
Howmet Turbine Components Corporation	3324	City of Milwaukee	Cooling	None	1	Kinnickinnic River	323,900	481,000
			Process and Cooling	None	2	Kinnickinnic River	201,400	258,400
			Process	Settling Pond	3	Kinnickinnic River	111,500	176,000
Kurth Malting Corporation– Plant No. 1	2083	Village of West Milwaukee	Cooling	None	3	S. 43rd Street Ditch via Storm Sewer	20,000	30,000
			Cooling	None	4	S. 43rd Street Ditch via Storm Sewer	130,000	450,000
Ladish Company	3462	City of Cudahy	Cooling	N/A	2	Wilson Park Creek via Storm Sewer	176,600	246,200
			Cooling	N/A	3	Wilson Park Creek via Storm Sewer	288,900	465,000
Maynard Steel Casting Company	3325	City of Milwaukee	Process and Cooling	Settling Basin, Lagoon and Chemical Precipitation	1	Kinnickinnic River	110,400	123,400
Milwaukee County Park Commission– Holler Park	7999	City of Milwaukee	Swimming Pool Overflow and Emptying	None	1	Holmes Avenue Creek via Storm Sewer	Intermittent	Intermittent
Milwaukee County Park Commission– Jackson Park	7999	City of Milwaukee	Swimming Pool Overflow	None	1	Kinnickinnic River via Storm Sewer	Intermittent	Intermittent

Table 80 (continued)

Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average Annual Hydraulic Discharge Rate (gallons per day)[a]	Reported Maximum Monthly Hydraulic Discharge Rate (gallons per day)[a]
Milwaukee County Park Commission—Kosciuszko Park	7999	City of Milwaukee	Swimming Pool Overflow	None	1	Kinnickinnic River via Storm Sewer	Intermittent	Intermittent
Milwaukee County Park Commission—Wilson Park	7999	City of Milwaukee	Swimming Pool Overflow	None	1	Wilson Park Creek via Storm Sewer	Intermittent	Intermittent
Milwaukee Solvay Coke Company	3312	City of Milwaukee	Cooling, Process, and Boiler Blowdown	None	1	Kinnickinnic River via Storm Sewer	2,120,800	3,158,100
			Cooling, Process, and Boiler Blowdown	None	2	Kinnickinnic River via Storm Sewer	2,700,000	2,700,000
Milwaukee Spring Company	--	City of Milwaukee	Cooling	N/A	1	Kinnickinnic River via Storm Sewer	78,000	N/A
Milwaukee Waterworks—Howard Avenue Plant	4941	City of Milwaukee	Filter Backwash	None	1	Wilson Park Creek via Storm Sewer	415,800	430,000
Murphy Diesel Company	3519	City of West Allis	Cooling	None	1	S. 43rd Street Ditch via Storm Sewer	5,500	5,800
			Cooling	None	2	S. 43rd Street Ditch via Storm Sewer	8,900	15,100
			Cooling	None	3	S. 43rd Street Ditch via Storm Sewer	6,200	12,400
			Cooling	None	4	S. 43rd Street Ditch via Storm Sewer	19,600	30,300
Oilgear Company	3561	City of Milwaukee	Cooling	None	1	Kinnickinnic River via Storm Sewer	1,000	2,000
Pelton Casteel, Inc.	3325	City of Milwaukee	Process and Cooling	Settling Basin, Oil Separator, and pH Adjustment	1	Kinnickinnic River via Drainage Ditch	79,800	92,600
Perfex, Inc.	3433	City of Milwaukee	Test and Cooling	None	1	Kinnickinnic River via Storm Sewer	130,000	140,000
Rexnord, Inc.—Nordberg Machinery Group	3532	City of Milwaukee	Cooling, Process, and Boiler Blowdown	None	1	Kinnickinnic River via Storm Sewer	145,500	220,000
			Process and Cooling	None	2	Kinnickinnic River via Storm Sewer	246,600	300,000
			Process	None	3	Kinnickinnic River	4,000	10,000
			Process and Cooling	None	4	Kinnickinnic River via Storm Sewer	52,700	77,500
Teledyne Wisconsin Motor	3519	City of West Allis	Process and Cooling	N/A	1	S. 43rd Street Ditch via Storm Sewer	3,800	5,500
			Process and Cooling	N/A	2	S. 43rd Street Ditch via Storm Sewer	22,500	30,000
			Process and Cooling	N/A	4	S. 43rd Street Ditch via Storm Sewer	1,200	1,500
			Process and Cooling	N/A	5	S. 43rd Street Ditch via Storm Sewer	8,500	14,000
Union Oil Company of California—General Mitchell Field	5170	City of Milwaukee	Oil-Contaminated Storm Water	Oil-Water Separator	1	Wilson Park Creek via Storm Sewer	Intermittent	Intermittent
Wehr Steel Company	3325	City of Milwaukee	Cooling	N/A	2	S. 43rd Street Ditch via Storm Sewer	182,000	239,000
			Cooling	N/A	3	S. 43rd Street Ditch via Storm Sewer	23,000	24,000
			Process	N/A	6	S. 43rd Street Ditch via Storm Sewer	31,000	50,000
			Cooling	N/A	7	S. 43rd Street Ditch via Storm Sewer	17,000	49,000

NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data were obtained, in order of priority, from: quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System or under Section 101 of the Wisconsin Administrative Code or from the Wisconsin Pollutant Discharge Elimination System permit itself. In some cases when 12 months of flow data were not reported, the average annual and maximum monthly hydraulic discharge rates were estimated from the available monthly discharge data or from the flow data as reported in the permit.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Map 50

SUITABILITY OF SOILS FOR RESIDENTIAL DEVELOPMENT WITH PUBLIC SANITARY SEWER SERVICE IN THE KINNICKINNIC RIVER WATERSHED

LEGEND

AREAS COVERED BY SOILS HAVING SEVERE OR VERY SEVERE LIMITATIONS FOR RESIDENTIAL DEVELOPMENT WITH PUBLIC SANITARY SEWER SERVICE

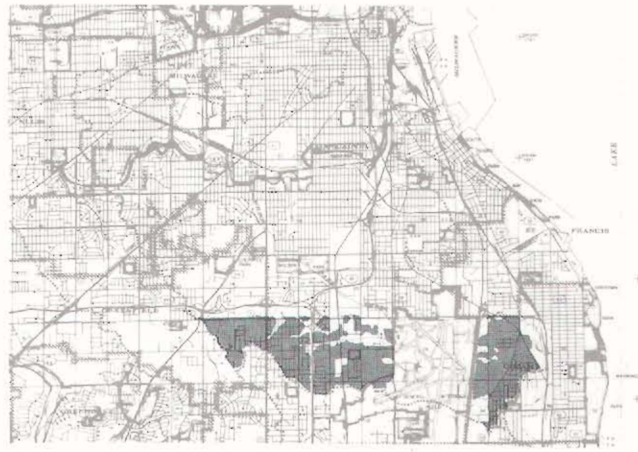
GRAPHIC SCALE 0 1 2 MILES 0 4000 8000 12000 16000 FEET

Of particular importance in comprehensive water quality planning is the recognition of the limitations inherent in the soil resource base. Only about 24 percent of the area of the Kinnickinnic River watershed has known soils data. Only a small percentages of this portion are covered with soils which are poorly suited for residential development with public sanitary sewer service or, more precisely, residential development of any kind. These soils, which include wet soils having a high water table or poor drainage, organic soils which are poorly drained and provide poor foundation support, and soils which have a flood hazard, are especially prevalent in the riverine areas of the watershed.

Source: U. S. Soil Conservation Service and SEWRPC.

Map 51

SUITABILITY OF SOILS FOR SMALL LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE IN THE KINNICKINNIC RIVER WATERSHED



LEGEND

AREAS COVERED BY SOILS HAVING SEVERE OR VERY SEVERE LIMITATIONS FOR RESIDENTIAL DEVELOPMENT WITH SEPTIC TANK SEWAGE DISPOSAL ON LOTS LESS THAN ONE ACRE IN SIZE

GRAPHIC SCALE 0 1 2 MILES 0 4000 8000 12000 16000 FEET

Most of the known portion of the Kinnickinnic River watershed is covered by soils poorly suited for residential development on lots having an area smaller than one acre and not served by public sanitary sewerage facilities. Reliance on septic tank sewage disposal systems in these areas, which are covered by relatively impervious soils or are subject to seasonally high water tables, can only result in eventual malfunctioning of such systems and the consequent intensification of water pollution and public health problems in the watershed.

Source: U. S. Soil Conservation Service and SEWRPC.

Pollution Loadings

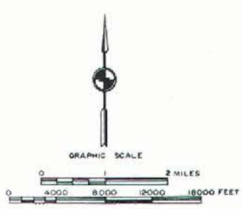
A summary of the estimated average annual pollution loadings in the Kinnickinnic River watershed is presented in Table 81 and depicted in Figure 32. Urban sources of pollution are estimated to contribute 94 percent of the nitrogen, 99 percent of the phosphorus, 99 percent of the biochemical oxygen demand, 100 percent of the fecal coliform, and 98 percent of the sediment which occur as water pollutants in the Kinnickinnic River watershed. Of the urban contribution, point sources of pollution are estimated to contribute 37 percent of the nitrogen, 63 percent of the phosphorus, 68 percent of the biochemical oxygen demand, 98 percent of the fecal coliform, and 10 percent of the sediment. Diffuse sources—including the estimated septic tank and construction-related contributions in the drainage area—account for the remaining 63 percent of the nitrogen, 37 percent of the phosphorus, 32 percent of the biochemical oxygen demand, 2 percent of the fecal coliform, and 90 percent of the sediment contributed from urban sources.

Map 52

SUITABILITY OF SOILS FOR LARGE LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE IN THE KINNICKINNIC RIVER WATERSHED

LEGEND

AREAS COVERED BY SOILS HAVING SEVERE OR VERY SEVERE LIMITATIONS FOR RESIDENTIAL DEVELOPMENT WITH SEPTIC TANK DISPOSAL ON LOTS ONE ACRE OR MORE IN SIZE



Detailed soils information is available for only about six square miles, or about 24 percent of the total area of the Kinnickinnic River watershed. Less than one-half of the area of the Kinnickinnic River watershed for which detailed soils data is available is covered by soils poorly suited for residential development on lots having an area of one acre or more and not served by public sanitary sewerage facilities. The inherent limitations of these soils for septic tank sewage disposal systems cannot be overcome simply by the provision of larger lots, and the use of such systems on these soils, which cannot absorb the sewage effluent, ultimately results in surface ponding and runoff of partially treated wastes into nearby watercourses.

Source: U. S. Soil Conservation Service and SEWRPC.

Rural pollution sources are estimated to contribute the remaining 6 percent of the nitrogen, 1 percent of the phosphorus, 1 percent of the biochemical oxygen demand, and 2 percent of the sediment which occur as water pollutants in the watershed. As noted, none of the estimated pollutant loading is associated with domestic livestock feeding operations. All of the estimated rural pollution load is estimated to be contributed by other rural diffuse sources, namely storm water runoff and atmospheric loadings to surface waters.

MENOMONEE RIVER WATERSHED

The Menomonee River watershed is a natural surface water drainage unit 135.9 square miles in areal extent located in the east-central portions of the Region. The boundaries of the basin, together with the locations of the main channels of the Menomonee River and its principal tributaries, are shown on Map 53, along with the locations of the known point sources of pollution and the generalized land uses as of 1975. The main stem of the Menomonee River originates in the Village of Germantown in Washington County and discharges to Lake Michigan through the Milwaukee Harbor in downtown Milwaukee. About 42 percent of the total area of the watershed is still in rural land uses, with about 79 percent of this rural area in agricultural use. Most of the agricultural-related land use is located in the northern half of the watershed. Table 82 sets forth the extent and proportion of the major land cover categories within the watershed as they relate to water quality conditions in 1975.

The soils within the Menomonee River watershed are rolling silt loams or gravelly loams. Most of the natural soils are relatively fertile and would produce high crop yields if managed correctly. Sediment discharges from these soils may result in high nutrient levels in stream waters. Where urbanization has occurred, artificial fill materials and paved surfaces have modified the natural character of the soils with regard to drainage and fertility.

Particularly important to comprehensive water quality management planning are the soil suitability interpretations for specified types of urban development. Detailed soils data are available for 115 square miles, or 85 percent, of the Menomonee River watershed. Based upon the interpretations of the soil properties, about 20 percent of the watershed for which soils data are available is covered by soils that have severe or very severe limitations for residential development with public sanitary sewer service, as shown on Map 54; about 80 percent of the watershed for which soils data are available is covered by soils that have severe or very severe limitations for small lot (less than one acre in size) residential development without public sanitary sewer, as shown on Map 55; and about 44 percent of the watershed for which soils data are available is covered by soils that have severe or very severe limitations for large lot (one acre or larger in size) residential development, as shown on Map 56.

Municipal and Private Sewage Treatment Facilities

In 1975, a total of 14 sanitary sewerage systems or portions thereof served a total area of about 72.3 square miles within the Menomonee River watershed, or about 53 percent of the total area of the watershed, and a total population of about 319,100 persons, or approximately 95 percent of the total resident population of the watershed. Three municipally owned sewage treatment plants are located in the watershed. All three plants, the Village of Germantown Old Village Plant and the two plants which serve the Village of Menomonee Falls, discharge treated effluents directly to the main stem of the Meno-

Table 81

SUMMARY OF ESTIMATED AVERAGE ANNUAL POLLUTANTS LOADINGS IN THE KINNICKINNIC RIVER WATERSHED: 1975

Source	Extent[a]	Parameter	Loads[b] Average Year Total Estimated Loading	Percent
Urban Point Sources				
Municipal Sewage Treatment Plants . .	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Private Sewage Treatment Plants	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Combined Sewer Overflow	23	Total Nitorgen	43,030.0	25.4
	23	Total Phosphorus	21,520.0	37.9
	23	Biochemical Oxygen Demand	430,340.0	24.1
	23	Fecal Coliform	140,000,000.0	97.4
	23	Sediment	645.0	1.5
Industrial Discharges	30	Total Nitrogen	15,190.0	9.0
	30	Total Phosphorus	13,750.0	24.2
	30	Biochemical Oxygen Demand	763,240.0	42.7
	30	Fecal Coliform	0.0	0.0
	30	Sediment	3,840.0	8.8
Sanitary Sewer Flow Relief Devices . .	29	Total Nitrogen	580.0	0.3
	29	Total Phosphorus	190.0	0.3
	29	Biochemical Oxygen Demand	5,760.0	0.3
	29	Fecal Coliform	870,000.0	0.6
	29	Sediment	5.0	0.0
Urban Point Source Totals		Total Nitrogen	58,800.0	34.7
		Total Phosphorus	35,460.0	62.4
		Biochemical Oxygen Demand	1,199,340.0	67.1
		Fecal Coliform	140,870,000.0	98.0
		Sediment	4,490.0	10.3
Urban Diffuse Sources				
Residential	7559	Total Nitrogen	30,240.0	17.8
	7559	Total Phosphorus	2,420.0	4.3
	7559	Biochemical Oxygen Demand	183,680.0	10.3
	7559	Fecal Coliform	1,209,440.0	0.8
	7559	Sediment	2,060.0	4.7
Commercial	1239	Total Nitrogen	11,150.0	6.6
	1239	Total Phosphorus	930.0	1.6
	1239	Biochemical Oxygen Demand	120,930.0	6.8
	1239	Fecal Coliform	408,870.0	0.3
	1239	Sediment	460.0	1.1
Industrial	1381	Total Nitrogen	11,600.0	6.8
	1381	Total Phosphorus	970.0	1.7
	1381	Biochemical Oxygen Demand	50,960.0	2.9
	1381	Fecal Coliform	856,220.0	0.6
	1381	Sediment	675.0	1.6
Extractive	15	Total Nitrogen	900.0	0.5
	15	Total Phosphorus	680.0	1.2
	15	Biochemical Oxygen Demand	1,800.0	0.1
	15	Fecal Coliform	0.0	0.0
	15	Sediment	1,125.0	2.6
Transportation	1709	Total Nitrogen	28,560.0	16.8
	1709	Total Phosphorus	3,740.0	6.6
	1709	Biochemical Oxygen Demand	172,600.0	9.7
	1709	Fecal Coliform	387,130.0	0.3
	1709	Sediment	13,640.0	31.4
Recreation	871	Total Nitrogen	2,070.0	1.2
	871	Total Phosphorus	60.0	0.1
	871	Biochemical Oxygen Demand	1,130.0	0.1
	871	Fecal Coliform	30,204.0	0.0
	871	Sediment	185.0	0.4
Construction	267	Total Nitrogen	16,020.0	9.4
	267	Total Phosphorus	12,020.0	21.1
	267	Biochemical Oxygen Demand	32,040.0	1.8
	267	Fecal Coliform	0.0	0.0
	267	Sediment	20,025.0	46.0
Septic Systems	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Urban Diffuse Source Totals		Total Nitrogen	100,540.0	59.3
		Total Phosphorus	20,820.0	36.6
		Biochemical Oxygen Demand	536,140.0	31.5
		Fecal Coliform	2,891,864.0	2.0
		Sediment	38,170.0	87.7
Urban Source Totals		Total Nitrogen	159,340.0	93.9
		Total Phosphorus	56,280.0	99.0
		Biochemical Oxygen Demand	1,762,480.0	98.6
		Fecal Coliform	143,761,864.0	100.0
		Sediment	42,660.0	98.1
Rural Diffuse Sources				
Livestock Operation	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Cropland, Pasture, and Unused Rural Land	1797	Total Nitrogen	10,010.0	5.9
	1797	Total Phosphorus	550.0	1.0
	1797	Biochemical Oxygen Demand	19,340.0	1.1
	1797	Fecal Coliform	0.0	0.0
	1797	Sediment	830.0	1.9
Silvicultural	20	Total Nitrogen	50.0	0.0
	20	Total Phosphorus	0.0	0.0
	20	Biochemical Oxygen Demand	90.0	0.0
	20	Fecal Coliform	132.0	0.0
	20	Sediment	5.0	0.0
Air Pollution to Surface Water	31	Total Nitrogen	280.0	0.2
	31	Total Phosphorus	20.0	0.0
	31	Biochemical Oxygen Demand	5,020.0	0.3
	31	Fecal Coliform	0.0	0.0
	31	Sediment	10.0	0.0
Rural Diffuse Source Totals		Total Nitrogen	10,340.0	6.1
		Total Phosphorus	570.0	1.0
		Biochemical Oxygen Demand	24,450.0	1.4
		Fecal Coliform	132.0	0.0
		Sediment	845.0	1.9
Diffuse Source Totals		Total Nitorgen	110,880.0	65.3
		Total Phosphorus	21,390.0	37.6
		Biochemical Oxygen Demand	587,590.0	32.9
		Fecal Coliform	2,891,996.0	2.0
		Sediment	39,015.0	89.7
Total Sources		Total Nitrogen	169,680.0	100.0
		Total Phosphorus	56,850.0	100.0
		Biochemical Oxygen Demand	1,786,930.0	100.0
		Fecal Coliform	143,761,996.0	100.0
		Sediment	43,505.0	100.0

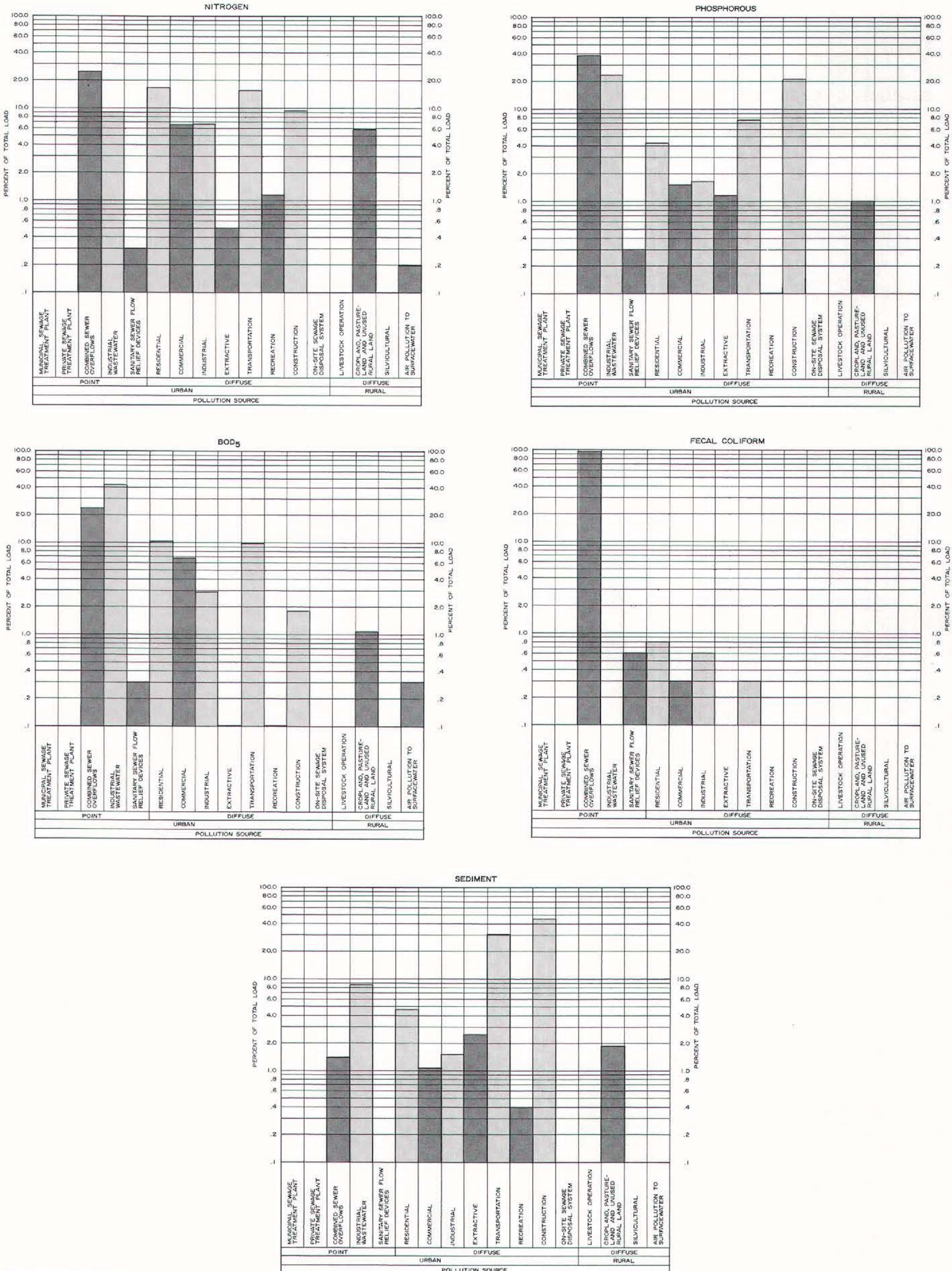
[a] *Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.*

[b] *Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year.*

Source: SEWRPC.

Figure 32

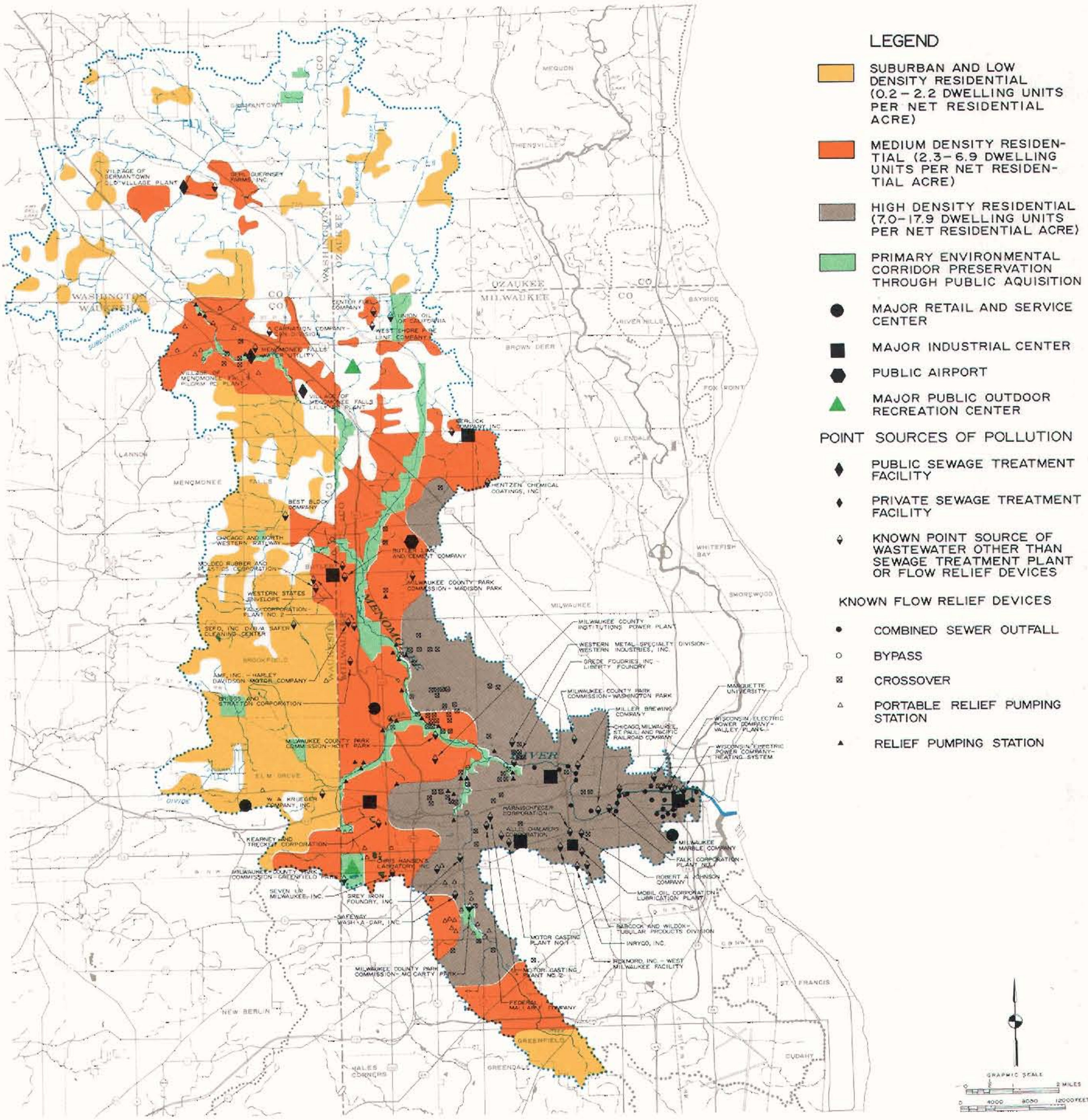
SUMMARY OF ESTIMATED AVERAGE ANNUAL POLLUTANT LOADINGS IN THE KINNICKINNIC RIVER WATERSHED: 1975



Source: SEWRPC.

Map 53

THE LOCATION, BOUNDARIES, AND MAJOR STREAMS OF THE MENOMONEE RIVER WATERSHED–SHOWING POINT SOURCES OF POLLUTION AND GENERALIZED LAND USES: 1975

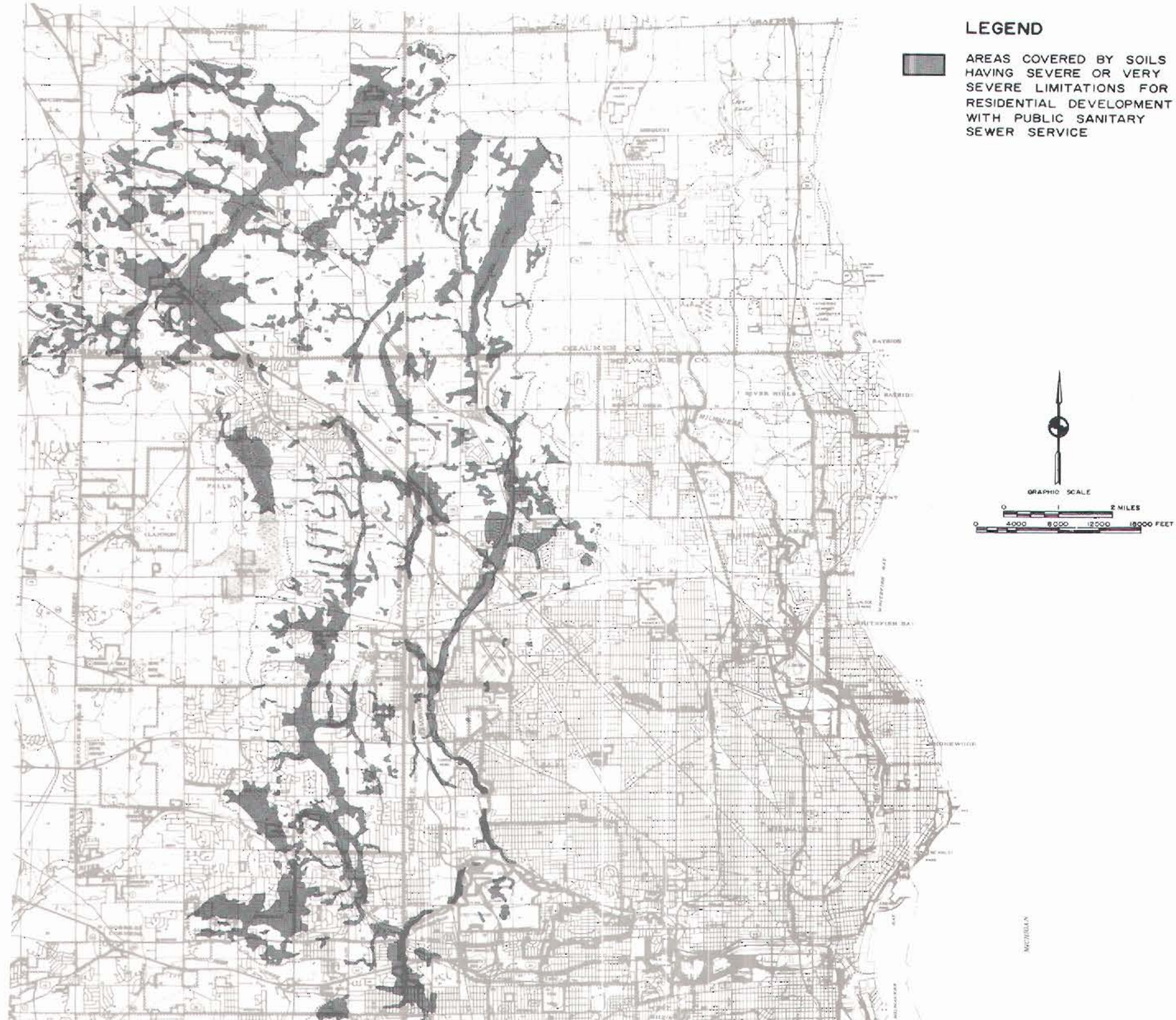


The Menomonee River watershed is about 136 square miles in areal extent, or about 5 percent of the total area of the Region. The water quality in the watershed is affected by the various land uses as well as by the three public wastewater treatment plants, 166 flow relief devices, and 49 other point sources of wastewater as shown.

Source: SEWRPC.

Map 54

SUITABILITY OF SOILS FOR RESIDENTIAL DEVELOPMENT WITH PUBLIC SANITARY SEWER SERVICE IN THE MENOMONEE RIVER WATERSHED

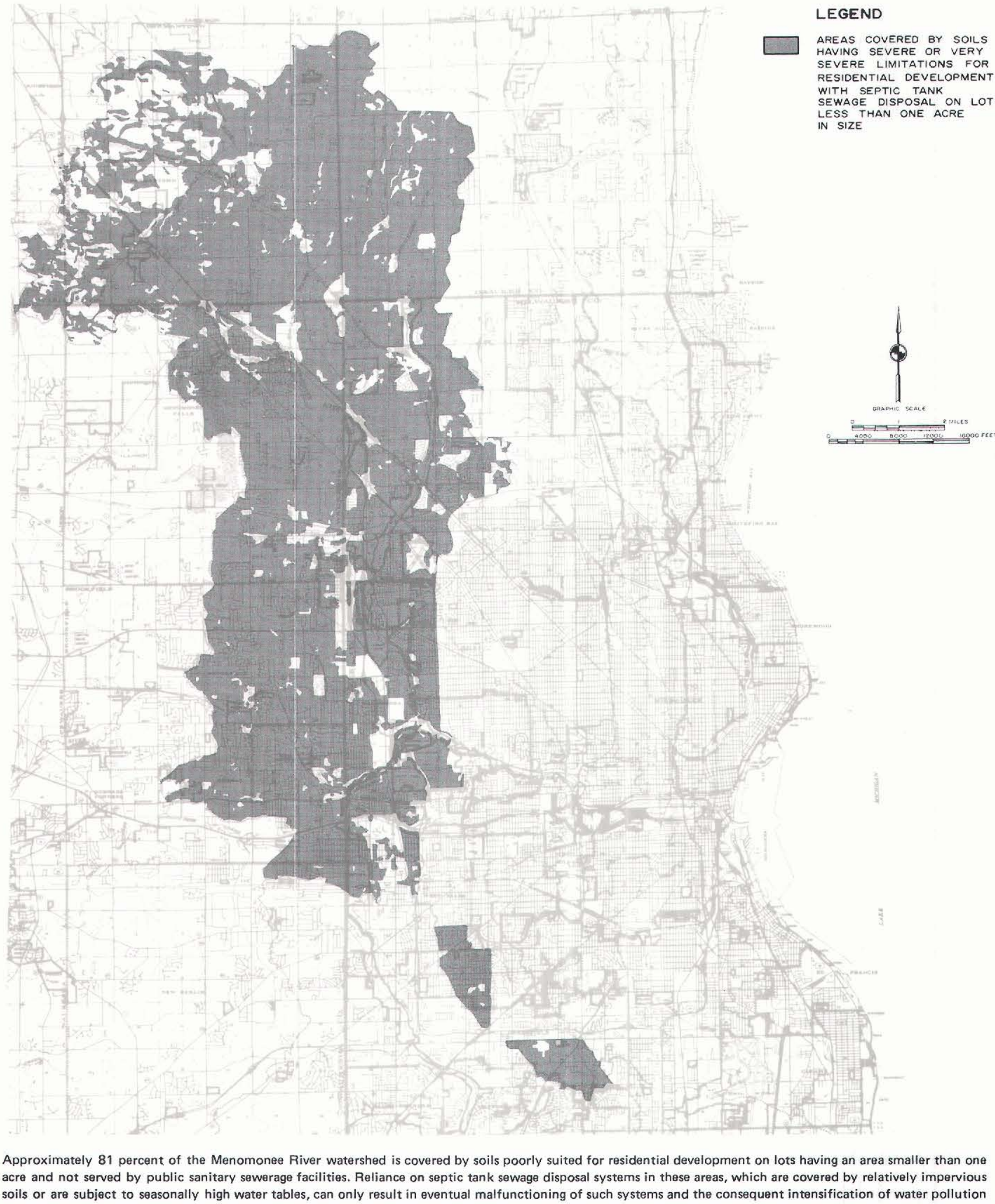


Of particular importance in comprehensive water quality planning is the recognition of the limitations inherent in the soil resource base essential to the sound urban and rural development of the watershed. About 20 percent of the Menomonee River watershed is covered by soils which are poorly suited for residential development with public sanitary sewer, or more precisely, residential development of any kind. These soils, which include wet soils having a high water table or poor drainage, organic soils which are poorly drained and provide poor foundation support, and soils which have a flood hazard, are especially prevalent in the riverine areas of the watershed.

Source: U. S. Soil Conservation Service and SEWRPC.

Map 55

SUITABILITY OF SOILS FOR SMALL LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE IN THE MENOMONEE RIVER WATERSHED

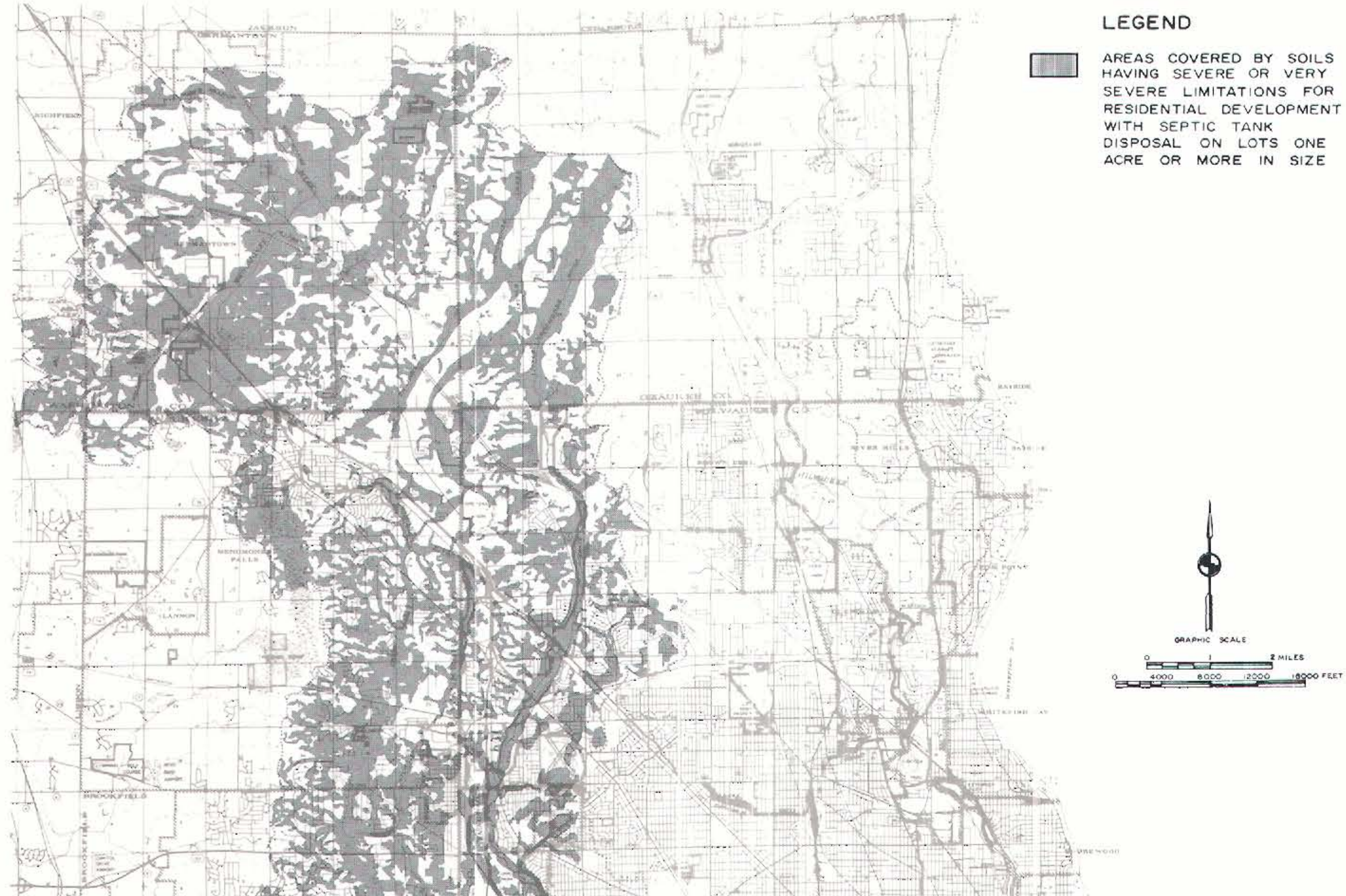


Approximately 81 percent of the Menomonee River watershed is covered by soils poorly suited for residential development on lots having an area smaller than one acre and not served by public sanitary sewerage facilities. Reliance on septic tank sewage disposal systems in these areas, which are covered by relatively impervious soils or are subject to seasonally high water tables, can only result in eventual malfunctioning of such systems and the consequent intensification of water pollution and public health problems in the watershed.

Source: U. S. Soil Conservation Service and SEWRPC.

Map 56

SUITABILITY OF SOILS FOR LARGE LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE IN THE MENOMONEE RIVER WATERSHED



Approximately 44 percent of the Menomonee River watershed is covered by soils poorly suited for residential development on lots having an area of one acre or more and not served by public sanitary sewerage facilities. The inherent limitations of these soils for septic tank sewage disposal systems cannot be overcome simply by the provision of larger lots, and the use of such systems on these soils, which cannot absorb the sewage effluent, ultimately results in surface ponding and runoff of partially treated wastes into nearby watercourses.

Source: U. S. Soil Conservation Service and SEWRPC.

Table 82

AREAL EXTENT OF WATER QUALITY-RELATED LAND COVER IN THE MENOMONEE RIVER WATERSHED: 1975

Land Cover[a]	Square Miles	Acres	Percent
Urban			
Residential	36.12	23,112	26.52
Commercial[b]	7.76	4,968	5.70
Industrial			
Manufacturing	3.51	2,247	2.58
Landfills and Dumps	0.46	296	0.34
Extractive	0.59	378	0.43
Transportation			
Streets and Highways	17.54	11,227	12.88
Airfields	0.58	372	0.43
Railroad Yards and Terminals	1.96	1,256	1.44
Recreation			
Golf Courses	1.84	1,177	1.35
Parks and Other Recreation	4.33	2,774	3.18
Land Under Development			
Residential[c]	3.01	1,926	2.20
Commercial	0.03	21	0.02
Industrial	0.75	481	0.55
Transportation	--	--	--
Recreation	--	--	--
Rural			
Agricultural			
Small Grains	3.70	2,365	2.71
Hay	6.76	4,329	4.96
Row Crops	13.45	8,610	9.88
Specialty Crops	3.67	2,346	2.69
Sod Farm	0.14	88	0.10
Other Open Space[d]	17.97	11,502	13.20
Silvicultural			
Woodlands	6.53	4,179	4.79
Orchards and Nurseries	0.75	481	0.55
Natural and Man-Made Water Areas—Subject to Atmospheric Pollutant Contributions			
Ponds, Lakes, and Streams	0.73	469	0.54
Wetlands, Swamps, and Marshes	3.99	2,552	2.93
Total	136.17	87,156	100.00

[a] *These special land cover categories, defined primarily according to their imperviousness and vegetative cover characteristics and effects on the quality of storm water runoff, were delineated at a scale of 1" = 400' on aerial photographs taken in May 1975 and were measured to the nearest full acre, using dot-counting overlays. The total acreages measured within hydrologic subbasins were then adjusted to the preliminary control totals measured by digitizer from base maps of hydrologic subbasins at a scale of 1" = 2000'. Both the "square miles" and the "percent" shown above were then computed and rounded to the nearest hundredth (0.01) of a percent. The final control total for the Menomonee River watershed is indicated on Map 53..*

[b] *Includes: retail, communication, utilities, administrative, and institutional land uses.*

[c] *Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.*

[d] *Includes: pasture, unused urban and rural lands.*

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service; County Soil and Water Conservation Districts; University of Wisconsin-Extension Service; and SEWRPC.

monee River. Selected information for these municipal sewage treatment plants is set forth in Table 83, and the plant locations are shown on Map 53. Included in this sanitary sewer service area are about 8.4 square miles, or about 6 percent of the watershed area, and an estimated total of about 68,500 persons, or about 20 percent of the resident population of the watershed, which were served by combined storm and sanitary sewers. There are no known privately owned wastewater treatment facilities discharging to the stream system of the Menomonee River watershed.

Sanitary Sewerage System Flow Relief Points

In 1975 there were 26 combined sewer outfalls and 140 known sanitary sewer flow relief devices in the watershed, as listed in Table 84 and shown on Map 53. Of the latter, 7 were sanitary sewerage system bypasses; 28 were relief pumping stations; 32 were portable pumping stations; and the remaining 73 were crossovers. Of the 166 flow relief devices and combined sewer outfalls, 106 discharge directly to the main stem of the Menomonee River; 36 discharge directly to Honey Creek; 15 discharge directly to Underwood Creek; 6 discharge directly to Burnham's Canal Branch; 2 discharge directly to South Menomonee Canal Branch; and 1 discharges directly to Butler Ditch.

Other Known Point Sources

A total of 48 other known point sources of pollution were identified in the watershed in 1975. These other point sources consisted primarily of 78 outfalls through which industrial cooling, process, rinse, and wash waters were discharged directly or indirectly to the surface water system. Of these, 37 were identified as discharging only cooling water. The remaining 41 were discharging other types of wastewaters. Industrial wastewater enters the Menomonee River and its major tributaries directly through industrial waste outfalls or indirectly through drainage ditches and storm sewers. Table 85 summarizes by receiving stream and civil division the characteristics of these other point sources, and Map 53 shows their locations. Ten of these other point source outfalls discharge directly to the Menomonee River main stem; 30 discharge indirectly to the Menomonee River; 37 discharge to tributaries of the Menomonee River; and the remaining outfall utilizes a soil absorption system.

Privately Owned Onsite Sanitary Wastewater Treatment

In addition to being provided through centralized sanitary sewerage service within the watershed, sanitary wastewater treatment and disposal is provided through approximately 7,819 privately owned onsite sewage disposal systems consisting of 4,325 septic tanks, 55 holding tanks, and 1 mound system. These systems serve a total resident population of about 17,800 persons, or about 5 percent of the total resident population of the watershed. Of this total, about 13,200 persons, or about 74 percent, resided in concentrated areas of urban development having at least 32 housing units in a U. S. Public Land Survey quarter section. These scattered quarter sections of urban land use concentration totaled about 10.4 square miles of urban land use, or slightly more than 8 percent of the total area of the watershed.

Table 83

SELECTED CHARACTERISTICS OF MUNICIPAL SEWAGE TREATMENT PLANTS IN THE MENOMONEE RIVER WATERSHED: 1975

Name	Total Area Served (square miles)	Estimated Total Population Served	Date of Construction and Major Modification	Type of Treatment[a]	Level of Treatment Provided[a]	Disposal of Effluent	Design Capacity: Population[b]	Design Capacity: Average Hydraulic (mgd)	Design Capacity: Peak Hydraulic (mgd)	Design Capacity: Average Organic (pounds per BOD_5 per day)	Design Capacity: Population[b] Equivalent	Existing Loading: Average Hydraulic (mgd)	Existing Loading: Average Per Capita (gpd)
Village of Germantown Old Village Plant	1.88	4,600	1956, 1973	Activated Sludge Phosphorus Removal	Secondary Advanced	Menomonee River	10,000	1.0	3.0	1,700	8,100	0.80	174
Village of Menomonee Falls Pilgrim Road Plant			1954, 1961, 1973, 1975	Trickling Filter and Activated Sludge Phosphorus Removal	Secondary Advanced	Menomonee River	N/A	1.9	2.5	935	4,450	1.4	
	6.17	20,400											107
Village of Menomonee Falls Lilly Road Plant			1969, 1973	Activated Sludge, and Flow-Through Lagoon Phosphorus Removal	Secondary Advanced	Menomonee River	N/A	1.0	2.0	1,700	8,100	0.78	

[a] *Auxiliary treatment for disinfection is provided at all treatment plants.*

[b] *The population design capacity for a given sewage treatment facility was obtained directly from engineering reports prepared by or for the local unit of government operating the facility and reflects assumptions made by the design engineer. The population equivalent design capacity was estimated by the Commission staff by dividing the design BOD_5 loading in pounds per day, as set forth in the engineering reports, by an estimated per capita contribution of 0.21 pound of BOD_5 per day. If the design engineer assumed a different daily per capita contribution of BOD_5, the population equivalent design capacity will differ from the population design capacity shown in the table.*

Source: SEWRPC.

Table 84

KNOWN SANITARY SEWERAGE SYSTEM FLOW RELIEF DEVICES IN THE MENOMONEE RIVER WATERSHED BY RECEIVING STREAM AND CIVIL DIVISION: 1975

Receiving Stream	Civil Division	Combined Sewer Outfalls	Other Flow Relief Devices: Crossovers	Other Flow Relief Devices: Bypasses	Other Flow Relief Devices: Relief Pumping Stations	Other Flow Relief Devices: Portable Pumping Stations	Total
Burnham's Canal Branch	City of Milwaukee	6	0	0	0	0	6
South Menomonee Canal Branch	City of Milwaukee	2	0	0	0	0	2
Menomonee River	City of Milwaukee	18	26	1	0	0	45
Menomonee River	City of Wauwatosa	0	29	1	11	0	41
Menomonee River	Village of Butler	0	0	2	0	0	2
Butler Ditch	City of Brookfield	0	0	0	0	1	1
Underwood Creek	City of Brookfield	0	0	0	0	2	2
Underwood Creek	City of West Allis	0	0	0	0	5	5
Honey Creek	City of West Allis	0	3	0	0	15	18
Menomonee River	Village of Menomonee Falls	0	5	0	4	9	18
Honey Creek	City of Wauwatosa	0	5	3	4	0	12
Underwood Creek	City of Wauwatosa	0	0	0	8	0	8
Subtotal	--	26	68	7	27	32	160
Honey Creek	City of Milwaukee	0	5	0	1	0	6
Total	--	26	73	7	28	32	166

Source: SEWRPC.

Table 85

CHARACTERISTICS OF OTHER KNOWN POINT SOURCES OF WATER POLLUTION IN THE MENOMONEE RIVER WATERSHED: 1975

Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average Annual Hydraulic Discharge Rate (gallons per day)[a]	Reported Maximum Monthly Hydraulic Discharge Rate (gallons per day)[a]
MILWAUKEE COUNTY								
Allis Chalmers Corporation	3523	City of West Allis	Process	N/A	1	Menomonee River via Storm Sewer	70,000	140,000
AMF, Inc.— Harley Davidson Motor Company	3751	City of Wauwatosa	Process and Cooling	Settling Pond, Oil Separator, Oil Skimmer, and pH Adjustment	2	Tributary of the Menomonee River	40,000	50,000
Babcock and Wilcox— Tubular Products Division	3312	Village of West Milwaukee	Cooling	Oil Separator	1	Menomonee River via Storm Sewer	825,000	900,000
Briggs & Stratton Corporation	3519	City of Wauwatosa	Cooling	Settling Basin and Oil Separator	1	Menomonee River via Storm Sewer	25,000	25,000
Butler Lime and Cement Company	3273	City of Milwaukee	Process	None	1	Menomonee River via Storm Sewer	1,700	2,300
Center Fuel Company	2911	City of Milwaukee	Runoff	Oil and Water Separator	1	Little Menomonee River via Storm Sewer	Intermittent	Intermittent
Chicago, Milwaukee, St. Paul & Pacific Railroad Company	4013	City of Milwaukee	Process	Oil Separator	1	Menomonee River via Drainage Ditch	316,800	418,500
			Process	Oil Separator	2	Menomonee River via Drainage Ditch	3,000	7,000
Chicago & North Western Railroad	4013	Village of Butler	Process	Oil and Water Separator	1	Menomonee River via Drainage Ditch	300	7,500
Chris Hansen's Laboratory, Inc.	2869	City of West Allis	Cooling	None	1	Honey Creek via Storm Sewer	50,000	63,000
Falk Corporation— Research and Development	3566	City of Milwaukee	Cooling	N/A	3	Menomonee River	30,000	33,000
			Process and Cooling	N/A	4	Menomonee River	8,000	11,000
			Cooling	N/A	5	Menomonee River	17,000	20,000
Falk Corporation— Plant No. 2	3566	City of Wauwatosa	Cooling	N/A	1	Tributary of the Menomonee River	21,000	26,000
			Cooling	N/A	2	Tributary of the Menomonee River	4,000	4,000
Falk Corporation— Plant No. 1	3566	City of Milwaukee	Process and Cooling	N/A	1	Menomonee River	121,100	126,000
			Process and Cooling	N/A	3	Menomonee River	23,000	36,000
			Process and Cooling	N/A	4	Menomonee River	41,000	80,000
			Process and Cooling	N/A	5	Menomonee River	243,000	270,000
Federal Malleable Company	3322	City of West Allis	Cooling	None	1	Honey Creek via Storm Sewer	9,500	11,500
			Cooling and Boiler Blowdown	None	2	Honey Creek via Storm Sewer	26,600	40,300
Grede Foundries, Inc.— Liberty Foundry	3321	City of Wauwatosa	Cooling	None	1	Menomonee River via Storm Sewer	45,000	53,000
			Cooling	None	2	Menomonee River via Storm Sewer	15,000	18,000
Grey Iron Foundry, Inc.	3321	City of West Allis	Process and Cooling	N/A	1	Honey Creek	370,000	391,000
			Cooling	N/A	2	Honey Creek	52,000	56,000
			Cooling	N/A	3	Honey Creek	52,000	56,000
Harnischfeger Corporation	3536	City of Milwaukee	Process and Cooling	N/A	1	Menomonee River via Storm Sewer	360,000	441,000
			Cooling	N/A	2	Menomonee River via Storm Sewer	6,000	10,000
			Process	N/A	3	Menomonee River via Storm Sewer	14,000	14,000
Hentzen Chemical Coatings, Inc.	2851	City of Milwaukee	Cooling	None	1	Little Menomonee River via Storm Sewer	49,000	49,000
			Cooling	None	2	Little Menomonee River via Storm Sewer	5,000	5,000
Inryco, Inc.	3444	City of Milwaukee	Cooling	N/A	3	Menomonee River via Storm Sewer	211,000	211,000
Kearney & Trecker Corporation	3540	City of West Allis	Cooling	None	1	Underwood Creek via Storm Sewer	121,900	127,000
Marquette University	8221	City of Milwaukee	Cooling and Steam Condensate	None	1	North Menomonee Canal via Storm Sewer	56,000	N/A
Miller Brewing Company	2082	City of Milwaukee	Cooling and Drainage	None	1	Menomonee River via Storm Sewer	7,100	7,200
			Cooling	None	2	Menomonee River via Storm Sewer	86,400	86,400
			Cooling	None	3	Menomonee River via Storm Sewer	31,000	31,000
			Cooling and Drainage	None	4	Menomonee River via Storm Sewer	1,328,400	1,420,800
			Cooling	None	5	Menomonee River via Storm Sewer	224,000	346,000

Table 85 (continued)

Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average Annual Hydraulic Discharge Rate (gallons per day)[a]	Reported Maximum Monthly Hydraulic Discharge Rate (gallons per day)[a]
Milwaukee County Institutions Power Plant	4911	City of Wauwatosa	Process and Cooling	None	1	Menomonee River via Drainage Ditch	67,000	N/A
Milwaukee County Park Commission—Greenfield Park	7999	City of West Allis	Swimming Pool Overflow and Drainage	None	1	South Branch of Underwood Creek via Storm Sewer	Intermittent	Intermittent
Milwaukee County Park Commission—Hoyt Park	7999	City of Wauwatosa	Swimming Pool Overflow and Drainage	None	1	Menomonee River via Storm Sewer	Intermittent	Intermittent
Milwaukee County Park Commission—Madison Park	7999	City of Wauwatosa	Swimming Pool Overflow and Drainage	None	1	Menomonee River via Storm Sewer	Intermittent	Intermittent
Milwaukee County Park Commission—McCarty Park	7999	City of West Allis	Swimming Pool Overflow and Drainage	None	1	Honey Creek via Storm Sewer	Intermittent	Intermittent
Milwaukee County Park Commission—Washington Park	7999	City of Milwaukee	Swimming Pool Overflow and Drainage	None	1	Menomonee River via Storm Sewer	Intermittent	Intermittent
Milwaukee Marble Company	3281	City of Milwaukee	Process	None	1	Menomonee Canal via Storm Sewer	1,900	1,900
			Process	None	2	Menomonee Canal via Storm Sewer	1,800	1,800
			Process	None	3	Menomonee Canal via Storm Sewer	1,800	1,800
Mobil Oil Corporation—Lubrication Plant	2992	City of Milwaukee	Cooling	Oil and Water Separator	1	Menomonee River via Storm Sewer	4,600	N/A
Motor Casting Plant No. 1	3321	City of West Allis	Cooling	None	1	Woods Creek via Storm Sewer	119,000	120,000
			Cooling	None	2	Woods Creek via Storm Sewer	101,000	101,000
Motor Casting Plant No. 2	3321	City of Milwaukee	Cooling	None	1	Honey Creek via Storm Sewer	18,000	20,000
Perlick Company, Inc.	3585	City of Milwaukee	Cooling	None	1	Little Menomonee River via Storm Sewer	1,000	N/A
Rexnord, Inc.—West Milwaukee Facility	3566	Village of West Milwaukee	Process	None	1	Woods Creek via Storm Sewer	21,000	26,000
			Process and Cooling	None	2	Woods Creek via Storm Sewer	159,000	180,000
			Process and Cooling	None	3	Woods Creek via Storm Sewer	6,600	7,300
			Cooling	None	4	Woods Creek via Storm Sewer	29,800	36,200
			Cooling	None	5	Woods Creek via Storm Sewer	3,500	4,000
			Cooling	None	6	Woods Creek via Storm Sewer	1,700	2,100
			Process and Cooling	None	7	Woods Creek via Storm Sewer	18,200	20,000
			Cooling	None	8	Woods Creek via Storm Sewer	24,800	27,000
			Process and Cooling	None	9	Woods Creek via Storm Sewer	11,000	12,000
Robert A. Johnston Company	2066	City of Milwaukee	Cooling	None	3	Menomonee River via Storm Sewer	511,600	650,400
Safeway Wash-A-Car, Inc.	7542	City of West Allis	Process	Catch Basin	1	Honey Creek via Storm Sewer	1,000	1,900
Union Oil of California—N. 107th Street	2911	City of Milwaukee	Runoff	Oil and Water Separator	1	Little Menomonee River via Drainage Ditch	Intermittent	Intermittent
Western Metal Specialty Division—Western Industries, Inc.	3449	City of Wauwatosa	Cooling	None	1	Menomonee River via Storm Sewer	10,000 to 50,000	N/A
West Shore Pipe Line Company	N/A	City of Milwaukee	Process	Oil and Water Separator	1	Menomonee River	4,000	N/A
Wisconsin Electric Power Company—Heating System	4911	City of Milwaukee	Steam Condensate and Seepage	None	1	Menomonee River	62,000	80,000
Wisconsin Electric Power Company—Valley Plant	4911	City of Milwaukee	Cooling, Boiler Blowdown, and Drainage	None	1	South Menomonee Canal	73,510,100	78,467,700
			Cooling, Boiler Blowdown, and Drainage	None	2	South Menomonee Canal	69,288,400	77,351,600

Table 85 (continued)

Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average Annual Hydraulic Discharge Rate (gallons per day)[a]	Reported Maximum Monthly Hydraulic Discharge Rate (gallons per day)[a]
WASHINGTON COUNTY								
Gehl Guernsey Farms, Inc.	2026	Village of Germantown	Cooling	N/A	1	Menomonee River via Storm Sewer	190,000	210,000
WAUKESHA COUNTY								
Best Block Company	3271	Village of Menomonee Falls	Process	Ridge and Furrow	1	Soil Absorption	9,200	12,400
Carnation Company—Can Division	3411	Village of Menomonee Falls	Cooling	N/A	1	Menomonee River via Storm Sewer	48,300	64,500
Menomonee Falls Water Utility	4941	Village of Menomonee Falls	Filter Backwash	N/A	1	Menomonee River	162,900	173,200
Molded Rubber and Plastics Corporation	3069	Village of Butler	Cooling	N/A	1	Menomonee River via Storm Sewer	33,100	50,000
SEFO, Inc. D/B/A Safer Cleaning Center	7216	City of Brookfield	Cooling	N/A	1	Menomonee River via Storm Sewer	1,000 to 15,000	N/A
W. A. Krueger Company, Inc.	2752	City of Brookfield	Cooling	N/A	1	Underwood Creek	10,000	32,000
Western States Envelope	2642	Village of Butler	Cooling	N/A	1	Menomonee River via Storm Sewer	15,000	N/A

NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data were obtained, in order of priority, from: quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System or under Section 101 of the Wisconsin Administrative Code or from the Wisconsin Pollutant Discharge Elimination System permit itself. In some cases when 12 months of flow data were not reported, the average annual and maximum monthly hydraulic discharge rates were estimated from the available monthly discharge data or from the flow data as reported in the permit.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Urban Storm Water Management Systems

As noted in Table 82, land cover categories associated with urban land uses as of 1975 comprised 50,200 acres, or about 58 percent of the Menomonee River watershed. The most important urban land cover category was residential land with about 27 percent, and streets and highways with about 13 percent.

There were a total of 10 known urban storm water drainage systems providing service to the subareas of the Menomonee River watershed in 1975. These include the systems operated by the Cities of Brookfield, Greenfield, Milwaukee, New Berlin, Wauwatosa, and West Allis; and the Villages of Butler, Elm Grove, Menomonee Falls, and West Milwaukee. Together, the 10 storm water drainage systems have a tributary drainage area of about 42.7 square miles, or about 31 percent of the total area of the watershed. About 8 percent of the total area of the watershed is served by combined sanitary and storm sewers as noted above. Included within this storm water drainage area are a total of 344 known storm water outfalls ranging in size from 12 inches in diameter to a triple 90 by 54-inch box culvert. There were no known storm water pumping facilities and two known storm water storage facilities in the watershed. The total annual average discharge from these outfalls is estimated to be about 5,587 million gallons per year occurring on the average in 65 events.

Rural Storm Water Runoff

About 36,900 acres, or 42 percent of the total area of the watershed, are devoted to rural land use activities. The most important rural land cover categories were small grains with 5 percent, hay with 10 percent, other open space with 13 percent, and woodlands with 5 percent of the watershed. As of May 1975, there were an estimated 49 domestic livestock operations—operations of 25 or more equivalent animal units—having a total of 3,870 equivalent animal units within the watershed. Of the 49 operations, 25, or 51 percent, were located within 500 feet of the surface water system of the watershed.

Pollution Loadings

A summary of the estimated average annual pollution loadings in the Menomonee River watershed is presented in Table 86 and depicted in Figure 33. Urban sources of pollution are estimated to contribute 68 percent of the nitrogen, 88 percent of the phosphorus, 87 percent of the biochemical oxygen demand, 94 percent of the fecal coliform, and 90 percent of the sediment which occur as water pollutants in the Menomonee River. Of the urban contribution, the point sources of pollution are estimated to contribute 27 percent of the nitrogen, 36 percent of the phosphorus, 28 percent of the biochemical oxygen demand, 93 percent of the fecal coliform, and 1 percent of the sediment. Diffuse sources—including the estimated septic tank and construction-related contributions in the drainage area—account for the remaining 73 percent of the nitrogen, 64 percent of the phosphorus, 72 percent of the biochemical oxygen demand, 7 percent of the fecal coliform, and 99 percent of the sediment contributed from urban sources.

Of the total pollutant loads, rural pollution sources are estimated to contribute the remaining 32 percent of the nitrogen, 12 percent of the phosphorus, 13 percent of the biochemical oxygen demand, 6 percent of the fecal

Table 86

SUMMARY OF ESTIMATED AVERAGE ANNUAL POLLUTANT LOADINGS IN THE MENOMONEE RIVER WATERSHED: 1975

Source	Extent[a]	Parameter	Loads[b] Average Year Total Estimated Loading	Loads[b] Average Year Percent
Urban Point Sources				
Municipal Sewage Treatment Plants . .	3	Total Nitrogen	104,690.0	7.5
	3	Total Phosphorus	27,730.0	8.9
	3	Biochemical Oxygen Demand	98,750.0	1.4
	3	Fecal Coliform	63,000.0	0.0
	3	Sediment	80.0	0.0
Private Sewage Treatment Plants	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Combined Sewer Overflow	26	Total Nitrogen	109,750.0	7.9
	26	Total Phosphorus	54,880.0	17.6
	26	Biochemical Oxygen Demand	1,097,540.0	15.6
	26	Fecal Coliform	350,000,000.0	84.4
	26	Sediment	1,645.0	0.3
Industrial Discharges	48	Total Nitrogen	32,840.0	2.4
	48	Total Phosphorus	14,080.0	4.5
	48	Biochemical Oxygen Demand	434,650.0	6.2
	48	Fecal Coliform	0.0	0.0
	48	Sediment	1,525.0	0.3
Sanitary Sewer Flow Relief Devices . .	140	Total Nitrogen	6,960.0	0.5
	140	Total Phosphorus	2,320.0	0.7
	140	Biochemical Oxygen Demand	69,560.0	1.0
	140	Fecal Coliform	11,000,000.0	2.7
	140	Sediment	35.0	0.0
Urban Point Source Totals		Total Nitrogen	254,240.0	18.3
		Total Phosphorus	99,010.0	31.8
		Biochemical Oxygen Demand	1,700,500.0	24.2
		Fecal Coliform	361,063,000.0	87.1
		Sediment	3,285.0	0.6
Urban Diffuse Sources				
Residential	23112	Total Nitrogen	92,450.0	6.6
	23112	Total Phosphorus	7,400.0	2.4
	23112	Biochemical Oxygen Demand	561,620.0	8.0
	23112	Fecal Coliform	3,697,920.0	0.9
	23112	Sediment	6,300.0	1.2
Commercial	4968	Total Nitrogen	44,710.0	3.2
	4968	Total Phosphorus	3,730.0	1.2
	4968	Biochemical Oxygen Demand	484,880.0	6.9
	4968	Fecal Coliform	1,639,440.0	0.4
	4968	Sediment	1,850.0	0.4
Industrial	2543	Total Nitrogen	21,360.0	1.5
	2543	Total Phosphorus	1,780.0	0.6
	2543	Biochemical Oxygen Demand	93,840.0	1.3
	2543	Fecal Coliform	1,576,660.0	0.4
	2543	Sediment	1,240.0	0.2
Extractive	378	Total Nitrogen	22,680.0	1.6
	378	Total Phosphorus	17,010.0	5.5
	378	Biochemical Oxygen Demand	45,360.0	0.6
	378	Fecal Coliform	0.0	0.0
	378	Sediment	28,350.0	5.5
Transportation	12855	Total Nitrogen	277,730.0	19.9
	12855	Total Phosphorus	18,190.0	5.8
	12855	Biochemical Oxygen Demand	1,837,990.0	26.1
	12855	Fecal Coliform	8,300,810.0	2.0
	12855	Sediment	240,345.0	46.5
Recreation	3951	Total Nitrogen	11,560.0	0.8
	3951	Total Phosphorus	400.0	0.1
	3951	Biochemical Oxygen Demand	5,140.0	0.1
	3951	Fecal Coliform	99,864.0	0.0
	3951	Sediment	830.0	0.2
Construction	2428	Total Nitrogen	145,680.0	10.5
	2428	Total Phosphorus	109,260.0	35.0
	2428	Biochemical Oxygen Demand	291,360.0	4.1
	2428	Fecal Coliform	0.0	0.0
	2428	Sediment	182,100.0	35.2
Septic Systems	17760	Total Nitrogen	76,370.0	5.5
	17760	Total Phosphorus	17,580.0	5.6
	17760	Biochemical Oxygen Demand	1,090,460.0	15.5
	17760	Fecal Coliform	13,320,000.0	3.2
	17760	Sediment	185.0	0.0
Urban Diffuse Source Totals		Total Nitrogen	692,540.0	49.7
		Total Phosphorus	175,350.0	56.2
		Biochemical Oxygen Demand	4,410,650.0	62.7
		Fecal Coliform	28,634,694.0	6.9
		Sediment	461,200.0	89.2
Urban Source Totals		Total Nitrogen	946,780.0	68.0
		Total Phosphorus	274,360.0	88.0
		Biochemical Oxygen Demand	6,111,150.0	86.8
		Fecal Coliform	389,697,694.0	94.0
		Sediment	464,485.0	89.9
Rural Diffuse Sources				
Livestock Operation	3870	Total Nitrogen	109,910.0	7.9
	3870	Total Phosphorus	25,540.0	8.2
	3870	Biochemical Oxygen Demand	430,340.0	6.1
	3870	Fecal Coliform	24,768,000.0	6.0
	3870	Sediment	1,355.0	0.3
Cropland, Pasture and Unused Rural Land	29240	Total Nitrogen	321,080.0	23.1
	29240	Total Phosphorus	11,050.0	3.5
	29240	Biochemical Oxygen Demand	397,930.0	5.7
	29240	Fecal Coliform	0.0	0.0
	29240	Sediment	50,285.0	9.7
Silvicultural	4660	Total Nitrogen	10,720.0	0.8
	4660	Total Phosphorus	650.0	0.2
	4660	Biochemical Oxygen Demand	21,440.0	0.3
	4660	Fecal Coliform	30,756.0	0.0
	4660	Sediment	585.0	0.1
Air Pollution to Surface Water	469	Total Nitrogen	4,170.0	0.3
	469	Total Phosphorus	230.0	0.1
	469	Biochemical Oxygen Demand	75,980.0	1.1
	469	Fecal Coliform	0.0	0.0
	469	Sediment	155.0	0.0
Rural Diffuse Source Totals		Total Nitrogen	445,880.0	32.0
		Total Phosphorus	37,470.0	12.0
		Biochemical Oxygen Demand	925,690.0	13.2
		Fecal Coliform	24,798,756.0	6.0
		Sediment	52,380.0	10.1
Diffuse Source Totals		Total Nitrogen	1,138,420.0	81.7
		Total Phosphorus	212,820.0	68.2
		Biochemical Oxygen Demand	5,336,340.0	75.8
		Fecal Coliform	53,433,450.0	12.9
		Sediment	513,580.0	99.4
Total Sources		Total Nitrogen	1,392,660.0	100.0
		Total Phosphorus	311,830.0	100.0
		Biochemical Oxygen Demand	7,036,840.0	100.0
		Fecal Coliform	414,496,450.0	100.0
		Sediment	516,865.0	100.0

[a] *Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.*

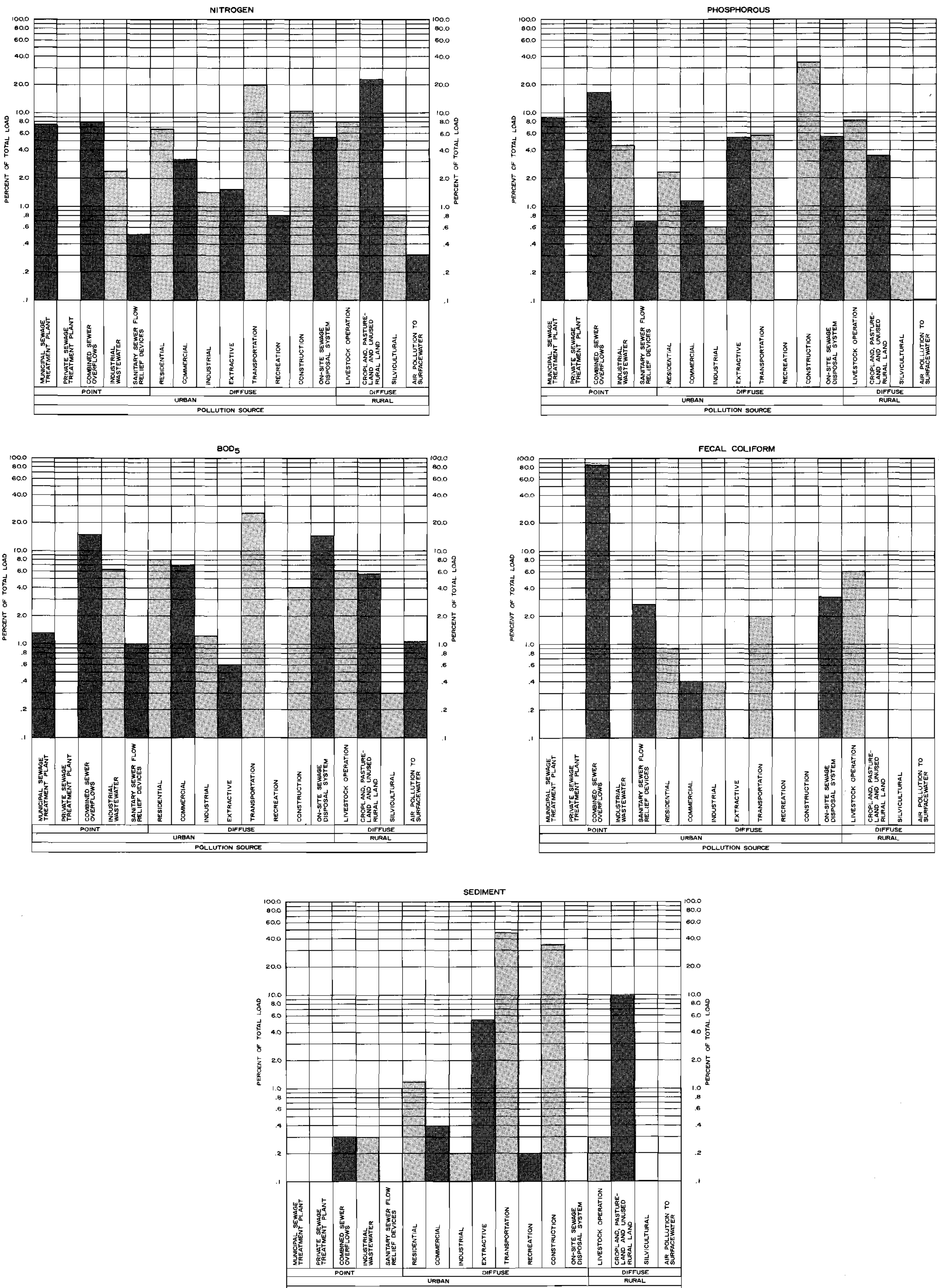
[b] *Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year.*

Source: SEWRPC.

coliform, and 10 percent of the sediment which occur as water pollutants in the watershed. Of the rural pollution sources, none are point sources, since none of the livestock operations in the watershed are of sufficient size to fall within the definition used in this report. Livestock feeding operations—inclusive of the disposal of manure on croplands—are estimated to contribute 25 percent of the nitrogen, 68 percent of the phosphorus, 47 percent of the biochemical oxygen demand, almost all of the fecal coliform, and 3 percent of the sediment from rural sources. The remainder of the estimated rural pollution load, or 75 percent of the nitrogen, 32 percent of the phosphorus, 53 percent of the biochemical oxygen demand, almost none of the fecal coliform, and 97 percent of the sediment, are contributed by other rural diffuse sources, namely storm water runoff from rural land uses and atmospheric loadings to surface waters.

Figure 33

SUMMARY OF ESTIMATED AVERAGE ANNUAL POLLUTANT LOADINGS IN THE MENOMONEE RIVER WATERSHED: 1975



Source: SEWRPC.

MILWAUKEE RIVER WATERSHED

The Milwaukee River watershed is a natural surface water drainage unit with 433 square miles of its total area of 683.2 square miles located in the northeastern and north central portions of the Region. The boundaries of the basin, together with the locations of the main channels of the Milwaukee River and its principal tributaries, are shown on Map 57, along with the locations of the known point sources of pollution and the generalized land uses as of 1975. The main stem of the Milwaukee River originates outside of the Region and discharges to Lake Michigan through the harbor estuary in the City of Milwaukee. About 88 percent of the total area of the watershed is still in rural land uses, with about 81 percent of this rural area in agricultural use. Most of the agricultural-related land use is located in the northern and central portions of the watershed. Table 87 sets forth the extent and proportion of the major land cover categories within the watershed as they relate to water quality conditions in 1975.

The soils within the Milwaukee River watershed are silt loams in Ozaukee County, rolling silt loams or gravelly loams in Washington County, and a clay-type soil in Milwaukee County. Most of the soils are relatively fertile and produce high crop yields if managed correctly. Sediment discharges from these soils may also result in high nutrient levels in stream waters.

Particularly important to comprehensive water quality management planning are the soil suitability interpretations for specified types of urban development. Based upon the interpretations of the soil properties, about 30 percent of the watershed is covered by soils that have severe or very severe limitations for residential development with public sanitary sewer service or, more precisely, are poorly suited for residential development of any kind, as shown on Map 58. About 56 percent of the watershed is covered by soils that have severe or very severe limitations for small lot (less than one acre in size) residential development without public sanitary sewer, as shown on Map 59; and about 46 percent of the watershed is covered by soils that have severe or very severe limitations for large lot (one acre or larger in size) residential development, as shown on Map 60. It must be noted that soils data are lacking for a portion of the watershed in Milwaukee County and therefore these soils suitability interpretations are only estimates.

Municipal and Private Sewage Treatment Facilities

In 1975 a total of 17 sanitary sewerage systems or portions thereof served a total area of about 78.3 square miles within the watershed, or about 18 percent of the in-Region portion of the watershed, and a total population of about 453,400 persons, or approximately 94 percent of the in-Region resident population of the watershed. These figures do not include data for the four systems located outside of the Region. These systems serve the Villages of Adell, Campbellsport, Cascade, and Random Lake. Included in this total are about 8.8 square miles, or about 1 percent of the watershed

Table 87

AREAL EXTENT OF WATER QUALITY-RELATED LAND COVER IN THE MILWAUKEE RIVER WATERSHED: 1975

Land Cover[a]	Square Miles	Acres	Percent
Urban			
Residential	45.51	29,129	6.66
Commercial[b]	8.52	5,454	1.25
Industrial			
Manufacturing	4.59	2,936	0.67
Landfills and Dumps	0.12	78	0.02
Extractive	1.67	1,017	0.24
Transportation			
Streets and Highways	3.26	2,086	0.48
Airfields	0.40	255	0.06
Railroad Yards and Terminals	0.14	90	0.02
Recreation			
Golf Courses	3.50	2,242	0.51
Parks and Other Recreation	5.65	3,616	0.83
Land Under Development			
Residential[c]	7.41	4,742	1.08
Commercial	0.27	175	0.04
Industrial	0.04	23	0.01
Transportation	0.24	156	0.04
Recreation	--	--	--
Rural			
Agricultural			
Small Grains	63.38	40,565	9.28
Hay	135.67	86,828	19.86
Row Crops	164.34	105,177	24.05
Specialty Crops	19.83	12,689	2.90
Sod Farm	0.22	143	0.03
Other Open Space[d]	104.65	66,978	15.32
Silvicultural			
Woodlands	61.05	39,070	8.94
Orchards and Nurseries	1.45	930	0.21
Natural and Man-Made Water Areas—Subject to Atmospheric Pollutant Contributions			
Ponds, Lakes, and Streams	7.99	5,112	1.17
Wetlands, Swamps, and Marshes	43.31	27,720	6.34
Total	683.21	437,211	100.00

[a] *These special land cover categories, defined primarily according to their imperviousness and vegetative cover characteristics and effects on the quality of storm water runoff, were delineated at a scale of 1" = 400' on aerial photographs taken in May 1975 and were measured to the nearest full acre, using dot-counting overlays. The total acreages measured within hydrologic subbasins were then adjusted to the control totals measured by digitizer from base maps of hydrologic subbasins at a scale of 1" = 2000'. Both the "square miles" and the "percent" shown above were then computed and rounded to the nearest hundredth (0.01)[e] of a percent.*

[b] *Includes: retail, communication, utilities, administrative, and institutional land uses.*

[c] *Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.*

[e] *The total area of the Milwaukee River watershed represented in this table is different than the total area of the Milwaukee River watershed identified in the text and on Map 57. This is due to the fact that the area set forth on Map 57 includes only that portion of the Milwaukee River watershed lying within the civil boundaries that comprise the Southeastern Wisconsin Region. This table presents the 1975 land cover of the entire Milwaukee River watershed, including about 250 square miles of the watershed located outside of the Region.*

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service; County Soil and Water Conservation Districts; University of Wisconsin-Extension Service; and SEWRPC.

Map 57

THE LOCATION, BOUNDARIES, MAJOR STREAMS, AND LAKES OF THE MILWAUKEE RIVER WATERSHED—SHOWING POINT SOURCES OF POLLUTION AND GENERALIZED LAND USES: 1975

LEGEND

- SUBURBAN AND LOW DENSITY RESIDENTIAL (0.2 – 2.2 DWELLING UNITS PER NET RESIDENTIAL ACRE)
- MEDIUM DENSITY RESIDENTIAL (2.3 – 6.9 DWELLING UNITS PER NET RESIDENTIAL ACRE)
- HIGH DENSITY RESIDENTIAL (7.0 – 17.9 DWELLING UNITS PER NET RESIDENTIAL ACRE)
- PRIMARY ENVIRONMENTAL CORRIDOR PRESERVATION THROUGH PUBLIC AQUISITION
- ● MAJOR RETAIL AND SERVICE CENTER
- ■ MAJOR INDUSTRIAL CENTER
- ⬣ PUBLIC AIRPORT
- ▲ MAJOR PUBLIC OUTDOOR RECREATION CENTER

POINT SOURCES OF POLLUTION

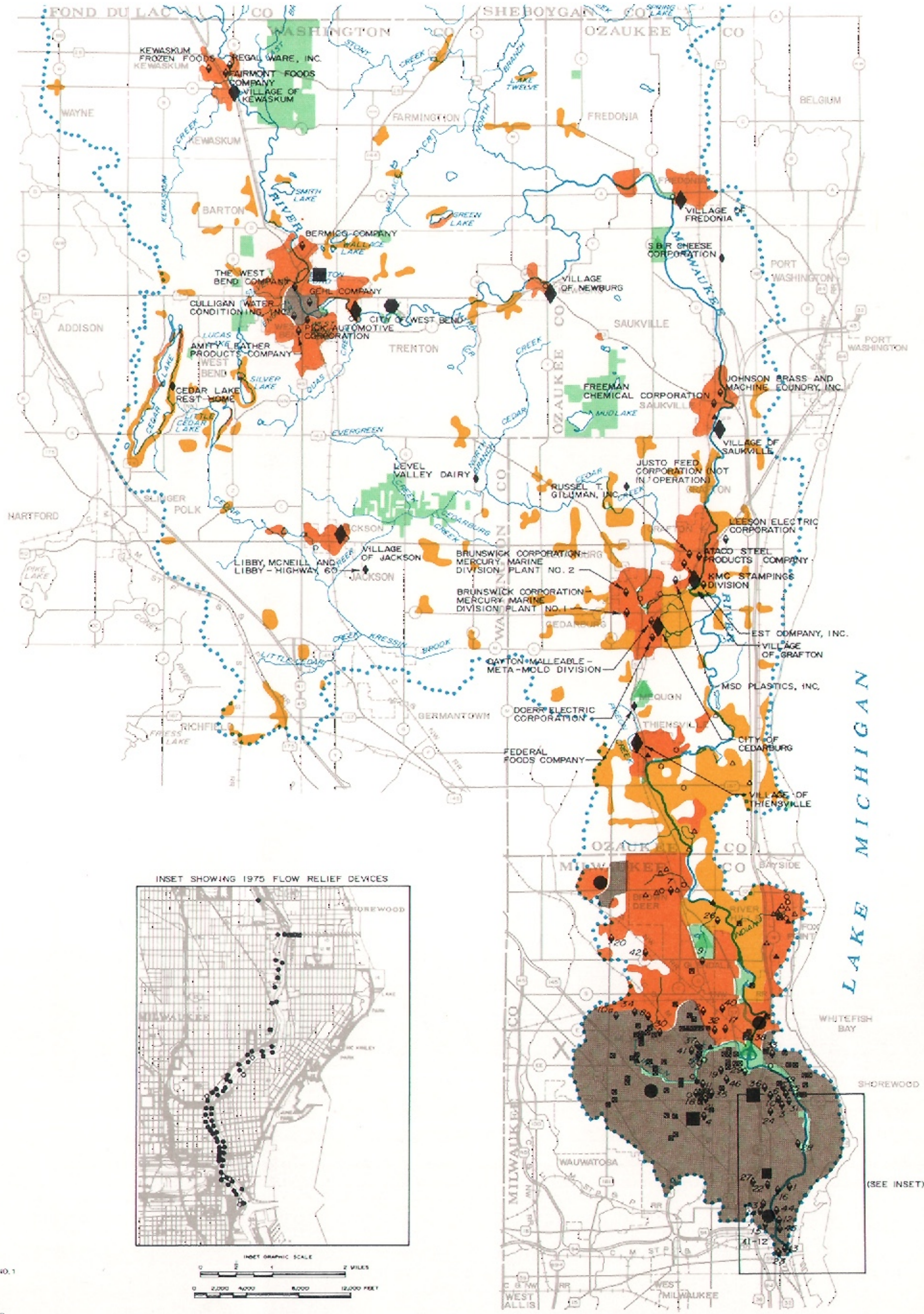
- ◆ PUBLIC SEWAGE TREATMENT FACILITY
- ♦ PRIVATE SEWAGE TREATMENT FACILITY
- ◊ KNOWN POINT SOURCE OF WASTEWATER OTHER THAN SEWAGE TREATMENT PLANT OR FLOW RELIEF DEVICES

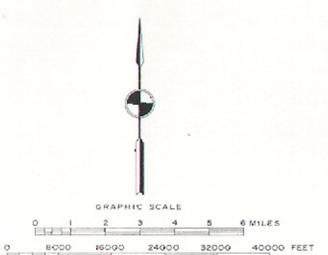
KNOWN FLOW RELIEF DEVICES

- COMBINED SEWER OUTFALL
- BYPASS
- CROSSOVER
- PORTABLE RELIEF PUMPING STATION
- RELIEF PUMPING STATION

MILWAUKEE COUNTY WASTEWATER DISCHARGES

1 A.F. GALLUN & SONS CORPORATION
2 AMERICAN CAN COMPANY
3 AMERICAN MOTORS CORPORATION—BODY PLANT
4 A. O. SMITH CORPORATION—AUTOMOTIVE DIVISION
5 AQUA-CHEM, INC.—NORTH PLANT NO. 1
6 AQUA-CHEM, INC.—NORTH PLANT NO. 2
7 BADGER METER, INC.
8 BEATRICE FOODS COMPANY
9 BRIGGS AND STRATTON CORPORATION
10 CONTINENTAL CAN COMPANY
10a CONTINENTAL EQUIPMENT CORPORATION
11 CUTLER HAMMER, INC. INDUSTRIAL SYSTEM DIVISION
12 FIRST WISCONSIN DEVELOPMENT CORPORATION
13 FLORENCE EISEMAN, INC.
14 FRED USINGER, INC.
15 GIMBELS MIDWEST, INC.
16 GIMBELS MIDWEST, INC.—WAREHOUSE
17 GLOBE UNION, INC.—ADMINISTRATION AND RESEARCH PARK
18 GLOBE UNION, INC.—CENTRAL LAB DIVISION
19 HOERNER WALDORF CORPORATION
20 INLAND RYERSON CONSTRUCTION PRODUCTS COMPANY
21 INTERSTATE DROP FORGE COMPANY
22 JOSEPH SCHLITZ BREWING COMPANY
23 KURTH MALTING CORPORATION—PLANT NO. 2
24 LONGVIEW FIBRE COMPANY—DOWNING BOX DIVISION
25 MILPRINT, INC.
26 MILWAUKEE COUNTRY CLUB
27 MILWAUKEE COUNTY PARK COMMISSION—CARVER PARK
28 MILWAUKEE COUNTY PARK COMMISSION—GORDON PARK
29 MILWAUKEE COUNTY PARK COMMISSION—LINCOLN PARK
30 MILWAUKEE COUNTY PARK COMMISSION—MCGOVERN PARK
31 MILWAUKEE DIE CASTING COMPANY
32 NORTH MILWAUKEE LIME & CEMENT COMPANY
33 OSTER CORPORATION
34 OUTBOARD MARINE CORPORATION—PLANTS NO. 2 AND 5
35 OUTBOARD MARINE CORPORATION—PLANT NO. 1 RESEARCH ANNEX
36 SQUARE D COMPANY
37 STAINLESS FOUNDRY AND ENGINEERING COMPANY
38 TREAT ALL METALS, INC.
39 WESTERN ELECTRIC COMPANY, INC. WISCONSIN SERVICE CENTER
40 W. H. BRADY COMPANY—FLORIST AVENUE PLANT
41 WISCONSIN BRIDGE AND IRON COMPANY
42 WISCONSIN CUNEO PRESS
43 WISCONSIN ELECTRIC POWER COMPANY—COMMERCE STREET
44 WISCONSIN ELECTRIC POWER COMPANY—WELLS STREET
45 WISCONSIN ELECTRIC POWER COMPANY—HEATING STEAM SYSTEM
46 WRIGHT METAL PROCESSORS, INC.



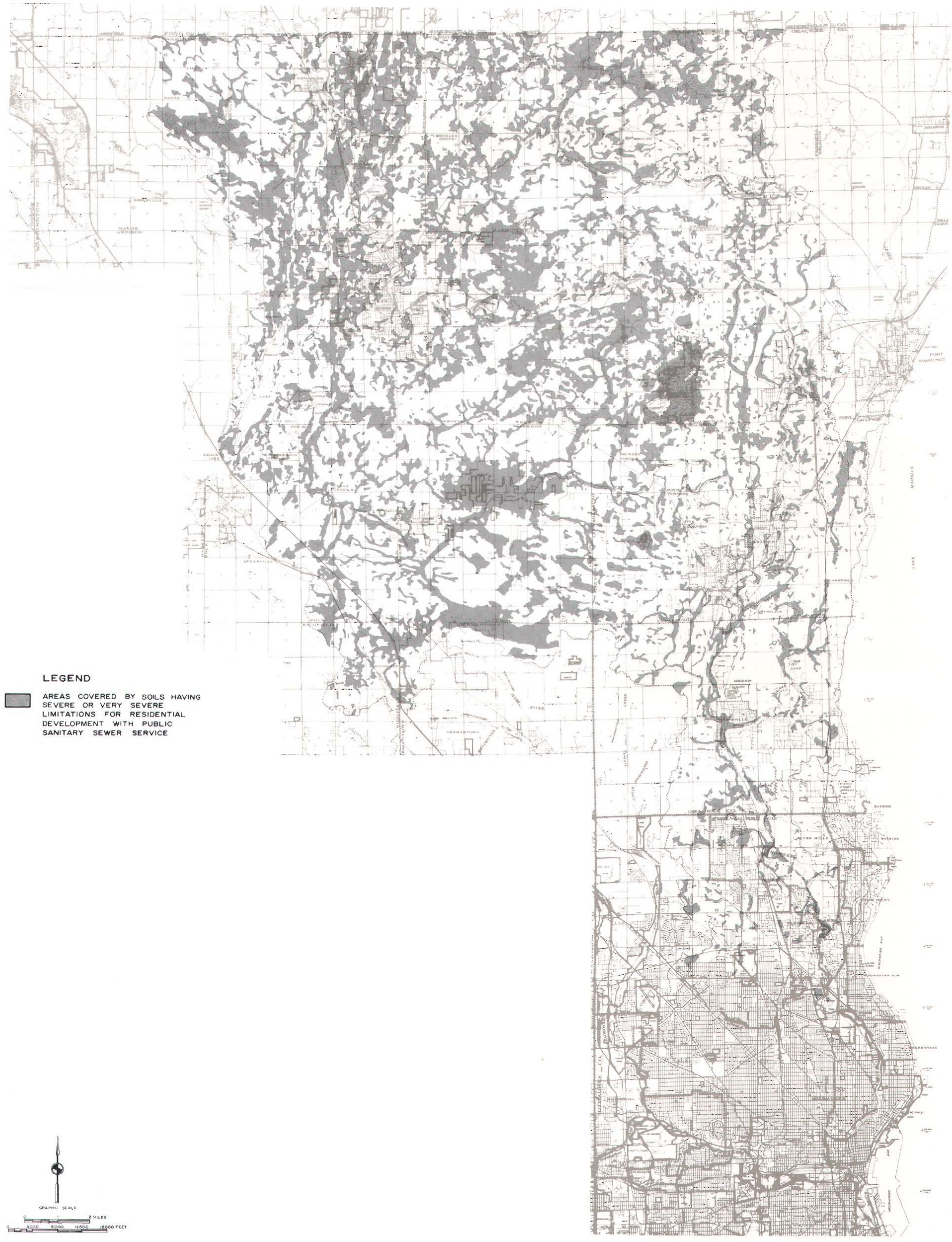


The Milwaukee River watershed is about 433 square miles in areal extent in the Region, or about 16 percent of the total area of the Region. The water quality in the watershed is affected by the various land uses as well as by the nine in-Region and four out-of-Region public wastewater treatment plants, six in-Region and one out-of-Region private wastewater treatment plants, 188 in-Region and two out-of-Region flow relief devices, and 68 in-Region and five out-of-Region other point sources of wastewater as shown.

Source: SEWRPC.

Map 58

SUITABILITY OF SOILS FOR RESIDENTIAL DEVELOPMENT WITH PUBLIC SANITARY SEWER SERVICE IN THE MILWAUKEE RIVER WATERSHED

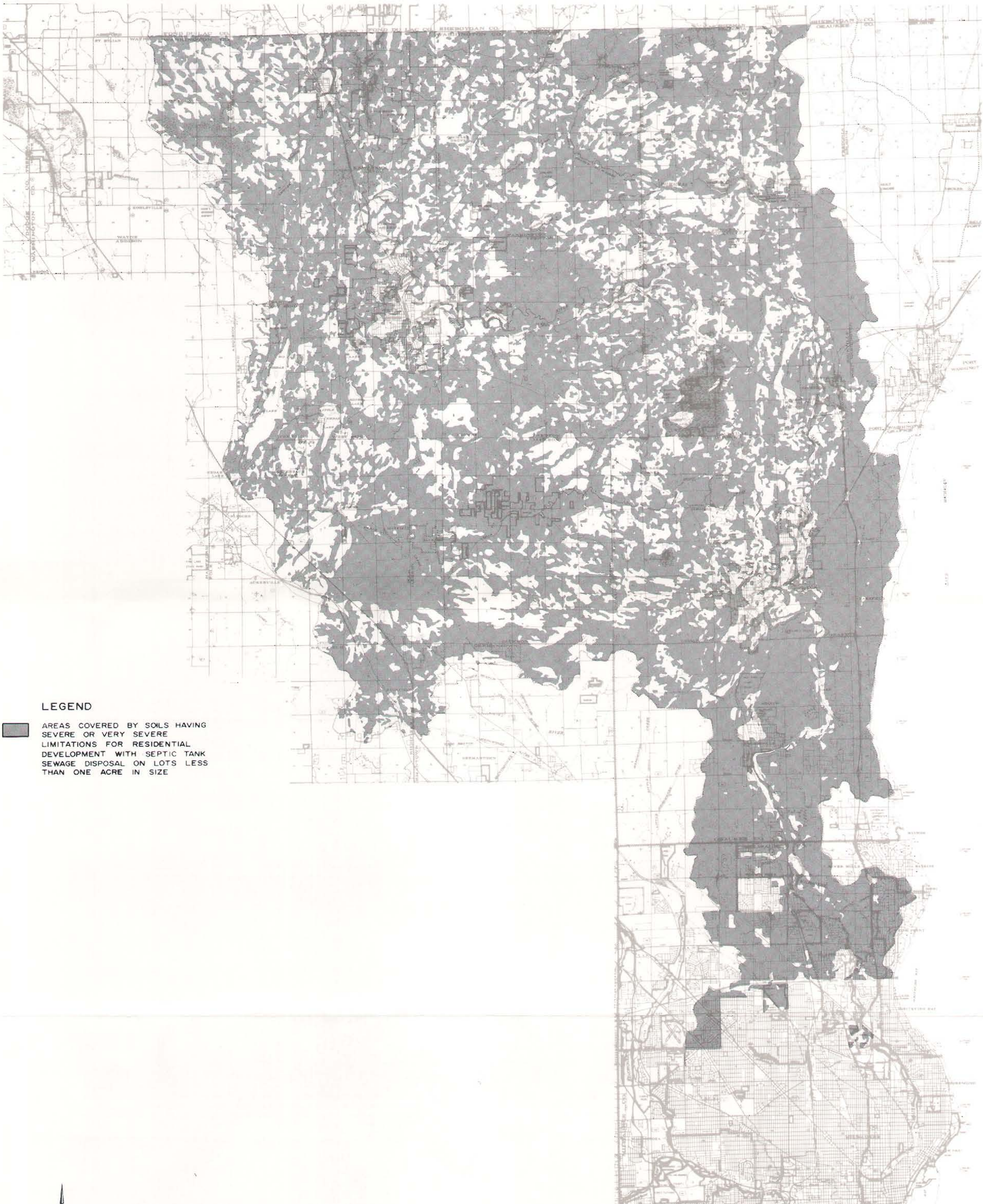


Of particular importance in comprehensive water quality planning is the recognition of the limitations inherent in the soil resource base essential to the sound urban and rural development of the watershed. About 30 percent of the Milwaukee River watershed area is covered by soils which are poorly suited for residential development with public sanitary sewer, or more precisely, residential development of any kind. These soils, which include wet soils having a high water table or poor drainage, organic soils which are poorly drained and provide poor foundation support, and soils which have a flood hazard, are especially prevalent in the riverine areas of the watershed.

Source: U. S. Soil Conservation Service and SEWRPC.

Map 59

SUITABILITY OF SOILS FOR SMALL LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE IN THE MILWAUKEE RIVER WATERSHED

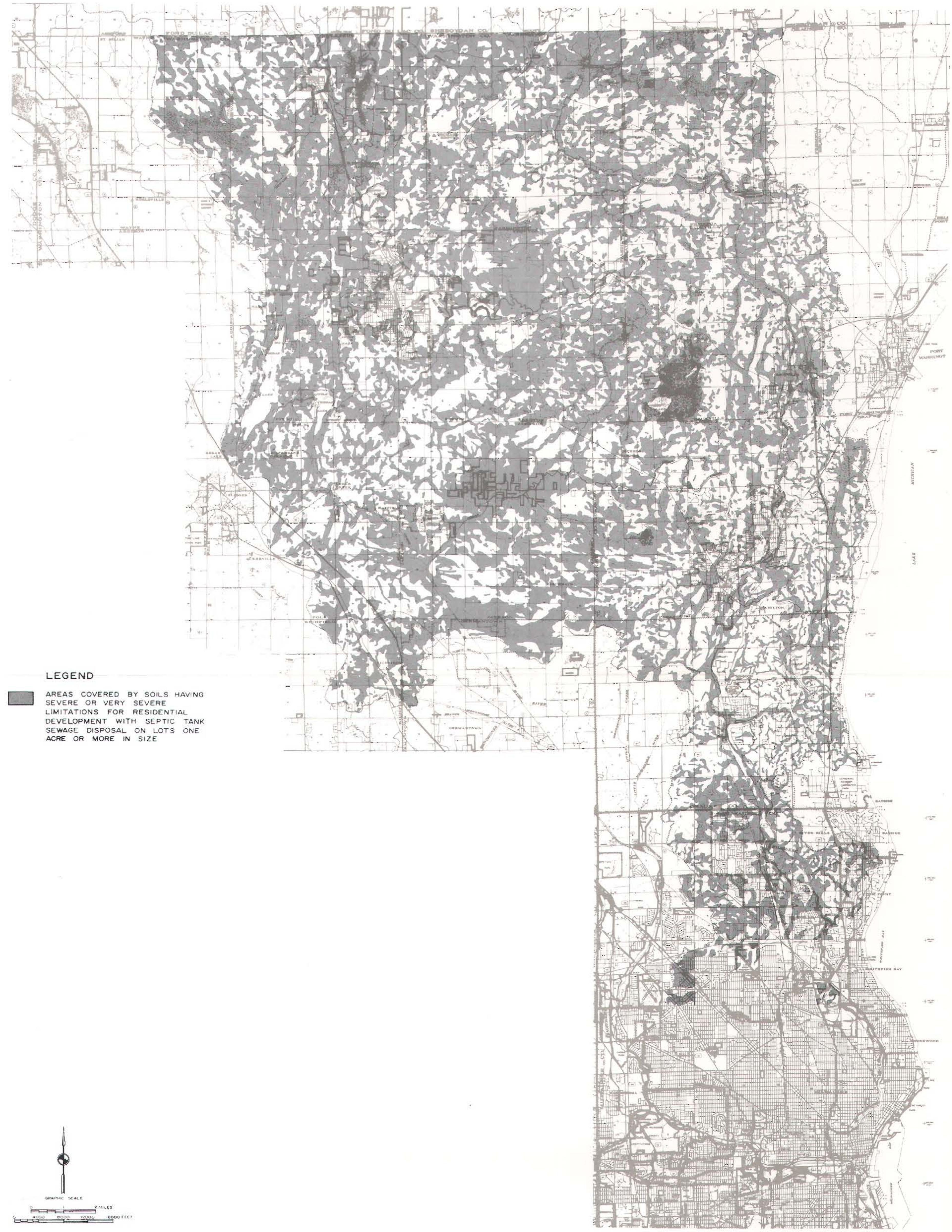


Approximately 56 percent of the Milwaukee River watershed area is covered by soils poorly suited for residential development on lots having an area smaller than one acre and not served by public sanitary sewerage facilities. Reliance on septic tank sewage disposal systems in these areas, which are covered by relatively impervious soils or are subject to seasonally high water tables, can only result in eventual malfunctioning of such systems and the consequent intensification of water pollution and public health problems in the watershed.

Source: SEWRPC.

Map 60

SUITABILITY OF SOILS FOR LARGE LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE IN THE MILWAUKEE RIVER WATERSHED



Approximately 46 percent of the Milwaukee River watershed area is covered by soils poorly suited for residential development on lots having an area of one acre or more and not served by public sanitary sewerage facilities. The inherent limitations of these soils for septic tank sewage disposal systems cannot be overcome simply by the provision of larger lots, and the use of such systems on these soils, which cannot absorb the sewage effluent, ultimately results in surface ponding and runoff of partially treated wastes into nearby watercourses.

Source: SEWRPC.

Table 88

SELECTED CHARACTERISTICS OF MUNICIPAL SEWAGE TREATMENT PLANTS IN THE MILWAUKEE RIVER WATERSHED WITHIN THE REGION: 1975

Name (in-Region)	Total Area Served (square miles)	Estimated Total Population Served	Date of Construction and Major Modification	Type of Treatment	Level of Treatment Provided	Disposal of Effluent	Design Capacity					Existing Loading	
							Population[a]	Average Hydraulic (mgd)	Peak Hydraulic (mgd)	Average Organic (pounds of BOD_5 per day)	Population[a] Equivalent	Average Hydraulic (mgd)	Average Per Capita (gpd)
City of Cedarburg	2.58	10,400	1925, 1935 1960, 1971	Trickling Filter Activated Sludge Phosphorus Removal Disinfection	Secondary Advanced Auxiliary	Cedar Creek	20,000	3.00	6.00	5,000	23,800	1.41	136
City of West Bend	6.28	21,000	1967,1973	Activated Sludge Phosphorus Removal Disinfection	Secondary Advanced Auxiliary	Milwaukee River	25,000	2.50	10.00	4,250	20,240	3.70	176
Village of Fredonia	0.66	1,500	1939, 1962	Activated Sludge Disinfection	Secondary Auxiliary	Tributary of Milwaukee River	1,200	0.12	0.25	200	950	0.28	187
Village of Grafton	2.15	8,800	1934, 1960 1970	Activated Sludge Phosphorus Removal Disinfection	Secondary Advanced Auxiliary	Milwaukee River	9,400	1.00	2.50	1,880	8,950	0.88	100
Village of Jackson	0.43	2,000	1939	Trickling Filter Disinfection	Secondary Auxiliary	Tributary of Cedar Creek	250	0.03	0.05	40	190	0.26	130
Village of Kewaskum	0.65	2,000	1955, 1972	Activated Sludge Phosphorus Removal Disinfection	Secondary Advanced Auxiliary	Milwaukee River	5,000	1.00	1.50	1,800	8,570	0.32	160
Village of Newburg	0.19	600	1964	Activated Sludge Disinfection	Secondary Auxiliary	Milwaukee River	800	0.05	0.10	136	650	0.07	117
Village of Saukville	0.43	2,300	1959	Trickling Filter Disinfection	Secondary Auxiliary	Milwaukee River	1,400	0.28	0.46	430	2,050	0.29	126
Village of Thiensville	1.16	4,200	1951,1963	Activated Sludge Phosphorus Removal Disinfection	Secondary Advanced Auxiliary	Pigeon Creek	3,000	0.24	0.36	N/A	N/A	0.57	136

[a] *The population design capacity for a given sewage treatment facility was obtained directly from engineering reports prepared by or for the local unit of government operating the facility and reflects assumptions made by the design engineer. The population equivalent design capacity was estimated by the Commission staff by dividing the design BOD_5 loading in pounds per day, as set forth in the engineering reports, by an estimated per capita contribution of 0.21 pound of BOD_5 per day. If the design engineer assumed a different daily per capita contribution of BOD_5, the population equivalent design capacity will differ from the population design capacity shown in the table.*

Source: SEWRPC.

area, and an estimated 175,800 persons, or about 36 percent of the resident population of the watershed, which were served by combined storm and sanitary sewers.

Thirteen municipally owned sewage treatment plants are located in the Milwaukee River watershed. The six plants which serve the City of West Bend and the Villages of Kewaskum, Campbellsport, Grafton, Newburg, and Saukville discharge treated effluents directly to the main stem of the Milwaukee River; the plant which serves the Village of Cascade discharges treated effluent to a tributary of the North Branch of the Milwaukee River; the plant which serves the City of Cedarburg discharges treated effluents to Cedar Creek; the plant which serves the Village of Random Lake discharges treated effluents to Silver Creek; the plant which serves the Village of Thiensville discharges treated effluents to Pigeon Creek; the plant which serves the Village of Jackson discharges treated effluents to a tributary of Cedar Creek; the plant which serves the Village of Fredonia discharges treated effluents to a tributary of the Milwaukee River; and the plant which serves the Village of Adell discharges treated effluent to the groundwater system through a seepage lagoon. Selected information for these municipal sewage treatment plants is set forth in Tables 88 and 89, and the plant locations are shown on Map 57. In addition to the publicly owned sewage treatment facilities, seven private wastewater treatment facilities exist in the Milwaukee River watershed owned and operated by: Cedar Lake Rest Home, Federal Foods Company, Justo Foods Company (not in operation), the Kettle Moraine Correctional Institution, a medium-security prison for adult males operated by the Department of Health and Social Services in the Town of Greenbush in Sheboygan County, Level Valley Dairy, Libby, McNeill, and Libby-Jackson, and S & R Cheese Corporation. Of these facilities, one discharges to Cedar Creek and the other six utilize soil absorption systems. Selected data on these privately owned wastewater treatment facilities are presented in Table 90, and the plant locations are shown on Map 57.

Sanitary Sewerage System Flow Relief Points

In 1975 there were 61 combined sewer outfalls and 129 (127 in-Region and two out-of-Region) known sanitary sewer flow relief devices in the watershed, as listed in Table 91 and shown on Map 57. Of the latter, 29 were sanitary sewerage system bypasses; 7 were relief pumping stations; 16 were portable pumping stations; and the remaining 77 were crossovers. Of the total 190 flow relief devices and combined sewer outfalls, 110 discharge directly to the main stem of the Milwaukee River; 4 discharge directly to Cedar Creek; 55 discharge directly to Lincoln Creek; 13 discharge directly to Indian Creek; 6 discharge directly to Beaver Creek; 1 discharges directly to Pigeon Creek; and 1 discharges directly to Silver Creek.

Table 89

SELECTED CHARACTERISTICS OF MUNICIPAL SEWAGE TREATMENT PLANTS IN THE MILWAUKEE RIVER WATERSHED OUTSIDE OF THE REGION: 1975

Name (out-of-Region)	Total Area Served (square miles)	Estimated Total Population Served	Date of Construction and Major Modification	Type of Treatment	Level of Treatment Provided	Disposal of Effluent	Design Capacity: Population[a]	Design Capacity: Average Hydraulic (mgd)	Design Capacity: Peak Hydraulic (mgd)	Design Capacity: Average Organic (pounds of BOD_5 per day)	Design Capacity: Population[a] Equivalent	Existing Loading: Average Hydraulic (mgd)	Existing Loading: Average Per Capita (gpd)
Village of Adell	N/A	500	1961	Activated Sludge Disinfection	Secondary Auxiliary	Soil Absorption	N/A	0.10	0.16	N/A	N/A	N/A	N/A
Village of Campbellsport	0.44	1,900	1935, 1962	Activated Sludge Disinfection	Secondary Auxiliary	Milwaukee River	N/A	0.24	N/A	N/A	N/A	0.31	163
Village of Cascade	0.22	600	1976	Aerated Lagoons Disinfection	Secondary Auxiliary	Tributary of North Branch Milwaukee River	N/A	0.17	0.60	N/A	N/A	0.04	67
Village of Random Lake	N/A	1,200	1936	Trickling Filter, Disinfection	Secondary Auxiliary	Silver Creek	N/A	0.08	0.30	N/A	N/A	0.20	167

[a] The population design capacity for a given sewage treatment facility was obtained directly from engineering reports prepared by or for the local unit of government operating the facility and reflects assumptions made by the design engineer. The population equivalent design capacity was estimated by the Commission staff by dividing the design BOD_5 loading in pounds per day, as set forth in the engineering reports, by an estimated per capita contribution of 0.21 pound of BOD_5 per day. If the design engineer assumed a different daily per capita contribution of BOD_5, the population equivalent design capacity will differ from the population design capacity shown in the table.

Source: SEWRPC.

Table 90

SELECTED CHARACTERISTICS OF PRIVATELY OWNED WASTEWATER TREATMENT FACILITIES IN THE MILWAUKEE RIVER WATERSHED: 1975

Name	Civil Division Location	Type of Land Use Served	Type of Wastewater	Type of Treatment Provided	Disposal of Effluent	Reported Average Annual Hydraulic Discharge Rate (gallons per day)[a]	Average Hydraulic Design Capacity (gallons per day)	Reported Maximum Monthly Hydraulic Discharge Rate (gallons per day)[a]
In-Region								
Cedar Lake Rest Home	Town of West Bend	Institutional	Sanitary	Contact Stabilization and Lagoon	Soil Absorption	N/A	N/A	35,000
Federal Foods Company	City of Mequon	Industrial	Process	Septic Tank, Lagoon	Soil Absorption	N/A	1,000	N/A
Justo Foods Company (not in operation)	Town of Cedarburg	Industrial	Process	Lagoon	Soil Absorption	N/A	N/A	N/A
Level Valley Dairy	Town of Jackson	Industrial	Process and Cooling	Aeration and Lagoon	Cedar Creek	172,000	N/A	218,100
Libby, McNeil, and Libby–Jackson	Town of Jackson	Industrial	Process and Cooling	Lagoon and Spray Irrigation	Soil Absorption	144,000	N/A	144,000
S & R Cheese Corporation	Town of Fredonia	Industrial	Process	Septic Tank and Lagoon	Soil Absorption	1,800	N/A	N/A
Out-of-Region								
Kettle Moraine Correctional Institution	Town of Greenbush	Institutional	Sanitary	Activated Sludge	Soil Absorption	65,000	60,000	N/A

NOTE: N/A indicates data not available.

[a] Unless specifically noted otherwise, data were obtained, in order of priority, from: quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System or under Section 101 of the Wisconsin Administrative Code or from the Wisconsin Pollutant Discharge Elimination System permit itself. In some cases when 12 months of flow data were not reported, the average annual and maximum monthly hydraulic discharge rates were estimated from the available monthly discharge data or from the flow data as reported in the permit.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 91

KNOWN COMBINED SEWER OUTFALLS AND OTHER FLOW RELIEF DEVICES IN THE MILWAUKEE RIVER WATERSHED IN THE REGION BY RECEIVING STREAM AND CIVIL DIVISION: 1975

Receiving Stream	Civil Division	Combined Sewer Outfalls	Other Flow Relief Devices				Total
			Crossovers	Bypasses	Relief Pumping Stations	Portable Pumping Stations	
In-Region							
Milwaukee River . .	City of Mequon	0	0	2	0	5	7
Beaver Creek	Village of Brown Deer	0	0	1	0	5	6
Indian Creek.	Village of Fox Point	0	1	3	2	5	11
Indian Creek.	City of Glendale	0	0	0	0	1	1
Milwaukee River . .	Village of River Hills	0	0	0	1	0	1
Lincoln Creek. . . .	City of Milwaukee	1	48	4	2	0	55
Pigeon Creek	Village of Thiensville	0	0	0	1	0	1
Milwaukee River . .	Village of Saukville	0	0	0	1	0	1
Cedar Creek	City of Cedarburg	0	0	2	0	0	2
Cedar Creek	Village of Jackson	0	0	2	0	0	2
Milwaukee River . .	City of West Bend	0	0	1	0	0	1
Milwaukee River . .	Village of Fredonia	0	0	1	0	0	1
Milwaukee River . .	Village of Newburg	0	0	1	0	0	1
Milwaukee River . .	Village of Thiensville	0	0	1	0	0	1
Milwaukee River . .	Village of Brown Deer	0	0	1	0	0	1
Milwaukee River . .	City of Glendale	0	1	1	0	0	2
Milwaukee River . .	City of Milwaukee	60	13	7	0	0	80
Milwaukee River . .	Village of Shorewood	0	8	0	0	0	8
Indian Creek.	Village of River Hills	0	1	0	0	0	1
Milwaukee River . .	Village of Whitefish Bay	0	5	0	0	0	5
Subtotal		61	77	27	7	16	188
Out-of-Region							
Milwaukee River . .	Village of Campbellsport	0	0	1	0	0	1
Silver Creek	Village of Random Lake	0	0	1	0	0	1
Subtotal		0	0	2	0	0	2
Total		61	77	29	7	16	190

Source: SEWRPC.

Other Known Point Sources

A total of 73 (68 in-Region and five out-of-Region) other known point sources of pollution were identified in the watershed in 1975. These other point sources consisted primarily of 123 outfalls through which industrial cooling, process, rinse, and wash waters were discharged directly or indirectly to the surface water system. Of these, 83, or 68 percent, were identified as discharging only cooling water. The remaining 40, or 32 percent, were discharging other types of wastewaters. Industrial wastewater enters the Milwaukee River and its major tributaries directly through industrial waste outfalls or indirectly through drainage ditches and storm sewers. Table 92 summarizes by receiving stream and civil division the characteristics of these other point sources, and Map 57 shows their locations. Forty-six of these other point source outfalls discharge the wastes directly to the Milwaukee River main stem, 41 point source outfalls discharge indirectly to the Milwaukee River main stem; 34 point source outfalls discharge to tributaries of the Milwaukee River; and the remaining two point source outfalls utilize soil absorption systems.

Privately Owned Onsite Sanitary Wastewater Treatment

In addition to being provided through centralized sanitary sewerage service within the in-Region portion of the watershed, sanitary wastewater treatment and disposal is provided through approximately 8,137 privately owned onsite sewage disposal systems consisting of 8,087 septic tanks, 48 holding tanks, and 2 mound systems. These systems serve a total resident population of about 29,800 persons, or about 6 percent of the total resident population of the watershed within the Region. Of this total, about 7,400 persons, or 25 percent, reside in concentrated areas of urban development having at least 32 housing units in a U. S. Public Land Survey quarter section. These scattered quarter sections of urban land use concentration totaled about 11.2 square miles of urban land use, or about 3 percent of the area of the watershed within the Region.

Table 92

CHARACTERISTICS OF OTHER KNOWN POINT SOURCES OF WATER POLLUTION IN THE MILWAUKEE RIVER WATERSHED: 1975

Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average Annual Hydraulic Discharge Rate (gallons per day)[a]	Reported Maximum Monthly Hydraulic Discharge Rate (gallons per day)[a]
MILWAUKEE COUNTY								
A. F. Gallun & Sons Corporation	3111	City of Milwaukee	Cooling	None	2	Milwaukee River via Storm Sewer	2,800	3,500
			Cooling	None	3	Milwaukee River via Storm Sewer	1,500	1,800
			Cooling	None	4	Milwaukee River via Storm Sewer	1,100	1,300
American Can Company	3411	City of Milwaukee	Cooling	Settling Basin, Screening, and pH Adjustment	1	Lincoln Creek via Storm Sewer	30,000	40,000
American Motors Corporation—Body Plant	3711	City of Milwaukee	Cooling	None	1	Milwaukee River via Storm Sewer	470,400	632,100
			Cooling	None	2	Milwaukee River via Storm Sewer	20,000	37,000
			Cooling	None	3	Milwaukee River via Storm Sewer	25,000	47,300
			Cooling	None	4	Milwaukee River via Storm Sewer	14,700	21,300
A. O. Smith Corporation—Automotive Division	3714	City of Milwaukee	Cooling	Settling Basin and Oil Separator	1	Lincoln Creek via Storm Sewer	1,094,900	1,235,900
			Cooling	Settling Basin and Oil Separator	2	Lincoln Creek via Storm Sewer	591,000	661,000
Aqua-Chem, Inc.—North Plant No. 1	3829	City of Milwaukee	Process and Cooling	None	2	Lincoln Creek via Storm Sewer	11,600	178,500
Aqua-Chem, Inc.—North Plant No. 2	3829	City of Milwaukee	Cooling, Process and Boiler Blowdown	None	2	Lincoln Creek via Storm Sewer	37,500	58,800
Badger Meter, Inc.	3824	Village of Brown Deer	Cooling	None	2	Beaver Creek via Storm Sewer and Drainage Ditch	7,000	14,000
Beatrice Foods Company	2037	City of Milwaukee	Cooling	None	1	Milwaukee River via Storm Sewer	51,000	51,000
Briggs and Stratton Corporation	3499	City of Milwaukee	Cooling	Lagoon	1	Brown Deer Park Creek	5,000	5,000
Continental Can Company	3551	City of Milwaukee	Cooling	None	1	Milwaukee River via Storm Sewer	340,000	500,000
Continental Equipment	3561	City of Milwaukee	Cooling	None	1	Milwaukee River via Storm Sewer	N/A	1,000
Cutler Hammer, Inc. Industrial System Division	3622	City of Milwaukee	Cooling	None	2	Lincoln Creek via Storm Sewer	80,000	100,000
			Cooling	None	3	Lincoln Creek via Storm Sewer	50,000	60,000
			Cooling	None	4	Lincoln Creek via Storm Sewer	15,000	20,000
First Wisconsin Development Corporation	6025	City of Milwaukee	Cooling	None	1	Milwaukee River	660,000	660,000
Florence Eiseman, Inc.	2339	City of Milwaukee	Cooling and Boiler Blowdown	None	1	Milwaukee River	100	N/A
Fred Usinger, Inc.	2013	City of Milwaukee	Cooling	None	1	Milwaukee River	45,000	50,000
Gimbels Midwest, Inc.	5311	City of Milwaukee	Cooling	None	1	Milwaukee River	1,470,000	3,370,000
			Cooling	None	2	Milwaukee River	47,000	73,000
			Process	None	3	Milwaukee River	200	5,000
			Process	None	4	Milwaukee River	2,000	2,500
Gimbels Midwest, Inc.—Warehouse	5311	City of Milwaukee	Boiler Blowdown	None	1	Milwaukee River	100	N/A
Globe Union, Inc.—Administration and Research Park	3691	City of Glendale	Cooling	Cooling Lagoon	1	Lincoln Creek via Storm Sewer	7,100	17,000
Globe Union, Inc.—Central Lab Division	3679	City of Milwaukee	Cooling	None	1	Lincoln Creek via Storm Sewer	60,000	80,000
			Cooling	None	2	Lincoln Creek via Storm Sewer	60,000	70,000
Hoerner Waldorf Corporation	2653	City of Milwaukee	Cooling and Boiler Blowdown	None	1	Milwaukee River via Storm Sewer	1,200	N/A
Inland Ryerson Construction Products Company	3444	City of Milwaukee	Cooling	None	1	Lincoln Creek via Storm Sewer	1,100	N/A
Interstate Drop Forge Company	3462	City of Milwaukee	Cooling	None	1	Lincoln Creek via Storm Sewer	60,000	N/A
Joseph Schlitz Brewing Company	2082	City of Milwaukee	Cooling	None	1	Milwaukee River via Storm Sewer	2,274,800	4,110,000
			Cooling	None	2	Milwaukee River via Storm Sewer	2,364,400	3,068,000
			Cooling	None	3	Milwaukee River via Storm Sewer	6,276,500	14,950,800

Table 92 (continued)

Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average Annual Hydraulic Discharge Rate (gallons per day)[a]	Reported Maximum Monthly Hydraulic Discharge Rate (gallons per day)[a]
Kurth Malting Corporation—Plant No. 2	2083	City of Milwaukee	Cooling	None	4	Milwaukee River	46,783,300	54,000,000
Longview Fibre Company—Downing Box Division	2653	City of Milwaukee	Cooling	Settling Basin	17	Milwaukee River via Storm Sewer	4,800	4,800
Milprint, Inc.	2649	City of Milwaukee	Cooling	N/A	1	Milwaukee River via Storm Sewer	202,000	259,400
			Cooling	N/A	2	Milwaukee River via Storm Sewer	86,700	111,000
Milwaukee Country Club	7999	City of Milwaukee	Cooling	None	1	Milwaukee River via Storm Sewer	17,600	50,500
			Cooling	None	2	Milwaukee River via Storm Sewer	100	300
Milwaukee County Park Commission—Carver Park	7999	City of Milwaukee	Swimming Pool Overflow and Drainage	None	1	Milwaukee River via Storm Sewer	Intermittent	Intermittent
Milwaukee County Park Commission—Gordon Park	7999	City of Milwaukee	Swimming Pool Overflow and Drainage	None	1	Milwaukee River via Storm Sewer	Intermittent	Intermittent
Milwaukee County Park Commission—Lincoln Park	7999	City of Milwaukee	Swimming Pool Overflow and Drainage	None	1	Milwaukee River via Storm Sewer	Intermittent	Intermittent
Milwaukee County Park Commission—McGovern Park	7999	City of Milwaukee	Swimming Pool Overflow and Drainage	None	1	Lincoln Creek via Storm Sewer	Intermittent	Intermittent
Milwaukee Die Casting Company	3361	City of Milwaukee	Cooling	None	1	Milwaukee River via Storm Sewer	11,000	15,000
North Milwaukee Lime & Cement Company	3273	City of Milwaukee	Process	Settling Pond and pH Adjustment	1	Lincoln Creek via Storm Sewer	2,000	2,500
Oster Corporation	3634	City of Milwaukee	Cooling	None	3	Milwaukee River via Storm Sewer	8,000	13,000
			Cooling	None	4	Milwaukee River via Storm Sewer	33,000	72,000
Outboard Marine Corporation—Evinrude Foundry	3519	City of Milwaukee	Cooling	None	1	Lincoln Creek via Storm Sewer	901,300	1,123,500
			Cooling	None	2	Lincoln Creek via Storm Sewer	85,200	179,800
			Cooling	None	3	Lincoln Creek via Storm Sewer	107,000	170,000
Outboard Marine Corporation—Plant No. 1 Research Annex	3519	City of Milwaukee	Cooling	None	1	Lincoln Creek via Storm Sewer	262,200	313,800
Square D Company	3622	Village of Glendale	Cooling	N/A	1	Milwaukee River via Storm Sewer	2,600	3,500
			Cooling	N/A	2	Milwaukee River via Storm Sewer	36,600	62,500
			Cooling	N/A	3	Milwaukee River via Storm Sewer	88,800	153,000
Stainless Foundry and Engineering Company	3325	City of Milwaukee	Cooling	N/A	2	Lincoln Creek via Storm Sewer	110,000	121,000
			Cooling	N/A	3	Lincoln Creek via Storm Sewer	20,000	22,000
Treat All Metals, Inc.	3398	City of Milwaukee	Cooling	N/A	1	Milwaukee River via Storm Sewer	200,000	200,000
Western Electric Company, Inc.—Wisconsin Service Center	7629	City of Milwaukee	Cooling	N/A	1	Milwaukee River via Storm Sewer	1,000	2,400
W. H. Brady Company—Florist Avenue Plant	2641	City of Glendale	Cooling	N/A	1	Milwaukee River via Storm Sewer	29,000	52,000
Wisconsin Bridge and Iron Company	3441	City of Milwaukee	Cooling and Drainage	Oil Separator	1	Lincoln Creek via Storm Sewer	5,600	N/A
Wisconsin Cuneo Press	2752	City of Milwaukee	Process and Cooling	None	1	Lincoln Creek via Storm Sewer	135,000	148,000
Wisconsin Electric Power Company—Commerce Street	4911	City of Milwaukee	Boiler Blowdown	None	1	Milwaukee River	200,000	200,000
			Cooling, Process, and Boiler Blowdown	None	4	Milwaukee River	46,521,200	51,887,100

Table 92 (continued)

Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average Annual Hydraulic Discharge Rate (gallons per day)[a]	Reported Maximum Monthly Hydraulic Discharge Rate (gallons per day)[a]
Wisconsin Electric Power Company— Wells Street	4911	City of Milwaukee	Boiler Blowdown	None	1	Milwaukee River	600	700
			Drainage	N/A	2	Milwaukee River	200	250
			Drainage	N/A	3	Milwaukee River	400	500
			Cooling and Boiler Blowdown	None	4	Milwaukee River	24,200	25,000
			Boiler Blowdown	N/A	5	Milwaukee River	7,000	8,700
			Drainage and Boiler Blowdown	N/A	6	Milwaukee River	20	25
			Boiler Blowdown	N/A	7	Milwaukee River	1,200	1,500
			Boiler Blowdown	N/A	8	Milwaukee River	1,200	3,000
			Drainage	N/A	9	Milwaukee River	20	25
			Drainage	N/A	10	Milwaukee River	20	25
			Drainage	N/A	11	Milwaukee River	100,000	125,000
			Tank Overflow	N/A	12	Milwaukee River	100	125
			Cooling, Boiler Blowdown, and Drainage	N/A	13	Milwaukee River	889,500	909,300
Wisconsin Electric Power Company— Heating Steam System	3585	City of Milwaukee	Steam Condensate and Groundwater	None	2	Milwaukee River	300	72,000
			Steam Condensate and Groundwater	None	3	Milwaukee River	62,000	80,000
			Steam Condensate and Groundwater	None	4	Milwaukee River	21,000	72,000
Wright Metal Processors, Inc.	3479	City of Milwaukee	Cooling	None	1	Lincoln Creek via Storm Sewer	3,000	4,000
OZAUKEE COUNTY								
Ataco Steel Products Company	3312	Village of Grafton	Cooling	None	1	Milwaukee River via Storm Sewer	20,000	35,000
Brunswick Corporation— Mercury Marine Division, Plant No. 1	3519	City of Cedarburg	Process and Cooling	None	1	Cedar Creek via Storm Sewer	43,000	70,000
Brunswick Corporation— Mercury Marine Division, Plant No. 2	3519	City of Cedarburg	Cooling	None	1	Cedar Creek via Storm Sewer	5,600	10,000
Dayton Malleable— Meta Mold Division	3361	City of Cedarburg	Cooling and Process	None	1	Cedar Creek via Storm Sewer and Drainage Ditch	21,000	35,000
Doerr Electric Corporation	3621	City of Cedarburg	Cooling	None	1	Cedar Crrek via Storm Sewer	1,000	1,000
			Process	Septic	2	Soil Absorption	N/A	N/A
EST Company, Inc.	3361	Village of Grafton	Cooling	None	2	Milwaukee River via Storm Sewer and Drainage Ditch	8,100	14,000
Freeman Chemical Corporation	2821	Village of Saukville	Cooling	None	1	Milwaukee River	344,200	436,700
Johnson Brass and Machine Foundry, Inc.	3362	Village of Saukville	Cooling	None	1	Milwaukee River via Storm Sewer	7,000	N/A
KMC Stampings Division	3469	Village of Grafton	Cooling	None	1	Milwaukee River via Drainage Ditch	125	N/A
Leeson Electric Corporation	3621	Village of Grafton	Cooling	Lagoon	1	Milwaukee River via Storm Sewer	5,000	N/A
MSD Plastics, Inc.	3079	Village of Grafton	Cooling	Settling Tank	1	Cedar Creek via Storm Sewer	25,000	25,000
Russel T. Gillman, Inc.	3545	Village of Grafton	Cooling	None	1	Milwaukee River via Storm Sewer	700	1,300
WASHINGTON COUNTY								
Amity Leather Products Company	3172	City of West Bend	Cooling	N/A	1	Milwaukee River via Storm Sewer	N/A	10,000
Bermico Company	2646	City of West Bend	Process and Cooling	N/A	1	Milwaukee River	228,800	295,000
Culligan Water Conditioning, Inc.	7399	City of West Bend	Filter Backwash	None	1	Milwaukee River via Storm Sewer	2,900	3,000
Fairmont Foods Company	2026	Village of Kewaskum	Cooling	None	1	Milwaukee River via Storm Sewer	8,000	10,000
Gehl Company	3523	City of West Bend	Cooling	None	1	Milwaukee River	64,000	94,000
			Cooling	None	2	Milwaukee River	4,000	4,000
			Cooling	None	3	Milwaukee River	17,000	37,000
			Cooling	None	4	Milwaukee River	168,000	456,000
Kewaskum Frozen Foods	2011	Village of Kewaskum	Cooling	None	1	Milwaukee River via Storm Sewer	10,000 to 50,000	N/A
Pick Automotive Corporation	3714	City of West Bend	Cooling	None	1	Milwaukee River via Storm Sewer	1,000	N/A
Regal Ware, Inc.	3631	Village of Kewaskum	Cooling	N/A	1	Milwaukee River	124,300	168,300

Table 92 (continued)

Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average Annual Hydraulic Discharge Rate (gallons per day)[a]	Reported Maximum Monthly Hydraulic Discharge Rate (gallons per day)[a]
The West Bend Company	3634	City of West Bend	Cooling	N/A	1	Milwaukee River	1,000	1,000
			Cooling	N/A	2	Milwaukee River	1,000	1,000
			Cooling	N/A	3	Milwaukee River	45,000	63,000
			Cooling	N/A	4	Milwaukee River	29,000	39,000
			Cooling	N/A	5	Milwaukee River	6,000	8,000
			Cooling	N/A	6	Milwaukee River	3,000	4,000
			Cooling	N/A	8	Milwaukee River	1,000	1,000
			Cooling	N/A	9	Milwaukee River	52,000	72,000
			Cooling	N/A	10	Milwaukee River	1,000	1,000
			Cooling	N/A	11	Milwaukee River	4,000	5,000
Out-of-Region								
Ben A. Winton Company	--	Town of Scott	Process	None	1	Melius Creek	1,600,000	N/A
Foremost Foods, Inc.	--	Village of Adell	Process and Cooling	Aerated Lagoons	1	Unnamed Tributary of North Branch of Milwaukee River	85,000	200,000
Krier Preserving Company	--	Village of Random Lake	Process and Cooling	Spray Irrigation	1	Soil Absorption	N/A	N/A
					2	Silver Creek	N/A	N/A
Loer's Meat Service	--	Village of Campbellsport	Cooling	None	1	Milwaukee River	N/A	N/A
Universal Foods Corporation (Stella Cheese)	--	Village of Campbellsport	Cooling	None	1	Milwaukee River	63,000	N/A

NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data were obtained, in order of priority, from: quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System or under Section 101 of the Wisconsin Administrative Code or from the Wisconsin Pollutant Discharge Elimination System permit itself. In some cases when 12 months of flow data were not reported, the average annual and maximum monthly hydraulic discharge rates were estimated from the available monthly discharge data or from the flow data as reported in the permit.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Urban Storm Water Management Systems

As noted in Table 87, land cover categories associated with urban land uses as of 1975 comprised about 52,000 acres, or about 12 percent of the Milwaukee River watershed. The most important urban land cover category was residential land, with about 7 percent.

There were a total of 13 known urban storm water drainage systems providing service to the subareas of the Milwaukee River watershed within the Region in 1975. These include the systems operated by the Cities of Cedarburg, Glendale, Milwaukee, and West Bend; and by the Villages of Brown Deer, Fox Point, Grafton, Jackson, Kewaskum, Saukville, Shorewood, Thiensville, and Whitefish Bay. A storm water drainage system in the Village of Kewaskum is known to exist, but local documentation in the form of a map of the system was not available. Information concerning the storm water drainage systems serving civil divisions located within the Milwaukee River watershed outside of the Region was not included in the inventory. Together, the 12 storm water drainage systems for which mapping was available have a tributary drainage area of about 38.7 square miles, or about 8.9 percent of the total area of the watershed. About 1 percent of the total area of the watershed is served by combined sanitary and storm sewers, as noted above. Included within this storm water drainage area are a total of 309 known storm water outfalls ranging in size from 12 inches in diameter to a 60 by 144-inch box culvert. There were no known storm water pumping facilities and four known storm water storage facilities in the watershed. The total annual average discharge from these outfalls was estimated to be about 5,369 million gallons per year occurring on the average in 70 events.

Rural Storm Water Runoff

About 385,000 acres, or 88 percent of the total area of the watershed, are devoted to rural land use activities. The most important rural land cover categories were row crops with 24 percent, hay with 20 percent, other open space with 15 percent, small grains with 9 percent, woodlands with 9 percent, and wetlands, swamps, and marshes with 6 percent of the watershed. As of May 1975, there were an estimated 479 domestic livestock operations—operations of 25 or more equivalent animal units—having a total of 40,790 equivalent animal units within the watershed. Of the 479 operations, 242, or 51 percent, were located within 500 feet of the surface water system of the watershed.

Pollution Loadings

A summary of the pollution loadings in the Milwaukee River watershed is presented in Table 93 and depicted in Figure 34. Urban sources of pollution are estimated to contribute 21 percent of the nitrogen, 46 percent of the phosphorus, 31 percent of the biochemical oxygen demand, 62 percent of the fecal coliform, and 47 percent of the sediment which occur as water pollutants in the Milwaukee River and its tributaries. Of the urban contribution, point sources of pollution are estimated to contribute 50 percent of the nitrogen, 30 percent of the phosphorus, 33 percent of the biochemical oxygen demand, 96 percent of the fecal coliform, and less than 1 percent of the sediment. Diffuse sources—including the estimated septic tank and construction-related con-

Table 93

SUMMARY OF ESTIMATED AVERAGE ANNUAL POLLUTANT LOADINGS IN THE MILWAUKEE RIVER WATERSHED: 1975

Source	Extent[b]	Parameter	Loads[c]	
			Average Year	
			Total Estimated Loading	Percent
Urban Point Sources				
Municipal Sewage Treatment Plants . .	9	Total Nitrogen	536,820.0	8.1
	9	Total Phosphorus	65,830.0	6.6
	9	Biochemical Oxygen Demand	460,450.0	2.6
	9	Fecal Coliform	280,000,000.0	26.1
	9	Sediment	310.0	0.0
Private Sewage Treatment Plants	1	Total Nitrogen	10,210.0	0.2
	1	Total Phosphorus	8,380.0	0.8
	1	Biochemical Oxygen Demand	27,070.0	0.2
	1	Fecal Coliform	0.0	0.0
	1	Sediment	15.0	0.0
Combined Sewer Overflows	61	Total Nitrogen	109,340.0	1.6
	61	Total Phosphorus	54,670.0	5.5
	61	Biochemical Oxygen Demand	1,093,370.0	6.3
	61	Fecal Coliform	350,000,000.0	32.6
	61	Sediment	1,640.0	0.1
Industrial Discharges	68	Total Nitrogen	37,530.0	0.6
	68	Total Phosphorus	6,720.0	0.7
	68	Biochemical Oxygen Demand	131,470.0	0.8
	68	Fecal Coliform	0.0	0.0
	68	Sediment	170.0	0.0
Sanitary Sewer Flow Relief Devices . .	127	Total Nitrogen	7,380.0	0.1
	127	Total Phosphorus	2,460.0	0.2
	127	Biochemical Oxygen Demand	73,800.0	0.4
	127	Fecal Coliform	11,000,000.0	1.0
	127	Sediment	35.0	0.0
Urban Point Source Totals		Total Nitrogen	701,280.0	10.5
		Total Phosphorus	138,060.0	13.9
		Biochemical Oxygen Demand	1,786,160.0	10.2
		Fecal Coliform	641,000,000.0	59.7
		Sediment	2,170.0	0.2
Urban Diffuse Sources				
Residential	29129	Total Nitorgen	116,520.0	1.7
	29129	Total Phosphorus	9,320.0	0.9
	29129	Biochemical Oxygen Demand	707,830.0	4.0
	29129	Fecal Coliform	4,660,640.0	0.4
	29129	Sediment	7,940.0	0.7
Commercial	5454	Total Nitrogen	49,090.0	0.7
	5454	Total Phosphorus	4,090.0	0.4
	5454	Biochemical Oxygen Demand	532,310.0	3.0
	5454	Fecal Coliform	1,799,820.0	0.2
	5454	Sediment	2,030.0	0.2
Industrial	3014	Total Nitrogen	25,320.0	0.4
	3014	Total Phosphorus	2,110.0	0.2
	3014	Biochemical Oxygen Demand	111,220.0	0.6
	3014	Fecal Coliform	1,868,680.0	0.2
	3014	Sediment	1,470.0	0.1
Extractive	1017	Total Nitrogen	61,020.0	0.9
	1017	Total Phosphorus	45,770.0	4.6
	1017	Biochemical Oxygen Demand	122,040.0	0.7
	1017	Fecal Coliform	0.0	0.0
	1017	Sediment	76,275.0	6.9
Transportation	2431	Total Nitrogen	52,630.0	0.8
	2431	Total Phosphorus	3,710.0	0.4
	2431	Biochemical Oxygen Demand	339,480.0	1.9
	2431	Fecal Coliform	1,453,420.0	0.1
	2431	Sediment	44,885.0	4.1
Recreation	5858	Total Nitrogen	18,180.0	0.3
	5858	Total Phosphorus	670.0	0.1
	5858	Biochemical Oxygen Demand	7,620.0	0.0
	5858	Fecal Coliform	130,176.0	0.0
	5858	Sediment	1,230.0	0.1
Construction	5096	Total Nitrogen	305,760.0	4.6
	5096	Total Phosphorus	229,320.0	23.2
	5096	Biochemical Oxygen Demand	611,520.0	3.5
	5096	Fecal Coliform	0.0	0.0
	5096	Sediment	382,200.0	34.5
Septic Systems	38780	Total Nitrogen	86,330.0	1.3
	38780	Total Phosphorus	19,650.0	2.0
	38780	Biochemical Oxygen Demand	1,214,580.0	6.9
	38780	Fecal Coliform	14,884,500.0	1.4
	38780	Sediment	210.0	0.0
Urban Diffuse Source Totals		Total Nitrogen	714,850.0	10.7
		Total Phosphorus	314,640.0	31.8
		Biochemical Oxygen Demand	3,646,600.0	20.9
		Fecal Coliform	24,797,236.0	2.3
		Sediment	516,240.0	46.6
Urban Source Totals		Total Nitrogen	1,416,130.0	21.2
		Total Phosphorus	452,700.0	45.7
		Biochemical Oxygen Demand	5,432,760.0	31.1
		Fecal Coliform	665,797,236.0	62.0
		Sediment	518,410.0	46.8
Rural Diffuse Sources				
Livestock Operations	63830	Total Nitrogen	1,812,770.0	27.2
	63830	Total Phosphorus	421,280.0	42.5
	63830	Biochemical Oxygen Demand	7,097,900.0	40.6
	63830	Fecal Coliform	408,512,000.0	38.0
	63830	Sediment	22,340.0	2.0
Cropland, Pasture, and Unused Rural Land	312380	Total Nitrogen	3,299,730.0	49.5
	312380	Total Phosphorus	107,960.0	10.9
	312380	Biochemical Oxygen Demand	3,936,460.0	22.5
	312380	Fecal Coliform	0.0	0.0
	312380	Sediment	560,110.0	50.6
Silvicultural	40000	Total Nitrogen	92,000.0	1.4
	40000	Total Phosphorus	5,600.0	0.6
	40000	Biochemical Oxygen Demand	184,000.0	1.1
	40000	Fecal Coliform	264,000.0	0.0
	40000	Sediment	5,020.0	0.5
Air Pollution to Surface Water	5112	Total Nitrogen	45,500.0	0.7
	5112	Total Phosphorus	2,560.0	0.3
	5112	Biochemical Oxygen Demand	828,140.0	4.7
	5112	Fecal Coliform	0.0	0.0
	5112	Sediment	1,700.0	0.2
Rural Diffuse Source Totals		Total Nitrogen	5,250,000.0	78.8
		Total Phosphorus	537,400.0	54.3
		Biochemical Oxygen Demand	12,046,500.0	68.9
		Fecal Coliform	408,776,000.0	38.0
		Sediment	589,170.0	53.2
Diffuse Source Totals		Total Nitrogen	5,964,850.0	85.5
		Total Phosphorus	852,040.0	86.1
		Biochemical Oxygen Demand	15,693,100.0	89.8
		Fecal Coliform	433,573,236.0	40.3
		Sediment	1,105,410.0	99.8
Total Sources		Total Nitrogen	6,666,130.0	100.0
		Total Phosphorus	990,100.0	100.0
		Biochemical Oxygen Demand	17,479,260.0	100.0
		Fecal Coliform	1,074,573,236.0	100.0
		Sediment	1,107,580.0	100.0

[a] *Includes pollution loadings from the approximately 264 square miles of the Milwaukee River watershed located outside of the Region.*

[b] *Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.*

[c] *Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year.*

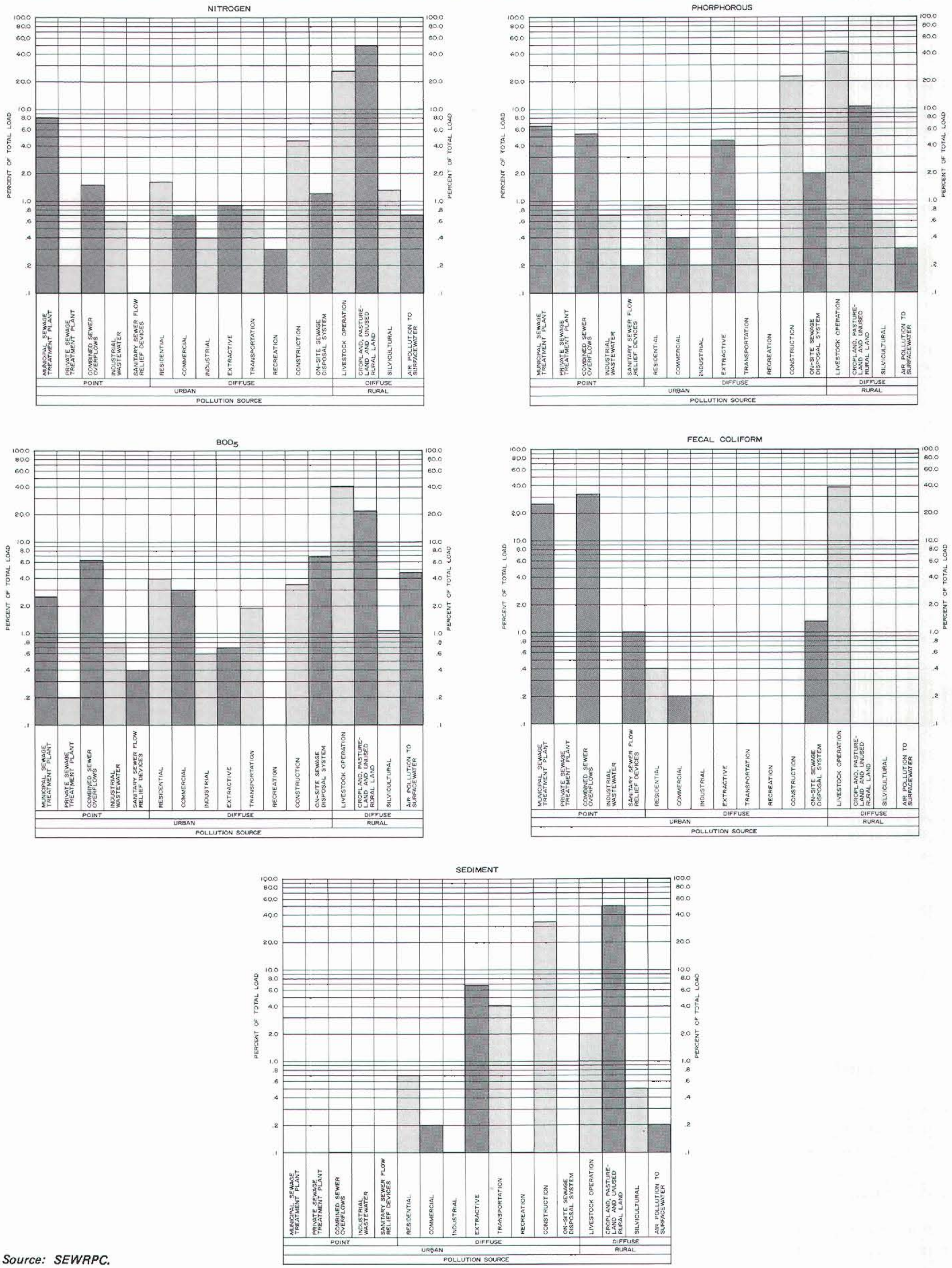
Source: SEWRPC.

tributions in the drainage area—account for the remaining 50 percent of the nitrogen, 70 percent of the phosphorus, 67 percent of the biochemical oxygen demand, 4 percent of the fecal coliform, and nearly all of the sediment contributed from urban sources.

Of the total pollutant loads, rural pollution sources are estimated to contribute the remaining 79 percent of the nitrogen, 54 percent of the phosphorus, 69 percent of the biochemical oxygen demand, 38 percent of the fecal coliform, and 53 percent of the sediment which occur as water pollutants in the watershed. Of the rural pollution sources, none are point sources, since none of the livestock operations in the watershed are of sufficient size to fall within the definition used in this report. Other livestock feeding operations—inclusive of the disposal of manure on croplands—are estimated to contribute 35 percent of the nitrogen, 78 percent of the phosphorus, 59 percent of the biochemical oxygen demand, almost all of the fecal coliform, and 4 percent of the sediment from rural sources. The remainder of the estimated rural pollution load, or 65 percent of the nitrogen, 22 percent of the phosphorus, 41 percent of the biochemical oxygen demand, essentially none of the fecal coliform, and 96 percent of the sediment, is contributed by other rural diffuse sources, namely storm water runoff from rural land uses and atmospheric loadings to surface waters.

Figure 34

SUMMARY OF ESTIMATED AVERAGE ANNUAL POLLUTANT LOADINGS IN THE MILWAUKEE RIVER WATERSHED: 1975



Source: SEWRPC.

WATERSHED OF MINOR STREAMS DIRECTLY TRIBUTARY TO LAKE MICHIGAN

Barnes Creek Subwatershed

The Barnes Creek subwatershed is a natural surface water drainage unit 4.5 square miles in areal extent located in the southeastern portion of the Region. The boundaries of the basin, together with the location of the main channel, are shown on Map 61, along with the generalized land uses as of 1975. The main stem of Barnes Creek originates two miles north of the Illinois state line and less than one mile from Lake Michigan in Kenosha County, and discharges to Lake Michigan in the Town of Pleasant Prairie in Kenosha County. About 65 percent of the total area of the subwatershed is still in rural land uses, with about 84 percent of this rural area still in agricultural use. Most of the agricultural-related land use is located in the southwestern portions of the subwatershed. Table 94 sets forth the extent and proportion of the major land cover categories within the drainage area as they relate to water quality conditions in 1975.

The soils within the Barnes Creek subwatershed are generally silt loams. Most of the soils are relatively fertile and produce high crop yields if managed correctly. Sediment discharges from these soils may result in high nutrient levels in stream waters.

Particularly important to comprehensive water quality management planning are the soil suitability interpretations for specified types of urban development. Based upon the interpretations of the soil properties, about 32 percent of the subwatershed is covered by soils that have severe or very severe limitations for residential development with public sanitary sewer service, as shown on Map 62; almost the entire subwatershed, or about 96 percent, is covered by soils which have severe or very severe limitations for small lot (less than one acre in size) residential development without public sanitary sewer, as shown on Map 63; and about 61 percent of the subwatershed consists of soils that have severe or very severe limitations for large lot (one acre or larger in size) residential development, as shown on Map 64.

Municipal and Private Sewage Treatment Facilities: In 1975, a portion of one sanitary sewerage system served a total area of about 0.34 square mile within the subwatershed, or about 7 percent of the total area of the subwatershed, and a total population of about 1,100 persons, or approximately 39 percent of the total resident population of the subwatershed.

There are no municipal or private sewage treatment plants located in the Barnes Creek subwatershed.

Sanitary Sewerage System Flow Relief Points: In 1975, there were no known sanitary sewer flow relief points in the Barnes Creek subwatershed.

Other Known Point Sources: There are no known other point sources of pollution (industrial waste discharges) in the Barnes Creek subwatershed.

Table 94

AREAL EXTENT OF WATER QUALITY-RELATED IN LAND COVER IN THE BARNES CREEK SUBWATERSHED: 1975

Land Cover[a]	Square Miles	Acres	Percent
Urban			
Residential	0.89	567	18.91
Commercial[b]	0.14	89	2.96
Industrial			
Manufacturing	0.01	3	0.10
Landfills and Dumps	0.00	2	0.07
Extractive	0.09	54	1.80
Transportation			
Streets and Highways	--	--	--
Airfields	--	--	--
Railroad Yards and Terminals	--	--	--
Recreation			
Golf Courses	--	--	--
Parks and Other Recreation	0.02	13	0.43
Land Under Development			
Residential[c]	0.50	319	10.63
Commercial	--	--	--
Industrial	--	--	--
Transportation	--	--	--
Recreation	--	--	--
Rural			
Agricultural			
Small Grains	0.16	100	3.35
Hay	0.03	19	0.63
Row Crops	1.40	895	29.82
Specialty Crops	0.06	38	1.27
Sod Farm	--	--	--
Other Open Space[d]	0.91	583	19.42
Silvicultural			
Woodlands	0.24	155	5.16
Orchards and Nurseries	0.01	9	0.30
Natural and Man-Made Water Areas—Subject to Atmospheric Pollutant Contributions			
Ponds, Lakes, and Streams	--	--	--
Wetlands, Swamps, and Marshes	0.24	154	5.14
Total	4.70	3,000	100.00

[a] *These special land cover categories, defined primarily according to their imperviousness and vegetative cover characteristics and effects on the quality of storm water runoff, were delineated at a scale of 1" = 400' on aerial photographs taken in May 1975 and were measured to the nearest full acre, using dot-counting overlays. The total acreages measured within hydrologic subbasins were then adjusted to the preliminary control totals measured by digitizer from base maps of hydrologic subbasins at a scale of 1" = 2000'. Both the "square miles" and the "percent" shown above were then computed and rounded to the nearest hundredth (0.01) of a percent. The final control total for the Barnes Creek subwatershed is indicated on Map 61.*

[b] *Includes: retail, communication, utilities, administrative, and institutional land uses.*

[c] *Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.*

[d] *Includes: pasture, unused urban and rural lands.*

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service; County Soil and Water Conservation Districts; University of Wisconsin-Extension Service; and SEWRPC.

Map 61

THE LOCATION, BOUNDARIES, AND MAJOR STREAMS OF THE BARNES CREEK SUBWATERSHED— SHOWING GENERALIZED LAND USES: 1975

LEGEND

- SUBURBAN AND LOW DENSITY RESIDENTIAL (0.2-2.2 DWELLING UNITS PER NET RESIDENTIAL ACRE)
- MEDIUM DENSITY RESIDENTIAL (2.3-6.9 DWELLING UNITS PER NET RESIDENTIAL ACRE)
- NONE HIGH DENSITY RESIDENTIAL (7.0-17.9 DWELLING UNITS PER NET RESIDENTIAL ACRE)
- PRIMARY ENVIRONMENTAL CORRIDOR PRESERVATION THROUGH PUBLIC AQUISITION
- NONE MAJOR RETAIL AND SERVICE CENTER
- NONE MAJOR INDUSTRIAL CENTER
- NONE PUBLIC AIRPORT
- NONE MAJOR PUBLIC OUTDOOR RECREATION CENTER

The Barnes Creek subwatershed is about five square miles in areal extent, or about 0.2 percent of the total area of the Region. The water quality in the subwatershed is affected by the various land uses as shown. There are no public or private wastewater treatment plants, flow relief devices, or other point sources of wastewater in the subwatershed.

Source: SEWRPC.

Privately Owned Onsite Sanitary Wastewater Treatment: In addition to being provided through the centralized sanitary sewerage service within the subwatershed, sanitary wastewater treatment and disposal is provided through approximately 522 privately owned onsite sewage disposal systems, consisting of 515 septic tanks, 4 holding tanks, and 3 mound systems. These systems serve a total resident population of about 1,900 persons, or about 61 percent of the total resident population of the subwatershed. Of this total, about 1,400 persons, or about 82 percent, resided in concentrated areas of urban development having at least 32 housing units in a U. S. Public Land Survey quarter section. These scattered quarter sections of urban land use concentration totaled about 1.4 square miles of urban land use, or about 31 percent of the total area of the subwatershed.

Urban Storm Water Management Systems: As noted in Table 94, land cover categories associated with urban land uses as of 1975 comprised about 1,000 acres, or about 35 percent of the Barnes Creek subwatershed. The most important urban land cover category was residential land, with about 19 percent.

There were no known urban storm water drainage systems providing service to the subareas of the Barnes Creek subwatershed.

Rural Storm Water Runoff: About 2,000 acres, or 65 percent of the total area of the subwatershed, are devoted to rural land use activities. The most important rural land cover categories were row crops with 30 percent, other open space with 19 percent, and wetlands, swamps, and marshes with 5 percent of the drainage area. As of May 1975, there was only one known domestic animal operation—an operation of 25 or more equivalent animal units—having a total of about 10 equivalent animal units within the tributary drainage area. The operation was not located within 500 feet of the surface water system of the subwatershed.

Pollution Loadings: A summary of the estimated average annual pollution loadings in the Barnes Creek subwatershed is presented in Table 95 and depicted in Figure 35. Urban sources of pollution are estimated to contribute 59 percent of the nitrogen, 96 percent of the phosphorus, 89 percent of the biochemical oxygen demand, 97 percent of the fecal coliform, and 89 percent of the sediment which occur as water pollutants in the Barnes Creek subwatershed. Urban sources of pollution are estimated to consist entirely of diffuse sources—including the estimated septic tank and construction-related contributions in the drainage area—since there are no known point sources of pollution in the subwatershed.

Of the total pollutant loads, rural pollution sources are estimated to contribute the remaining 41 percent of the nitrogen, 4 percent of the phosphorus, 11 percent of the biochemical demand, 3 percent of the fecal coliform, and 11 percent of the sediment which occur as water pollutants within the subwatershed. Of the rural pollution sources, none are point sources, since none of the livestock operations in the subwatershed are of sufficient size to fall within the definition used in this report. Other livestock feeding operations—inclusive of the disposal of manure on croplands—are estimated to contribute

Map 62

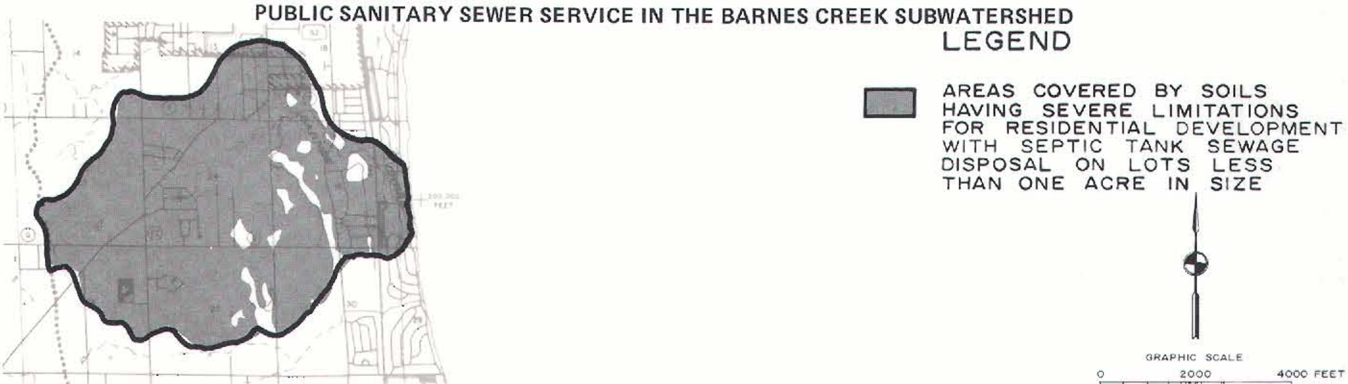
SUITABILITY OF SOILS FOR RESIDENTIAL DEVELOPMENT WITH PUBLIC SANITARY SEWER SERVICE IN THE BARNES CREEK SUBWATERSHED

Of particular importance in comprehensive water quality planning is the recognition of the limitations inherent in the soil resource base. About 32 percent of the area of the Barnes Creek subwatershed is covered with soils which are poorly suited for residential development with public sanitary sewer service or, more precisely, residential development of any kind. These soils, which include wet soils having a high water table or poor drainage, organic soils which are poorly drained and provide poor foundation support, and soils which have a flood hazard, are especially prevalent in the riverine areas of the subwatershed.

Source: U. S. Soil Conservation Service and SEWRPC.

Map 63

SUITABILITY OF SOILS FOR SMALL LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE IN THE BARNES CREEK SUBWATERSHED

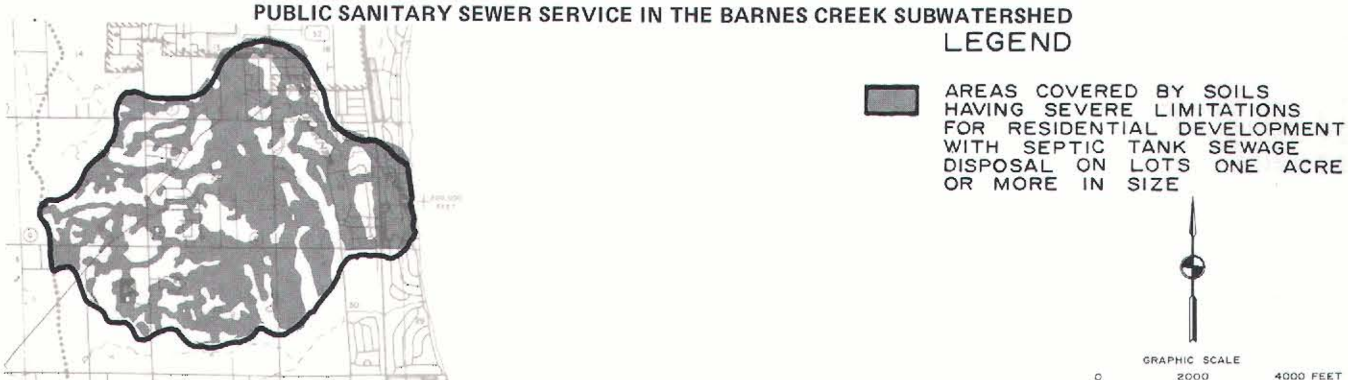


Approximately 96 percent of the area of the Barnes Creek subwatershed is covered by soils poorly suited for residential development on lots having an area smaller than one acre and not served by public sanitary sewerage facilities. Reliance on septic tank sewage disposal systems in these areas, which are covered by relatively impervious soils or are subject to seasonally high water tables, can only result in eventual malfunctioning of such systems and the consequent intensification of water pollution and public health problems in the subwatershed.

Source: U. S. Soil Conservation Service and SEWRPC.

Map 64

SUITABILITY OF SOILS FOR LARGE LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE IN THE BARNES CREEK SUBWATERSHED



Approximately 61 percent of the area of the Barnes Creek subwatershed is covered by soils poorly suited for residential development on lots having an area of one acre or more and not served by public sanitary sewerage facilities. The inherent limitations of these soils for septic tank sewage disposal systems cannot be overcome simply by the provision of larger lots, and the use of such systems on these soils, which cannot absorb the sewage effluent, ultimately results in surface ponding and runoff of partially treated wastes into nearby watercourses.

Source: U. S. Soil Conservation Service and SEWRPC.

Table 95

SUMMARY OF ESTIMATED AVERAGE ANNUAL POLLUTANT LOADINGS IN THE BARNES CREEK SUBWATERSHED: 1975

Source	Extent[a]	Parameter	Loads[b] Average Year Total Estimated Loading	Percent
Urban Point Sources				
Municipal Sewage Treatment Plants	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Private Sewage Treatment Plants	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Combined Sewer Overflow	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Industrial Discharges	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Sanitary Sewer Flow Relief Devices	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Urban Point Source Totals		Total Nitrogen	0.0	0.0
		Total Phosphorus	0.0	0.0
		Biochemical Oxygen Demand	0.0	0.0
		Fecal Coliform	0.0	0.0
		Sediment	0.0	0.0
Urban Diffuse Sources				
Residential	567	Total Nitrogen	2,270.0	3.7
	567	Total Phosphorus	180.0	0.9
	567	Biochemical Oxygen Demand	13,780.0	5.6
	567	Fecal Coliform	90,720.0	4.4
	567	Sediment	155.0	0.5
Commercial	89	Total Nitrogen	800.0	1.3
	89	Total Phosphorus	70.0	0.3
	89	Biochemical Oxygen Demand	8,690.0	3.5
	89	Fecal Coliform	29,370.0	1.4
	89	Sediment	35.0	0.1
Industrial	5	Total Nitrogen	40.0	0.1
	5	Total Phosphorus	0.0	0.0
	5	Biochemical Oxygen Demand	180.0	0.1
	5	Fecal Coliform	3,100.0	0.2
	5	Sediment	0.0	0.0
Extractive	54	Total Nitrogen	3,240.0	5.3
	54	Total Phosphorus	2,430.0	11.9
	54	Biochemical Oxygen Demand	6,480.0	2.6
	54	Fecal Coliform	0.0	0.0
	54	Sediment	4,050.0	12.8
Transportation	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Recreation	13	Total Nitrogen	30.0	0.0
	13	Total Phosphorus	0.0	0.0
	13	Biochemical Oxygen Demand	20.0	0.0
	13	Fecal Coliform	871.0	0.0
	13	Sediment	5.0	0.0
Construction	319	Total Nitrogen	19,140.0	31.1
	319	Total Phosphorus	14,360.0	70.5
	319	Biochemical Oxygen Demand	38,280.0	15.6
	319	Fecal Coliform	0.0	0.0
	319	Sediment	23,925.0	75.7
Septic Systems	1860	Total Nitrogen	10,600.0	17.2
	1860	Total Phosphorus	2,460.0	12.1
	1860	Biochemical Oxygen Demand	151,780.0	61.7
	1860	Fecal Coliform	1,860,000.0	90.8
	1860	Sediment	25.0	0.1
Urban Diffuse Source Totals		Total Nitrogen	36,120.0	58.7
		Total Phosphorus	19,500.0	95.7
		Biochemical Oxygen Demand	219,210.0	89.1
		Fecal Coliform	1,984,061.0	96.8
		Sediment	28,195.0	89.3
Urban Source Totals		Total Nitrogen	36,120.0	58.7
		Total Phosphorus	19,500.0	95.7
		Biochemical Oxygen Demand	219,210.0	89.1
		Fecal Coliform	1,984,061.0	96.8
		Sediment	28,195.0	89.3
Rural Diffuse Sources				
Livestock Operations	10	Total Nitrogen	280.0	0.5
	10	Total Phosphorus	70.0	0.3
	10	Biochemical Oxygen Demand	1,110.0	0.5
	10	Fecal Coliform	64,000.0	3.1
	10	Sediment	5.0	0.0
Cropland, Pasture, and Unused Rural Land	1635	Total Nitrogen	24,720.0	40.2
	1635	Total Phosphorus	780.0	3.8
	1635	Biochemical Oxygen Demand	25,030.0	10.2
	1635	Fecal Coliform	0.0	0.0
	1635	Sediment	3,365.0	10.7
Silvicultural	164	Total Nitrogen	380.0	0.6
	164	Total Phosphorus	20.0	0.1
	164	Biochemical Oxygen Demand	750.0	0.3
	164	Fecal Coliform	1,082.4	0.1
	164	Sediment	20.0	0.1
Rural Diffuse Source Totals		Total Nitrogen	25,380.0	41.3
		Total Phosphorus	870.0	4.3
		Biochemical Oxygen Demand	26,890.0	10.9
		Fecal Coliform	65,082.4	3.2
		Sediment	3,390.0	10.7
Diffuse Source Totals		Total Nitrogen	61,500.0	100.0
		Total Phosphorus	20,370.0	100.0
		Biochemical Oxygen Demand	246,100.0	100.0
		Fecal Coliform	2,049,143.4	100.0
		Sediment	31,585.0	100.0
Total Sources		Total Nitrogen	61,500.0	100.0
		Total Phosphorus	20,370.0	100.0
		Biochemical Oxygen Demand	246,100.0	100.0
		Fecal Coliform	2,049,143.4	100.0
		Sediment	31,585.0	100.0

[a] *Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.*

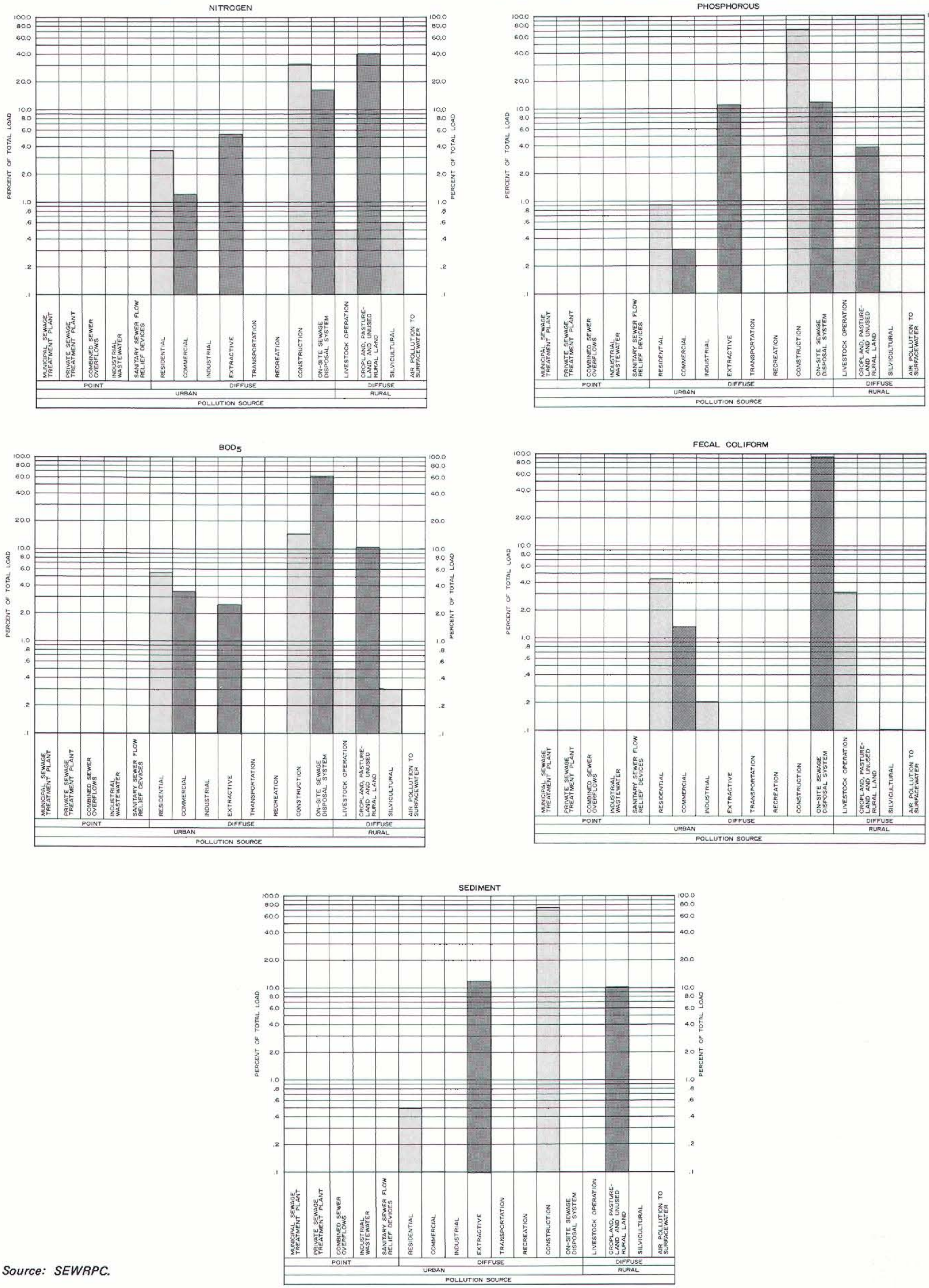
[b] *Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year.*

Source: SEWRPC.

1 percent of the nitrogen, 8 percent of the phosphorus, 4 percent of the biochemical oxygen demand, 98 percent of the fecal coliform, and almost none of the sediment from rural sources. The remainder of the estimated rural pollution load, or 99 percent of the nitrogen, 92 percent of the phosphorus, 96 percent of the biochemical oxygen demand, 2 percent of the fecal coliform, and almost all of the sediment, is contributed by other rural diffuse sources, namely storm water runoff from rural land uses and atmospheric loadings to surface waters.

Figure 35

SUMMARY OF ESTIMATED AVERAGE ANNUAL POLLUTANT LOADINGS IN THE BARNES CREEK SUBWATERSHED: 1975



Source: SEWRPC.

Pike Creek Subwatershed

The Pike Creek subwatershed is a natural surface water drainage unit 7.1 square miles in areal extent located in the southeastern portion of the Region. The boundaries of the basin, together with the location of the main channel of the Pike Creek, are shown on Map 65, along with the locations of the known point sources of pollution and the generalized land uses as of 1975. The main stem of Pike Creek originates in the north-central portion of the City of Kenosha in Kenosha County and discharges to Lake Michigan at the Kenosha harbor in the City of Kenosha. About 28 percent of the total area of the subwatershed remains in rural land uses, with about 91 percent of this rural area in agricultural use. Table 96 sets forth the extent and proportion of the major land cover categories within the drainage area as they relate to water quality conditions in 1975.

The natural soils within the Pike Creek subwatershed are generally silt loams. Most of the soils are relatively fertile and produce high crop yields if managed correctly. Sediment discharges from these soils may result in high nutrient levels in stream waters.

Particularly important to comprehensive water quality management planning are the soil suitability interpretations for specified types of urban development. Based upon the interpretations of the soil properties, about 15 percent of the subwatershed is covered by soils that have severe or very severe limitations for residential development with public sanitary sewer service, as shown on Map 66; about 95 percent of the subwatershed is covered by soils that have severe or very severe limitations for small lot (less than one acre in size) residential development without public sanitary sewer, as shown on Map 67; and about 37 percent of the subwatershed is covered by soils that have severe or very severe limitations for large lot (one acre or larger in size) residential development, as shown on Map 68.

Municipal and Private Sewage Treatment Facilities: In 1975, a portion of one sanitary sewerage system served a total area of about 5.4 square miles within the subwatershed, or about 76 percent of the total area of the subwatershed, and a total population of about 30,800 persons, or approximately 99 percent of the total resident population of the subwatershed. In addition, a small portion of the subwatershed area, with negligible population, was served by combined storm and sanitary sewerage systems.

There are no municipal or private sewage treatment plants located in the Pike Creek subwatershed.

Sanitary Sewerage Flow Relief Points: In 1975, there were five known sanitary sewer flow relief devices in the subwatershed, as listed in Table 97 and shown on Map 65. Of the total five flow relief devices, three were sanitary sewerage system crossovers and two were relief pumping stations. All five of these flow relief devices discharge directly to the main stem of Pike Creek.

Table 96

AREAL EXTENT OF WATER QUALITY-RELATED LAND COVER IN THE PIKE CREEK SUBWATERSHED: 1975

Land Cover[a]	Square Miles	Acres	Percent
Urban			
Residential	3.06	1,957	43.05
Commercial[b]	0.50	323	7.11
Industrial			
Manufacturing	0.85	546	12.01
Landfills and Dumps	--	--	--
Extractive	--	--	--
Transportation			
Streets and Highways	0.07	42	0.92
Airfields	--	--	--
Railroad Yards and Terminals	--	--	--
Recreation			
Golf Courses	--	--	--
Parks and Other Recreation	0.22	141	3.10
Land Under Development			
Residential[c]	0.40	254	5.59
Commercial	--	--	--
Industrial	--	--	--
Transportation	--	--	--
Recreation	--	--	--
Rural			
Agricultural			
Small Grains	0.16	102	2.24
Hay	0.12	75	1.65
Row Crops	1.00	641	14.10
Specialty Crops	0.03	16	0.35
Sod Farm	--	--	--
Other Open Space[d]	0.52	330	7.26
Silvicultural			
Woodlands	0.08	51	1.12
Orchards and Nurseries	--	--	--
Natural and Man-Made Water Areas—Subject to Atmospheric Pollutant Contributions			
Ponds, Lakes, and Streams	--	--	--
Wetlands, Swamps, and Marshes	0.11	68	1.50
Total	7.13	4,546	100.00

[a] *These special land cover categories, defined primarily according to their imperviousness and vegetative cover characteristics and effects on the quality of storm water runoff, were delineated at a scale of 1" = 400' on aerial photographs taken in May 1975 and were measured to the nearest full acre, using dot-counting overlays. The total acreages measured within hydrologic subbasins were then adjusted to the preliminary control totals measured by digitizer from base maps of hydrologic subbasins at a scale of 1" = 2000'. Both the "square miles" and the "percent" shown above were then computed and rounded to the nearest hundredth (0.01) of a percent. The final control total for the Pike Creek subwatershed is indicated on Map 65.*

[b] *Includes: retail, communication, utilities, administrative, and institutional land uses.*

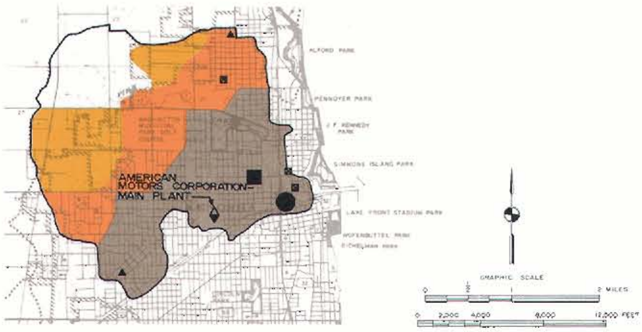
[c] *Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.*

[d] *Includes: pasture, unused urban and rural lands.*

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service; County Soil and Water Conservation Districts; University of Wisconsin-Extension Service; and SEWRPC.

Map 65

THE LOCATION, BOUNDARIES, AND MAJOR STREAMS OF THE PIKE CREEK SUBWATERSHED– SHOWING POINT SOURCES OF POLLUTION AND GENERALIZED LAND USES: 1975



LEGEND

- SUBURBAN AND LOW DENSITY RESIDENTIAL (0.2-2.2 DWELLING UNITS PER NET RESIDENTIAL ACRE)
- MEDIUM DENSITY RESIDENTIAL (2.3-6.9 DWELLING UNITS PER NET RESIDENTIAL ACRE)
- HIGH DENSITY RESIDENTIAL (7.0-17.9 DWELLING UNITS PER NET RESIDENTIAL ACRE)
- NONE PRIMARY ENVIRONMENTAL CORRIDOR PRESERVATION THROUGH PUBLIC AQUISITION
- ● MAJOR RETAIL AND SERVICE CENTER
- ■ MAJOR INDUSTRIAL CENTER
- NONE PUBLIC AIRPORT
- NONE MAJOR PUBLIC OUTDOOR RECREATION CENTER

POINT SOURCES OF POLLUTION

- ◆ PUBLIC SEWAGE TREATMENT FACILITY
- ◆ PRIVATE SEWAGE TREATMENT FACILITY
- ◈ KNOWN POINT SOURCE OF WASTEWATER OTHER THAN SEWAGE TREATMENT PLANT OR FLOW RELIEF DEVICES

KNOWN FLOW RELIEF DEVICES

- ● COMBINED SEWER OUTFALL
- ○ BYPASS
- ⊠ CROSSOVER
- △ PORTABLE RELIEF PUMPING STATION
- ▲ RELIEF PUMPING STATION

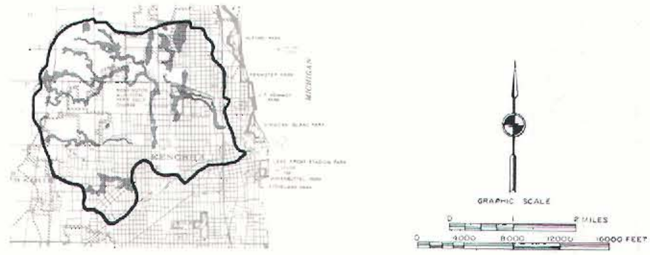
The Pike Creek subwatershed is about seven square miles in areal extent, or about 0.3 percent of the total area of the Region. The water quality in the subwatershed is affected by the various land uses as well as the five flow relief devices and one other point source of wastewater as shown.

Source: SEWRPC.

Other Known Point Sources: One other known point source of pollution was identified in the subwatershed in 1975. The American Motors Corporation—Main Plant discharges cooling water indirectly to Pike Creek via storm sewers. Table 98 summarizes the characteristics of this point source, and its location is shown on Map 65.

Map 66

SUITABILITY OF SOILS FOR RESIDENTIAL DEVELOPMENT WITH PUBLIC SANITARY SEWER SERVICE IN THE PIKE CREEK SUBWATERSHED



LEGEND

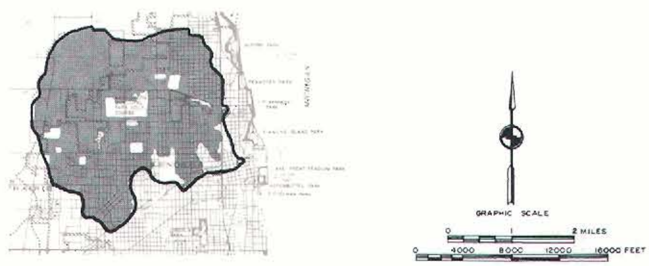
- AREAS COVERED BY SOILS HAVING SEVERE OR VERY SEVERE LIMITATIONS FOR RESIDENTIAL DEVELOPMENT WITH PUBLIC SANITARY SEWER SERVICE

Of particular importance in comprehensive water quality planning is the recognition of the limitations inherent in the soil resource base. About 15 percent of the area of the Pike Creek subwatershed is covered with soils which are poorly suited for residential development with public sanitary sewer service or, more precisely, residential development of any kind. These soils, which include wet soils having a high water table or poor drainage, organic soils which are poorly drained and provide poor foundation support, and soils which have a flood hazard, are especially prevalent in the riverine areas of the subwatershed.

Source: SEWRPC.

Map 67

SUITABILITY OF SOILS FOR SMALL LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE IN THE PIKE CREEK SUBWATERSHED



LEGEND

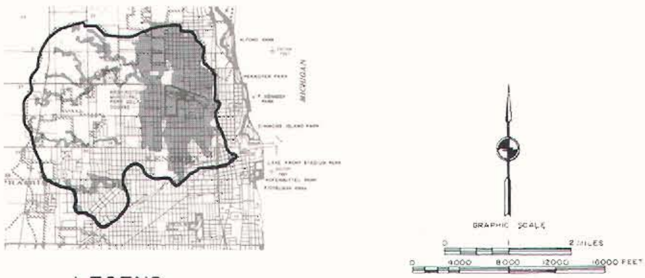
- AREAS COVERED BY SOILS HAVING SEVERE OR VERY SEVERE LIMITATIONS FOR RESIDENTIAL DEVELOPMENT WITH SEPTIC TANK SEWAGE DISPOSAL ON LOTS LESS THAN AN ACRE IN SIZE

Approximately 95 percent of the area of the Pike Creek subwatershed is covered by soils poorly suited for residential development on lots having an area smaller than one acre and not served by public sanitary sewerage facilities. Reliance on septic tank sewage disposal systems in these areas, which are covered by relatively impervious soils or are subject to seasonally high water tables, can only result in eventual malfunctioning of such systems and the consequent intensification of water pollution and public health problems in the subwatershed.

Source: SEWRPC.

Map 68

SUITABILITY OF SOILS FOR LARGE LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE IN THE PIKE CREEK SUBWATERSHED



LEGEND

AREAS COVERED BY SOILS HAVING SEVERE OR VERY SEVERE LIMITATIONS FOR RESIDENTIAL DEVELOPMENT WITH SEPTIC TANK SEWAGE DISPOSAL ON LOTS ONE ACRE OR MORE IN SIZE

Approximately 37 percent of the area of the Pike Creek subwatershed is covered by soils poorly suited for residential development on lots having an area of one acre or more and not served by public sanitary sewerage facilities. The inherent limitations of these soils for septic tank sewage disposal systems cannot be overcome simply by the provision of larger lots, and the use of such systems on these soils, which cannot absorb the sewage effluent, ultimately results in surface ponding and runoff of partially treated wastes into nearby watercourses.

Source: SEWRPC.

Privately Owned Onsite Sanitary Wastewater Treatment: In addition to being provided through the centralized sanitary sewerage service within the subwatershed, sanitary wastewater treatment and disposal is provided through approximately 161 privately owned onsite sewage disposal systems, all of which are septic tanks. These systems serve a total resident population of about 400 persons, or about 1 percent of the total resident population of the subwatershed. Of this total, about 370 persons, or about 88 percent, resided in concentrated areas of urban development having at least 32 housing units in a U. S. Public Land Survey quarter section. These scattered quarter sections of urban land use concentration totaled about 0.25 square mile of urban land use, or about 4 percent of the total area of the subwatershed.

Urban Storm Water Management Systems: As noted in Table 96, land cover categories associated with urban land uses as of 1975 comprised about 3,300 acres, or about 72 percent of the Pike Creek subwatershed. The most important urban land cover category was residential land, with about 43 percent.

There was one known urban storm water drainage system providing service to the subareas of the Pike Creek subwatershed. This system was operated by the City of Kenosha.

Table 97

KNOWN SANITARY SEWERAGE SYSTEM FLOW RELIEF DEVICES IN THE PIKE CREEK WATERSHED IN THE REGION BY RECEIVING STREAM AND CIVIL DIVISION: 1975

Receiving Stream	Civil Division	Combined Sewer Outfalls	Other Flow Relief Devices: Crossovers	Other Flow Relief Devices: Bypasses	Other Flow Relief Devices: Relief Pumping Stations	Other Flow Relief Devices: Portable Pumping Stations	Total
Pike Creek	City of Kenosha	--	3	--	2	--	5
Total		--	3	--	2	--	5

Source: SEWRPC.

Table 98

CHARACTERISTICS OF OTHER KNOWN POINT SOURCES OF WATER POLLUTION IN THE PIKE CREEK SUBWATERSHED: 1975

Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average Annual Hydraulic Discharge Rate (gallons per day)[a]	Reported Maximum Monthly Hydraulic Discharge Rate (gallons per day)[a]
KENOSHA COUNTY American Motors Corporation— Main Plant	3711	City of Kenosha	Cooling	None	1	Pike River via Storm Sewer	2,335,000	2,834,000

[a] *Unless specifically noted otherwise, data were obtained, in order of priority, from: quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System or under Section 101 of the Wisconsin Administrative Code or from the Wisconsin Pollutant Discharge Elimination System permit itself. In some cases when 12 months of flow data were not reported, the average annual and maximum monthly hydraulic discharge rates were estimated from the available monthly discharge data or from the flow data as reported in the permit.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 99

SUMMARY OF ESTIMATED AVERAGE ANNUAL POLLUTANT LOADINGS IN THE PIKE CREEK SUBWATERSHED: 1975

Source	Extent[a]	Parameter	Loads[b] Average Year Total Estimated Loading	Percent
Urban Point Sources				
Municipal Sewage Treatment Plants	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Private Sewage Treatment Plants	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Combined Sewer Overflow	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Industrial Discharges	1	Total Nitrogen	2,490.0	4.6
	1	Total Phosphorus	710.0	4.8
	1	Biochemical Oxygen Demand	21,320.0	10.0
	1	Fecal Coliform	0.0	0.0
	1	Sediment	35.0	0.1
Sanitary Sewer Flow Relief Devices	5	Total Nitrogen	250.0	0.5
	5	Total Phosphorus	80.0	0.5
	5	Biochemical Oxygen Demand	2,500.0	1.2
	5	Fecal Coliform	380,000.0	23.8
	5	Sediment	0.0	0.0
Urban Point Source Totals		Total Nitrogen	2,740.0	5.0
		Total Phosphorus	790.0	5.4
		Biochemical Oxygen Demand	23,820.0	11.2
		Fecal Coliform	380,000.0	23.8
		Sediment	35.0	0.1
Urban Diffuse Sources				
Residential	1957	Total Nitrogen	7,830.0	14.4
	1957	Total Phosphorus	630.0	4.3
	1957	Biochemical Oxygen Demand	47,560.0	22.3
	1957	Fecal Coliform	313,120.0	19.6
	1957	Sediment	535.0	2.3
Commercial	323	Total Nitrogen	2,910.0	5.4
	323	Total Phosphorus	240.0	1.6
	323	Biochemical Oxygen Demand	31,520.0	14.8
	323	Fecal Coliform	106,590.0	6.7
	323	Sediment	120.0	0.5
Industrial	546	Total Nitrogen	4,590.0	8.4
	546	Total Phosphorus	380.0	2.6
	546	Biochemical Oxygen Demand	20,150.0	9.5
	546	Fecal Coliform	338,520.0	21.2
	546	Sediment	265.0	1.1
Extractive	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Transportation	42	Total Nitrogen	980.0	1.8
	42	Total Phosphorus	60.0	0.4
	42	Biochemical Oxygen Demand	6,680.0	3.1
	42	Fecal Coliform	28,140.0	1.8
	42	Sediment	895.0	3.8
Recreation	141	Total Nitrogen	320.0	0.6
	141	Total Phosphorus	10.0	0.1
	141	Biochemical Oxygen Demand	180.0	0.1
	141	Fecal Coliform	5,076.0	0.3
	141	Sediment	30.0	0.1
Construction	254	Total Nitrogen	15,240.0	28.0
	254	Total Phsophorus	11,430.0	78.0
	254	Biochemical Oxygen Demand	30,480.0	14.3
	254	Fecal Coliform	0.0	0.0
	254	Sediment	19,050.0	81.3
Septic Systems	425	Total Nitrogen	2,420.0	4.4
	425	Total Phosphorus	560.0	3.8
	425	Biochemical Oxygen Demand	34,680.0	16.3
	425	Fecal Coliform	425,000.0	26.6
	425	Sediment	5.0	0.0
Urban Diffuse Source Totals		Total Nitrogen	34,290.0	63.0
		Total Phosphorus	13,310.0	90.9
		Biochemical Oxygen Demand	171,250.0	80.4
		Fecal Coliform	1,216,446.0	76.2
		Sediment	20,900.0	89.2
Urban Source Totals		Total Nitrogen	37,030.0	68.1
		Total Phosphorus	14,100.0	96.2
		Biochemical Oxygen Demand	195,070.0	91.6
		Fecal Coliform	1,596,446.0	100.0
		Sediment	20,935.0	89.4
Rural Diffuse Sources				
Livestock Operations	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Cropland, Pasture, and Unused Rural Land	1164	Total Nitrogen	17,240.0	31.7
	1164	Total Phosphorus	540.0	3.7
	1164	Biochemical Oxygen Demand	17,620.0	8.3
	1164	Fecal Coliform	0.0	0.0
	1164	Sediment	2,485.0	10.6
Silvicultural	51	Total Nitrogen	120.0	0.2
	51	Total Phosphorus	10.0	0.1
	51	Biochemical Oxygen Demand	230.0	0.1
	51	Fecal Coliform	336.6	0.0
	51	Sediment	5.0	0.0
Rural Diffuse Source Totals		Total Nitrogen	17,360.0	31.9
		Total Phosphorus	550.0	3.8
		Biochemical Oxygen Demand	17,850.0	8.4
		Fecal Coliform	336.6	0.0
		Sediment	2,490.0	10.6
Diffuse Source Totals		Total Nitrogen	51,650.0	95.0
		Total Phosphorus	13,860.0	94.6
		Biochemical Oxygen Demand	189,100.0	88.8
		Fecal Coliform	1,216,782.6	76.2
		Sediment	23,390.0	99.9
Total Sources		Total Nitrogen	54,390.0	100.0
		Total Phosphorus	14,650.0	100.0
		Biochemical Oxygen Demand	212,920.0	100.0
		Fecal Coliform	1,596,782.6	100.0
		Sediment	23,425.0	100.0

[a] *Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.*

[b] *Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year.*

Source: SEWRPC.

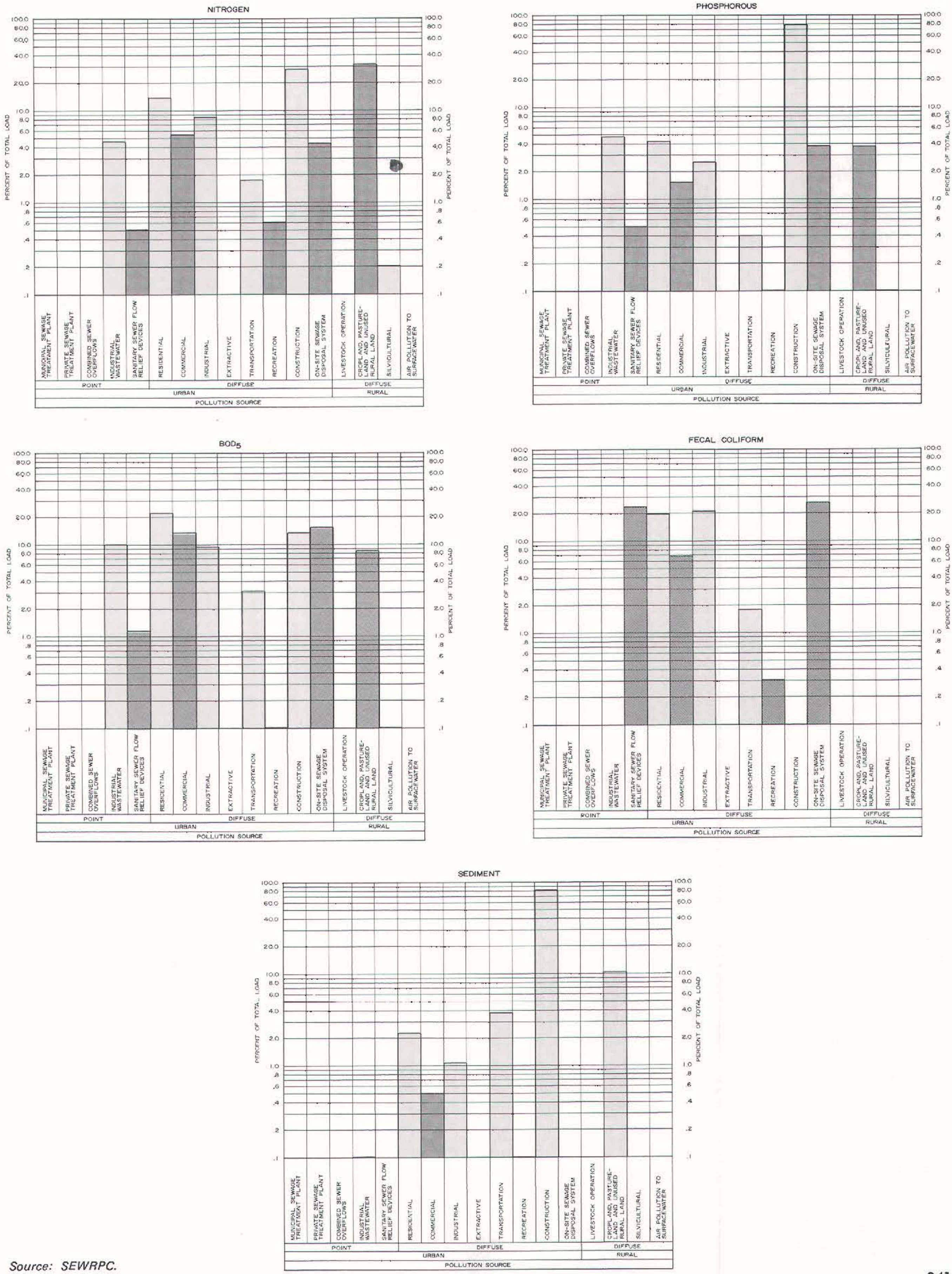
The storm water drainage system has a tributary drainage area of about 5.0 square miles, or about 70 percent of the total area of the subwatershed. A negligible percent of the total area of the subwatershed is served by combined sanitary and storm sewers as noted above. Included within this storm water drainage area are a total of 12 known storm water outfalls ranging in size from 15 inches to 84 inches in diameter. There were two known storm water pumping facilities and no known storm water storage facilities in the subwatershed. The total annual average discharge from these outfalls is estimated to be about 641 million gallons per year occurring on the average in 70 events.

Rural Storm Water Runoff: About 1,300 acres, or 28 percent of the total area of the subwatershed, are devoted to rural land use activities. The most important rural land cover categories were row crops with 14 percent and other open space with 7 percent of the subwatershed. As of May 1975, there were no domestic livestock operations within the tributary drainage area.

Pollution Loadings: A summary of the estimated average annual pollution loadings in the Pike Creek subwatershed is presented in Table 99 and depicted in Figure 36. Urban sources of pollution are estimated to contribute 68 percent of the nitrogen, 96 percent of the phosphorus, 92 percent of the biochemical oxygen demand, all of the fecal coliform, and 89 percent of the sediment which occur as water pollutants to the Pike Creek subwatershed. Of the urban contribution, point sources of pollution are estimated to contribute 7 percent of the nitrogen, 6 percent of the phosphorus, 12 percent of the biochemical oxygen demand, 24 percent of the fecal coliform, and a negligible portion of the sediment. Diffuse sources—including the estimated septic tank and construction-related contributions in the

Figure 36

SUMMARY OF ESTIMATED AVERAGE ANNUAL POLLUTANT LOADINGS IN THE PIKE CREEK SUBWATERSHED: 1975



Source: SEWRPC.

drainage area—account for the remaining 93 percent of the nitrogen, 94 percent of the phosphorus, 88 percent of the biochemical oxygen demand, 76 percent of the fecal coliform, and almost all of the sediment contributed from urban sources.

Of the total pollutant loads, rural pollution sources are estimated to contribute the remaining 32 percent of the nitrogen, 4 percent of the phosphorus, 8 percent of the biochemical oxygen demand, a negligible portion of the fecal coliform, and 11 percent of the sediment which occur as water pollutants in the tributary area. Of the rural pollution sources, none are point sources, since there are no livestock operations in the subwatershed. The remainder of the estimated rural pollution load is contributed by other rural diffuse sources, namely storm water runoff from rural land uses and atmospheric loadings to surface waters.

Sucker Creek Subwatershed

The Sucker Creek subwatershed is a natural surface water drainage unit 10.4 square miles in areal extent located in the northeast portion of the Region. The boundaries of the basin, together with the location of the main channel of the Sucker Creek, are shown on Map 69, along with the generalized land uses as of 1975. The main stem of Sucker Creek originates in the northeast corner of Ozaukee County and discharges to Lake Michigan three miles north of the harbor in the City of Port Washington in the same county. About 93 percent of the total area of the subwatershed is still in rural land uses, with about 94 percent of this rural area in agricultural use. Most of the urban-related land use is located in the southern tip of the subwatershed. Table 100 sets forth the extent and proportion of the major land cover categories within the subwatershed as they relate to water quality conditions in 1975.

The soils within the Sucker Creek subwatershed are generally silt loams. Most of the soils are relatively fertile and produce high crop yields if managed correctly. Sediment discharges from these soils may result in high nutrient levels in stream waters.

Particularly important to comprehensive water quality management planning are the soil suitability interpretations for specified types of urban development. Based upon the interpretations of the soil properties, about 15 percent of the subwatershed is covered by soils that have severe or very severe limitations for residential development with public sanitary sewer service, as shown on Map 70, almost the entire subwatershed, or about 96 percent, is covered by soils that have severe or very severe limitations for small lot (less than one acre in size) residential development without public sanitary sewer, as shown on Map 71; and about 29 percent of the subwatershed is covered by soils that have severe or very severe limitations for large lot (one acre or larger in size) residential development without public sanitary sewer, as shown on Map 72.

Municipal and Private Sewage Treatment Facilities: In 1975, a portion of one sanitary sewerage system served a total area of about 0.03 square mile within the subwatershed, or about 0.3 percent of the total area of

Table 100

AREAL EXTENT OF WATER QUALITY-RELATED LAND COVER IN THE SUCKER CREEK SUBWATERSHED: 1975

Land Cover[a]	Square Miles	Acres	Percent
Urban			
Residential	0.09	61	0.85
Commercial[b]	0.03	22	0.30
Industrial			
Manufacturing	0.01	5	0.07
Landfills and Dumps	--	--	--
Extractive	--	--	--
Transportation			
Streets and Highways	0.17	109	1.53
Airfields	--	--	--
Railroad Yards and Terminals	--	--	--
Recreation			
Golf Courses	--	--	--
Parks and Other Recreation	--	--	--
Land Under Development			
Residential[c]	0.01	3	0.05
Commercial	--	--	--
Industrial	--	--	--
Transportation	0.43	273	3.81
Recreation	--	--	--
Rural			
Agricultural			
Small Grains	1.39	890	12.40
Hay	2.66	1,703	23.74
Row Crops	3.05	1,953	27.22
Specialty Crops	2.37	1,514	21.10
Sod Farm	--	--	--
Other Open Space[d]	0.33	210	2.92
Silvicultural			
Woodlands	0.39	250	3.49
Orchards and Nurseries	--	--	--
Natural and Man-Made Water Areas—Subject to Atmospheric Pollutant Contributions			
Ponds, Lakes, and Streams	--	--	--
Wetlands, Swamps, and Marshes	0.28	180	2.51
Total	11.21	7,173	100.00

[a] *These special land cover categories, defined primarily according to their imperviousness and vegetative cover characteristics and effects on the quality of storm water runoff, were delineated at a scale of 1" = 400' on aerial photographs taken in May 1975 and were measured to the nearest full acre, using dot-counting overlays. The total acreages measured within hydrologic subbasins were then adjusted to the control totals measured by digitizer from base maps of hydrologic subbasins at a scale of 1" = 2000'. Both the "square miles" and the "percent" shown above were then computed and rounded to the nearest hundredth (0.01) of a percent.*

[b] *Includes: retail, communication, utilities, administrative, and institutional land uses.*

[c] *Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.*

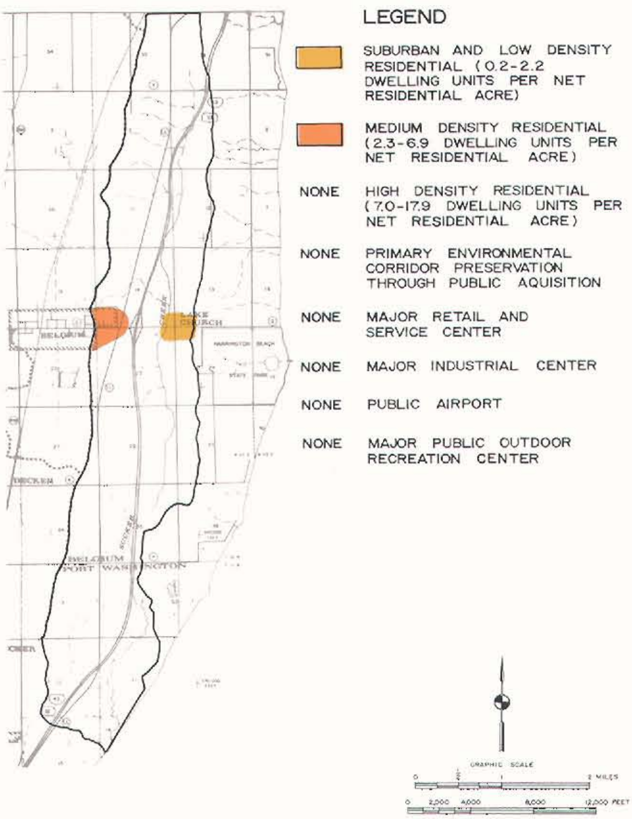
[d] *Includes: pasture, unused urban and rural lands.*

[e] *The total area of the Sucker Creek subwatershed represented in this table is different than the total area of the Sucker Creek subwatershed identified in the text and on Map 69. This is due to the fact that the area set forth on Map 69 includes only that portion of the Sucker Creek subwatershed lying within the civil boundaries that comprise the Southeastern Wisconsin Region. The area of the Sucker Creek subwatershed represented in this table represents an aggregation of subbasins, the boundaries of which do not always coincide with the civil boundaries of the Region.*

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service; County Soil and Water Conservation Districts; University of Wisconsin-Extension Service; and SEWRPC.

Map 69

THE LOCATION, BOUNDARIES, AND MAJOR STREAMS OF THE SUCKER CREEK SUBWATERSHED—SHOWING GENERALIZED LAND USES: 1975

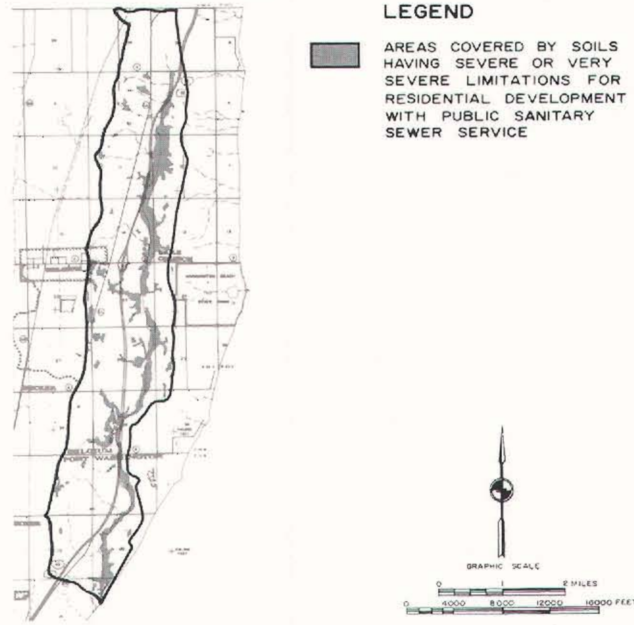


The Sucker Creek subwatershed is about 10 square miles in areal extent, or about 0.4 percent of the total area of the Region. The water quality in the subwatershed is affected by the various land uses as shown. There are no public or private wastewater treatment plants, flow relief devices, or other point sources of wastewater in the subwatershed.

Source: SEWRPC.

Map 70

SUITABILITY OF SOILS FOR RESIDENTIAL DEVELOPMENT WITH PUBLIC SANITARY SEWER SERVICE IN THE SUCKER CREEK SUBWATERSHED



Of particular importance in comprehensive water quality planning is the recognition of the limitations inherent in the soil resource base. About 15 percent of the area of the Sucker Creek subwatershed is covered with soils which are poorly suited for residential development with public sanitary sewer service or, more precisely, residential development of any kind. These soils, which include wet soils having a high water table or poor drainage, organic soils which are poorly drained and provide poor foundation support, and soils which have a flood hazard, are especially prevalent in the riverine areas of the subwatershed.

Source: U. S. Soil Conservation Service and SEWRPC.

the subwatershed, and a total population of about 100 persons, or approximately 20 percent of the total resident population of the subwatershed.

There were no municipal or private sewage treatment plants located in the Sucker Creek subwatershed as of 1975.

Sanitary Sewerage Flow Relief Points: In 1975, there were no known sanitary sewage flow relief points in the Sucker Creek subwatershed.

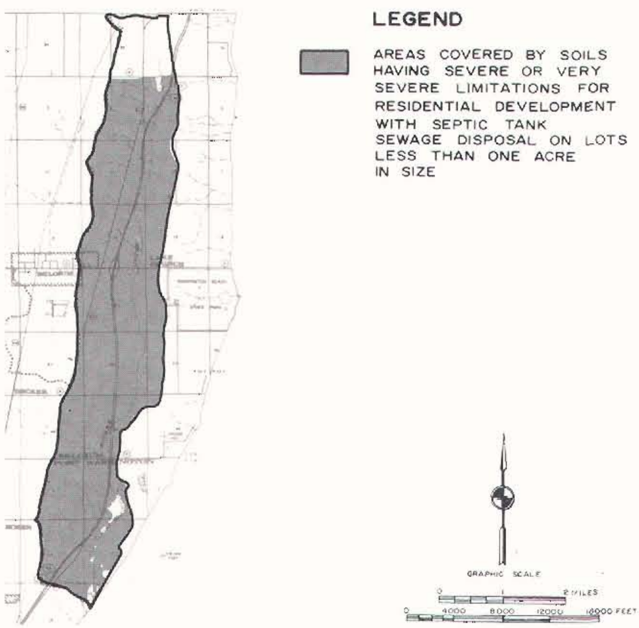
Other Known Point Sources: There were no known other point sources of pollution (industrial waste discharges) in the Sucker Creek subwatershed as of 1975.

Privately Owned Onsite Sanitary Wastewater Treatment: In addition to being provided through the centralized sanitary sewerage service within the subwatershed, sanitary wastewater treatment and disposal is provided through approximately 140 privately owned onsite sewage disposal systems, consisting of 138 septic tanks and 2 holding tanks. These systems serve a total resident population of about 500 persons, or about 80 percent of the total resident population of the subwatershed. There are no concentrated areas of urban development having at least 32 housing units in a U. S. Public Land Survey quarter section in the Sucker Creek subwatershed.

Urban Storm Water Management Systems: As noted in Table 100, land cover categories associated with urban land uses as of 1975 comprised about 500 acres, or about 7 percent of the Sucker Creek subwatershed. The most important urban land cover category was transpor-

Map 71

SUITABILITY OF SOILS FOR SMALL LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE IN THE SUCKER CREEK SUBWATERSHED

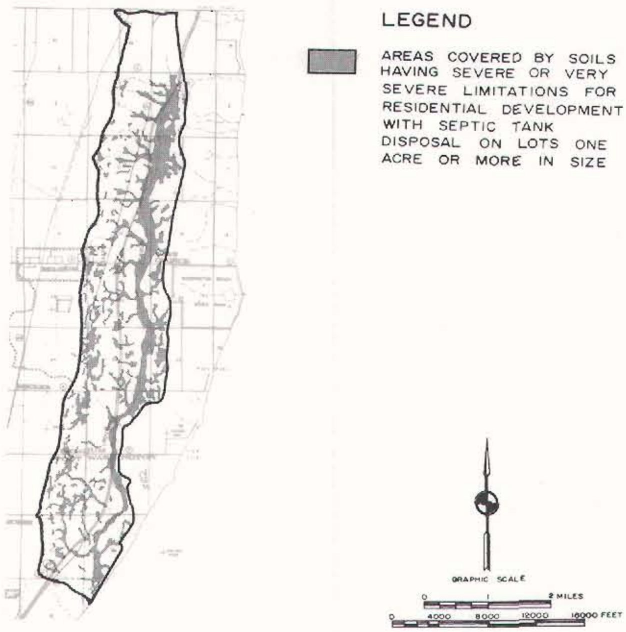


Approximately 96 percent of the area of the Sucker Creek subwatershed is covered by soils poorly suited for residential development on lots having an area smaller than one acre and not served by public sanitary sewerage facilities. Reliance on septic tank sewage disposal systems in these areas, which are covered by relatively impervious soils or are subject to seasonally high water tables, can only result in eventual malfunctioning of such systems and the consequent intensification of water pollution and public health problems in the subwatershed.

Source: SEWRPC.

Map 72

SUITABILITY OF SOILS FOR LARGE LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE IN THE SUCKER CREEK SUBWATERSHED



Approximately 29 percent of the area of the Sucker Creek subwatershed is covered by soils poorly suited for residential development on lots having an area of one acre or more and not served by public sanitary sewerage facilities. The inherent limitations of these soils for septic tank sewage disposal systems cannot be overcome simply by the provision of larger lots, and the use of such systems on these soils, which cannot absorb the sewage effluent, ultimately results in surface ponding and runoff of partially treated wastes into nearby watercourses.

Source: SEWRPC.

tation land under development because of the large area covered by IH 43, in the final stages of construction in 1975.

There were no known urban storm water drainage systems providing service to the subareas of the Sucker Creek subwatershed within the Region in 1975.

Rural Storm Water Runoff: About 6,700 acres, or 93 percent of the total area of the subwatershed, are devoted to rural land use activities. The most important rural land cover categories were row crops with 27 percent, hay with 24 percent, and specialty crops with 21 percent of the subwatershed. As of May 1975, there were an estimated 34 domestic livestock operations—operations of 25 or more equivalent animal units—having a total of 3,420 equivalent animal units within the subwatershed. Of the 34 operations, 20, or 59 percent, were located within 500 feet of the surface water system of the subwatershed.

Pollution Loadings: A summary of the estimated average annual pollution loadings in the Sucker Creek subwatershed is presented in Table 101 and depicted in Figure 37. Urban sources of pollution are estimated to contribute 11 percent of the nitrogen, 35 percent of the phosphorus, 16 percent of the biochemical oxgen demand, 3 percent of the fecal coliform, and 55 percent of the sediment which occur as water pollutants in the Sucker Creek subwatershed. Urban sources of pollution are estimated to consist entirely of diffuse sources—including the estimated septic tank and construction-related contributions in the drainage area—since there are no known point sources of pollution in the drainage area.

Table 101

SUMMARY OF ESTIMATED AVERAGE ANNUAL POLLUTANT LOADINGS IN THE SUCKER CREEK SUBWATERSHED: 1975

Source	Extent[a]	Parameter	Loads[b] Average Year Total Estimated Loading	Percent
Urban Point Sources				
Municipal Sewage Treatment Plants	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Private Sewage Treatment Plants	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Combined Sewer Overflow	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Industrial Discharges	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Sanitary Sewer Flow Relief Devices	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Urban Point Source Totals		Total Nitrogen	0.0	0.0
		Total Phosphorus	0.0	0.0
		Biochemical Oxygen Demand	0.0	0.0
		Fecal Coliform	0.0	0.0
		Sediment	0.0	0.0
Urban Diffuse Sources				
Residential	61	Total Nitrogen	240.0	0.1
	61	Total Phosphorus	20.0	0.1
	61	Biochemical Oxygen Demand	1,480.0	0.3
	61	Fecal Coliform	9,760.0	0.0
	61	Sediment	15.0	0.0
Commercial	22	Total Nitrogen	200.0	0.1
	22	Total Phosphorus	20.0	0.1
	22	Biochemical Oxygen Demand	2,150.0	0.4
	22	Fecal Coliform	7,260.0	0.0
	22	Sediment	10.0	0.0
Industrial	5	Total Nitrogen	40.0	0.0
	5	Total Phosphorus	0.0	0.0
	5	Biochemical Oxygen Demand	180.0	0.0
	5	Fecal Coliform	3,100.0	0.0
	5	Sediment	0.0	0.0
Extractive	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Transportation	109	Total Nitrogen	2,550.0	1.2
	109	Total Phosphorus	150.0	0.4
	109	Biochemical Oxygen Demand	17,330.0	3.0
	109	Fecal Coliform	73,030.0	0.3
	109	Sediment	2,320.0	5.5
Recreation	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Construction	276	Total Nitrogen	16,560.0	8.0
	276	Total Phosphorus	12,420.0	32.3
	276	Biochemical Oxygen Demand	33,120.0	5.7
	276	Fecal Coliform	0.0	0.0
	276	Sediment	20,700.0	48.9
Septic Systems	476	Total Nitrogen	2,710.0	1.3
	476	Total Phosphorus	630.0	1.6
	476	Biochemical Oxygen Demand	38,840.0	6.6
	476	Fecal Coliform	476,000.0	2.1
	476	Sediment	5.0	0.0
Urban Diffuse Source Totals		Total Nitrogen	22,300.0	10.8
		Total Phosphorus	13,240.0	34.5
		Biochemical Oxygen Demand	93,100.0	15.9
		Fecal Coliform	569,150.0	2.5
		Sediment	23,050.0	54.5
Urban Source Totals		Total Nitrogen	22,300.0	10.8
		Total Phosphorus	13,240.0	34.5
		Biochemical Oxygen Demand	93,100.0	15.9
		Fecal Coliform	569,150.0	2.5
		Sediment	23,050.0	54.5
Rural Diffuse Sources				
Livestock Operations	3420	Total Nitrogen	97,130.0	47.0
	3420	Total Phosphorus	22,570.0	58.8
	3420	Biochemical Oxygen Demand	380,300.0	65.1
	3420	Fecal Coliform	21,888,000.0	97.5
	3420	Sediment	1,195.0	2.8
Cropland, Pasture and Unused Rural Land	6270	Total Nitrogen	86,770.0	42.0
	6270	Total Phosphorus	2,550.0	6.6
	6270	Biochemical Oxygen Demand	109,650.0	18.8
	6270	Fecal Coliform	0.0	0.0
	6270	Sediment	18,015.0	42.6
Silvicultural	250	Total Nitrogen	580.0	0.3
	250	Total Phosphorus	40.0	0.1
	250	Biochemical Oxygen Demand	1,150.0	0.2
	250	Fecal Coliform	1,650.0	0.0
	250	Sediment	30.0	0.1
Rural Diffuse Source Totals		Total Nitrogen	184,480.0	89.2
		Total Phosphorus	25,160.0	65.5
		Biochemical Oxygen Demand	491,100.0	84.1
		Fecal Coliform	21,889,650.0	97.5
		Sediment	19,240.0	45.5
Diffuse Source Totals		Total Nitrogen	206,780.0	100.0
		Total Phosphorus	38,400.0	100.0
		Biochemical Oxygen Demand	584,200.0	100.0
		Fecal Coliform	22,458,800.0	100.0
		Sediment	42,290.0	100.0
Total Sources		Total Nitrogen	206,780.0	100.0
		Total Phosphorus	38,400.0	100.0
		Biochemical Oxygen Demand	584,200.0	100.0
		Fecal Coliform	22,458,800.0	100.0
		Sediment	42,290.0	100.0

[a] *Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.*

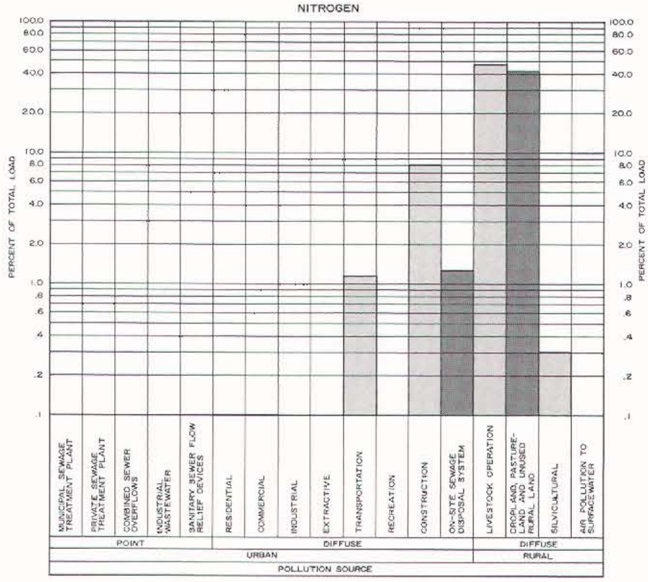
[b] *Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year.*

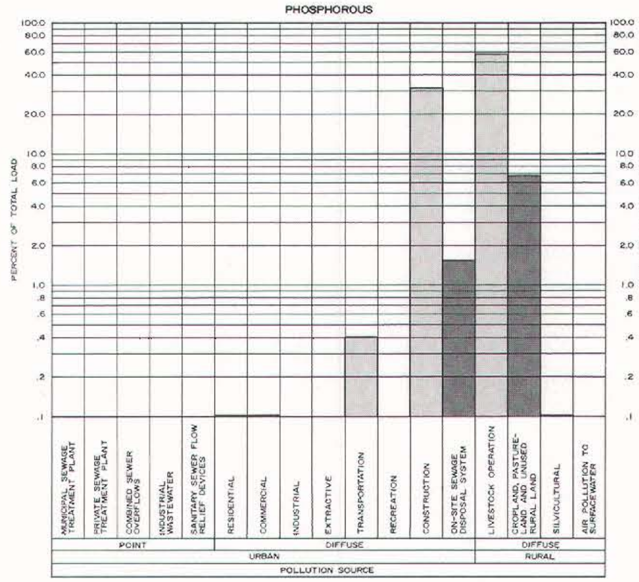
Source: SEWRPC.

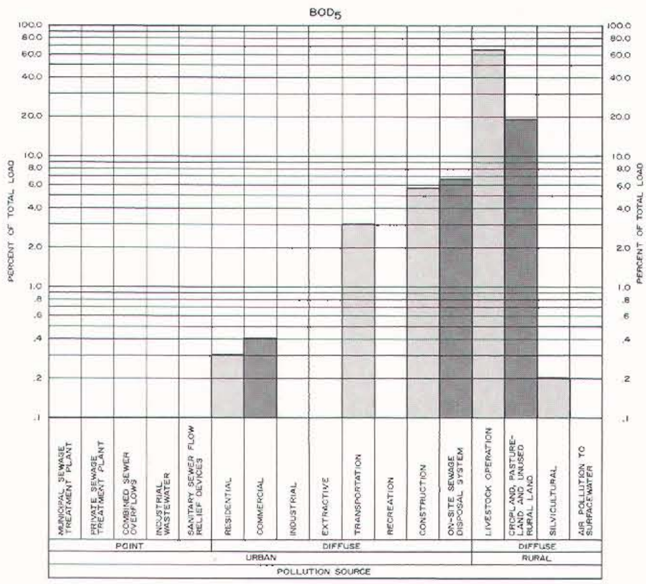
Of the total pollutant loads, rural pollution sources are estimated to contribute the remaining 89 percent of the nitrogen, 65 percent of the phosphorus, 84 percent of the biochemical oxygen demand, 97 percent of the fecal coliform, and 45 percent of the sediment which occur as water pollutants in the subwatershed. Of the rural pollution sources, none are point sources, since none of the livestock operations in the subwatershed are of sufficient size to fall within the definition used in this report. Other livestock feeding operations—inclusive of the disposal of manure on croplands—are estimated to contribute 53 percent of the nitrogen, 90 percent of the phosphorus, 77 percent of the biochemical oxygen demand, all of the fecal coliform, and 6 percent of the sediment from rural sources. The remainder of the estimated rural pollution load, or 47 percent of the nitrogen, 10 percent of the phosphorus, 23 percent of the biochemical oxygen demand, essentially none of the fecal coliform, and 94 percent of the sediment, are contributed by other rural diffuse sources, namely storm water runoff from rural land uses and atmospheric loadings to surface waters.

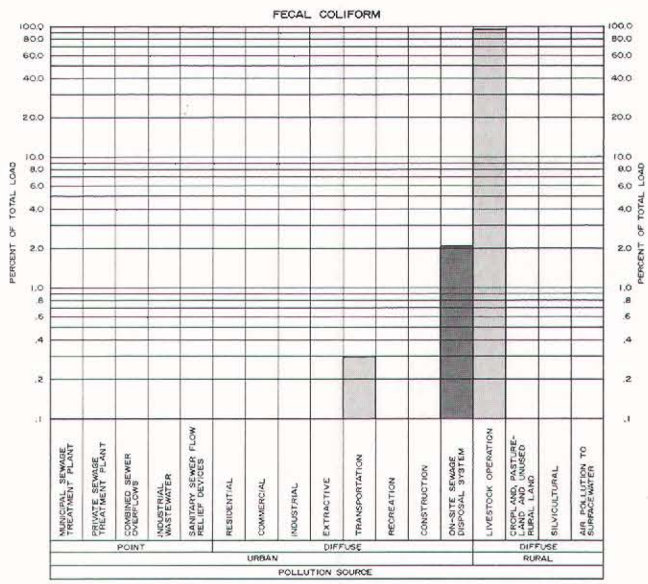
Figure 37

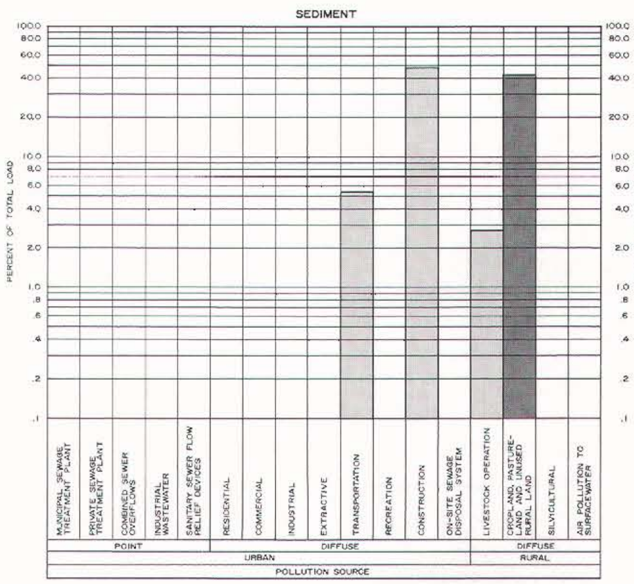
SUMMARY OF ESTIMATED AVERAGE ANNUAL POLLUTANT LOADINGS IN THE SUCKER CREEK SUBWATERSHED: 1975











Source: SEWRPC.

OAK CREEK WATERSHED

The Oak Creek watershed is a natural surface water drainage unit 26.3 square miles in areal extent located in the east central portion of the Region. The boundaries of the basin, together with the locations of the main channels of Oak Creek and its principal tributaries, are shown on Map 73, along with the locations of the known point sources of pollution and the generalized land uses as of 1975. The main stem of the Oak Creek originates in the City of Franklin and discharges to Lake Michigan at Grant Park in the City of South Milwaukee. About 57 percent of the total area of the watershed is still in rural land uses, with about 88 percent of this rural area in agricultural use. Most of the agricultural-related land use is located in the western and southern portions of the watershed. Table 102 sets forth the extent and proportion of the major land cover categories within the watershed as they relate to water quality conditions in 1975.

The soils within the Oak Creek watershed are silty clay loams, loams, and sandy loams, and are developed on glacial till on gently sloping or rolling morainal topography. Most of the soils are relatively fertile and produce high crop yields if managed correctly. Sediment discharges from these soils may result in high nutrient levels in stream waters.

Particularly important to comprehensive water quality management planning are the soil suitability interpretations for specified types of urban development. It must be noted that soils data are lacking for a negligible portion of the watershed and therefore all soils interpretations, although basically correct, must be considered to be estimates. Based upon the interpretations of the soil properties, about 13 percent of the watershed is covered by soils that have severe or very severe limitations for residential development with public sanitary sewer service as shown on Map 74; about 93 percent of the watershed is covered by soils that have severe or very severe limitations for small lot (less than one acre in size) residential development without public sanitary sewer, as shown on Map 75; and about 49 percent of the watershed is covered by soils that have severe or very severe limitations for large lot (one acre or larger in size) residential development, as shown on Map 76.

Municipal and Private Sewage Treatment Facilities

In 1975 a total of six sanitary sewerage systems or portions thereof served a total area of about 17.1 square miles within the watershed, or about 65 percent of the total area of the watershed, and a total population of about 38,300 persons, or approximately 97 percent of the total resident population of the watershed. There are no publicly or privately owned sewage treatment plants discharging to the stream system of the watershed.

Sanitary Sewerage System Flow Relief Points

In 1975 there were two known sanitary sewer flow relief devices in the watershed, as listed in Table 103

Table 102

AREAL EXTENT OF WATER QUALITY-RELATED LAND COVER IN THE OAK CREEK WATERSHED: 1975

Land Cover[a]	Square Miles	Acres	Percent
Urban			
Residential	5.48	3,508	20.83
Commercial[b]	1.03	661	3.92
Industrial			
Manufacturing	0.96	614	3.64
Landfills and Dumps	0.03	20	0.12
Extractive	0.09	55	0.33
Transportation			
Streets and Highways	0.73	465	2.76
Airfields	0.77	493	2.93
Railroad Yards and Terminals	--	--	--
Recreation			
Golf Courses	0.15	98	0.58
Parks and Other Recreation	1.10	703	4.17
Land Under Development			
Residential[c]	0.96	614	3.65
Commercial	--	--	--
Industrial	0.02	12	0.07
Transportation	--	--	--
Recreation	--	--	--
Rural			
Agricultural			
Small Grains	1.64	1,047	6.22
Hay	1.30	832	4.94
Row Crops	3.92	2,509	14.89
Specialty Crops	0.59	378	2.25
Sod Farm	0.10	64	0.38
Other Open Space[d]	5.62	3,596	21.35
Silvicultural			
Woodlands	0.82	521	3.09
Orchards and Nurseries	0.24	155	0.92
Natural and Man-Made Water Areas—Subject to Atmospheric Pollutant Contributions			
Ponds, Lakes, and Streams	0.03	19	0.12
Wetlands, Swamps, and Marshes	0.75	478	2.83
Total	26.33	16,842	100.00

[a] These special land cover categories, defined primarily according to their imperviousness and vegetative cover characteristics and effects on the quality of storm water runoff, were delineated at a scale of 1" = 400' on aerial photographs taken in May 1975 and were measured to the nearest full acre, using dot-counting overlays. The total acreages measured within hydrologic subbasins were then adjusted to the control totals measured by digitizer from base maps of hydrologic subbasins at a scale of 1" = 2000'. Both the "square miles" and the "percent" shown above were then computed and rounded to the nearest hundredth (0.01) of a percent.

[b] Includes: retail, communication, utilities, administrative, and institutional land uses.

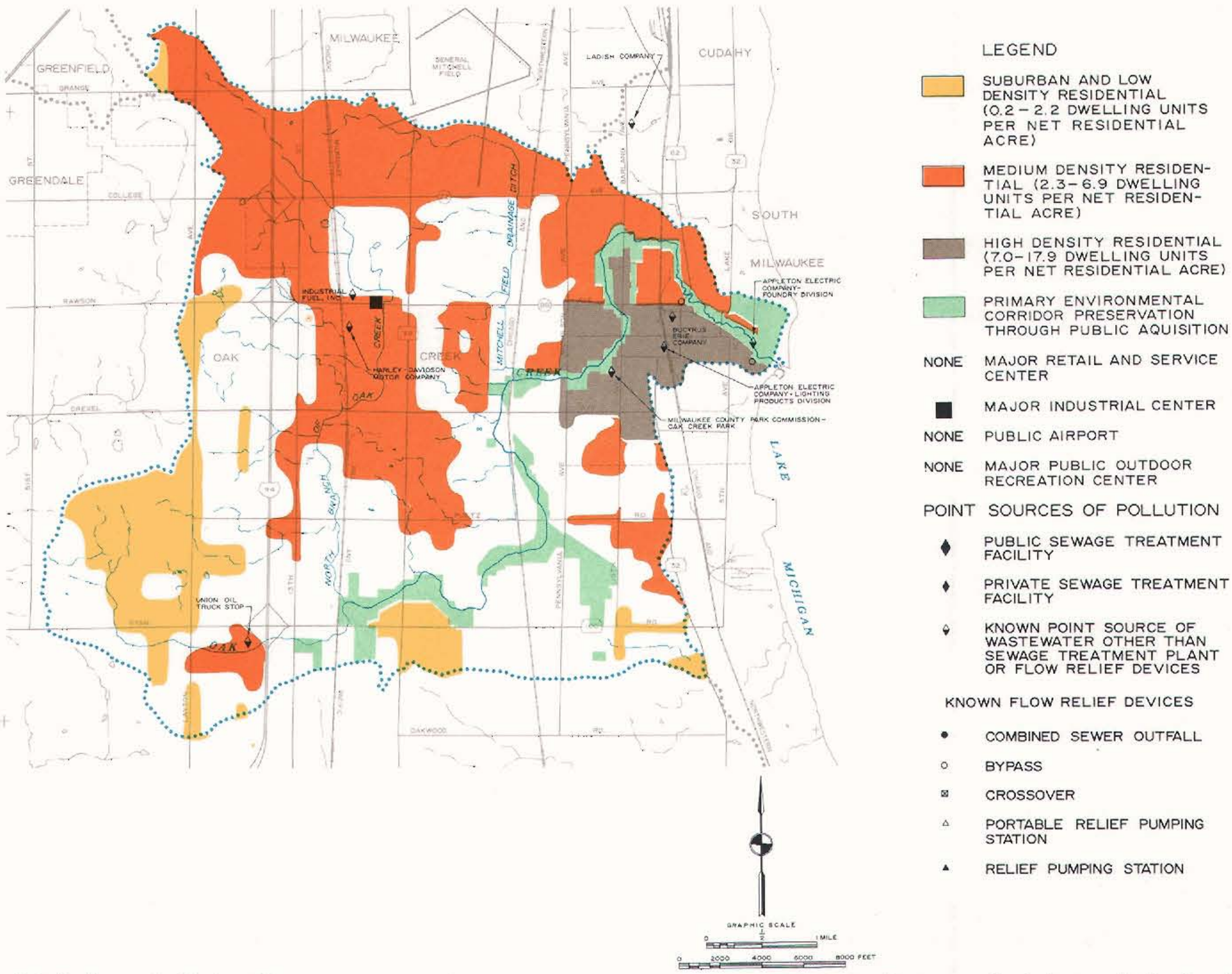
[c] Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.

[d] Includes: pasture, unused urban and rural lands.

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service; County Soil and Water Conservation Districts; University of Wisconsin-Extension Service; and SEWRPC.

Map 73

THE LOCATION, BOUNDARIES, AND MAJOR STREAMS OF THE OAK CREEK WATERSHED— SHOWING POINT SOURCES OF POLLUTION AND GENERALIZED LAND USES: 1975



The Oak Creek watershed is about 26 square miles in areal extent, or about 1 percent of the total area of the Region. The water quality in the watershed is affected by the various land uses as well as by the two flow relief devices and eight other point sources of wastewater as shown.

Source: SEWRPC.

Table 103

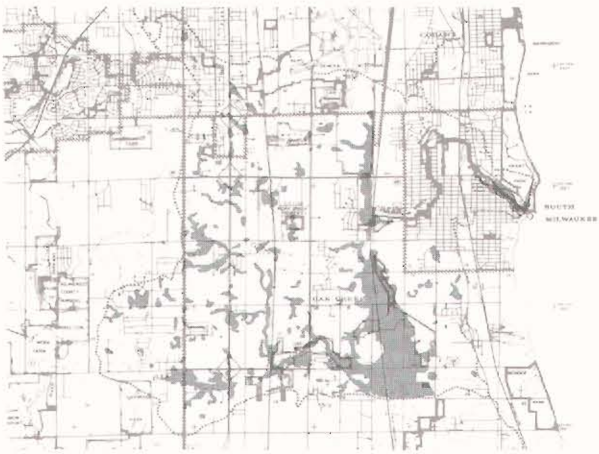
KNOWN SANITARY SEWERAGE SYSTEM FLOW RELIEF DEVICES IN THE OAK CREEK WATERSHED BY RECEIVING STREAM AND CIVIL DIVISION: 1975

Receiving Stream	Civil Division	Combined Sewer Outfalls	Other Flow Relief Devices				
			Crossovers	Bypasses	Relief Pumping Stations	Portable Pumping Stations	Total
Oak Creek	City of South Milwaukee	0	0	2	0	0	2
Total		0	0	2	0	0	2

Source: SEWRPC.

Map 74

SUITABILITY OF SOILS FOR RESIDENTIAL DEVELOPMENT WITH PUBLIC SANITARY SEWER SERVICE IN THE OAK CREEK WATERSHED



LEGEND

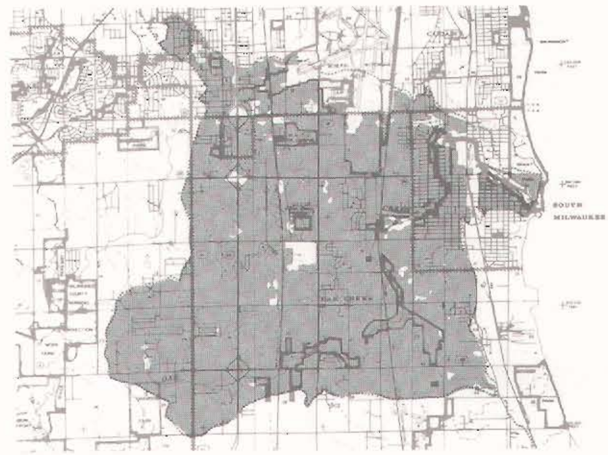
AREAS COVERED BY SOILS HAVING SEVERE OR VERY SEVERE LIMITATIONS FOR RESIDENTIAL DEVELOPMENT WITH PUBLIC SANITARY SEWER SERVICE

Of particular importance in comprehensive water quality planning is the recognition of the limitations inherent in the soil resource base. About 13 percent of the area of the Oak Creek watershed is covered with soils which are poorly suited for residential development with public sanitary sewer service or, more precisely, residential development of any kind. These soils, which include wet soils having a high water table or poor drainage, organic soils which are poorly drained and provide poor foundation support, and soils which have a flood hazard, are especially prevalent in the riverine areas of the watershed.

Source: U. S. Soil Conservation Service and SEWRPC.

Map 75

SUITABILITY OF SOILS FOR SMALL LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE IN THE OAK CREEK WATERSHED



LEGEND

AREAS COVERED BY SOILS HAVING SEVERE OR VERY SEVERE LIMITATIONS FOR RESIDENTIAL DEVELOPMENT WITH SEPTIC TANK SEWAGE DISPOSAL ON LOTS LESS THAN ONE ACRE IN SIZE

Approximately 93 percent of the area of the Oak Creek watershed is covered by soils poorly suited for residential development on lots having an area smaller than one acre and not served by public sanitary sewerage facilities. Reliance on septic tank sewage disposal systems in these areas, which are covered by relatively impervious soils or are subject to seasonally high water tables, can only result in eventual malfunctioning of such systems and the consequent intensification of water pollution and public health problems in the watershed.

Source: U. S. Soil Conservation Service and SEWRPC.

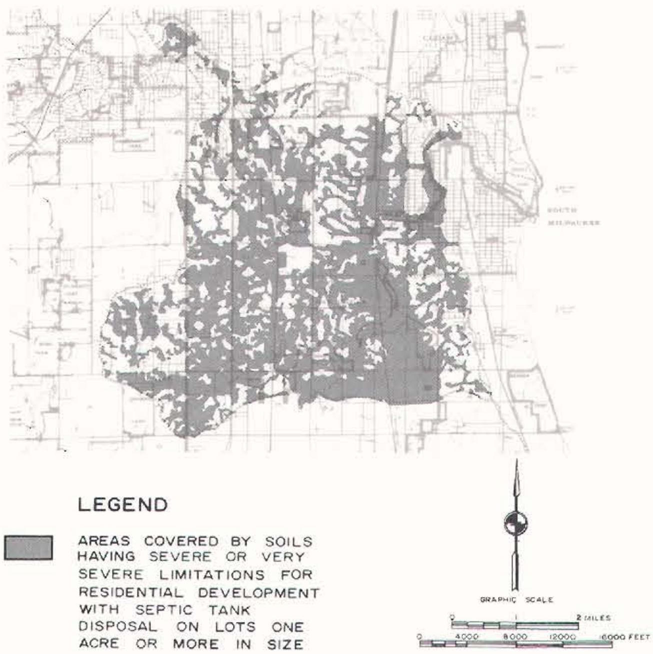
and shown on Map 73. Both of the known sanitary sewer flow relief devices were sanitary sewerage system bypasses which discharge directly to the main stem of the Oak Creek.

Other Known Point Sources

A total of eight other known point sources of pollution were identified in the watershed in 1975. These other point sources consisted primarily of 13 outfalls through which industrial cooling and process wastewaters were discharged directly or indirectly to the surface water system. Of these six were identified as discharging only cooling water. The remaining seven were discharging other types of wastewaters. Industrial wastewater enters Oak Creek and its major tributaries directly through industrial waste outfalls or indirectly through drainage ditches and storm sewers. Table 104 summarizes by receiving stream and civil division the characteristics of these other point sources, and Map 73 shows their locations. Four of these other point source outfalls discharge wastewater directly to Oak Creek and seven of the industrial outfalls discharge indirectly to Oak Creek. The remaining two outfalls discharge indirectly to the North Branch of Oak Creek.

Map 76

SUITABILITY OF SOILS FOR LARGE LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE IN THE OAK CREEK WATERSHED



Approximately 49 percent of the area of the Oak Creek watershed is covered by soils poorly suited for residential development on lots having an area of one acre or more and not served by public sanitary sewerage facilities. The inherent limitations of these soils for septic tank sewage disposal systems cannot be overcome simply by the provision of larger lots, and the use of such systems on these soils, which cannot absorb the sewage effluent, ultimately results in surface ponding and runoff of partially treated wastes into nearby watercourses.

***Source:** U. S. Soil Conservation Service and SEWRPC.*

Privately Owned Onsite Sanitary Wastewater Treatment

In addition to being provided through centralized sanitary sewerage service within the watershed, sanitary wastewater treatment and disposal is provided through approximately 309 privately owned onsite sewage disposal systems consisting of 308 septic tanks, 1 holding tank, and no mound systems. These systems serve a total resident population of about 1,200 persons, or about 3 percent, of the total resident population of the watershed. Of this total, about 500 persons, or 42 percent, resided in concentrated areas of urban development having at least 32 housing units in a U. S. Public Land Survey quarter section. These scattered quarter sections of urban land use concentration totaled about 0.7 square mile of urban land use, or about 3 percent of the total area of the watershed.

Urban Storm Water Management Systems

As noted in Table 102, land cover categories associated with urban land uses as of 1975 comprised 7,200 acres, or about 43 percent of the Oak Creek watershed. The most important urban land cover category was residential land, with about 21 percent of the total watershed area.

There were a total of four known urban storm water drainage systems providing service to the subareas of the Oak Creek watershed within the Region in 1975. These include the systems operated by the Cities of Franklin, Milwaukee, Oak Creek, and South Milwaukee. Together, the four storm water drainage systems have a tributary drainage area of about 9.7 square miles, or about 37 percent of the total area of the watershed. Included within this storm water drainage area are a total of 85 known storm water outfalls ranging in size from 12 to 78 inches in diameter. There were no known storm water pumping facilities or storm water storage facilities in the watershed. The total annual average discharge from these outfalls is estimated to be about 1,133 million gallons per year occurring on the average in 70 events.

Rural Storm Water Runoff

About 9,600 acres, or 57 percent of the total area of the watershed, are devoted to rural land use activities. The most important rural land cover categories comprising more than 5 percent of the watershed area were row crops with 15 percent, hay with 5 percent, other open space with 21 percent, and small grains with 6 percent of the watershed. As of May 1975, there were an estimated two domestic livestock operations—operations of 25 or more equivalent animal units—having a total of about 110 equivalent animal units within the watershed. Of the two operations, one was located within 500 feet of the surface water system of the watershed.

Pollution Loadings

A summary of the estimated average annual pollution loadings in the Oak Creek watershed is presented in Table 105 and depicted in Figure 38. Urban sources of pollution are estimated to contribute 51 percent of the nitrogen, 90 percent of the phosphorus, 79 percent of the biochemical oxygen demand, 79 percent of the fecal coliform, and 82 percent of the sediment which occur as water pollutants in the Oak Creek watershed. Of the urban contribution, point sources of pollution are estimated to contribute 5 percent of the nitrogen, 3 percent of the phosphorus, 7 percent of the biochemical oxygen demand, none of the fecal coliform, and almost no sediment. Diffuse sources—including the estimated septic tank and construction-related contributions in the drainage area—account for the remaining 95 percent of the nitrogen, 97 percent of the phosphorus, 93 percent of the biochemical oxygen demand, all of the fecal coliform, and almost all of the sediment contributed from urban sources.

Table 104

CHARACTERISTICS OF OTHER KNOWN POINT SOURCES OF WATER POLLUTION IN THE OAK CREEK WATERSHED: 1975

Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average Annual Hydraulic Discharge Rate (gallons per day)[a]	Reported Maximum Monthly Hydraulic Discharge Rate (gallons per day)[a]
MILWAUKEE COUNTY								
Appleton Electric Company—Lighting Products Division	3643	City of South Milwaukee	Process	None	1	Oak Creek via Storm Sewer	22,600	28,800
			Process	None	3	Oak Creek via Storm Sewer	11,500	14,000
Appleton Electric Company—Foundry Division	3679	City of South Milwaukee	Cooling	None	1	Oak Creek	66,000	84,000
Bucyrus Erie Company	3532	City of South Milwaukee	Cooling	None	1	Oak Creek via Storm Sewer	42,200	78,000
			Cooling	None	2	Oak Creek via Storm Sewer	117,000	162,500
			Process and Cooling	None	3	Oak Creek	136,600	300,000
			Process and Cooling	None	5	Oak Creek	468,400	590,000
Harley-Davidson Motor Company	3751	City of Oak Creek	Cooling	N/A	1	Tributary of North Branch Oak Creek via Storm Sewer	4,400	7,500
Industrial Fuel, Inc.	5093	City of Oak Creek	Process	Holding Pond	1	North Branch Oak Creek via Storm Sewer	600	600
Ladish Company	3462	City of Cudahy	Cooling	N/A	1	Oak Creek via Storm Sewer	585,000	1,585,000
			Cooling	N/A	12	Oak Creek via Storm Sewer	171,000	1,013,000
Milwaukee County Park Commission—Oak Creek Park	7032	City of South Milwaukee	Swimming Pool Overflow	None	1	Oak Creek via Storm Sewer	Intermittent	Intermittent
Union Oil Truck Stop	5541	City of Oak Creek	Runoff	Oil Separator	1	Oak Creek	Intermittent	Intermittent

NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data were obtained, in order of priority, from: quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System or under Section 101 of the Wisconsin Administrative Code or from the Wisconsin Pollutant Discharge Elimination System permit itself. In some cases when 12 months of flow data were not reported, the average annual and maximum monthly hydraulic discharge rates were estimated from the available monthly discharge data or from the flow data as reported in the permit.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Of the total pollutant loads, rural pollution sources are estimated to contribute the remaining 49 percent of the nitrogen, 10 percent of the phosphorus, 21 percent of the biochemical oxygen demand, 21 percent of the fecal coliform, and 18 percent of the sediment which occur as water pollutants in the watershed. Livestock feeding operations—inclusive of the disposal of manure on croplands—are estimated to contribute 3 percent of the nitrogen, 19 percent of the phosphorus, 9 percent of the biochemical oxygen demand, 99 percent of the fecal coliform, and almost no sediment from rural sources. The remainder of the estimated rural pollution load, or 97 percent of the nitrogen, 81 percent of the phosphorus, 91 percent of the biochemical oxygen demand, 1 percent of the fecal coliform, and almost all of the sediment, are contributed by other rural diffuse sources, namely storm water runoff from rural land uses and atmospheric loadings to surface waters.

Table 105

SUMMARY OF ESTIMATED AVERAGE ANNUAL POLLUTANT LOADINGS IN THE OAK CREEK WATERSHED: 1975

Source	Extent[a]	Parameter	Loads[b] Average Year Total Estimated Loading	Percent
Urban Point Sources				
Municipal Sewage Treatment Plants . .	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Private Sewage Treatment Plants	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Combined Sewer Overflow	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Industrial Discharges	8	Total Nitrogen	4,920.0	2.6
	8	Total Phosphorus	930.0	2.3
	8	Biochemical Oxygen Demand	36,300.0	5.8
	8	Fecal Coliform	0.0	0.0
	8	Sediment	55.0	0.1
Sanitary Sewer Flow Relief Devices . .	2	Total Nitrogen	0.0	0.0
	2	Total Phosphorus	0.0	0.0
	2	Biochemical Oxygen Demand	0.0	0.0
	2	Fecal Coliform	0.0	0.0
	2	Sediment	0.0	0.0
Urban Point Source Totals		Total Nitrogen	4,920.0	2.6
		Total Phosphorus	930.0	2.3
		Biochemical Oxygen Demand	36,300.0	5.8
		Fecal Coliform	0.0	0.0
		Sediment	55.0	0.1
Urban Diffuse Sources				
Residential	3508	Total Nitrogen	14,030.0	7.3
	3508	Total Phosphorus	1,120.0	2.7
	3508	Biochemical Oxygen Demand	85,240.0	13.6
	3508	Fecal Coliform	561,280.0	16.5
	3508	Sediment	955.0	1.2
Commercial	661	Total Nitrogen	5,950.0	3.1
	661	Total Phosphorus	500.0	1.2
	661	Biochemical Oxygen Demand	64,510.0	10.3
	661	Fecal Coliform	218,130.0	6.4
	661	Sediment	245.0	0.3
Industrial	634	Total Nitrogen	5,330.0	2.8
	634	Total Phosphorus	440.0	1.1
	634	Biochemical Oxygen Demand	23,390.0	3.7
	634	Fecal Coliform	393,080.0	11.6
	634	Sediment	310.0	0.4
Extractive	55	Total Nitrogen	3,300.0	1.7
	55	Total Phosphorus	2,480.0	6.0
	55	Biochemical Oxygen Demand	6,600.0	1.0
	55	Fecal Coliform	0.0	0.0
	55	Sediment	4,125.0	5.3
Transportation	958	Total Nitrogen	17,540.0	9.2
	958	Total Phosphorus	1,930.0	4.7
	958	Biochemical Oxygen Demand	109,920.0	17.5
	958	Fecal Coliform	311,550.0	9.2
	958	Sediment	10,620.0	13.7
Recreation	801	Total Nitrogen	2,050.0	1.1
	801	Total Phosphorus	60.0	0.1
	801	Biochemical Oxygen Demand	1,040.0	0.2
	801	Fecal Coliform	25,308.0	0.7
	801	Sediment	170.0	0.2
Construction	626	Total Nitrogen	37,560.0	19.6
	626	Total Phosphorus	28,170.0	68.5
	626	Biochemical Oxygen Demand	75,120.0	11.9
	626	Fecal Coliform	0.0	0.0
	626	Sediment	46,950.0	60.8
Septic Systems	1175	Total Nitrogen	6,700.0	3.5
	1175	Total Phosphorus	1,550.0	3.8
	1175	Biochemical Oxygen Demand	95,880.0	15.2
	1175	Fecal Coliform	1,175,000.0	34.6
	1175	Sediment	15.0	0.0
Urban Diffuse Source Totals		Total Nitrogen	92,460.0	48.4
		Total Phosphorus	36,250.0	88.2
		Biochemical Oxygen Demand	461,700.0	73.4
		Fecal Coliform	2,684,348.0	79.1
		Sediment	63,390.0	82.0
Urban Source Totals		Total Nitrogen	97,380.0	50.9
		Total Phosphorus	37,180.0	90.4
		Biochemical Oxygen Demand	498,000.0	79.2
		Fecal Coliform	2,684,348.0	79.1
		Sediment	63,445.0	82.1
Rural Diffuse Sources				
Livestock Operations	110	Total Nitrogen	3,120.0	1.6
	110	Total Phosphorus	730.0	1.8
	110	Biochemical Oxygen Demand	12,230.0	1.9
	110	Fecal Coliform	704,000.0	20.7
	110	Sediment	40.0	0.1
Cropland, Pasture, and Unused Rural Land	8426	Total Nitrogen	88,960.0	46.5
	8426	Total Phosphorus	3,110.0	7.6
	8426	Biochemical Oxygen Demand	112,320.0	17.9
	8426	Fecal Coliform	0.0	0.0
	8426	Sediment	13,705.0	17.7
Silvicultural	676	Total Nitrogen	1,550.0	0.8
	676	Total Phosphorus	90.0	0.2
	676	Biochemical Oxygen Demand	3,110.0	0.5
	676	Fecal Coliform	4,461.6	0.1
	676	Sediment	85.0	0.1
Air Pollution to Surface Water	19	Total Nitrogen	170.0	0.1
	19	Total Phosphorus	10.0	0.0
	19	Biochemical Oxygen Demand	3,080.0	0.5
	19	Fecal Coliform	0.0	0.0
	19	Sediment	5.0	0.0
Rural Diffuse Source Totals		Total Nitrogen	93,800.0	49.1
		Total Phosphorus	3,940.0	9.6
		Biochemical Oxygen Demand	130,740.0	20.8
		Fecal Coliform	708,461.6	20.9
		Sediment	13,835.0	17.9
Diffuse Source Totals		Total Nitrogen	186,260.0	97.4
		Total Phosphorus	40,190.0	97.7
		Biochemical Oxygen Demand	592,440.0	94.2
		Fecal Coliform	3,392,809.6	100.0
		Sediment	77,225.0	99.9
Total Sources		Total Nitrogen	191,180.0	100.0
		Total Phosphorus	41,120.0	100.0
		Biochemical Oxygen Demand	628,740.0	100.0
		Fecal Coliform	3,392,809.6	100.0
		Sediment	77,280.0	100.0

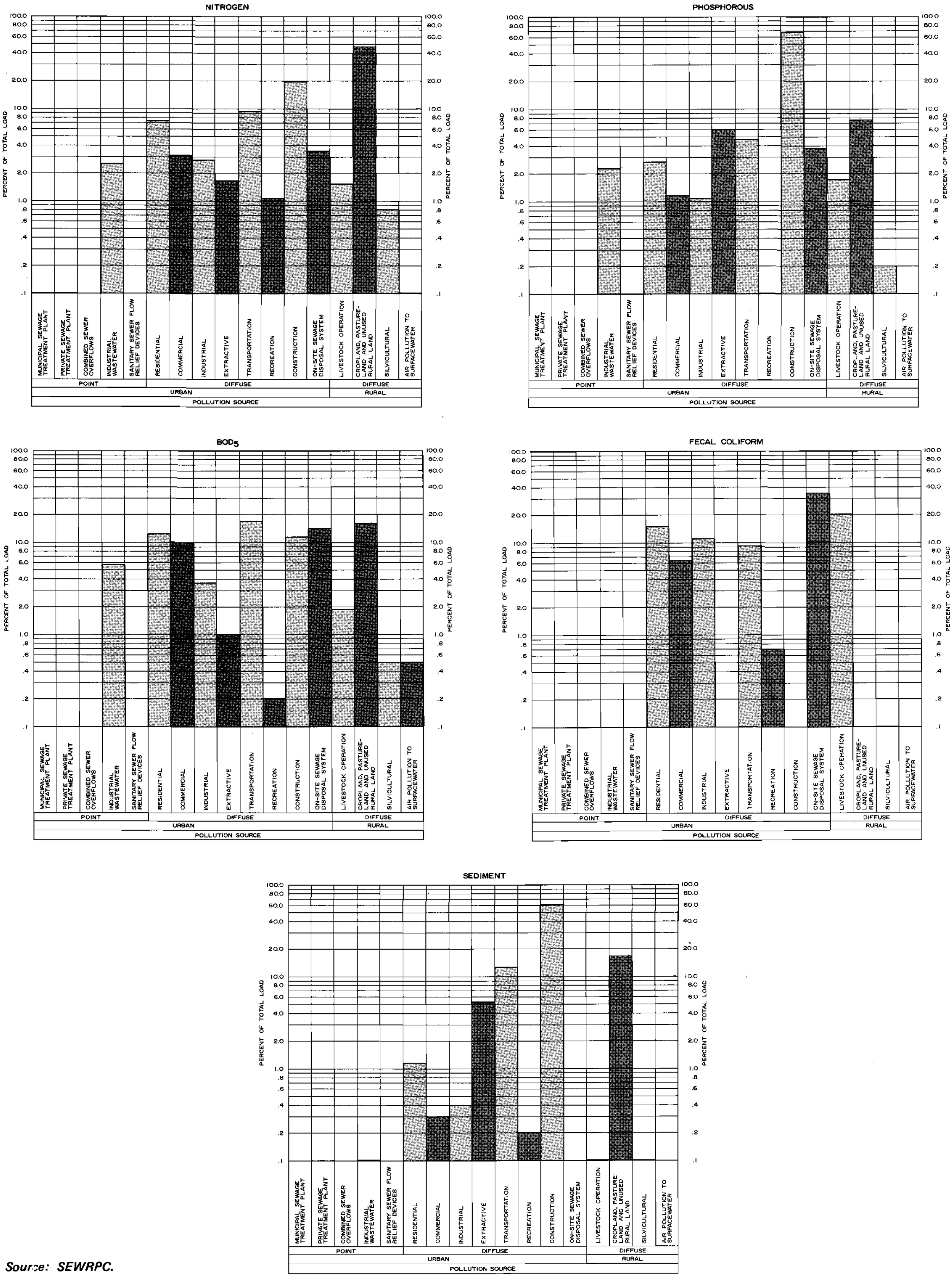
[a] *Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.*

[b] *Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year.*

Source: SEWRPC.

Figure 38

SUMMARY OF ESTIMATED AVERAGE ANNUAL POLLUTANT LOADINGS IN THE OAK CREEK WATERSHED: 1975



Source: SEWRPC.

PIKE RIVER WATERSHED

The Pike River watershed is a natural surface water drainage unit about 50.7 square miles in areal extent located in the southeastern portion of the Region. The boundaries of the basin, together with the locations of the main channels of the Pike River and its principal tributaries, are shown on Map 77, along with the locations of the known point sources of pollution and the generalized land uses as of 1975. The main stem of the Pike River rises in southeastern Racine County two miles north of the Village of Sturtevant and flows easterly and southerly through the northern part of the City of Kenosha to Lake Michigan. About 80 percent of the total area of the watershed is still in rural land uses, with about 92 percent of this rural area in agricultural use. Most of the urban-related land uses are located in the north-central and eastern portions of the watershed. Table 106 sets forth the extent and proportion of the major land cover categories within the watershed as they relate to water quality conditions in 1975.

The soils within the Pike River watershed consist of deep to moderately deep silt loams. Most of the soils are relatively fertile and produce high crop yields if managed correctly. Sediment discharges from these soils may result in high nutrient levels in stream waters.

Particularly important to comprehensive water quality management planning are the soil suitability interpretations for specified types of urban development. Based upon the interpretations of the soil properties, about 25 percent of the watershed is covered by soils that have severe or very severe limitations for residential development with public sanitary sewer service as shown on Map 78; approximately all of the watershed, or about 95 percent, is covered by soils that have severe or very severe limitations for small lot (less than one acre in size) residential development without public sanitary sewer, as shown on Map 79; and about 51 percent of the watershed is covered by soils that have severe or very severe limitations for large lot (one acre or larger in size) residential development, as shown on Map 80.

Municipal and Private Sewage Treatment Facilities

In 1975, a total of seven sanitary sewerage systems or portions thereof served a total area of about 9.6 square miles within the watershed, or about 19 percent of the total area of the watershed, and a total population of about 23,600 persons, or approximately 85 percent of the total resident population of the watershed.

Two municipally owned sewage treatment plants are located in the Pike River watershed. The two plants, which serve the Village of Sturtevant and portions of the Town of Somers, discharge treated effluents to the Waxdale tributary and the Somers tributary of the Pike Creek, respectively. Selected information for these municipal sewage treatment plants is set forth in Table 107, and the plant locations are shown on Map 77. In addition to the publicly owned sewage treatment facilities, two private wastewater treatment facilities exist

Table 106

AREAL EXTENT OF WATER QUALITY-RELATED LAND COVER IN THE PIKE RIVER WATERSHED: 1975

Land Cover[a]	Square Miles	Acres	Percent
Urban			
Residential	4.89	3,127	9.66
Commercial[b]	1.08	690	2.13
Industrial			
Manufacturing	1.03	657	2.03
Landfills and Dumps	0.15	95	0.29
Extractive	0.14	92	0.28
Transportation			
Streets and Highways	0.17	110	0.34
Airfields	0.26	167	0.52
Railroad Yards and Terminals	0.07	42	0.13
Recreation			
Golf Courses	0.96	617	1.91
Parks and Other Recreation	0.31	200	0.62
Land Under Development			
Residential[c]	1.07	687	2.12
Commercial	--	--	--
Industrial	0.15	93	0.28
Transportation	--	--	--
Recreation	--	--	--
Rural			
Agricultural			
Small Grains	2.94	1,881	5.81
Hay	2.15	1,404	4.34
Row Crops	23.05	14,749	45.55
Specialty Crops	3.45	2,207	6.82
Sod Farm	0.27	170	0.53
Other Open Space[d]	5.36	3,431	10.64
Silvicultural			
Woodlands	1.47	940	2.90
Orchards and Nurseries	0.43	273	0.84
Natural and Man-Made Water Areas—Subject to Atmospheric Pollutant Contributions			
Ponds, Lakes, and Streams	0.13	82	0.25
Wetlands, Swamps, and Marshes	1.03	662	2.04
Total	50.56	32,376	100.00

[a] *These special land cover categories, defined primarily according to their imperviousness and vegetative cover characteristics and effects on the quality of storm water runoff, were delineated at a scale of 1" = 400' on aerial photographs taken in May 1975 and were measured to the nearest full acre, using dot-counting overlays. The total acreages measured within hydrologic subbasins were then adjusted to the preliminary control totals measured by digitizer from base maps of hydrologic subbasins at a scale of 1" = 2000'. Both the "square miles" and the "percent" shown above were then computed and rounded to the nearest hundredth (0.01) of a percent. The final control total for the Pike Creek watershed is indicated on Map 77.*

[b] *Includes: retail, communication, utilities, administrative, and institutional land uses.*

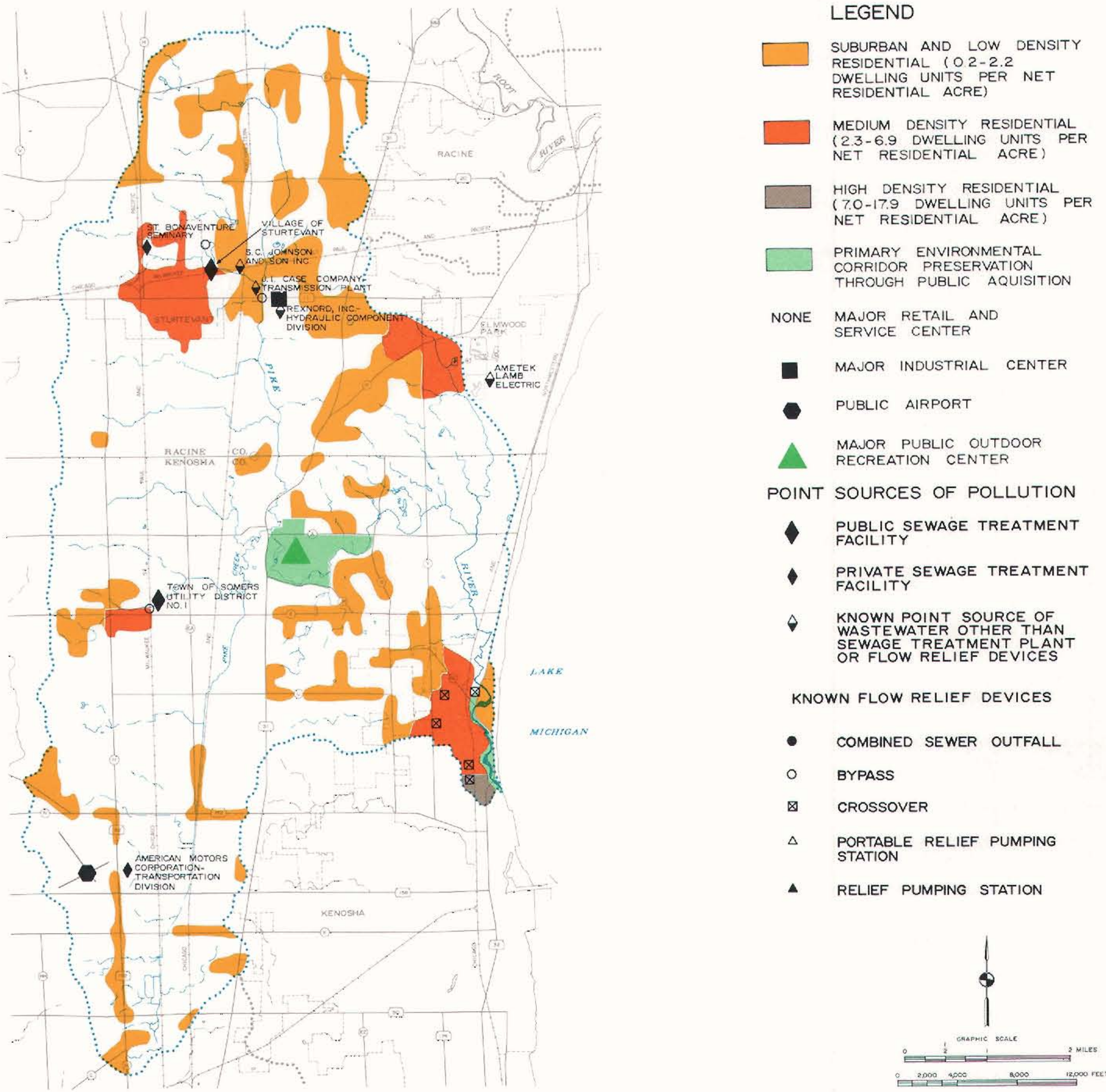
[c] *Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.*

[d] *Includes: pasture, unused urban and rural lands.*

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service; County Soil and Water Conservation Districts; University of Wisconsin-Extension Service; and SEWRPC.

Map 77

THE LOCATION, BOUNDARIES, AND MAJOR STREAMS OF THE PIKE RIVER WATERSHED—SHOWING POINT SOURCES OF POLLUTION AND GENERALIZED LAND USES: 1975

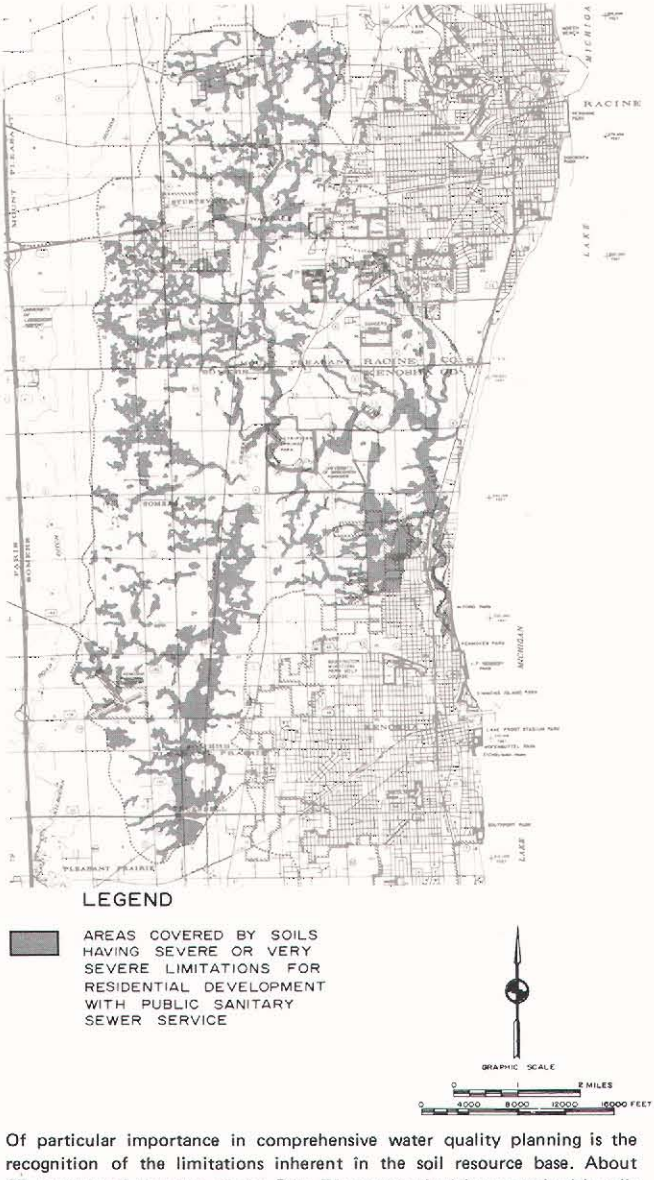


The Pike River watershed is about 51 square miles in areal extent, or about 2 percent of the total area of the Region. The water quality in the watershed is affected by the various land uses as well as by the two public wastewater treatment plants, two private wastewater treatment plants, eight flow relief devices, and five other point sources of wastewater as shown.

Source: SEWRPC.

Map 78

SUITABILITY OF SOILS FOR RESIDENTIAL DEVELOPMENT WITH PUBLIC SANITARY SEWER SERVICE IN THE PIKE RIVER WATERSHED



LEGEND

AREAS COVERED BY SOILS HAVING SEVERE OR VERY SEVERE LIMITATIONS FOR RESIDENTIAL DEVELOPMENT WITH PUBLIC SANITARY SEWER SERVICE

GRAPHIC SCALE

0 1 2 MILES

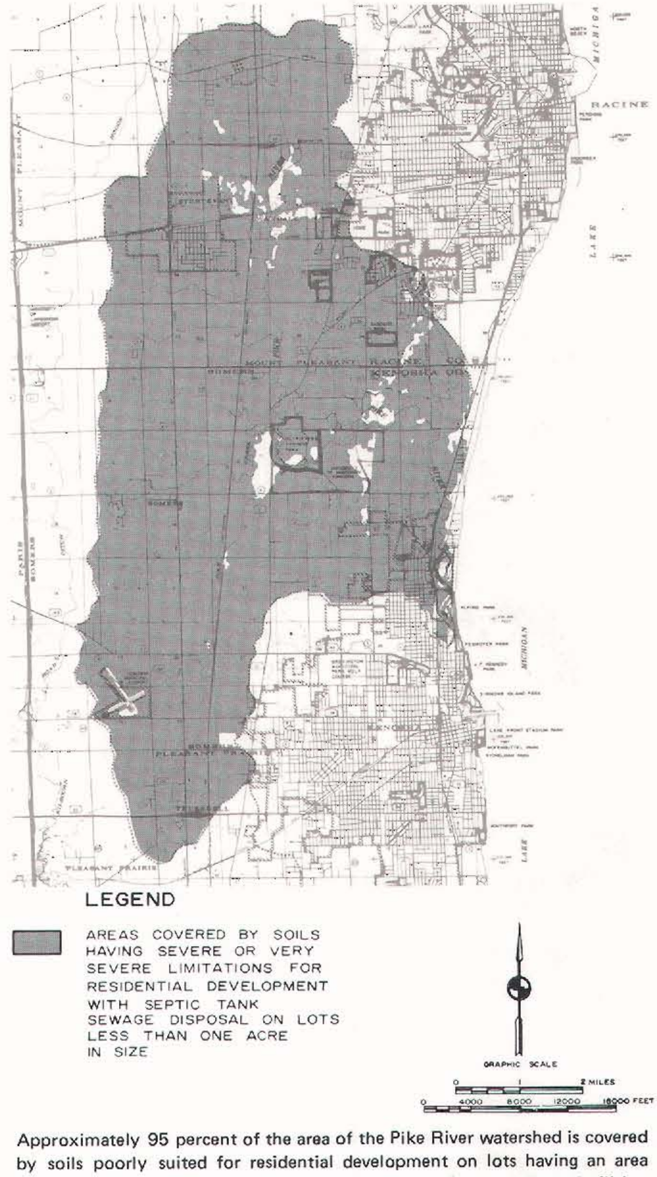
0 4000 8000 12000 16000 FEET

Of particular importance in comprehensive water quality planning is the recognition of the limitations inherent in the soil resource base. About 25 percent of the area of the Pike River watershed is covered with soils which are poorly suited for residential development with public sanitary sewer service or, more precisely, residential development of any kind. These soils, which include wet soils having a high water table or poor drainage, organic soils which are poorly drained and provide poor foundation support, and soils which have a flood hazard, are especially prevalent in the riverine areas of the watershed.

Source: U. S. Soil Conservation Service and SEWRPC.

Map 79

SUITABILITY OF SOILS FOR SMALL LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE IN THE PIKE RIVER WATERSHED



LEGEND

AREAS COVERED BY SOILS HAVING SEVERE OR VERY SEVERE LIMITATIONS FOR RESIDENTIAL DEVELOPMENT WITH SEPTIC TANK SEWAGE DISPOSAL ON LOTS LESS THAN ONE ACRE IN SIZE

GRAPHIC SCALE

0 1 2 MILES

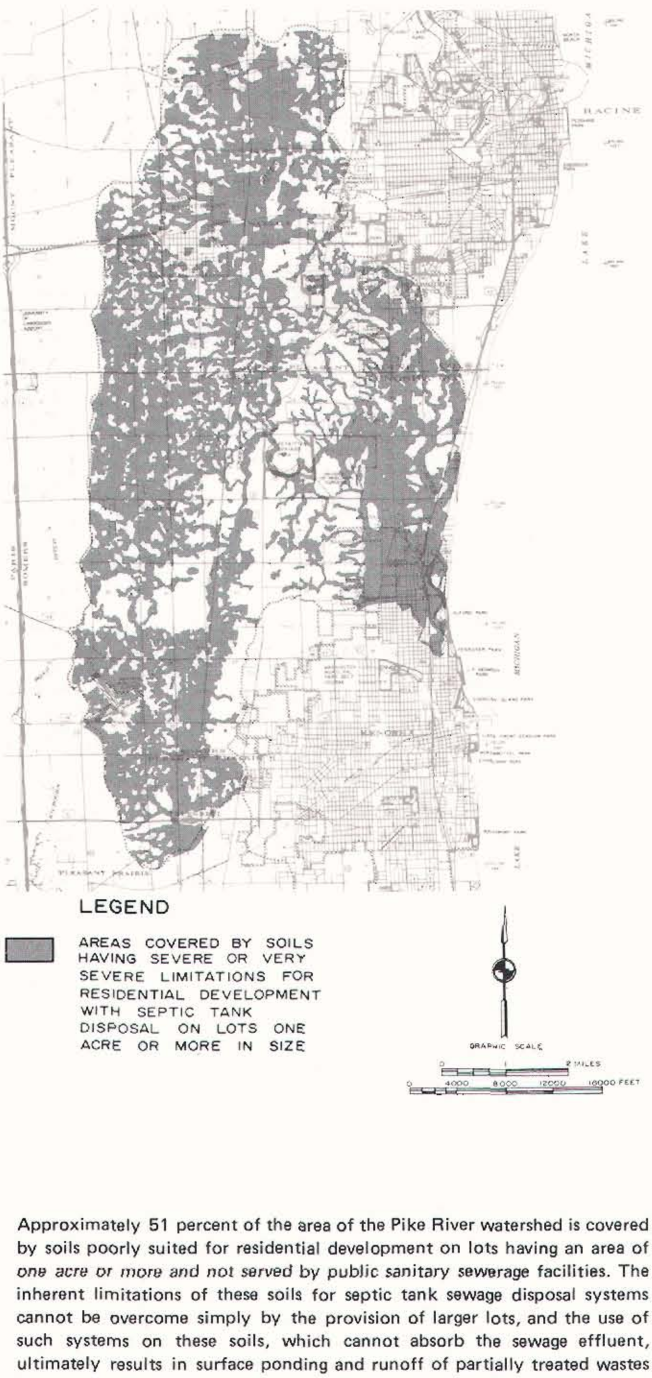
0 4000 8000 12000 16000 FEET

Approximately 95 percent of the area of the Pike River watershed is covered by soils poorly suited for residential development on lots having an area smaller than one acre and not served by public sanitary sewerage facilities. Reliance on septic tank sewage disposal systems in these areas, which are covered by relatively impervious soils or are subject to seasonally high water tables, can only result in eventual malfunctioning of such systems and the consequent intensification of water pollution and public health problems in the watershed.

Source: U. S. Soil Conservation Service and SEWRPC.

Map 80

SUITABILITY OF SOILS FOR LARGE LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE IN THE PIKE RIVER WATERSHED



Approximately 51 percent of the area of the Pike River watershed is covered by soils poorly suited for residential development on lots having an area of one acre or more and not served by public sanitary sewerage facilities. The inherent limitations of these soils for septic tank sewage disposal systems cannot be overcome simply by the provision of larger lots, and the use of such systems on these soils, which cannot absorb the sewage effluent, ultimately results in surface ponding and runoff of partially treated wastes into nearby watercourses.

Source: U. S. Soil Conservation Service and SEWRPC.

in the Pike River watershed and are owned and operated by American Motors Corporation (Transportation Division) in the Town of Somers and St. Bonaventure Seminary in the Town of Mt. Pleasant. Selected data on these privately owned wastewater treatment facilities are presented in Table 108, and the locations of these facilities are shown on Map 77. All four sewage treatment plants provide a secondary level of treatment and the effluents are discharged into tributaries of the Pike River.

Sanitary Sewerage System Flow Relief Points

In 1975, there were eight known sanitary sewer flow relief devices in the watershed, as listed in Table 109 and shown on Map 77. Of the known sanitary sewer flow relief devices, three were sanitary sewerage bypasses and five were crossovers. Of the total of eight flow relief devices, seven discharge directly to the main stem of the Pike River and one discharges directly to Pike Creek.

Other Known Point Sources

A total of four other known point sources of pollution were identified in the watershed in 1975. These other point sources consisted primarily of six outfalls through which industrial cooling and process waters were discharged directly or indirectly to the surface water system. All six were identified as discharging only cooling water. Industrial wastewater enters the Pike River and its major tributaries directly through industrial waste outfalls or indirectly through drainage ditches and storm sewers. Table 110 summarizes by receiving stream and civil division the characteristics of these other point sources, and Map 77 shows their locations. Two of these other point source outfalls discharge directly to the Pike River main stem, one discharges directly to Sorenson Creek, and the remaining three discharge directly to the Waxdale tributary of the Pike River.

Privately Owned Onsite Sanitary Wastewater Treatment

In addition to being provided through centralized sanitary sewerage system within the watershed, sanitary wastewater treatment and disposal is provided through approximately 1,393 privately owned onsite sewage disposal systems consisting of 1,387 septic tanks, 4 holding tanks, and 2 mound systems. These systems serve a total resident population of about 4,200 persons, or 15 percent of the total resident population of the watershed. Of this total, about 700 persons, or 17 percent, resided in concentrated areas of urban development having at least 32 housing units in a U. S. Public Land Survey quarter section. These scattered quarter sections of urban land use concentration totaled about 2.2 square miles of urban land use, or about 4.3 percent of the total area of the watershed.

Urban Storm Water Management Systems

As noted in Table 106, land cover categories associated with urban land uses as of 1975 comprised about 6,600 acres, or about 20 percent of the Pike River watershed. The most important urban land cover category was residential land, with about 9.7 percent.

Table 107

SELECTED CHARACTERISTICS OF MUNICIPAL SEWAGE TREATMENT PLANTS IN THE PIKE RIVER WATERSHED: 1975

Name	Total Area Served (square miles)	Estimated Total Population Served	Date of Construction and Major Modification	Type of Treatment	Level of Treatment Provided	Disposal of Effluent	Design Capacity					Existing Loading	
							Population[a]	Average Hydraulic (mgd)	Peak Hydraulic (mgd)	Average Organic (pounds of BOD_5 per day)	Population[a] Equivalent	Average Hydraulic (mgd)	Average Per Capita (gpd)
Town of Somers Utility District No. 1	0.29	700	1964	Activated Sludge, Disinfection	Secondary and Auxiliary	Tributary of Pike River	250	0.03	0.10	N/A	N/A	0.06	87
Village of Sturtevant	0.83	4,400	1959, 1974	Phosphorus Removal, Trickling Filter, and Disinfection	Secondary, Advanced, Auxiliary	Tributary of Pike River	2,500	0.30	0.50	425	2,025	0.53	120

[a] *The population design capacity for a given sewage treatment facility was obtained directly from engineering reports prepared by or for the local unit of government operating the facility and reflects assumptions made by the design engineer. The population equivalent design capacity was estimated by the Commission staff by dividing the design BOD_5 loading in pounds per day, as set forth in the engineering reports, by an estimated per capita contribution of 0.21 pound of BOD_5 per day. If the design engineer assumed a different daily per capita contribution of BOD_5, the population equivalent design capacity will differ from the population design capacity shown in the table.*

Source: SEWRPC.

Table 108

SELECTED CHARACTERISTICS OF PRIVATELY OWNED WASTEWATER TREATMENT FACILITIES IN THE PIKE RIVER WATERSHED: 1975

Name	Civil Division Location	Type of Land Use Served	Type of Wastewater	Type of Treatment Provided	Disposal of Effluent	Reported Average Annual Hydraulic Discharge Rate (gallons per day)[a]	Average Hydraulic Design Capacity (gallons per day)	Reported Maximum Monthly Hydraulic Discharge Rate (gallons per day)[a]
RACINE COUNTY								
American Motors Corporation— (Transportation Division)	Town of Somers	Industrial	Process	Activated Sludge and Sand Filter	Tributary of Pike Creek	2,000	2,000	N/A
St. Bonaventure Seminary	Town of Mt. Pleasant	Institutional	Sanitary	Contact Stabilization and Lagoon	Waxdale Creek	8,000	15,000	10,000

NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data were obtained, in order of priority, from: quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System or under Section 101 of the Wisconsin Administrative Code or from the Wisconsin Pollutant Discharge Elimination System permit itself. In some cases when 12 months of flow data were not reported, the average annual and maximum monthly hydraulic discharge rates were estimated from the available monthly discharge data or from the flow data as reported in the permit.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 109

KNOWN SANITARY SEWERAGE SYSTEM FLOW RELIEF DEVICES IN THE PIKE RIVER WATERSHED BY RECEIVING STREAM AND CIVIL DIVISION: 1975

Receiving Stream	Civil Division	Combined Sewer Outfalls	Other Flow Relief Devices				Total
			Crossovers	Bypasses	Relief Pumping Stations	Portable Pumping Stations	
Pike River	City of Kenosha	0	5	0	0	0	5
Pike River	Village of Sturtevant	0	0	1	0	0	1
Pike River	Town of Mt. Pleasant	0	0	1	0	0	1
Pike Creek	Town of Somers	0	0	1	0	0	1
Total	--	0	5	3	0	0	8

Source: SEWRPC.

Table 110

CHARACTERISTICS OF OTHER KNOWN POINT SOURCES OF WATER POLLUTION IN THE PIKE RIVER WATERSHED: 1975

Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average Annual Hydraulic Discharge Rate (gallons per day)[a]	Reported Maximum Monthly Hydraulic Discharge Rate (gallons per day)[a]
RACINE COUNTY								
Ametek-Lamb Electric	3621	City of Racine	Cooling	N/A	1	Sorenson Creek	3,000	7,000
J. I. Case Company—Transmission Plant	3714	Town of Mt. Pleasant	Cooling	N/A	1	Pike River	70,000	80,000
Rexnord, Inc.—Hydraulic Component Division	3599	Town of Mt. Pleasant	Cooling	N/A	1	Pike River	130,000	231,000
S. C. Johnson and Son, Inc.	2842	Village of Sturtevant	Cooling	N/A	1	Waxdale Tributary of the Pike River	1,291,400	1,550,000
			Cooling	N/A	2	Waxdale Tributary of the Pike River	248,000	320,000
			Cooling	N/A	3	Waxdale Tributary of the Pike River	96,000	120,000

NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data were obtained, in order of priority, from: quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System or under Section 101 of the Wisconsin Administrative Code or from the Wisconsin Pollutant Discharge Elimination System permit itself. In some cases when 12 months of flow data were not reported, the average annual and maximum monthly hydraulic discharge rates were estimated from the available monthly discharge data or from the flow data as reported in the permit.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

There were a total of three known urban storm water drainage systems providing service to the subareas of the Pike River watershed within the Region in 1975. These include the systems operated by the Cities of Kenosha and Racine, and the Village of Sturtevant. Together, these three storm water drainage systems have a tributary drainage area of about 3.8 square miles, or about 7.5 percent of the total area of the watershed. Included within this storm water drainage area are a total of 13 known storm water outfalls ranging in size from 15 inches in diameter to a 72 by 113-inch box culvert. There were no known storm water pumping facilities and only one known storm water storage facility in the watershed. The total annual average discharge from these outfalls is estimated to be about 246 million gallons per year occurring on the average in 57 events.

Rural Storm Water Runoff

About 25,800 acres, or 80 percent of the total area of the watershed, are devoted to rural land use activities. The most important rural land cover categories were row crops with 46 percent, other open space with about 11 percent, and small grains with about 6 percent of the watershed. As of May 1975, there were an estimated 13 domestic livestock operations—operations of 25 or more equivalent animal units—having a total of 980 equivalent animal units within the watershed. Of the 13 operations, three, or 23 percent, were located within 500 feet of the surface water system of the watershed.

Pollution Loadings

A summary of the estimated average annual pollution loadings in the Pike River watershed is presented in Table 111 and depicted in Figure 39. Urban sources of pollution are estimated to contribute 23 percent of the nitrogen, 74 percent of the phosphorus, 56 percent of the biochemical oxygen demand, 75 percent of the fecal coliform, and 51 percent of the sediment which occur as water pollutants in the Pike River watershed. Of the urban contribution, point sources of pollution are estimated to contribute 18 percent of the nitrogen, 9 percent of the phosphorus, 10 percent of the biochemical oxygen demand, 71 percent of the fecal coliform, and almost no sediment. Diffuse sources—including the estimated septic tank and construction-related contributions in the drainage area—account for the remaining 82 percent of the nitrogen, 91 percent of the phosphorus, 90 percent of the biochemical oxygen demand, 29 percent of the fecal coliform, and almost all of the sediment contributed from urban sources.

Of the total pollutant loadings, rural pollution sources are estimated to contribute the remaining 77 percent of the nitrogen, 26 percent of the phosphorus, 44 percent of the biochemical oxygen demand, 25 percent of the fecal coliform, and 49 percent of the sediment which occur as water pollutants in the watershed. Livestock feeding operations—inclusive of the disposal of manure on croplands—are estimated to contribute 6 percent of the

Table 111

SUMMARY OF ESTIMATED AVERAGE ANNUAL POLLUTANT LOADINGS IN THE PIKE RIVER WATERSHED: 1975

Source	Extent[a]	Parameter	Loads[b] Average Year Total Estimated Loading	Percent
Urban Point Sources				
Municipal Sewage Treatment Plants	2	Total Nitrogen	24,070.0	4.1
	2	Total Phosphorus	4,620.0	6.5
	2	Biochemical Oxygen Demand	64,020.0	5.0
	2	Fecal Coliform	13,000,000.0	51.3
	2	Sediment	35.0	0.0
Private Sewage Treatment Plants	2	Total Nitrogen	0.0	0.0
	2	Total Phosphorus	0.0	0.0
	2	Biochemical Oxygen Demand	0.0	0.0
	2	Fecal Coliform	0.0	0.0
	2	Sediment	0.0	0.0
Combined Sewer Overflow	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Industrial Discharges	4	Total Nitrogen	30.0	0.0
	4	Total Phosphorus	0.0	0.0
	4	Biochemical Oxygen Demand	920.0	0.1
	4	Fecal Coliform	0.0	0.0
	4	Sediment	0.0	0.0
Sanitary Sewer Flow Relief Devices	8	Total Nitrogen	380.0	0.1
	8	Total Phosphorus	130.0	0.2
	8	Biochemical Oxygen Demand	3,750.0	0.3
	8	Fecal Coliform	570,000.0	2.2
	8	Sediment	0.0	0.0
Urban Point Source Totals		Total Nitrogen	24,480.0	4.2
		Total Phosphorus	4,750.0	6.7
		Biochemical Oxygen Demand	68,690.0	5.4
		Fecal Coliform	13,570,000.0	53.5
		Sediment	35.0	0.0
Urban Diffuse Sources				
Residential	3127	Total Nitrogen	12,510.0	2.1
	3127	Total Phosphorus	1,000.0	1.4
	3127	Biochemical Oxygen Demand	75,990.0	6.0
	3127	Fecal Coliform	500,320.0	2.0
	3127	Sediment	850.0	0.6
Commercial	690	Total Nitrogen	6,210.0	1.1
	690	Total Phosphorus	520.0	0.7
	690	Biochemical Oxygen Demand	67,340.0	5.3
	690	Fecal Coliform	227,700.0	0.9
	690	Sediment	255.0	0.2
Industrial	752	Total Nitrogen	6,320.0	1.1
	752	Total Phosphorus	530.0	0.7
	752	Biochemical Oxygen Demand	27,750.0	2.2
	752	Fecal Coliform	466,240.0	1.8
	752	Sediment	365.0	0.3
Extractive	92	Total Nitrogen	5,520.0	0.9
	92	Total Phosphorus	4,140.0	5.8
	92	Biochemical Oxygen Demand	11,040.0	0.9
	92	Fecal Coliform	0.0	0.0
	92	Sediment	6,900.0	5.0
Transportation	319	Total Nitrogen	4,930.0	0.8
	319	Total Phosphorus	650.0	0.9
	319	Biochemical Oxygen Demand	21,980.0	1.7
	319	Fecal Coliform	99,740.0	0.4
	319	Sediment	2,630.0	1.9
Recreation	817	Total Nitrogen	3,170.0	0.5
	817	Total Phosphorus	140.0	0.2
	817	Biochemical Oxygen Demand	1,060.0	0.1
	817	Fecal Coliform	7,200.0	0.0
	817	Sediment	170.0	0.1
Construction	780	Total Nitrogen	46,800.0	8.0
	780	Total Phosphorus	35,100.0	49.2
	780	Biochemical Oxygen Demand	93,600.0	7.3
	780	Fecal Coliform	0.0	0.0
	780	Sediment	58,500.0	42.3
Septic Systems	4200	Total Nitrogen	23,940.0	4.1
	4200	Total Phosphorus	5,540.0	7.8
	4200	Biochemical Oxygen Demand	342,720.0	26.9
	4200	Fecal Coliform	4,200,000.0	16.6
	4200	Sediment	60.0	0.0
Urban Diffuse Source Totals		Total Nitrogen	109,400.0	18.8
		Total Phosphorus	47,620.0	66.8
		Biochemical Oxygen Demand	641,480.0	50.3
		Fecal Coliform	5,501,200.0	21.7
		Sediment	69,730.0	50.4
Urban Source Totals		Total Nitrogen	133,880.0	23.0
		Total Phosphorus	52,370.0	73.5
		Biochemical Oxygen Demand	710,170.0	55.7
		Fecal Coliform	19,071,200.0	75.2
		Sediment	69,765.0	50.5
Rural Diffuse Sources				
Livestock Operations	980	Total Nitrogen	27,830.0	4.8
	980	Total Phosphorus	6,470.0	9.1
	980	Biochemical Oxygen Demand	108,980.0	8.5
	980	Fecal Coliform	6,272,000.0	24.7
	980	Sediment	345.0	0.2
Cropland, Pasture, and Unused Rural Land	23842	Total Nitrogen	417,720.0	71.7
	23842	Total Phosphorus	12,230.0	17.2
	23842	Biochemical Oxygen Demand	436,690.0	34.3
	23842	Fecal Coliform	0.0	0.0
	23842	Sediment	67,955.0	49.2
Silvicultural	1213	Total Nitrogen	2,790.0	0.5
	1213	Total Phosphorus	170.0	0.2
	1213	Biochemical Oxygen Demand	5,580.0	0.4
	1213	Fecal Coliform	8,005.8	0.0
	1213	Sediment	150.0	0.1
Air Pollution to Surface Water	82	Total Nitrogen	730.0	0.1
	82	Total Phosphorus	40.0	0.1
	82	Biochemical Oxygen Demand	13,280.0	1.0
	82	Fecal Coliform	0.0	0.0
	82	Sediment	25.0	0.0
Rural Diffuse Source Totals		Total Nitrogen	449,070.0	77.0
		Total Phosphorus	18,910.0	26.5
		Biochemical Oxygen Demand	564,530.0	44.3
		Fecal Coliform	6,280,005.8	24.8
		Sediment	68,475.0	49.5
Diffuse Source Totals		Total Nitrogen	558,470.0	95.8
		Total Phosphorus	66,530.0	93.3
		Biochemical Oxygen Demand	1,206,010.0	94.6
		Fecal Coliform	11,781,205.8	46.5
		Sediment	138,205.0	100.0
Total Sources		Total Nitrogen	582,950.0	100.0
		Total Phosphorus	71,280.0	100.0
		Biochemical Oxygen Demand	1,274,700.0	100.0
		Fecal Coliform	25,351,205.8	100.0
		Sediment	138,240.0	100.0

[a] *Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.*

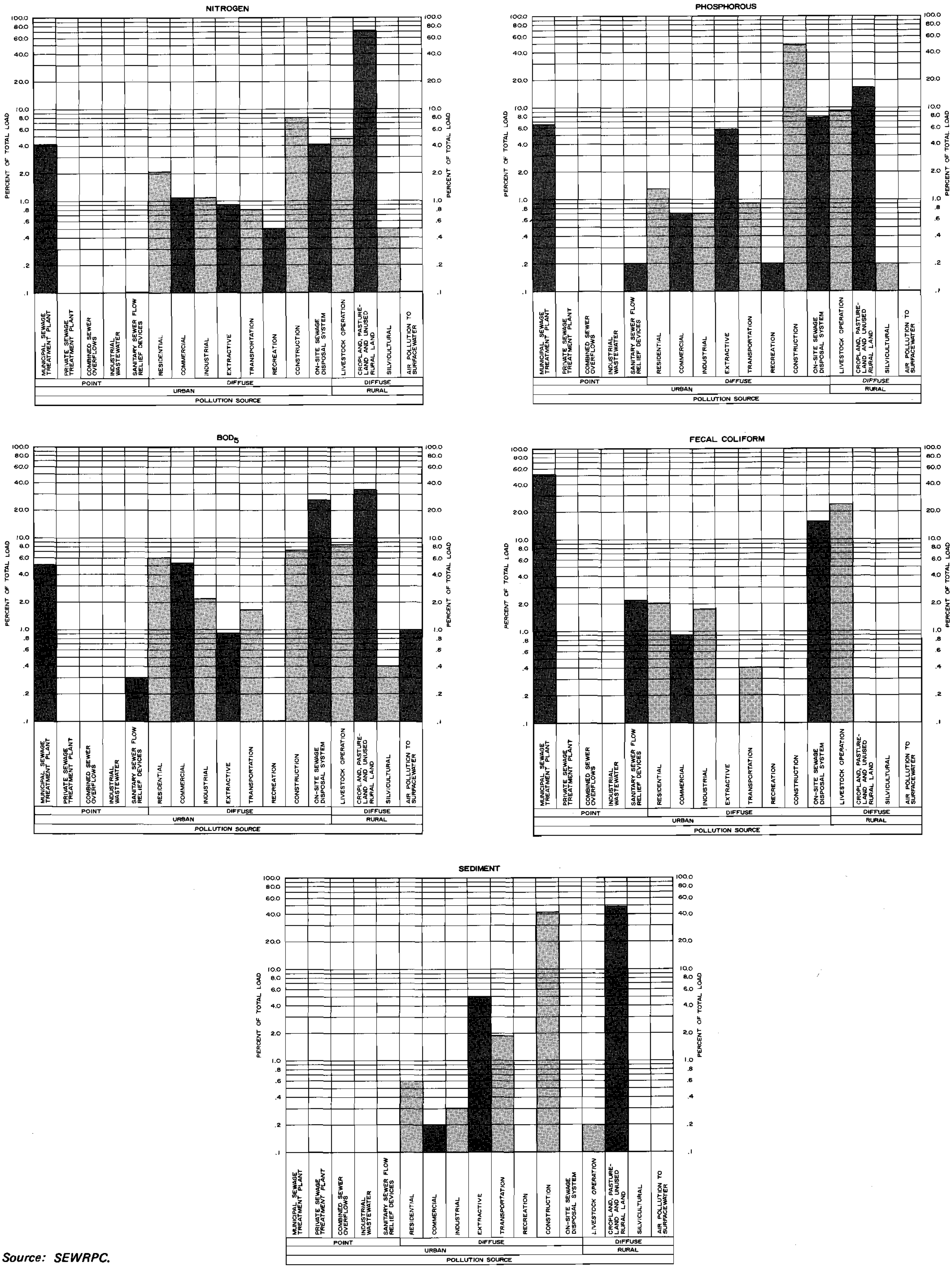
[b] *Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year.*

Source: SEWRPC.

nitrogen, 34 percent of the phosphorus, 19 percent of the biochemical oxygen demand, most of the fecal coliform, and 1 percent of the sediment from rural sources. The remainder of the estimated rural pollution load, or 94 percent of the nitrogen, 66 percent of the phosphorus, 81 percent of the biochemical oxygen demand, almost none of the fecal coliform, and almost all of the sediment, are contributed by other rural diffuse sources, namely storm water runoff from rural land uses and atmospheric loadings to surface waters.

Figure 39

SUMMARY OF ESTIMATED AVERAGE ANNUAL POLLUTANT LOADINGS IN THE PIKE RIVER WATERSHED: 1975



Source: SEWRPC.

ROCK RIVER WATERSHED

The Rock River watershed within southeastern Wisconsin is a natural surface water drainage unit 612.4 square miles in areal extent located in the western portion of the Region. An additional 74.1 square miles of land from select portions of Dodge, Jefferson, and Rock Counties have been added for water quality simulation purposes to give a total of 683.5 square miles. The boundaries of the basin, together with the locations of the principal tributaries of the Rock River, are shown on Map 81, along with the locations of the known point sources of pollution and the generalized land uses as of 1975. The watershed is only partly contained in the Region, and the main stem of the Rock River originates in the marshy areas of southern Fond du Lac County, outside of the Region, and flows southerly through Dodge, Jefferson, and Rock Counties, all outside the Region. The major tributaries originating in the Region are found in western Washington, Waukesha, and Walworth Counties, and meander to the western boundaries of these counties. About 92 percent of the total area of the watershed is still in rural land uses, with about 77 percent of this rural area in agricultural use. Most of the agricultural-related land use is dispersed throughout the watershed. Table 112 sets forth the extent and proportion of the major land cover categories within the watershed as they relate to water quality conditions in 1975.

The soils within the Rock River watershed are generally rolling silt loams or gravelly loams in Washington and Waukesha Counties and gradually change to prairie loam soils in Walworth County. Most of the soils are relatively fertile and produce high crop yields if managed correctly. Sediment discharges from these soils may also result in high nutrient levels in stream waters.

Particularly important to comprehensive water quality management planning are the soil suitability interpretations for specified types of urban development. Based upon the interpretations of the soil properties, about 27 percent of the in-Region portion of the watershed is covered by soils that have severe or very severe limitations for residential development with public sanitary sewer service, as shown on Map 82; about 42 percent of the watershed is covered by soils that have severe or very severe limitations for small lot (less than one acre in size) residential development without public sanitary sewer, as shown on Map 83; and about 39 percent of the watershed is covered by soils that have severe or very severe limitations for large lot (one acre or larger in size) residential development, as shown on Map 84.

Municipal and Private Sewage Treatment Facilities

In 1975, a total of 13 sanitary sewerage systems or portions thereof served a total area of about 14.1 square miles within the in-Region portion of the watershed, or about 2 percent of the total area of the watershed, and a total population of about 46,400 persons, or approximately 48 percent of the total resident population of the in-Region portion of the watershed.

Twelve municipally owned wastewater treatment plants are located in the Rock River watershed. The plant serving the City of Delavan discharges treated effluents

Table 112

AREAL EXTENT OF WATER QUALITY-RELATED LAND COVER IN THE ROCK RIVER WATERSHED: 1975

Land Cover[a]	Square Miles	Acres	Percent
Urban			
Residential	27.96	17,896	4.09
Commercial[b]	4.30	2,750	0.63
Industrial			
Manufacturing	1.56	997	0.22
Landfills and Dumps	0.38	244	0.06
Extractive	2.49	1,595	0.36
Transportation			
Streets and Highways	1.71	1,096	0.25
Airfields	0.26	165	0.04
Railroad Yards and Terminals	--	--	--
Recreation			
Golf Courses	2.60	1,665	0.38
Parks and Other Recreation	4.01	2,567	0.59
Land Under Development			
Residential[c]	7.80	4,989	1.14
Commercial	--	--	--
Industrial	0.18	118	0.03
Transportation	0.75	479	0.11
Recreation	0.03	20	0.00
Rural			
Agricultural			
Small Grains	25.64	16,407	3.75
Hay	94.06	60,200	13.76
Row Crops	289.40	185,219	42.34
Specialty Crops	11.73	7,509	1.72
Sod Farm	1.21	774	0.18
Other Open Space[d]	65.28	41,777	9.55
Silvicultural			
Woodlands	63.98	40,949	9.36
Orchards and Nurseries	0.65	417	0.09
Natural and Man-Made Water Areas—Subject to Atmospheric Pollutant Contributions			
Ponds, Lakes, and Streams	22.27	14,256	3.25
Wetlands, Swamps, and Marshes	55.25	35,360	8.08
Total	683.50[e]	437,449	100.00

[a] *These special land cover categories, defined primarily according to their imperviousness and vegetative cover characteristics and effects on the quality of storm water runoff, were delineated at a scale of 1" = 400' on aerial photographs taken in May 1975 and were measured to the nearest full acre, using dot-counting overlays. The total acreages measured within hydrologic subbasins were then adjusted to the control totals measured by digitizer from base maps of hydrologic subbasins at a scale of 1" = 2000'. Both the "square miles" and the "percent" shown above were then computed and rounded to the nearest hundredth (0.01) of a percent.*

[b] *Includes: retail, communication, utilities, administrative, and institutional land uses.*

[c] *Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.*

[d] *Includes: pasture, unused urban and rural lands.*

[e] *The total area of the Rock River watershed represented in this table is different than the total area of the Rock River watershed identified in the text and on Map 89. This is due to the fact that the area set forth on Map 81 includes only that portion of the Rock River watershed lying within the civil boundaries that comprise the Southeastern Wisconsin Region. The area of the Rock River watershed represented in this table represents an aggregation of subbasins, the boundaries of which do not always coincide with the civil boundaries of the Region.*

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service; County Soil and Water Conservation Districts; University of Wisconsin-Extension Service; and SEWRPC.

Table 113

SELECTED CHARACTERISTICS OF MUNICIPAL SEWAGE TREATMENT PLANTS IN THE ROCK RIVER WATERSHED: 1975

Name	Total Area Served (square miles)	Estimated Total Population Served	Date of Construction and Major Modification	Type of Treatment	Level of Treatment Provided	Disposal of Effluent	Design Capacity					Existing Loading	
							Population[a]	Average Hydraulic (mgd)	Peak Hydraulic (mgd)	Average Organic (pounds of BOD_5 per day)	Population[a] Equivalent	Average Annual Hydraulic (mgd)	Average Annual Per Capita (gpd)
City of Delavan	2.01	5,800	1930, 1949, 1975	Trickling Filter Disinfection	Secondary Auxiliary	Turtle Creek	10,000	1.0	1.5	N/A	N/A	0.59	102
City of Elkhorn	2.42	4,400	1927, 1949, 1976	Trickling Filter Disinfection	Secondary Auxiliary	Tributary of Jackson Creek	4,500	0.5	N/A	1,510	7,200	0.69	157
City of Whitewater	2.38	11,000	1937, 1956, 1968	Activated Sludge and Trickling Filter Disinfection	Secondary Auxiliary	Whitewater Creek	35,750	2.5	3.75	6,080	28,950	1.14	104
City of Hartford	1.92	7,600	1973	Phosphorus Removal Activated Sludge Microscreening Disinfection	Advanced Secondary Auxiliary Tertiary	Rubicon River	10,000	2.00	6.00	10,000	47,620	1.37	180
Village of Slinger	0.45	1,300	1950	Trickling Filter Disinfection	Secondary Auxiliary	Marshland Drained by the Rubicon River	1,900	0.15	0.30	792	3,770	0.15	115
Allenton Sanitary District	0.19	800	1961	Activated Sludge Disinfection	Secondary Auxiliary	East Branch of the Rock River	1,000	0.10	0.15	170	810	0.08	100
City of Oconomowoc	2.71	11,100	1936	Trickling Filter Disinfection	Secondary Auxiliary	Oconomowoc River	5,000	1.50	3.00	2,500	11,900	1.90	171
Village of Dousman	0.45	1,000	1961, 1972	Activated Sludge Disinfection	Secondary Auxiliary	Bark River	1,500	0.12	0.30	200	950	0.11	110
Village of Hartland	1.16	4,400	1933, 1962	Activated Sludge Disinfection	Secondary Auxiliary	Bark River	3,500	0.35	0.70	700	3,330	0.42	95
Village of Darien	0.47	1,000	1968	Activated Sludge Disinfection	Secondary Auxiliary	Tributary of Darien Creek	1,500	0.15	0.30	255	1,210	0.14	140
Village of Sharon	0.53	1,400	1959	Trickling Filter Disinfection	Secondary Auxiliary	Little Turtle Creek	2,000	0.15	0.30	260	1,240	0.08	57
Village of Walworth	0.47	1,700	1952, 1965, 1975	Trickling Filter Disinfection	Auxiliary Secondary	Tributary of Piscasaw Creek	7,050	0.15	0.30	1,480	7,050	N/A	N/A

NOTE: N/A indicates data not available.

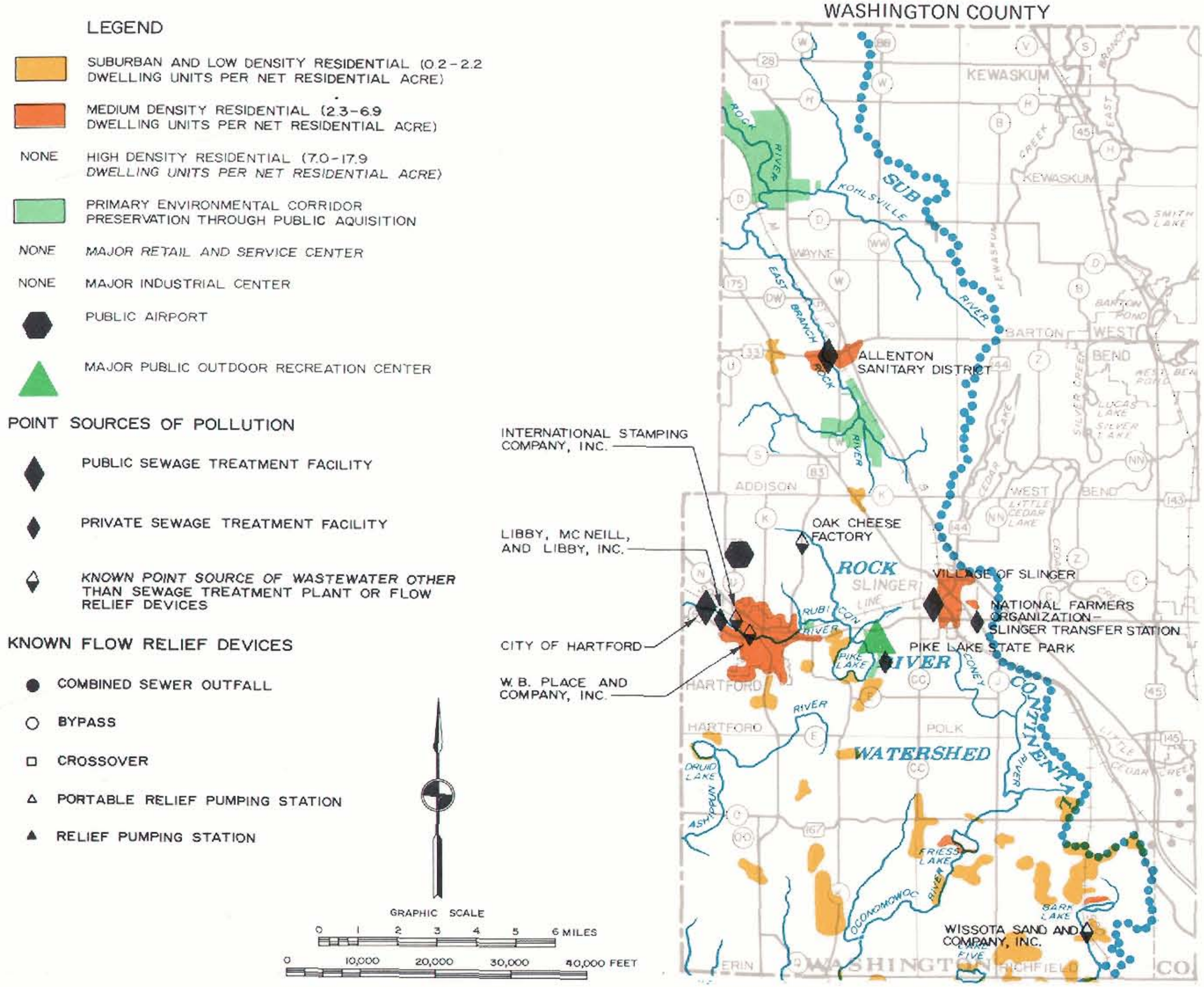
[a] The population design capacity for a given sewage treatment facility was obtained directly from engineering reports prepared by or for the local unit of government operating the facility and reflects assumptions made by the design engineer. The population equivalent design capacity was estimated by the Commission staff by dividing the design BOD_5 loading in pounds per day, as set forth in the engineering reports, by an estimated per capita contribution of 0.21 pound of BOD_5 per day. If the design engineer assumed a different daily per capita contribution of BOD_5, the population equivalent design capacity will differ from the population design capacity shown in the table.

Source: SEWRPC.

directly to Turtle Creek; the plant serving the Village of Sharon discharges treated effluents directly to Little Turtle Creek; the plant serving the Village of Darien discharges treated effluents to a tributary of Darien Creek; the plant serving the City of Elkhorn discharges treated effluents to a tributary of Jackson Creek; the two plants serving the Villages of Dousman and Hartland discharge treated effluents directly to the Bark River; the plant which serves the City of Whitewater discharges treated effluents directly to Whitewater Creek; the plant which serves the City of Hartford discharges treated effluents directly to the Rubicon River; the plant which serves the Village of Slinger discharges treated effluents indirectly to the Rubicon River; the plant which serves the Allenton Sanitary District discharges treated effluents directly to the East Branch of the Rock River; the plant which serves the City of Oconomowoc discharges treated effluents directly to the Oconomowoc River; and the plant which serves the Village of Walworth discharges treated effluents to a tributary of Piscasaw Creek. Selected information on these municipal sewage treatment plants is set forth in Table 113, and the plant locations are shown on Map 81. In addition to the publicly owned sewage treatment facilities, 11 private wastewater treatment facilities exist in the Rock River watershed owned and operated by: Kikkomen Foods,

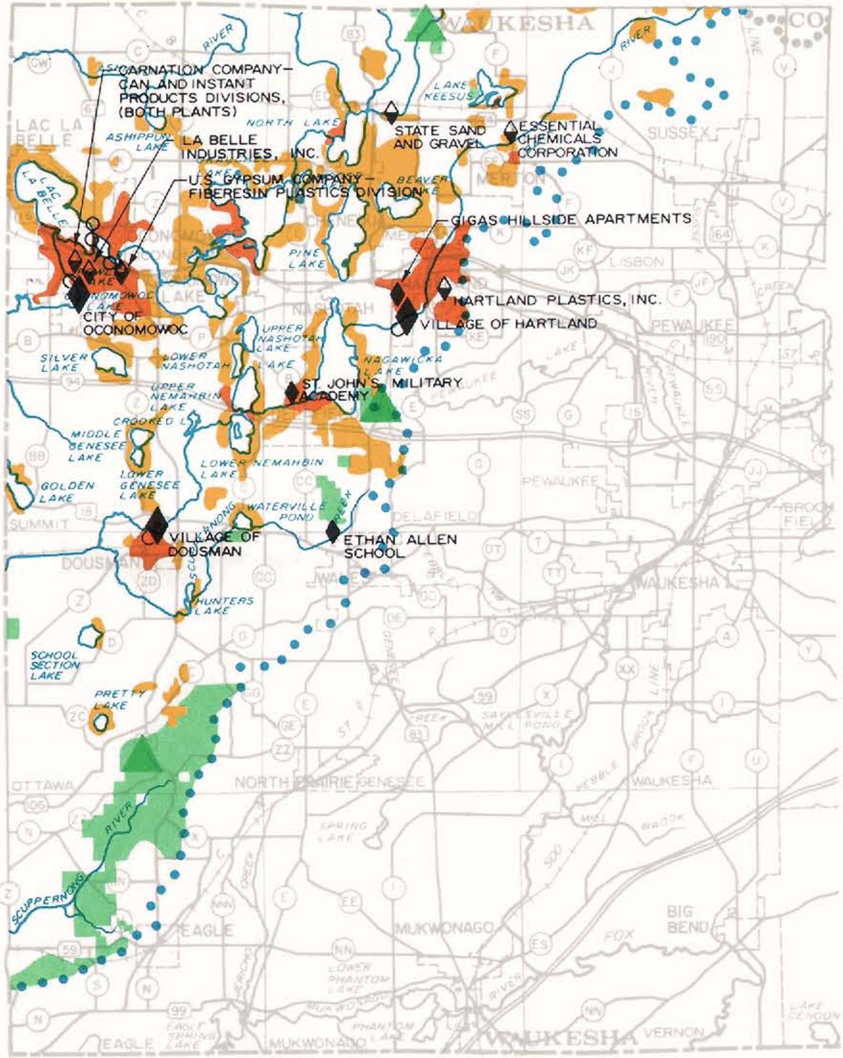
Map 81

THE LOCATION, BOUNDARIES, MAJOR STREAMS, AND LAKES OF THE ROCK RIVER WATERSHED— SHOWING POINT SOURCES OF POLLUTION AND GENERALIZED LAND USES: 1975

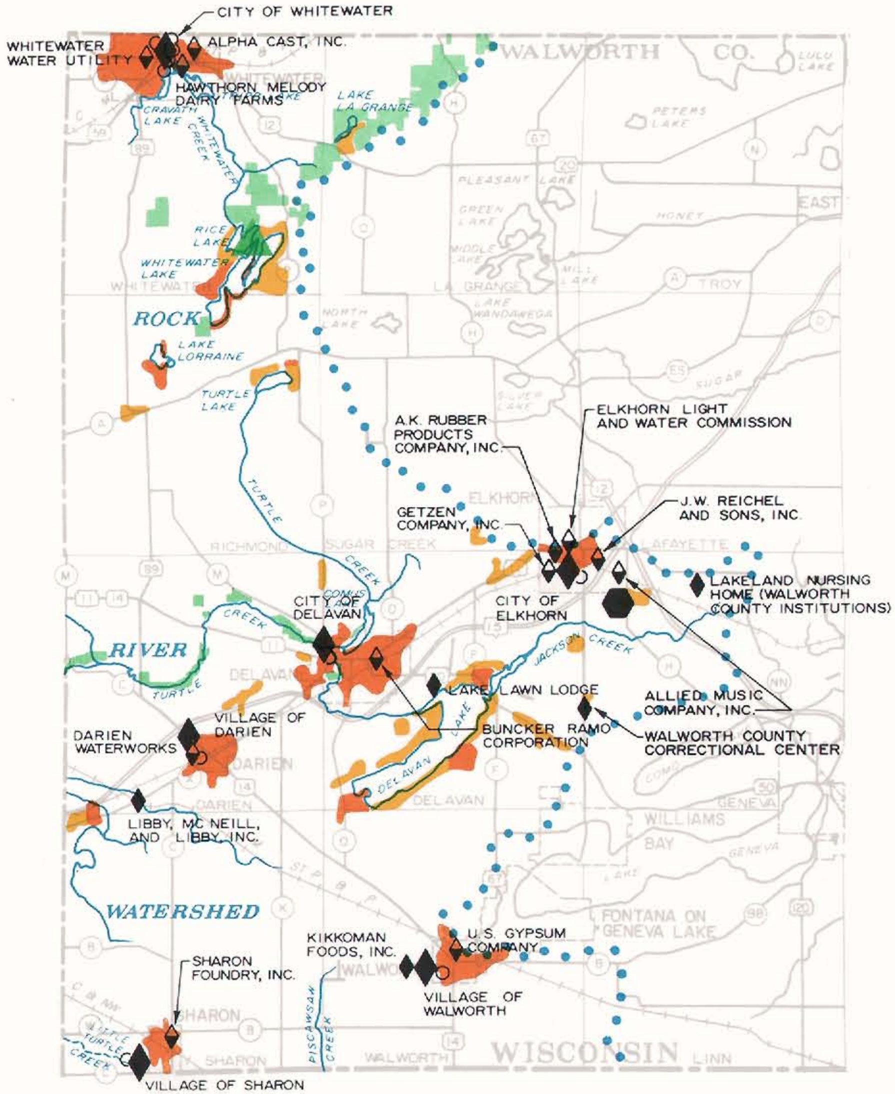


Map 81 (continued)

WAUKESHA COUNTY



WALWORTH COUNTY



The Rock River watershed is about 612 square miles in areal extent, or about 23 percent of the total area of the Region. The water quality in the watershed is affected by the various land uses as well as by the 12 public wastewater treatment plants, 11 private wastewater treatment plants, 16 flow relief devices, and 23 other point sources of wastewater as shown.

Source: SEWRPC.

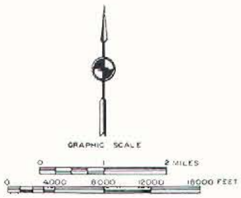
Map 82

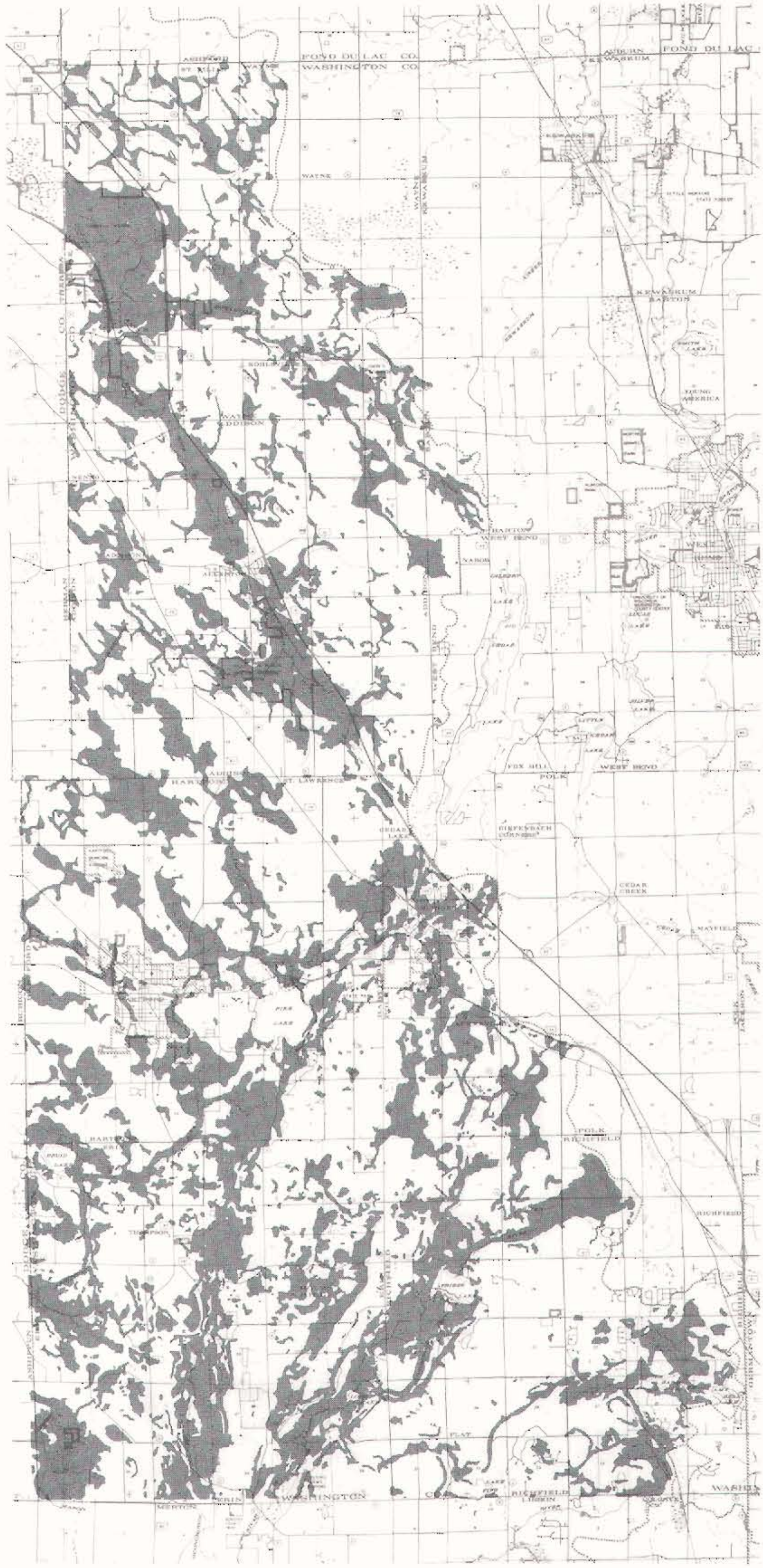
SUITABILITY OF SOILS FOR RESIDENTIAL DEVELOPMENT WITH PUBLIC SANITARY SEWER SERVICE IN THE ROCK RIVER WATERSHED

WASHINGTON COUNTY

LEGEND

AREAS COVERED BY SOILS HAVING SEVERE OR VERY SEVERE LIMITATIONS FOR RESIDENTIAL DEVELOPMENT WITH PUBLIC SANITARY SEWER SERVICE



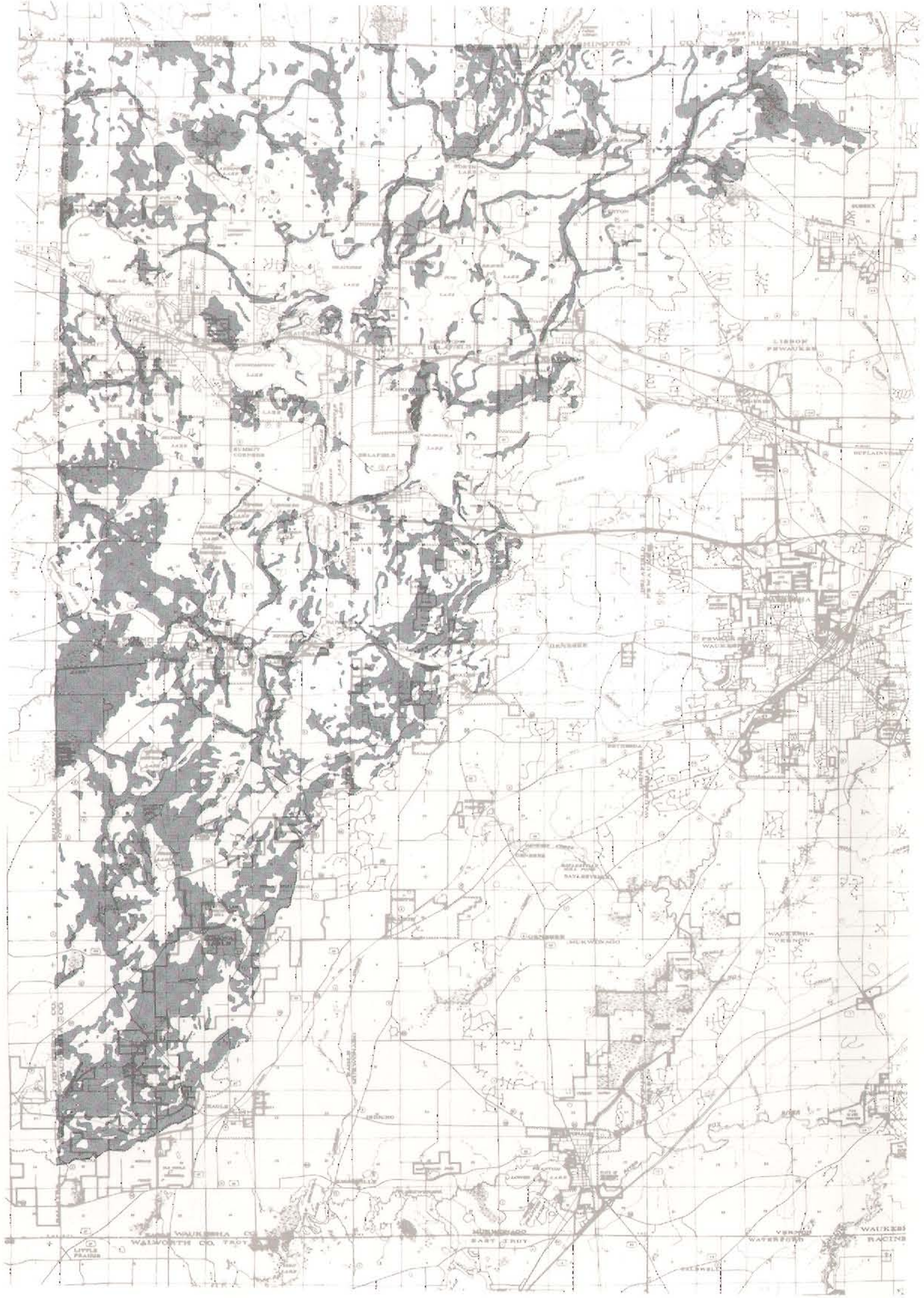


Of particular importance in comprehensive water quality planning is the recognition of the limitations inherent in the soil resource base. About 27 percent of the area of the Pike River watershed is covered with soils which are poorly suited for residential development with public sanitary sewer service or, more precisely, residential development of any kind. These soils, which include wet soils having a high water table or poor drainage, organic soils which are poorly drained and provide poor foundation support, and soils which have a flood hazard, are especially prevalent in the riverine areas of the watershed.

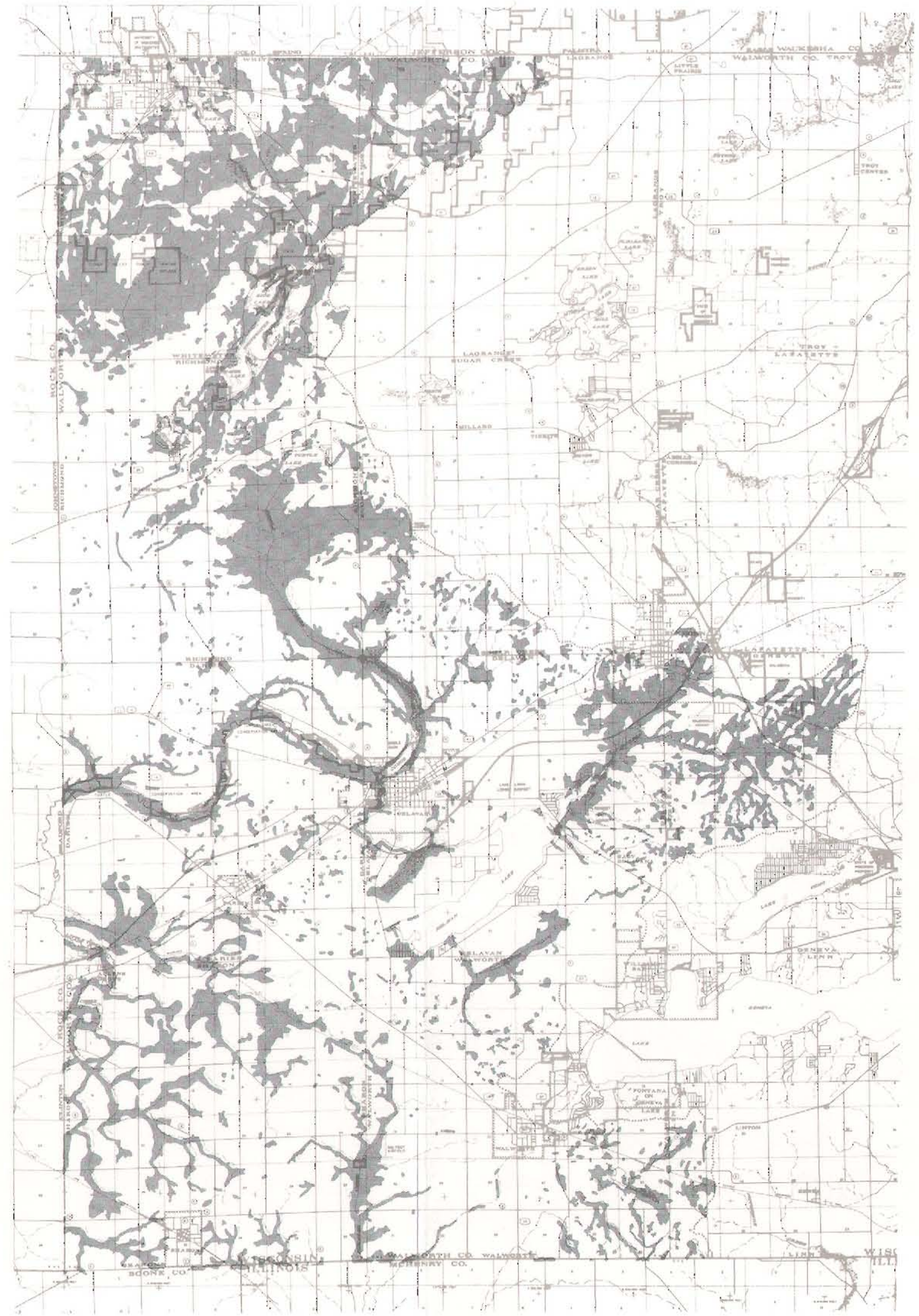
Source: U. S. Soil Conservation Service and SEWRPC.

Map 82 (continued)

WAUKESHA COUNTY



WALWORTH COUNTY



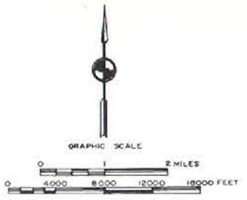
Map 83

SUITABILITY OF SOILS FOR SMALL LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE IN THE ROCK RIVER WATERSHED

WASHINGTON COUNTY

LEGEND

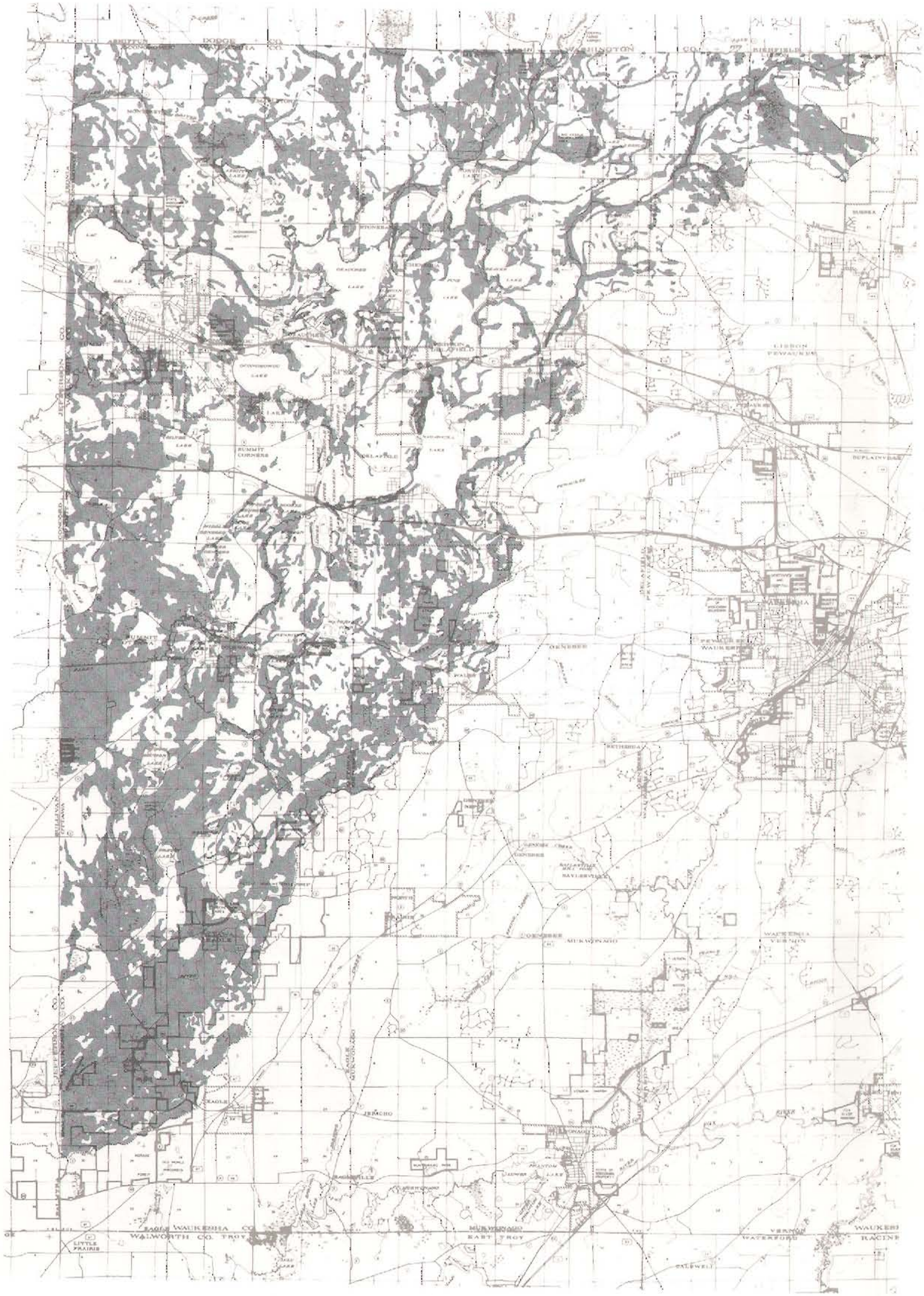
AREAS COVERED BY SOILS HAVING SEVERE OR VERY SEVERE LIMITATIONS FOR RESIDENTIAL DEVELOPMENT WITH SEPTIC TANK SEWAGE DISPOSAL ON LOTS LESS THAN ONE ACRE IN SIZE



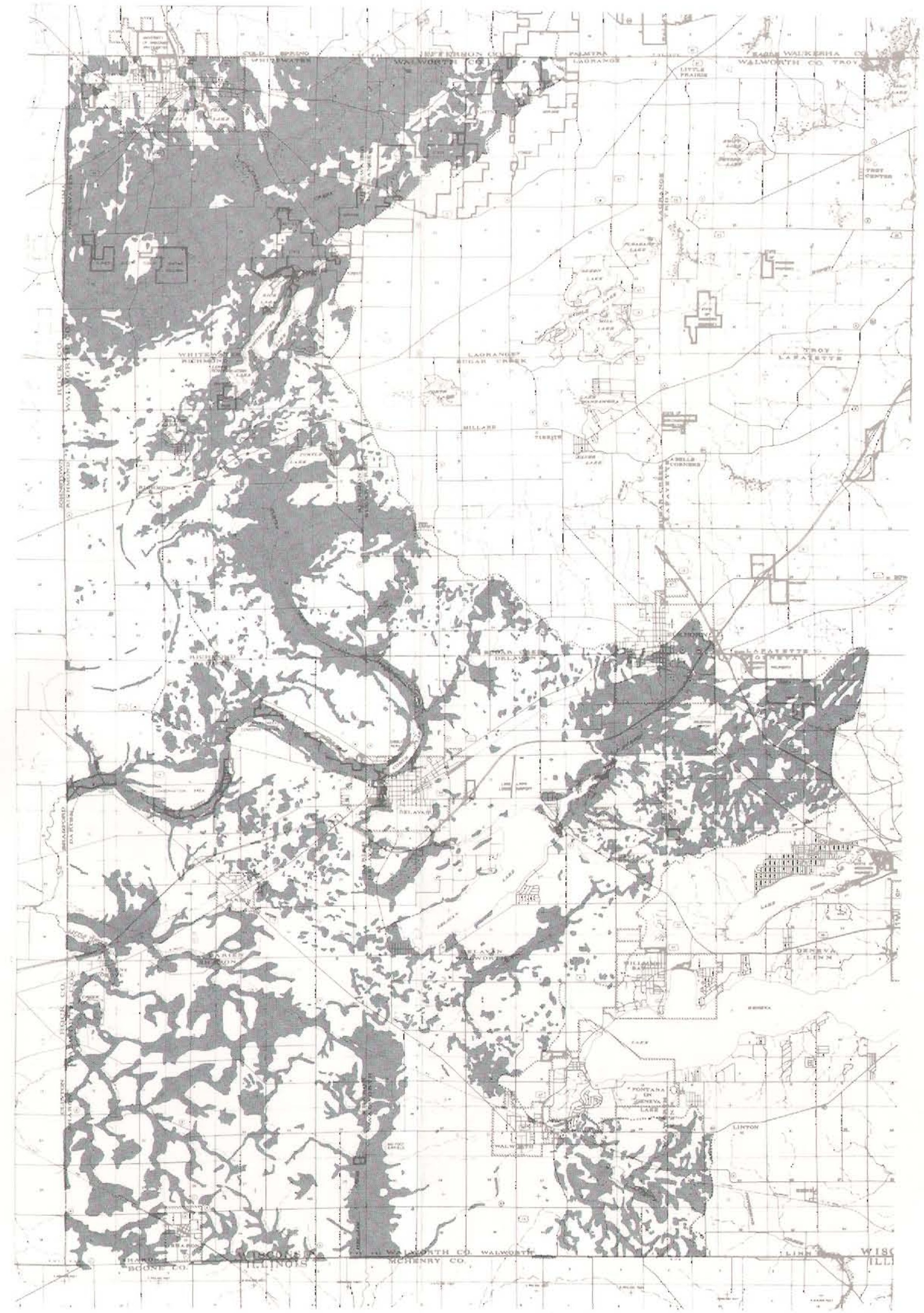
Approximately 42 percent of the area of the Rock River watershed is covered by soils poorly suited for residential development on lots having an area smaller than one acre and not served by public sanitary sewerage facilities. Reliance on septic tank sewage disposal systems in these areas, which are covered by relatively impervious soils or are subject to seasonally high water tables, can only result in eventual malfunctioning of such systems and the consequent intensification of water pollution and public health problems in the watershed.

Source: U. S. Soil Conservation Service and SEWRPC.

WAUKESHA COUNTY



WALWORTH COUNTY



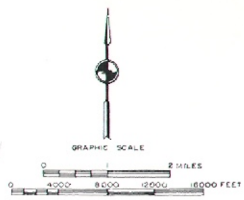
Map 84

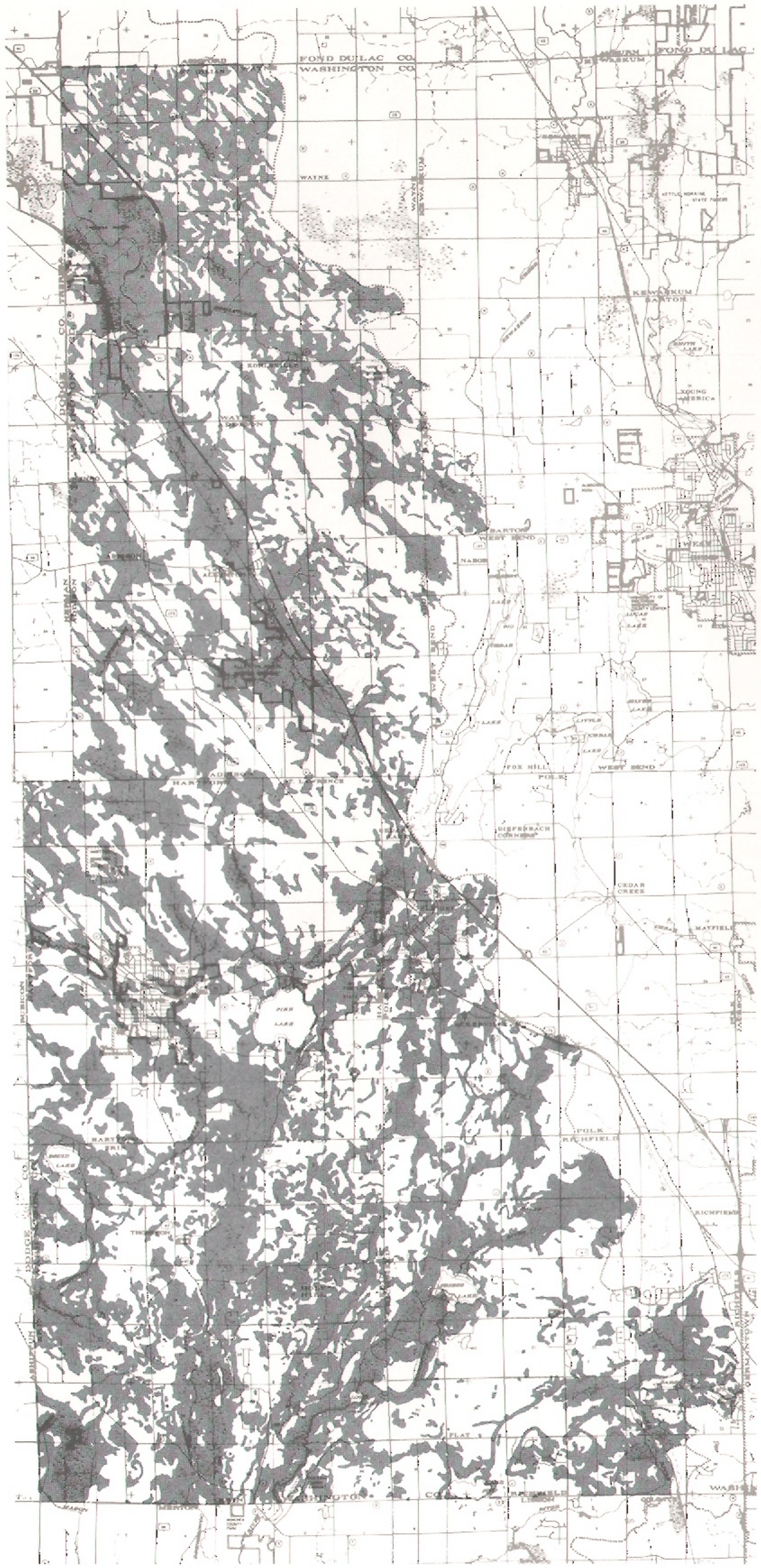
SUITABILITY OF SOILS FOR LARGE LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE IN THE ROCK RIVER WATERSHED

WASHINGTON COUNTY

LEGEND

AREAS COVERED BY SOILS HAVING SEVERE OR VERY SEVERE LIMITATIONS FOR RESIDENTIAL DEVELOPMENT WITH SEPTIC TANK SEWAGE DISPOSAL ON LOTS ONE ACRE OR MORE IN SIZE





Approximately 39 percent of the area of the Rock River watershed is covered by soils poorly suited for residential development on lots having an area of one acre or more and not served by public sanitary sewerage facilities. The inherent limitations of these soils for septic tank sewage disposal systems cannot be overcome simply by the provision of larger lots, and the use of such systems on these soils, which cannot absorb the sewage effluent, ultimately results in surface ponding and runoff of partially treated wastes into nearby watercourses.

Source: U. S. Soil Conservation Service and SEWRPC.

Map 84 (continued)

WAUKESHA COUNTY

WALWORTH COUNTY

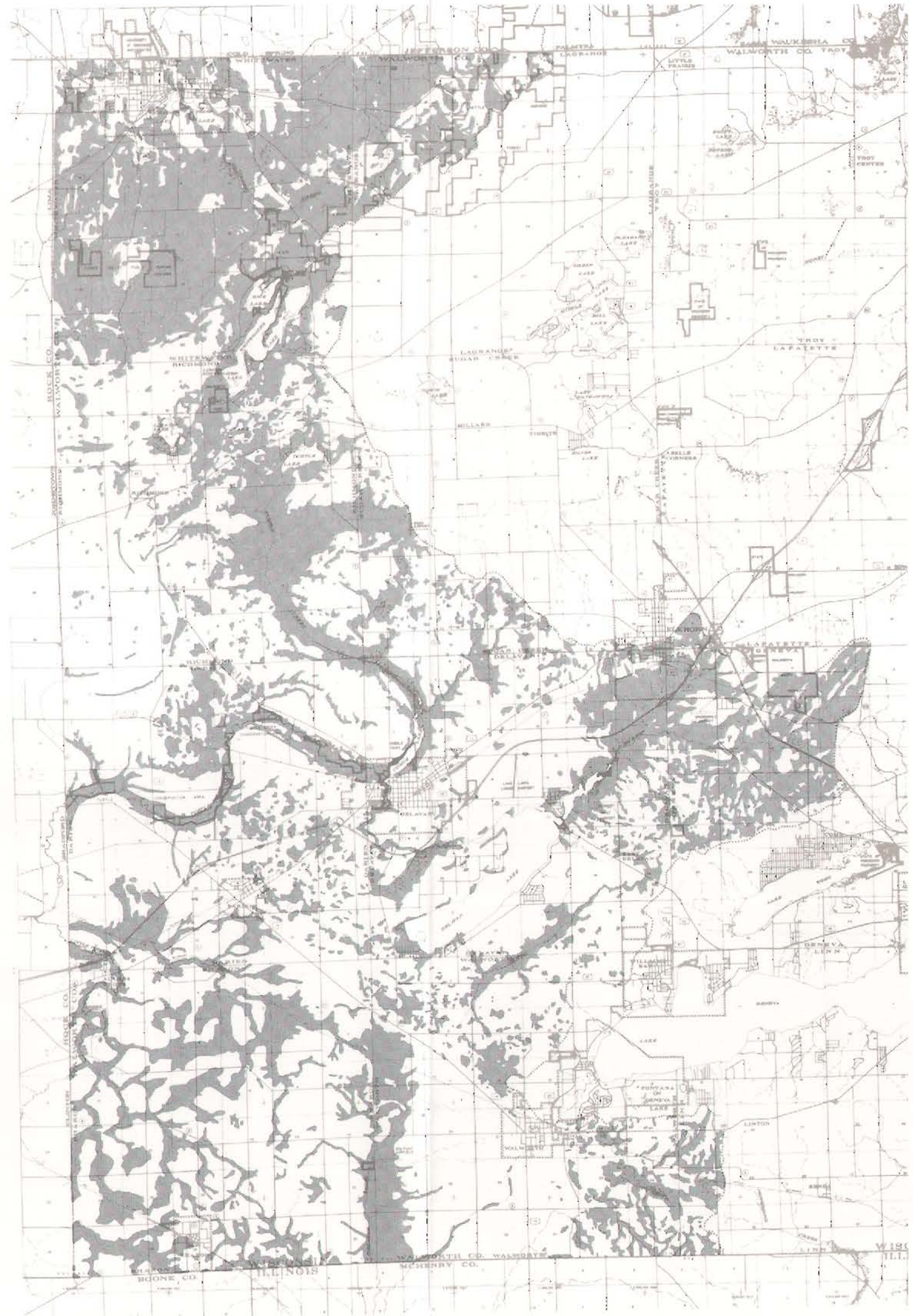


Table 114

SELECTED CHARACTERISTICS OF PRIVATELY OWNED WASTEWATER TREATMENT FACILITIES IN THE ROCK RIVER WATERSHED: 1975

Name	Civil Division Location	Type of Land Use Served	Type of Wastewater	Type of Treatment Provided	Disposal of Effluent	Reported Average Annual Hydraulic Discharge Rate (gallons per day)[a]	Average Hydraulic Design Capacity (gallons per day)	Reported Maximum Monthly Hydraulic Discharge Rate (gallons per day)[a]
WALWORTH COUNTY								
Kikkomen Foods, Inc.	Town of Walworth	Industrial	Process and Sanitary	Aerobic Digestor and Lagoon	Soil Absorption	240,000	N/A	264,000
Lakeland Nursing Home (Walworth County Institutions)	Town of Geneva	Institutional	Sanitary	Activated Sludge and Lagoon	Jackson Creek	80,000	230,000	N/A
Lake Lawn Lodge	Town of Delavan	Recreational	Sanitary	Activated Sludge	Delavan Lake	69,000	100,000	103,000
Libby, McNeil, and Libby, Inc. Outfall 1	Town of Darien	Industrial	Process	Lagoon and Spray Irrigation	Soil Absorption	1,100,000	N/A	1,700,000
Outfall 2			Sanitary	Septic System	Soil Absorption	10,000	N/A	10,000
Walworth County Correctional Center (not in operation)	Town of Geneva	Institutional	Sanitary	Activated Sludge and Lagoon	Tributary of Jackson Creek	--	N/A	--
WASHINGTON COUNTY								
Libby, McNeill and Libby, Inc.	City of Hartford	Industrial	Process	Lagoon	Hartford Sewage Treatment Plant	458,000	N/A	763,000
National Farmers Organization—Slinger Transfer Station	Town of Polk	Industrial	Washwater	Ridge and Furrow and Septic Tank	Soil Absorption	N/A	N/A	5,500
Pike Lake State Park	Town of Hartford	Recreational	Sanitary	Lagoon	Soil Absorption	N/A	N/A	N/A
WAUKESHA COUNTY								
Ethan Allen School	Town of Delafield	Institutional	Sanitary	Contact Stabilization and Lagoon	Soil Absorption	59,000	165,000	86,000
Gigas Hillside Apartments	Town of Delafield	Residential	Sanitary	Lagoon and Activated Sludge	Soil Absorption	N/A	20,000	N/A
St. John's Military Academy	City of Delafield	Institutional	Sanitary	Septic System and Lagoon	Bark River	30,000[b]	75,000	N/A

NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data were obtained, in order of priority, from: quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System or under Section 101 of the Wisconsin Administrative Code or from the Wisconsin Pollutant Discharge Elimination System permit itself. In some cases when 12 months of flow data were not reported, the average annual and maximum monthly hydraulic discharge rates were estimated from the available monthly discharge data or from the flow data as reported in the permit.*

[b] *Data obtained from 1970 sample reported in Wisconsin Department of Natural Resources Report of Lower Rock River Pollution Investigation Survey, 1971.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Inc., Lakeland Nursing Home, Lake Lawn Lodge, Libby, McNeill and Libby, Inc., and Walworth County Correction Center (not in operation) in Walworth County; Libby, McNeill and Libby, Inc., National Farmers Organization—Slinger Transfer Station, and Pike Lake State Park in Washington County; and Ethan Allen School, Gigas Hillside Apartments, and St. John's Military Academy in Waukesha County. Selected data on these 11 privately owned wastewater treatment facilities are presented in Table 114, and the locations of these facilities are shown on Map 81. Of the 12 publicly and 11 privately operated sewage treatment facilities, 16 facilities discharge effluent directly to various tributaries of the Rock River and seven dischargers utilize soil absorption systems.

Sanitary Sewerage System Flow Relief Points

In 1975, there were 16 known sanitary sewer flow relief devices in the watershed, as listed in Table 115, and shown on Map 81. All 16 of these flow relief devices are sanitary sewerage system bypasses. Of the 16 devices, five discharge directly to Whitewater Creek; two discharge directly to Lac La Belle, Turtle Creek, and the Bark River; and one each discharge directly to Little Turtle Creek, Piscasaw Creek, Jackson Creek, the Oconomowoc River, and Fowler Lake.

Other Known Point Sources

A total of 24 other known point sources of pollution were identified in the watershed in 1975. These other point sources consisted primarily of 26 outfalls through

Table 115

KNOWN SANITARY SEWERAGE SYSTEM FLOW RELIEF DEVICES IN THE ROCK RIVER WATERSHED BY RECEIVING STREAM AND CIVIL DIVISION: 1975

Receiving Stream	Civil Division	Combined Sewer Outfalls	Other Flow Relief Devices				Total
			Crossovers	Bypasses	Relief Pumping Stations	Portable Pumping Stations	
Turtle Creek	City of Delavan	0	0	1	0	0	1
Turtle Creek	Village of Darien	0	0	1	0	0	1
Little Turtle Creek	Village of Sharon	0	0	1	0	0	1
Piscasaw Creek	Village of Walworth	0	0	1	0	0	1
Jackson Creek	City of Elkhorn	0	0	1	0	0	1
Whitewater Creek	City of Whitewater	0	0	5	0	0	5
Bark River	Village of Hartland	0	0	1	0	0	1
Bark River	Village of Dousman	0	0	1	0	0	1
Oconomowoc River	City of Oconomowoc	0	0	1	0	0	1
Lac La Belle	City of Oconomowoc	0	0	2	0	0	2
Fowler Lake	City of Oconomowoc	0	0	1	0	0	1
Total	-	0	0	16	0	0	16

Source: SEWRPC.

which industrial cooling, process, rinse, and wash waters were discharged directly or indirectly to the surface water system. Of these, 12, or 45 percent, were identified as discharging only cooling water. The remaining 15, or 55 percent, were discharging other types of wastewaters. Industrial wastewater enters the Rock River and its major tributaries directly through industrial waste outfalls or indirectly through drainage ditches and storm sewers. Table 116 summarizes by receiving stream and civil division the characteristics of these other point sources, and Map 81 shows their locations. Twenty of these other point source outfalls discharge wastes to the various tributaries of the Rock River either directly or indirectly while the remaining six outfalls utilize soil absorption systems.

Privately Owned Onsite Sanitary Wastewater Treatment

In addition to being provided through the centralized sanitary sewerage service within the in-Region portion of the watershed, sanitary wastewater treatment and disposal is provided through approximately 14,730 privately owned onsite sewage disposal systems, consisting of 14,699 septic tanks, 30 holding tanks, and 1 mound system. These systems serve a total resident population of about 50,900 persons, or about 52 percent of the total in-Region resident population of the watershed. Of this total, about 23,100 persons, or about 45 percent, resided in concentrated areas of urban development having at least 32 housing units in a U. S. Public Land Survey quarter section. These scattered quarter sections of urban land use concentration totaled about 36 square miles of urban land use, or about 6 percent of the in-Region portion of the watershed.

Urban Storm Water Management Systems

As noted in Table 112, land cover categories associated with urban land uses as of 1975 comprised about 34,600 acres, or about 8 percent of the Rock River watershed. The most important urban land cover category was residential land, with about 4 percent.

There were a total of seven known urban storm water drainage systems providing service to the subareas of the Rock River watershed within the Region in 1975. These included the systems operated by the Cities of Delavan, Elkhorn, Hartford, Oconomowoc, and Whitewater and the Villages of Hartland and Slinger. The City of Oconomowoc and the Village of Hartland were unable to provide a copy of a map of their systems. Together, the five storm water drainage systems for which mapping was available have a tributary drainage area of about 5.6 square miles, or about 1 percent of the total area of the watershed. Included within this storm water drainage area are a total of 67 known storm water outfalls ranging in size from 12 to 78 inches in diameter. There were no known storm water pumping facilities or storm water storage facilities in the watershed. The total annual average discharge from these outfalls is estimated to be about 282 million gallons per year occurring on the average in 65 events.

Rural Storm Water Runoff

About 402,900 acres, or 92 percent of the total area of the watershed, are devoted to rural land use activities. The most important rural land cover categories were row crops with 42 percent, hay with 14 percent, other open space with 10 percent, woodlands with

Table 116

CHARACTERISTICS OF OTHER KNOWN POINT SOURCES OF WATER POLLUTION IN THE ROCK RIVER WATERSHED: 1975

Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average Annual Hydraulic Discharge Rate (gallons per day)[a]	Reported Maximum Monthly Hydraulic Discharge Rate (gallons per day)[a]
WALWORTH COUNTY								
A. K. Rubber Products Company, Inc.	3069	City of Elkhorn	Cooling	None	1	Tributary of Jackson Creek via Storm Sewer	1,600	N/A
Allied Music Corporation	7696	City of Elkhorn	Process	Lagoon	1	Soil Absorption	3,000	N/A
Alpha Cast, Inc.	3321	City of Whitewater	Cooling	None	1	Whitewater Creek	125,000	150,000
Buncker Ramo Corporation	3829	City of Delavan	Cooling	None	8	Tributary of Swan Creek via Storm Sewer	2,200	3,300
Darien Waterworks	4941	Village of Darien	Filter Backwash	Sedimentation Tank	1	Tributary of Darien Creek via Storm Sewer	Intermittent	Intermittent
Elkhorn Light & Water Commission	4941	City of Elkhorn	Filter Backwash	N/A	1	Tributary of Jackson Creek via Storm Sewer	40,000	40,000
			Process	N/A	2	Tributary of Jackson Creek via Storm Sewer	10,000	10,000
Frank Holten and Company	3931	City of Elkhorn	Process	Settling Basin, pH, Adjustment, and Lagoon	1	Soil Absorption	40,000	40,000
Getzen Company, Inc.	3931	City of Elkhorn	Process	Lagoon	1	Soil Absorption	N/A	10,000
Hawthorn Melody Farms Dairy	2026	Town of Whitewater	Cooling	None	1	Whitewater Creek	1,157,000	1,458,000
			Cooling	None	2	Whitewater Creek	123,000	163,000
J. W. Reichel & Sons, Inc.	3369	City of Elkhorn	Cooling	None	1	Tributary of Jackson Creek via Storm Sewer	3,500	4,500
Sharon Foundry, Inc.	3321	Town of Sharon	Cooling	N/A	1	Little Turtle Creek via Storm Sewer	750	750
U. S. Gypsum Company	3296	Village of Walworth	Boiler Blowdown	Lagoon	1	Soil Abosrption	35,000	N/A
Whitewater Water Utility	4941	City of Whitewater	Backwash	N/A	1	Whitewater Creek via Storm Sewer	92,000	120,000
WASHINGTON COUNTY								
International Stamping Company, Inc.	3469	City of Hartford	Cooling	None	1	Rubicon River	154,000	217,000
Oak Cheese Factory	2022	Town of Hartford	Washwater	Septic System and Lagoon	1	Soil Absorption	N/A	400
W. B. Place and Company, Inc.	3111	City of Hartford	Process	Settling Basin, Screening, Sludge, and Dewatering	1	Rubicon River	200	400
Wissota Sand and Gravel Company, Inc.	1442	Town of Richfield	Washwater	N/A	1	Bark River	50,000	N/A
WAUKESHA COUNTY								
Carnation Company—Can Division	3411	City of Oconomowoc	Cooling	None	1	Oconomowoc River via Storm Sewer	18,200	19,500
Carnation Company—Instant Products Division	2034	City of Oconomowoc	Cooling and Boiler	None	1	Oconomowoc River via Storm Sewer	1,234,000	1,554,000
Essential Chemicals Corporation	2841	Village of Merton	Cooling	None	1	Bark River via Storm Sewer	500	N/A
Hartland Plastics, Inc.	2821	Village of Hartland	Cooling	Lagoon	1	Soil Absorption	3,000	3,000
La Belle Industries, Inc.	3651	City of Oconomowoc	Cooling	None	1	Oconomowoc River	17,500	21,000
State Sand and Gravel	1442	Village of North Lake	Washwater	Lagoon	1	Little Oconomowoc River	670,000	670,000
U. S. Gypsum Company—Fiberesin Plastics Division	2621	City of Oconomowoc	Cooling and Boiler Blowdown	N/A	1	Soil Absorption	3,500	5,000

NOTE: N/A indicates data not available.

[a] Unless specifically noted otherwise, data were obtained, in order of priority, from: quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System or under Section 101 of the Wisconsin Administrative Code or from the Wisconsin Pollutant Discharge Elimination System permit itself. In some cases when 12 months of flow data were not reported, the average annual and maximum monthly hydraulic discharge rates were estimated from the available monthly discharge data or from the flow data as reported in the permit.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 117

SUMMARY OF ESTIMATED AVERAGE ANNUAL POLLUTANT LOADINGS IN THE ROCK RIVER WATERSHED: 1975

Source	Extent[a]	Parameter	Load[b] Average Year Total Estimated Loading	Percent
Urban Point Sources				
Municipal Sewage Treatment Plants	12	Total Nitrogen	306,390.0	3.9
	12	Total Phosphorus	141,430.0	12.9
	12	Biochemical Oxygen Demand	615,410.0	3.3
	12	Fecal Coliform	190,000.0	0.0
	12	Sediment	425.0	0.0
Private Sewage Treatment Plants	5	Total Nitrogen	8,200.0	0.1
	5	Total Phosphorus	3,830.0	0.3
	5	Biochemical Oxygen Demand	25,400.0	0.1
	5	Fecal Coliform	410,000.0	0.1
	5	Sediment	10.0	0.0
Combined Sewer Overflow	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Industrial Discharges	17	Total Nitrogen	170.0	0.0
	17	Total Phosphorus	30.0	0.0
	17	Biochemical Oxygen Demand	2,990.0	0.0
	17	Fecal Coliform	0.0	0.0
	17	Sediment	5.0	0.0
Sanitary Sewer Flow Relief Devices	16	Total Nitrogen	400.0	0.0
	16	Total Phosphorus	130.0	0.0
	16	Biochemical Oxygen Demand	4,000.0	0.0
	16	Fecal Coliform	610,000.0	0.1
	16	Sediment	0.0	0.0
Urban Point Source Totals		Total Nitrogen	315,160.0	4.0
		Total Phosphorus	145,420.0	13.2
		Biochemical Oxygen Demand	647,800.0	3.5
		Fecal Coliform	1,210,000.0	0.3
		Sediment	440.0	0.0
Urban Diffuse Sources				
Residential	17896	Total Nitrogen	71,580.0	0.9
	17896	Total Phosphorus	5,730.0	0.5
	17896	Biochemical Oxygen Demand	434,870.0	2.4
	17896	Fecal Coliform	2,863,360.0	0.6
	17896	Sediment	4,875.0	0.4
Commercial	2750	Total Nitrogen	24,750.0	0.3
	2750	Total Phosphorus	2,060.0	0.2
	2750	Biochemical Oxygen Demand	268,400.0	1.5
	2750	Fecal Coliform	907,500.0	0.2
	2750	Sediment	1,025.0	0.1
Industrial	1241	Total Nitrogen	10,420.0	0.1
	1241	Total Phosphorus	870.0	0.1
	1241	Biochemical Oxygen Demand	45,790.0	0.2
	1241	Fecal Coliform	769,420.0	0.2
	1241	Sediment	605.0	0.0
Extractive	1595	Total Nitrogen	95,700.0	1.2
	1595	Total Phosphorus	71,780.0	6.5
	1595	Biochemical Oxygen Demand	191,400.0	1.0
	1595	Fecal Coliform	0.0	0.0
	1595	Sediment	119,625.0	8.8
Transportation	1261	Total Nitrogen	27,630.0	0.4
	1261	Total Phosphorus	1,980.0	0.2
	1261	Biochemical Oxygen Demand	177,170.0	1.0
	1261	Fecal Coliform	734,320.0	0.2
	1261	Sediment	23,610.0	1.7
Recreation	4232	Total Nitrogen	13,230.0	0.2
	4232	Total Phosphorus	490.0	0.0
	4232	Biochemical Oxygen Demand	5,500.0	0.0
	4232	Fecal Coliform	92,412.0	0.0
	4232	Sediment	890.0	0.1
Construction	5606	Total Nitrogen	336,360.0	4.3
	5606	Total Phosphorus	252,270.0	23.0
	5606	Biochemical Oxygen Demand	672,720.0	3.7
	5606	Fecal Coliform	0.0	0.0
	5606	Sediment	420,450.0	30.8
Septic Systems	50942	Total Nitrogen	71,320.0	0.9
	50942	Total Phosphorus	16,810.0	1.5
	50942	Biochemical Oxygen Demand	1,039,220.0	5.7
	50942	Fecal Coliform	12,735,500.0	2.8
	50942	Sediment	180.0	0.0
Urban Diffuse Source Totals		Total Nitrogen	650,990.0	8.3
		Total Phosphorus	351,990.0	32.1
		Biochemical Oxygen Demand	2,835,070.0	15.4
		Fecal Coliform	18,102,512.0	4.0
		Sediment	571,260.0	41.8
Urban Source Totals		Total Nitrogen	966,150.0	12.3
		Total Phosphorus	497,410.0	45.3
		Biochemical Oxygen Demand	3,482,870.0	19.0
		Fecal Coliform	19,312,512.0	4.3
		Sediment	571,700.0	41.8
Rural Diffuse Sources				
Livestock Operations	67300	Total Nitrogen	1,911,320.0	24.3
	67300	Total Phosphorus	444,180.0	40.5
	67300	Biochemical Oxygen Demand	7,483,760.0	40.7
	67300	Fecal Coliform	430,720,000.0	95.7
	67300	Sediment	23,555.0	1.7
Cropland, Pasture, and Unused Rural Land	311886	Total Nitrogen	4,776,180.0	60.6
	311886	Total Phosphorus	143,080.0	13.0
	311886	Biochemical Oxygen Demand	4,905,240.0	26.7
	311886	Fecal Coliform	0.0	0.0
	311886	Sediment	761,860.0	55.7
Silvicultural	41366	Total Nitrogen	95,140.0	1.2
	41366	Total Phosphorus	5,790.0	0.5
	41366	Biochemical Oxygen Demand	190,280.0	1.0
	41366	Fecal Coliform	273,015.6	0.1
	41366	Sediment	5,190.0	0.4
Air Pollution to Surface Water	14256	Total Nitrogen	126,880.0	1.6
	14256	Total Phosphorus	7,130.0	0.6
	14256	Biochemical Oxygen Demand	2,309,470.0	12.6
	14256	Fecal Coliform	0.0	0.0
	14256	Sediment	4,740.0	0.3
Rural Diffuse Soruce Totals		Total Nitrogen	6,909,520.0	87.7
		Total Phosphorus	600,180.0	54.7
		Biochemical Oxygen Demand	14,888,750.0	81.0
		Fecal Coliform	430,993,015.6	95.7
		Sediment	795,345.0	58.2
Diffuse Source Totals		Total Nitrogen	7,560,510.0	96.0
		Total Phosphorus	952,170.0	86.8
		Biochemical Oxygen Demand	17,723,820.0	96.5
		Fecal Coliform	449,095,527.6	99.7
		Sediment	1,366,605.0	100.0
Total Sources		Total Nitrogen	7,875,670.0	100.0
		Total Phosphorus	1,097,590.0	100.0
		Biochemical Oxygen Demand	18,371,620.0	100.0
		Fecal Coliform	450,305,527.6	100.0
		Sediment	1,367,045.0	100.0

[a] *Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.*

[b] *Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year.*

Source: SEWRPC.

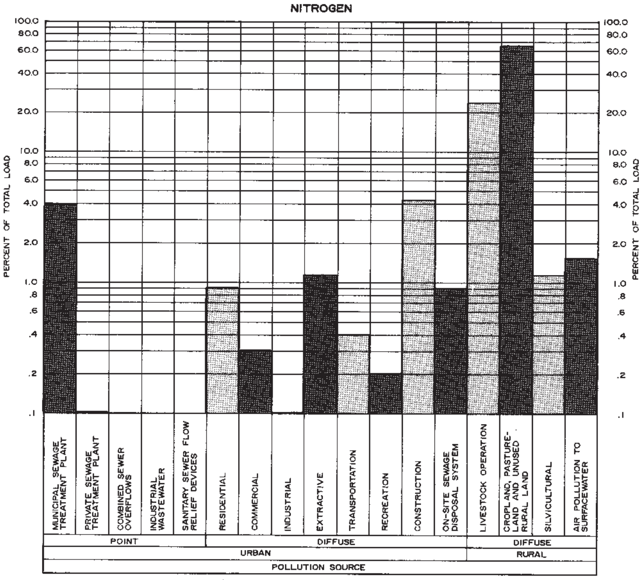
9 percent, and wetlands, swamps, and marshes with 8 percent of the watershed. As of May 1975, there were an estimated 692 domestic livestock operations—operations of 25 or more equivalent animal units—having a total of 67,300 equivalent animal units within the watershed. Of the 692 operations, 244, or 35 percent, were located within 500 feet of the surface water system of the watershed.

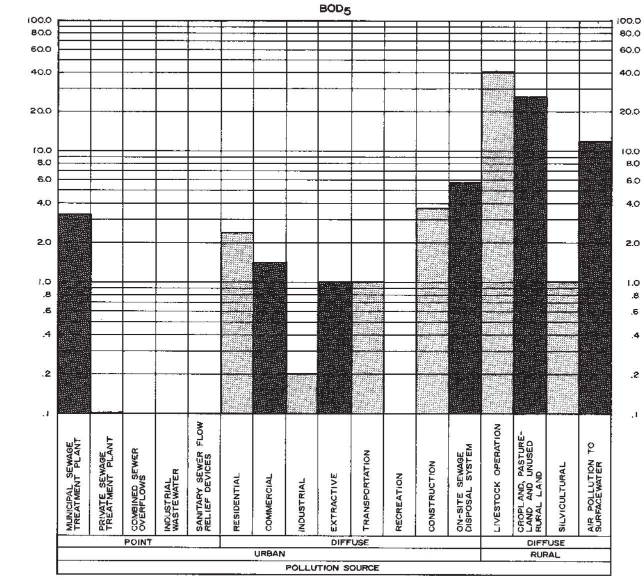
Pollution Loadings

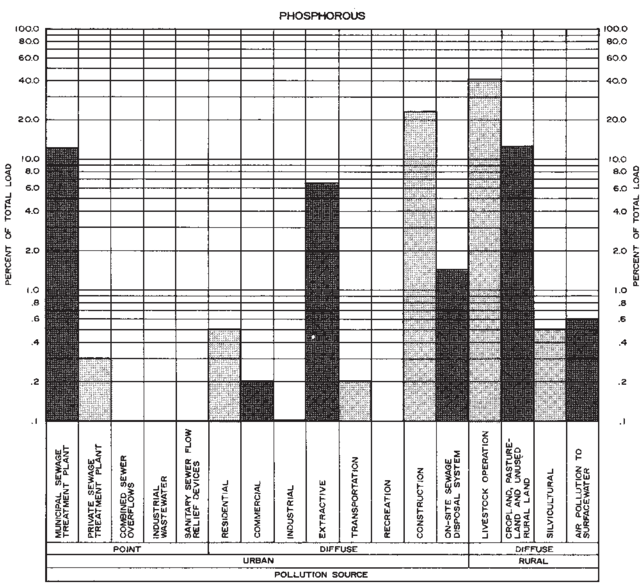
A summary of the estimated average annual pollution loadings in the Rock River watershed is presented in Table 117 and depicted in Figure 40. Urban sources of pollution are estimated to contribute 12 percent of the nitrogen, 45 percent of the phosphorus, 19 percent of the biochemical oxygen demand, 4 percent of the fecal coliform, and 42 percent of the sediment which occur as water pollutants in the Rock River watershed. Of the urban contribution, point sources of pollution are estimated to contribute 33 percent of the nitrogen, 29 percent of the phosphorus, 19 percent of the bio-

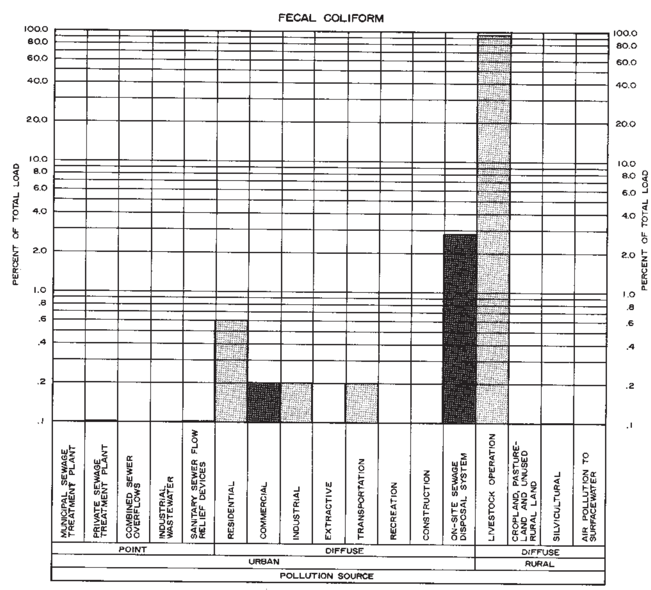
Figure 40

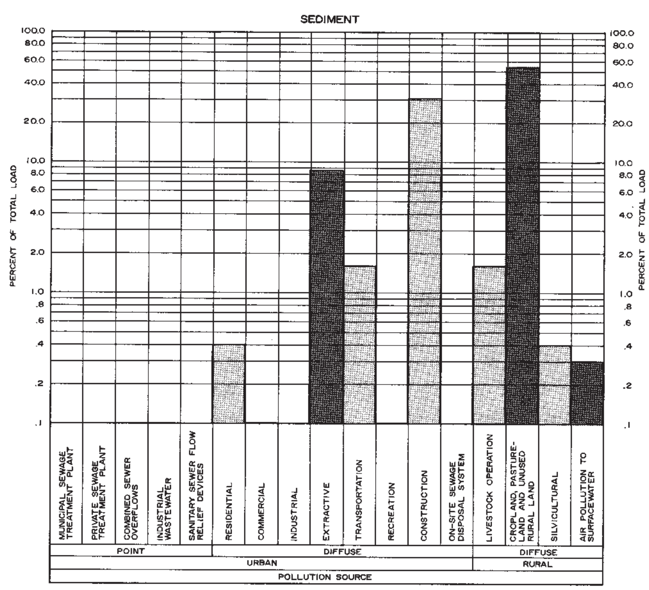
SUMMARY OF ESTIMATED AVERAGE ANNUAL POLLUTANT LOADINGS IN THE ROCK RIVER WATERSHED: 1975











Source: SEWRPC.

chemical oxygen demand, 6 percent of the fecal coliform, and almost none of the sediment. Diffuse sources—including the estimated septic tank and construction-related contributions in the drainage area—account for the remaining 67 percent of the nitrogen, 71 percent of the phosphorus, 81 percent of the biochemical oxygen demand, 94 percent of the fecal coliform, and almost all of the sediment contributed from urban sources.

Of the total pollutant loads, rural pollution sources are estimated to contribute the remaining 88 percent of the nitrogen, 55 percent of the phosphorus, 81 percent of the biochemical oxygen demand, 96 percent of the fecal coliform, and 58 percent of the sediment which occur as water pollutants in the watershed. Of the rural pollution sources, none are point sources, since none of the livestock operations in the watershed are of sufficient size to fall within the definition used in this report. Other livestock feeding operations—inclusive of the disposal of manure on croplands—are estimated to contribute 28 percent of the nitrogen, 74 percent of the phosphorus, 50 percent of the biochemical oxygen demand, almost all of the fecal coliform, and 3 percent of the sediment from rural sources. The remainder of the estimated rural pollution load, or 72 percent of the nitrogen, 26 percent of the phosphorus, 50 percent of the biochemical oxygen demand, almost none of the fecal coliform, and 97 percent of the sediment, are contributed by other rural diffuse sources, namely storm water runoff from rural land uses and atmospheric loadings to surface waters.

ROOT RIVER WATERSHED

The Root River watershed is a natural surface water drainage unit with 196.9 square miles in areal extent located in the east-central portions of the Region. The boundaries of the basin, together with the locations of the main channels of the Root River and its principal tributaries, are shown on Map 85, along with the locations of the known point sources of pollution and the generalized land uses as of 1975. The main stem of the Root River originates in the City of Greenfield and discharges to Lake Michigan at the City of Racine in Racine County. About 77 percent of the total area of the watershed is still in rural land uses, with about 88 percent of this rural area in agricultural use. Most of the agricultural-related land use is located in the southwest portions of the watershed. Table 118 sets forth the extent and proportion of the major land cover categories within the watershed as they relate to water quality conditions in 1975.

The soils within the Root River watershed are deep to moderately deep silt loams in the eastern parts of Racine, Kenosha, and Milwaukee Counties. Prairie loam soils appear in the western areas of these counties. Soils in Waukesha County generally consist of rolling silt loams or gravelly loams. Parts of Milwaukee County also consist of a clay type soil. Most of the soils are relatively fertile and produce high crop yields if managed correctly. Sediment discharges from these soils may result in high levels of nutrients in stream waters.

Table 118

AREAL EXTENT OF WATER QUALITY-RELATED LAND COVER IN THE ROOT RIVER WATERSHED: 1975

Land Cover[a]	Square Miles	Acres	Percent
Urban			
Residential	26.17	16,751	13.42
Commercial[b]	4.42	2,830	2.27
Industrial			
Manufacturing	0.10	580	0.47
Landfills and Dumps	0.42	271	0.22
Extractive	0.69	441	0.35
Transportation			
Streets and Highways	2.05	1,309	1.05
Airfields	0.37	237	0.19
Railroad Yards and Terminals	0.00	1	0.00
Recreation			
Golf Courses	3.79	2,424	1.94
Parks and Other Recreation	2.54	1,628	1.30
Land Under Development			
Residential[c]	3.64	2,332	1.87
Commercial	0.06	41	0.03
Industrial	--	--	--
Transportation	--	--	--
Recreation	0.07	46	0.00
Rural			
Agricultural			
Small Grains	9.78	6,259	5.02
Hay	10.34	6,618	5.30
Row Crops	83.50	53,438	42.82
Specialty Crops	3.61	2,313	1.85
Sod Farm	0.55	349	0.28
Other Open Space[d]	23.86	15,272	12.24
Silvicultural			
Woodlands	9.46	6,054	4.85
Orchards and Nurseries	0.86	553	0.44
Natural and Man-Made Water Areas—Subject to Atmospheric Pollutant Contributions			
Ponds, Lakes, and Streams	0.70	447	0.36
Wetlands, Swamps, and Marshes	7.17	4,590	3.68
Total	194.15	124,784	100.00

[a] *These special land cover categories, defined primarily according to their imperviousness and vegetative cover characteristics and effects on the quality of storm water runoff, were delineated at a scale of 1" = 400' on aerial photographs taken in May 1975 and were measured to the nearest full acre, using dot-counting overlays. The total acreages measured within hydrologic subbasins were then adjusted to the preliminary control totals measured by digitizer from base maps of hydrologic subbasins at a scale of 1" = 2000'. Both the "square miles" and the "percent" shown above were then computed and rounded to the nearest hundredth (0.01) of a percent. The final control total for the Root River watershed is indicated on Map 85.*

[b] *Includes: retail, communication, utilities, administrative, and institutional land uses.*

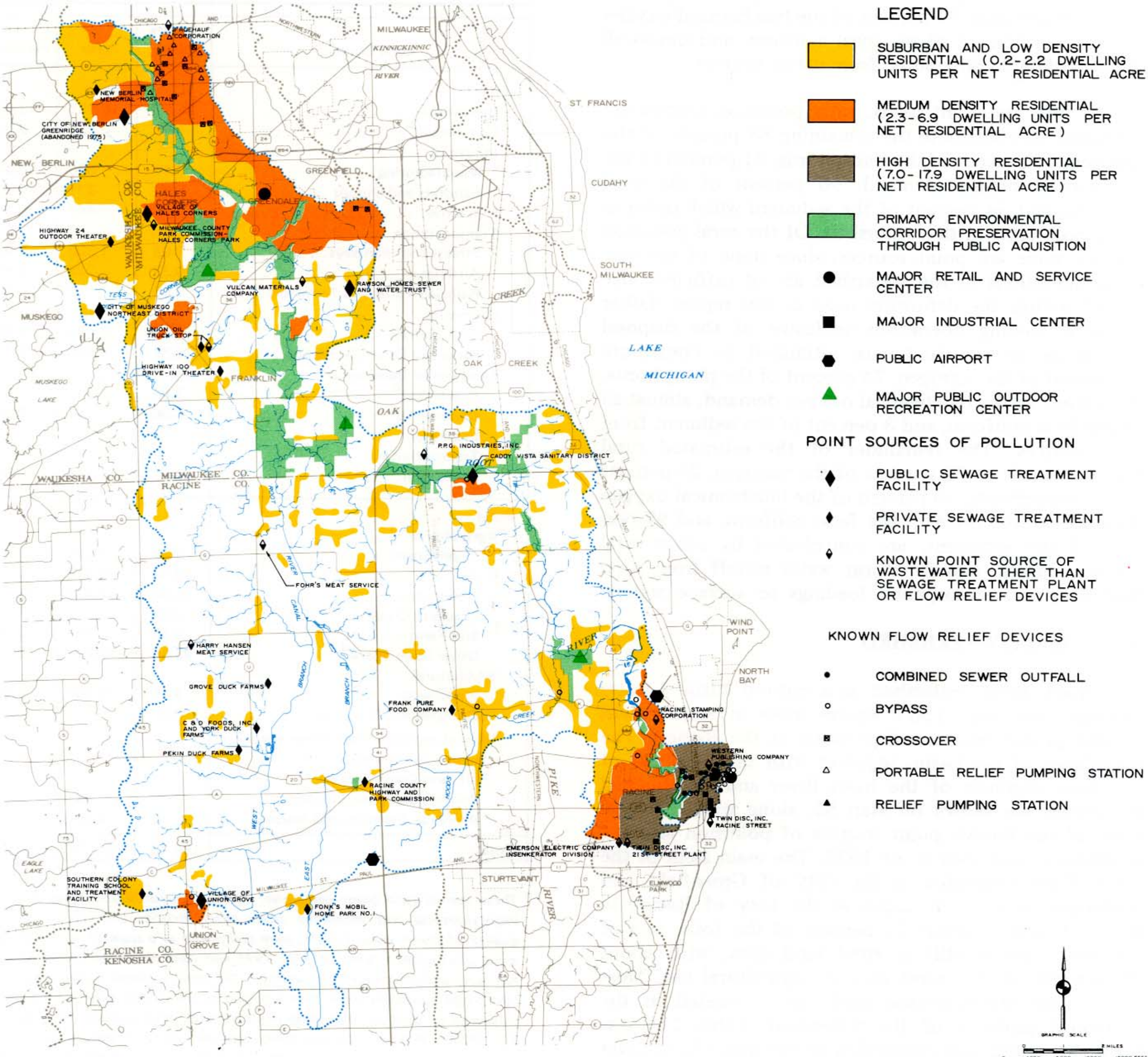
[c] *Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.*

[d] *Includes: pasture, unused urban and rural lands.*

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service; County Soil and Water Conservation Districts; University of Wisconsin-Extension Service; and SEWRPC.

Map 85

THE LOCATION, BOUNDARIES, AND MAJOR STREAMS OF THE ROOT RIVER WATERSHED—SHOWING POINT SOURCES OF POLLUTION AND GENERALIZED LAND USES: 1975



The Root River watershed is about 197 square miles in areal extent, or about 7 percent of the total area of the Region. The water quality in the watershed is affected by the various land uses as well as by the five public wastewater treatment plants, 11 private wastewater treatment plants, 61 flow relief devices, and 13 other point sources of wastewater as shown.

Source: SEWRPC.

Table 119

SELECTED CHARACTERISTICS OF MUNICIPAL SEWAGE TREATMENT PLANTS IN THE ROOT RIVER WATERSHED: 1975

Name	Total Area Served (square miles)	Estimated Total Population Served	Date of Construction and Major Modification	Type of Treatment	Level of Treatment Provided	Disposal of Effluent	Design Capacity: Population[a]	Design Capacity: Average Hydraulic (mgd)	Design Capacity: Peak Hydraulic (mgd)	Design Capacity: Average Organic (pounds of BOD_5 per day)	Design Capacity: Population[a] Equivalent	Existing Loading: Average Hydraulic (mgd)	Existing Loading: Average Per Capita (gpd)
Caddy Vista Sanitary District	0.29	1,000	1956	Trickling Filter	Secondary	Root River	N/A	0.25	0.40	N/A	N/A	0.09	90
Hales Corners Plant	2.99	8,800	1942, 1957	Trickling Filter Disinfection	Secondary Auxiliary	Tributary of Whitnall Park Creek	9,000	0.90	N/A	1,333	6,350	0.52	59
City of Muskego, Northeast District	2.60	6,000	1972	Activated Sludge Phosphorus Removal Disinfection	Secondary Advanced Auxiliary	Tess Corners Creek	5,000	0.50	1.0	1,000	4,760	0.34	57
City of New Berlin Greenridge Plant (Abandoned in 1975)	0.12	800	1966	Activated Sludge	Secondary	Tributary of Whitnall Park Creek	1,000	0.10	N/A	200	955	--	--
Rawson Homes Sewer and Water Trust	0.16	600	1954	Activated Sludge Disinfection	Secondary Auxiliary	Tributary of Whitnall	402	0.04	N/A	67	320	N/A	N/A
Village of Union Grove	0.97	3,200	1937, 1962	Activated Sludge Disinfection	Secondary Auxiliary	West Branch Root River Canal	3,000	0.30	0.72	510	2,400	0.43	134

[a] *The population design capacity for a given sewage treatment facility was obtained directly from engineering reports prepared by or for the local unit of government operating the facility and reflects assumptions made by the design engineer. The population equivalent design capacity was estimated by the Commission staff by dividing the design BOD_5 loading in pounds per day, as set forth in the engineering reports, by an estimated per capita contribution of 0.21 pound of BOD_5 per day. If the design engineer assumed a different daily per capita contribution of BOD_5, the population equivalent design capacity will differ from the population design capacity shown in the table.*

Source: SEWRPC.

Particularly important to comprehensive water quality management planning are the soil suitability interpretations for specified types of urban development. Based upon the interpretations of the soil properties, about 22 percent of the watershed is covered by soils that have severe or very severe limitations for residential development with public sanitary sewer service, as shown on Map 86; about 94 percent of the watershed is covered by soils that have severe or very severe limitations for small lot (less than one acre in size) residential development without public sanitary sewer, as shown on Map 87; and about 53 percent of the watershed is covered by soils that have severe or very severe limitations for large lot (one acre or larger in size) residential development, as shown on Map 88.

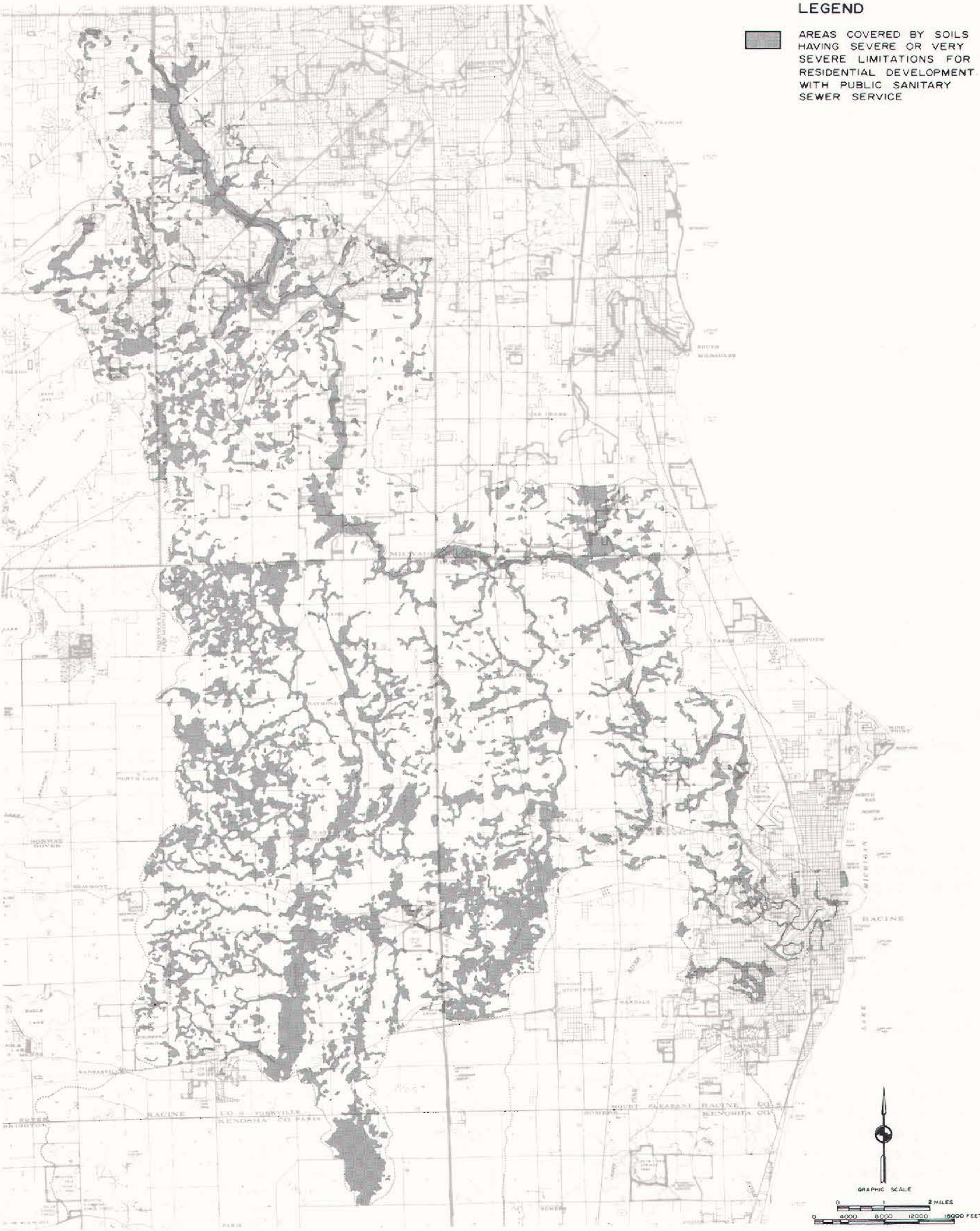
Municipal and Private Sewage Treatment Facilities

In 1975, a total of 14 sanitary sewerage systems or portions thereof served a total area of about 35.3 square miles within the watershed, or about 18 percent of the total area of the watershed, and a total population of about 124,900 persons, or approximately 82 percent of the total resident population of the watershed. Included in this total is the 0.9 square mile, or 0.5 percent of the watershed area, and estimated total of about 8,100 persons, or about 5 percent of the resident population of the watershed, served by combined storm and sanitary sewerage systems.

Five municipally owned sewage treatment plants are located in the Root River watershed. The Hales Corners plant, operated by the Milwaukee Metropolitan Sewerage District, which serves the Village of Hales Corners, and the Rawson Homes Sewer and Water Trust plant, which serves portions of the City of Franklin, discharge treated effluents to tributaries of Whitnall Park Creek; the Caddy Vista Sanitary District, which serves portions of the Town of Caledonia, discharges treated effluents to the Root River directly; the plant which serves the Village of Union Grove discharges treated effluents to the West Branch of the Root River Canal; and the City of Muskego Northeast District plant, which serves portions of the City of Muskego, discharges treated effluents directly to Tess Corners Creek. The City of New Berlin Greenridge plant, which had been discharging treated effluents to a tributary of Whitnall Park Creek, was abandoned in 1975 and its service area was connected to the Milwaukee Metropolitan Sewerage District. Selected information for these municipal sewage treatment plants is set forth in Table 119, and the plant locations are shown on Map 85. In addition to the publicly owned sewage treatment facilities, 11 private wastewater treatment facilities exist in the Root River watershed owned and operated by: Cooper-Dixon (C&D) Duck Farms, Fonk's Mobile Home Park No. 1, Frank's Pure Foods Company, Grove Duck Farms, Highway 100 Drive-In Theater, Highway 24 Outdoor Theater, New Berlin Memorial Hospital, Pekin Duck Farm, Inc., Racine County Highway and Park Commission, Southern Colony Training School and Treatment Facility (center for the developmentally disabled), and Union Oil Truck Stop. Selected data on these 11 privately owned wastewater treatment facilities are presented in Table 120, and their locations are shown on Map 85. Of the five publicly and

Map 86

SUITABILITY OF SOILS FOR RESIDENTIAL DEVELOPMENT WITH PUBLIC SANITARY SEWER SERVICE IN THE ROOT RIVER WATERSHED

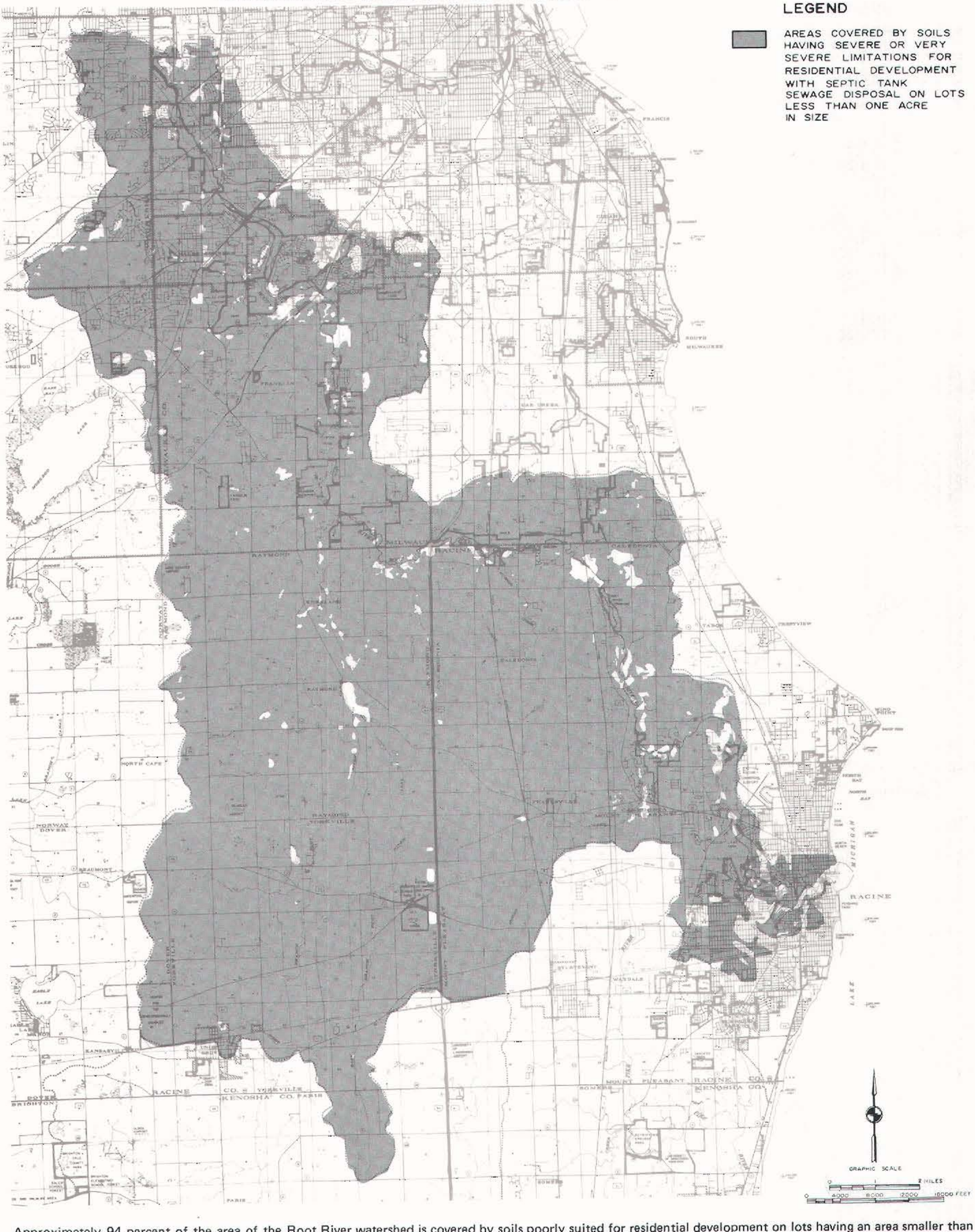


Of particular importance in comprehensive water quality planning is the recognition of the limitations inherent in the soil resource base. About 22 percent of the area of the Root River watershed is covered with soils which are poorly suited for residential development with public sanitary sewer service or, more precisely, residential development of any kind. These soils, which include wet soils having a high water table or poor drainage, organic soils which are poorly drained and provide poor foundation support, and soils which have a flood hazard, are especially prevalent in the riverine areas of the watershed.

Source: U. S. Soil Conservation Service and SEWRPC.

Map 87

SUITABILITY OF SOILS FOR SMALL LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE IN THE ROOT RIVER WATERSHED

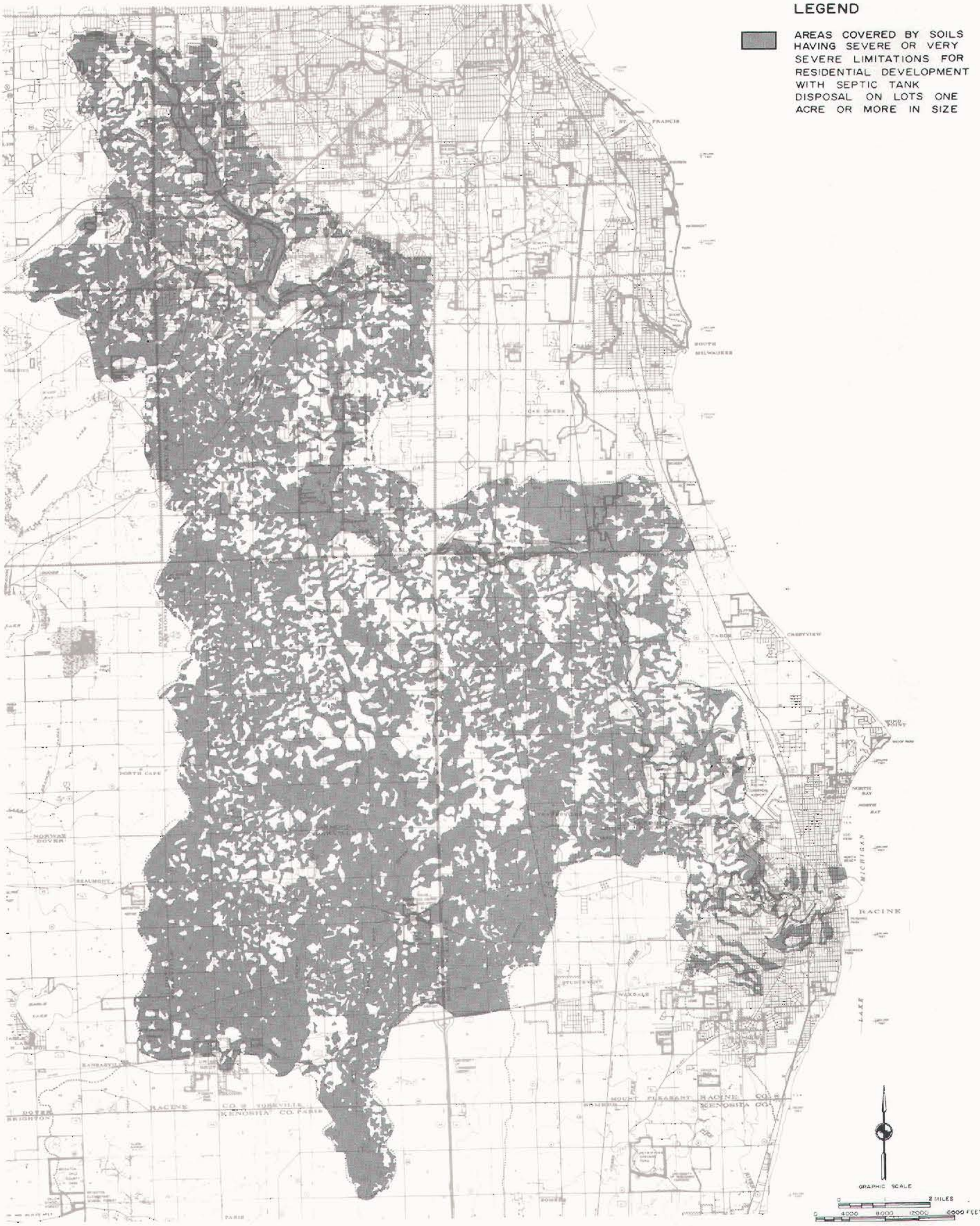


Approximately 94 percent of the area of the Root River watershed is covered by soils poorly suited for residential development on lots having an area smaller than one acre and not served by public sanitary sewerage facilities. Reliance on septic tank sewage disposal systems in these areas, which are covered by relatively impervious soils or are subject to seasonally high water tables, can only result in eventual malfunctioning of such systems and the consequent intensification of water pollution and public health problems in the watershed.

Source: U. S. Soil Conservation Service and SEWRPC.

Map 66

SUITABILITY OF SOILS FOR LARGE LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE IN THE ROOT RIVER WATERSHED



Approximately 53 percent of the area of the Root River watershed is covered by soils poorly suited for residential development on lots having an area of one acre or more and not served by public sanitary sewerage facilities. The inherent limitations of these soils for septic tank sewage disposal systems cannot be overcome simply by the provision of larger lots, and the use of such systems on these soils, which cannot absorb the sewage effluent, ultimately results in surface ponding and runoff of partially treated wastes into nearby watercourses.

Source: U. S. Soil Conservation Service and SEWRPC.

Table 120

SELECTED CHARACTERISTICS OF PRIVATELY OWNED WASTEWATER TREATMENT FACILITIES IN THE ROOT RIVER WATERSHED: 1975

Name	Civil Division Location	Type of Land Use Served	Type of Wastewater	Type of Treatment Provided	Disposal of Effluent	Reported Average Annual Hydraulic Discharge Rate (gallons per day)[a]	Average Hydraulic Design Capacity (gallons per day)	Reported Maximum Monthly Hydraulic Discharge Rate (gallons per day)[a]
MILWAUKEE COUNTY								
Highway 100 Drive-In Theater	City of Franklin	Commercial	Sanitary	Septic Tank, Sand Filter, and Lagoon	*Soil Absorption*	N/A	6,000	N/A
Union Oil Truck Stop	City of Franklin	Commercial	Sanitary	Extended Aeration	Tributary of Root River	N/A	10,000	N/A
RACINE COUNTY								
C & D Foods Duck Farms	Town of Yorkville	Industrial	Process and Sanitary	Lagoon and Activated Sludge	Tributary of West Branch Root River Canal	269,900	N/A	322,600
Fonk's Mobile Park No. 1	Town of Yorkville	Residential	Sanitary	Extended Aeration and Lagoon	East Branch Root River Canal	13,000	15,000	N/A
Frank's Pure Food Company	Town of Caledonia	Industrial	Process	Screening and Lagoon	Hoods Creek via Drainage Tile	70,000	N/A	70,000
Grove Duck Farm, Inc.	Town of Raymond	Industrial	Process and Sanitary	Lagoon	Tributary of West Branch Root River Canal	25,000	N/A	40,000
Pekin Duck Farm	Town of Yorkville	Industrial	Process	Lagoon and Spray Irrigation	Soil Absorption	6,000	50,000	90,000
Racine County Highway and Park Commission	Town of Yorkville	Governmental	Sanitary	Activated Sludge and Lagoon	Hoods Creek	N/A	10,000	N/A
Southern Colony Training School and Treatment Facility (Center for Developmentally Disabled)	Town of Dover	Institutional	Sanitary	Contact Stabilization, and Lagoon	West Branch Root River Canal	180,000	445,000	210,000
WAUKESHA COUNTY								
Highway 24 Outdoor Theater	City of New Berlin	Commercial	Sanitary	Septic Tank and Lagoon	Soil Absorption	N/A	Intermittent	Intermittent
New Berlin Memorial Hospital	City of New Berlin	Institutional	Sanitary	Activated Sludge and Lagoon	Root River via Drainage Ditch	26,000	19,000	37,000

NOTE: N/A indicates data not available.

[a] Unless specifically noted otherwise, data were obtained, in order of priority, from: quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System or under Section 101 of the Wisconsin Administrative Code or from the Wisconsin Pollutant Discharge Elimination System permit itself. In some cases when 12 months of flow data were not reported, the average annual and maximum monthly hydraulic discharge rates were estimated from the available monthly discharge data or from the flow data as reported in the permit.

Source: Wisconsin Department of Natural Resources and SEWRPC.

11 privately operated sewage treatment facilities, one facility discharges effluent directly to the main stem of the Root River; one discharges to a tributary of the Root River; one discharges to the Root River via a drainage ditch; two discharge to tributaries of Whitnall Park Creek[13]; two discharge to the West Branch of the Root River Canal; two discharge to tributaries of the West Branch of the Root River Canal; one discharges to the East Branch of the Root River Canal; one discharges to Tess Corners Creek; one discharges to Hoods Creek; and one discharges to Hoods Creek via a drainage tile. The remaining three facilities utilize soil absorption systems.

Sanitary Sewerage System Flow Relief Points

In 1975 there were 8 combined sewer outfalls and 53 known sanitary sewer flow relief devices in the watershed, as listed in Table 121 and shown on Map 85. Of the latter, 20 were sanitary sewerage system bypasses; 11 were portable pumping stations; and the remaining 22 were crossovers. Of the total 61 flow relief devices and combined sewer outfalls, 56 discharge directly to the main stem of the Root River; 2 discharge directly to the East Branch of the Root River; 2 discharge directly to Hoods Creek; and 1 discharges directly to the West Branch of the Root River Canal.

Table 121

KNOWN SANITARY SEWERAGE SYSTEM FLOW RELIEF DEVICES IN THE ROOT RIVER WATERSHED BY RECEIVING STREAM AND CIVIL DIVISION: 1975

Receiving Stream	Civil Division	Combined Sewer Outfalls	Other Flow Relief Devices				Total
			Crossovers	Bypasses	Relief Pumping Stations	Portable Pumping Stations	
Root River.	City of West Allis	0	7	0	0	11	18
Root River.	City of Milwaukee	0	2	0	0	0	2
East Branch of Root River.	City of Milwaukee	0	2	0	0	0	2
Root River.	Town of Caledonia	0	0	2	0	0	2
Root River.	City of Racine	8	11	14	0	0	33
Hoods Creek.	Town of Caledonia	0	0	2	0	0	2
Root River.	Town of Mt. Pleasant	0	0	1	0	0	1
West Branch of Root River Canal. .	Village of Union Grove	0	0	1	0	0	1
Total		8	22	20	0	11	61

Source: SEWRPC.

Other Known Point Sources

A total of 13 other known point sources of pollution were identified in the watershed in 1975. These other point sources consisted primarily of 20 outfalls through which industrial cooling, process, rinse, runoff, and wash waters were discharged directly or indirectly to the surface water system. Of these, 13 were identified as discharging only cooling water. The remaining 7 were discharging other types of wastewaters. Industrial wastewater enters the Root River and its major tributaries directly through industrial waste outfalls or indirectly through drainage ditches and storm sewers. Table 122 summarizes by receiving stream and civil division the characteristics of these other point sources, and Map 85 shows their locations. Four of these other point source outfalls discharge directly to the Root River main stem and 11 outfalls discharge to the Root River via storm sewers, drainage ditches, or unnamed tributaries, discharge to tributaries of the Root River, and two utilize a soil absorption system.

Privately Owned Onsite Sanitary Wastewater Treatment

In addition to being provided through centralized sanitary sewerage service within the watershed, sanitary wastewater treatment and disposal is provided through approximately 6,712 privately owned onsite sewage disposal systems consisting of 6,686 septic tanks, 21 holding tanks, and 5 mound systems. These systems serve a total resident population of about 27,600 persons, or 18 percent of the total resident population of the watershed. Of this total, about 9,500 persons, or about 34 percent, resided in concentrated areas of urban development having at least 32 housing units in a U. S. Public Land Survey quarter section. These scattered quarter sections of urban land use concentration totaled about 7.2 square miles of urban land use, or about 4 percent of the total area of the watershed.

Urban Storm Water Management Systems

As noted in Table 118, land cover categories associated with urban land uses as of 1975 comprised 28,900 acres, or about 23 percent of the Root River watershed. The most important urban land cover category was residential land, with about 13.4 percent.

There were a total of 11 known storm water drainage systems providing service to the subareas of the Root River watershed within the Region in 1975. These include the systems operated by the Cities of Franklin, Greenfield, Milwaukee, Muskego, New Berlin, Oak Creek,

Table 122

CHARACTERISTICS OF OTHER KNOWN SOURCES OF WATER POLLUTION IN THE ROOT RIVER WATERSHED: 1975

Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average Annual Hydraulic Discharge Rate (gallons per day)[a]	Reported Maximum Monthly Hydraulic Discharge Rate (gallons per day)[a]
MILWAUKEE COUNTY								
Fruehauf Corporation	7539	City of West Allis	Process and Cooling	None	1	South Branch Root River via Storm Sewer and Drainage Ditch	3,200	4,000
Milwaukee County Park Commission—Hales Corners Park	7999	Village of Hales Corners	Swimming Pool Overflow and Drainage	None	1	Root River via Storm Sewer	Intermittent	Intermittent
P.P.G. Industries, Inc.	2851	City of Oak Creek	Cooling Boiler and Cooling Tower Blowdown	Oil Separator and pH Adjustment	1	Root River via Drainage Ditch	4,000	6,600
Union Oil Milwaukee Truck Stop	5541	City of Franklin	Runoff	Oil Separator	1	Tributary of the Root River	Intermittent	Intermittent
Vulcan Materials Company	1422	City of Franklin	Runoff	N/A	1	Root River	321,000	1,260,000
RACINE COUNTY								
C & D Foods, Inc.	0259	Town of Yorkville	Process and Sanitary	Activated Sludge and Lagoon	1	West Branch Root River	269,000	322,600
Emerson Electric Company—Insinkerator Division	3639	City of Racine	Cooling	None	1	Root River via Storm Sewer	27,200	33,000
			Cooling	None	2	Root River via Storm Sewer	13,400	15,800
Fohr's Meat Service	2033	Town of Raymond	Process and Sanitary	Septic System	1	Groundwater	N/A	1,000
Frank's Pure Food Company	2033	Town of Caledonia	Cooling	None	2	Hoods Creek via Drainage Tile	12,800	16,000
Harry Hansen Meat Service	2011	Town of Raymond	Process	Septic Tank	1	Groundwater	1,400	N/A
Racine Stamping Corporation	3469	City of Racine	Cooling	None	1	Root River via Storm Sewer	17,500	N/A
Twin Disc, Inc. Racine Street	3566	City of Racine	Cooling	N/A	1	Root River via Storm Sewer	17,000	30,000
			Cooling	N/A	2	Root River via Storm Sewer	11,000	25,000
			Cooling	N/A	3	Root River via Storm Sewer	29,000	40,000
Twin Disc, Inc.—21st Street Plant	3566	City of Racine	Cooling	N/A	1	Root River via Storm Sewer	45,000	65,000
			Cooling	N/A	2	Root River via Storm Sewer	73,000	94,000
			Cooling	N/A	3	Root River via Storm Sewer	6,000	9,000
Western Publishing Company	2731	City of Racine	Cooling	N/A	1	Root River	154,000	601,300
			Cooling	N/A	2	Root River	108,300	371,000
			Cooling	N/A	3	Root River	96,000	328,000

NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data were obtained, in order of priority, from: quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System or under Section 101 of the Wisconsin Administrative Code or from the Wisconsin Pollutant Discharge Elimination System permit itself. In some cases when 12 months of flow data were not reported, the average annual and maximum monthly hydraulic discharge rates were estimated from the available monthly discharge data or from the flow data as reported in the permit.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Racine, and West Allis and the Villages of Greendale, Hales Corners, and Union Grove. Local documentation in the form of a map of the storm water drainage system was not available for the City of Muskego and the Village of Hales Corners. Together, the nine storm water drainage systems for which mapping was available have a tributary drainage area of about 16.5 square miles, or about 8 percent of the total area of the watershed. About 0.5 percent of the total area of the watershed is served by combined sanitary and storm sewers, as noted above. Included within this storm water drainage area are a total of 124 known storm water outfalls ranging in size from 12 to 96 inches in diameter. There were no known storm water pumping facilities and three known storm water storage facilities in the watershed. The total annual average discharge from these outfalls is estimated to be about 2,113 million gallons per year occurring on the average in 70 events.

Table 123

SUMMARY OF ESTIMATED AVERAGE ANNUAL POLLUTANT LOADINGS IN THE ROOT RIVER WATERSHED: 1975

Source	Extent[a]	Parameter	Load[b] Average Year Total Estimated Loading	Percent
Urban Point Sources				
Municipal Sewage Treatment Plants	5	Total Nitrogen	50,870.0	2.2
	5	Total Phosphorus	9,700.0	3.0
	5	Biochemical Oxygen Demand	140,000.0	2.1
	5	Fecal Coliform	850,000.0	0.6
	5	Sediment	70.0	0.0
Private Sewage Treatment Plants	8	Total Nitrogen	70,790.0	3.1
	8	Total Phosphorus	20,480.0	6.4
	8	Biochemical Oxygen Demand	65,520.0	1.0
	8	Fecal Coliform	170,000.0	0.1
	8	Sediment	40.0	0.0
Combined Sewer Overflow	8	Total Nitrogen	13,340.0	0.6
	8	Total Phosphorus	6,670.0	2.1
	8	Biochemical Oxygen Demand	133,440.0	2.0
	8	Fecal Coliform	42,000,000.0	29.5
	8	Sediment	200.0	0.0
Industrial Discharges	11	Total Nitrogen	13,560.0	0.6
	11	Total Phosphorus	1,060.0	0.3
	11	Biochemical Oxygen Demand	15,670.0	0.2
	11	Fecal Coliform	33,000.0	0.0
	11	Sediment	0.0	0.0
Sanitary Sewer Flow Relief Devices	53	Total Nitrogen	4,580.0	0.2
	53	Total Phosphorus	1,530.0	0.5
	53	Biochemical Oxygen Demand	45,790.0	0.7
	53	Fecal Coliform	6,900,000.0	4.8
	53	Sediment	20.0	0.0
Urban Point Source Totals		Total Nitrogen	153,140.0	6.6
		Total Phosphorus	39,440.0	12.3
		Biochemical Oxygen Demand	400,420.0	6.1
		Fecal Coliform	49,953,000.0	35.1
		Sediment	330.0	0.1
Urban Diffuse Sources				
Residential	16751	Total Nitrogen	67,000.0	2.9
	16751	Total Phosphorus	5,360.0	1.7
	16751	Biochemical Oxygen Demand	407,050.0	6.2
	16751	Fecal Coliform	2,680,160.0	1.9
	16751	Sediment	4,565.0	1.0
Commercial	2830	Total Nitrogen	25,470.0	1.1
	2830	Total Phosphorus	2,120.0	0.7
	2830	Biochemical Oxygen Demand	276,210.0	4.2
	2830	Fecal Coliform	933,900.0	0.7
	2830	Sediment	1,055.0	0.2
Industrial	851	Total Nitrogen	7,150.0	0.3
	851	Total Phosphorus	600.0	0.2
	851	Biochemical Oxygen Demand	31,400.0	0.5
	851	Fecal Coliform	527,620.0	0.4
	851	Sediment	415.0	0.1
Extractive	441	Total Nitrogen	26,460.0	1.1
	441	Total Phosphorus	19,850.0	6.2
	441	Biochemical Oxygen Demand	52,920.0	0.8
	441	Fecal Coliform	0.0	0.0
	441	Sediment	33,075.0	7.0
Transportation	1547	Total Nitrogen	33,480.0	1.5
	1547	Total Phosphorus	2,470.0	0.8
	1547	Biochemical Oxygen Demand	212,340.0	3.3
	1547	Fecal Coliform	877,650.0	0.6
	1547	Sediment	28,260.0	6.0
Recreation	4052	Total Nitrogen	14,410.0	0.6
	4052	Total Phosphorus	580.0	0.2
	4052	Biochemical Oxygen Demand	5,270.0	0.1
	4052	Fecal Coliform	58,608.0	0.0
	4052	Sediment	850.0	0.2
Construction	2419	Total Nitrogen	145,140.0	6.3
	2419	Total Phosphorus	108,860.0	34.0
	2419	Biochemical Oxygen Demand	290,280.0	4.5
	2419	Fecal Coliform	0.0	0.0
	2419	Sediment	181,425.0	38.2
Septic Systems	27562	Total Nitrogen	157,100.0	6.8
	27562	Total Phosphorus	36,380.0	11.4
	27562	Biochemical Oxygen Demand	2,249,060.0	34.5
	27562	Fecal Coliform	27,562,000.0	19.3
	27562	Sediment	385.0	0.1
Urban Diffuse Source Totals		Total Nitrogen	476,210.0	20.6
		Total Phosphorus	176,220.0	55.1
		Biochemical Oxygen Demand	3,524,530.0	54.1
		Fecal Coliform	32,639,938.0	22.9
		Sediment	250,030.0	52.7
Urban Source Totals		Total Nitrogen	629,350.0	27.3
		Total Phosphorus	215,660.0	67.4
		Biochemical Oxygen Demand	3,924,950.0	60.2
		Fecal Coliform	82,592,938.0	58.0
		Sediment	250,360.0	52.8
Rural Diffuse Sources				
Livestock Operations	9350	Total Nitrogen	265,540.0	11.5
	9350	Total Phosphorus	61,710.0	19.3
	9350	Biochemical Oxygen Demand	1,039,720.0	16.0
	9350	Fecal Coliform	59,840,000.0	42.0
	9350	Sediment	3,275.0	0.7
Cropland, Pasture, and Unused Rural Land	84249	Total Nitrogen	1,393,790.0	60.4
	84249	Total Phosphorus	41,550.0	13.0
	84249	Biochemical Oxygen Demand	1,448,050.0	22.2
	84249	Fecal Coliform	0.0	0.0
	84249	Sediment	219,860.0	46.3
Silvicultural	6607	Total Nitrogen	15,200.0	0.7
	6607	Total Phosphorus	930.0	0.3
	6607	Biochemical Oxygen Demand	30,390.0	0.5
	6607	Fecal Coliform	43,606.2	0.0
	6607	Sediment	830.0	0.2
Air Pollution to Surface Water	447	Total Nitrogen	3,980.0	0.2
	447	Total Phosphorus	220.0	0.1
	447	Biochemical Oxygen Demand	72,410.0	1.1
	447	Fecal Coliform	0.0	0.0
	447	Sediment	150.0	0.0
Rural Diffuse Source Totals		Total Nitrogen	1,678,510.0	72.7
		Total Phosphorus	104,410.0	32.6
		Biochemical Oxygen Demand	2,590,570.0	39.8
		Fecal Coliform	59,883,606.2	42.0
		Sediment	224,115.0	47.2
Diffuse Source Totals		Total Nitrogen	2,154,720.0	93.4
		Total Phosphorus	280,630.0	87.7
		Biochemical Oxygen Demand	6,115,100.0	93.9
		Fecal Coliform	92,523,544.2	64.9
		Sediment	474,145.0	99.9
Total Sources		Total Nitrogen	2,307,860.0	100.0
		Total Phosphorus	320,070.0	100.0
		Biochemical Oxygen Demand	6,515,520.0	100.0
		Fecal Coliform	142,476,544.2	100.0
		Sediment	474,475.0	100.0

[a] Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.

[b] Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year.

Source: SEWRPC.

Rural Storm Water Runoff

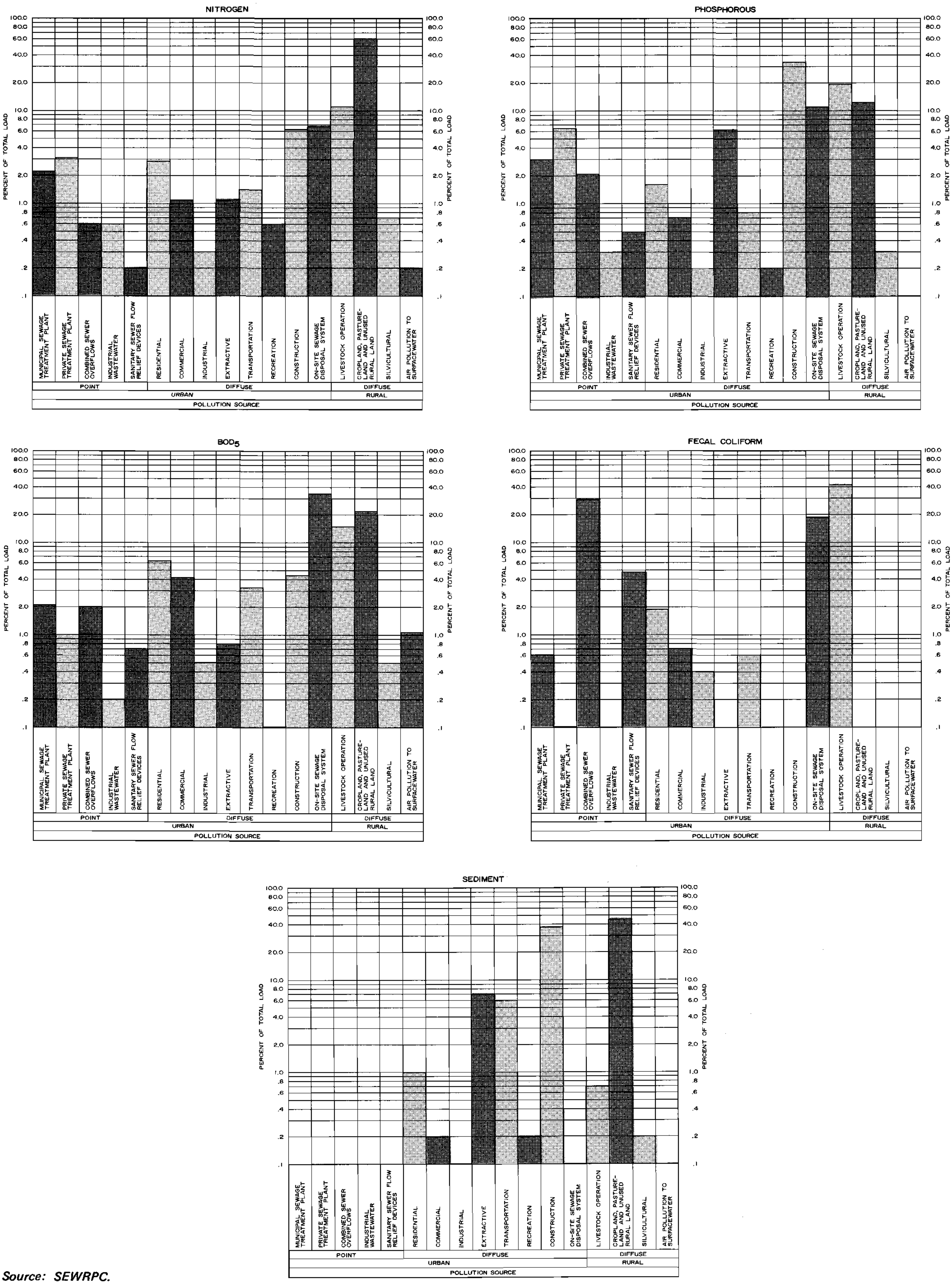
About 95,900 acres, or 77 percent, of the total area of the watershed, are devoted to rural land use activities. The most important rural land cover categories were row crops with 43 percent, hay with 5 percent, other open space with 12 percent, small grains with 5 percent, woodlands with 5 percent, and wetlands, swamps, and marshes with 4 percent of the watershed. As of May 1975, there were an estimated 102 domestic livestock operations—operations of 25 or more equivalent animal units—having a total of 9,350 equivalent animal units within the watershed. This figure does not include three duck farms with a total of 230,900 ducks, or 2,309 equivalent animal units, for which the associated wastes are treated in treatment plants discussed above as point sources. Of the 102 operations, 47, or 46 percent, were located within 500 feet of the surface water system of the watershed.

Pollution Loadings

A summary of the estimated average annual pollution loadings in the Root River watershed is presented in Table 123 and depicted in Figure 41. Urban sources of pollution are estimated to contribute 27 percent

Figure 41

SUMMARY OF ESTIMATED AVERAGE ANNUAL POLLUTANT LOADINGS IN THE ROOT RIVER WATERSHED: 1975



Source: SEWRPC.

of the nitrogen, 67 percent of the phosphorus, 60 percent of the biochemical oxygen demand, 58 percent of the fecal coliform, and 53 percent of the sediment which occur as water pollutants in the Root River watershed. Of the urban contribution, point sources of pollution are estimated to contribute 24 percent of the nitrogen, 18 percent of the phosphorus, 10 percent of the biochemical oxygen demand, 61 percent of the fecal coliform, and almost no sediment. Diffuse sources—including the estimated septic tank and construction-related contributions in the drainage area—account for the remaining 76 percent of the nitrogen, 82 percent of the phosphorus, 90 percent of the biochemical oxygen demand, 39 percent of the fecal coliform, and almost all of the sediment contributed from urban sources.

Of the total pollutant loads, rural pollution sources are estimated to contribute the remaining 73 percent of the nitrogen, 33 percent of the phosphorus, 40 percent of the biochemical oxygen demand, 42 percent of the fecal coliform, and 47 percent of the sediment which occur as water pollutants in the watershed. Livestock feeding operations—inclusive of the disposal of manure on croplands—are estimated to contribute 16 percent of the nitrogen, 59 percent of the phosphorus, 40 percent of the biochemical oxygen demand, almost all of the fecal coliform, and 1 percent of the sediment from rural sources. The remainder of the estimated rural pollution load, or 84 percent of the nitrogen, 41 percent of the phosphorus, 60 percent of the biochemical oxygen demand, almost none of the fecal coliform, and 99 percent of the sediment, are contributed by other rural diffuse sources, namely storm water runoff from rural land uses and atmospheric loadings to surface waters.

SAUK CREEK WATERSHED

The Sauk Creek watershed is a natural surface water drainage unit 33.7 square miles in areal extent located in the northern portion of the Region. The boundaries of the basin, together with the locations of the main channels of Sauk Creek, are shown on Map 89, along with the locations of the known point sources of pollution and the generalized land uses as of 1975. The main stem of Sauk Creek originates two miles northeast of the Village of Fredonia in north-central Ozaukee County and discharges to Lake Michigan at the harbor area in the City of Port Washington. About 94 percent of the total area of the watershed is still in rural land uses, with about 93 percent of this rural area in agricultural use. Most of the urban-related land use is located in and near Port Washington and near Fredonia in the southern and west-central portions of the watershed, respectively. Table 124 sets forth the extent and proportion of the major land cover categories within the watershed as they relate to water quality conditions in 1975.

The soils within the Sauk Creek watershed are generally silt loams. Most of the soils are relatively fertile and produce high crop yields if managed correctly. Sediment discharges from these soils may result in high nutrient levels in stream waters.

Table 124

AREAL EXTENT OF WATER QUALITY-RELATED COVER IN THE SAUK CREEK WATERSHED: 1975

Land Cover[a]	Square Miles	Acres	Percent
Urban			
Residential	0.93	597	2.70
Commercial[b]	0.34	218	0.99
Industrial			
Manufacturing	0.20	128	0.58
Landfills and Dumps	0.02	12	0.05
Extractive	--	--	--
Transportation			
Streets and Highways	0.19	118	0.54
Airfields	0.09	57	0.26
Railroad Yards and Terminals	--	--	--
Recreation			
Golf Courses	--	--	--
Parks and Other Recreation	0.13	72	0.33
Land Under Development			
Residential[c]	0.07	45	0.20
Commercial	--	--	--
Industrial	0.02	10	0.05
Transportation	--	--	--
Recreation	--	--	--
Rural			
Agricultural			
Small Grains	4.16	2,665	12.06
Hay	9.53	6,099	27.60
Row Crops	12.93	8,275	37.43
Specialty Crops	1.84	1,178	5.33
Sod Farm	--	--	--
Other Open Space[d]	1.67	1,070	4.84
Silvicultural			
Woodlands	1.34	859	3.89
Orchards and Nurseries	0.17	110	0.50
Natural and Man-Made Water Areas—Subject to Atmospheric Pollutant Contributions			
Ponds, Lakes, and Streams	0.03	18	0.08
Wetlands, Swamps, and Marshes	0.88	563	2.55
Total	34.54[e]	22,094	100.00

[a] *These special land cover categories, defined primarily according to their imperviousness and vegetative cover characteristics and effects on the quality of storm water runoff, were delineated at a scale of 1" = 400' on aerial photographs taken in May 1975 and were measured to the nearest full acre, using dot-counting overlays. The total acreages measured within hydrologic subbasins were then adjusted to the control totals measured by digitizer from base maps of hydrologic subbasins at a scale of 1" = 2000'. Both the "square miles" and the "percent" shown above were then computed and rounded to the nearest hundredth (0.01) of a percent.*

[b] *Includes: retail, communication, utilities, administrative, and institutional land uses.*

[c] *Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.*

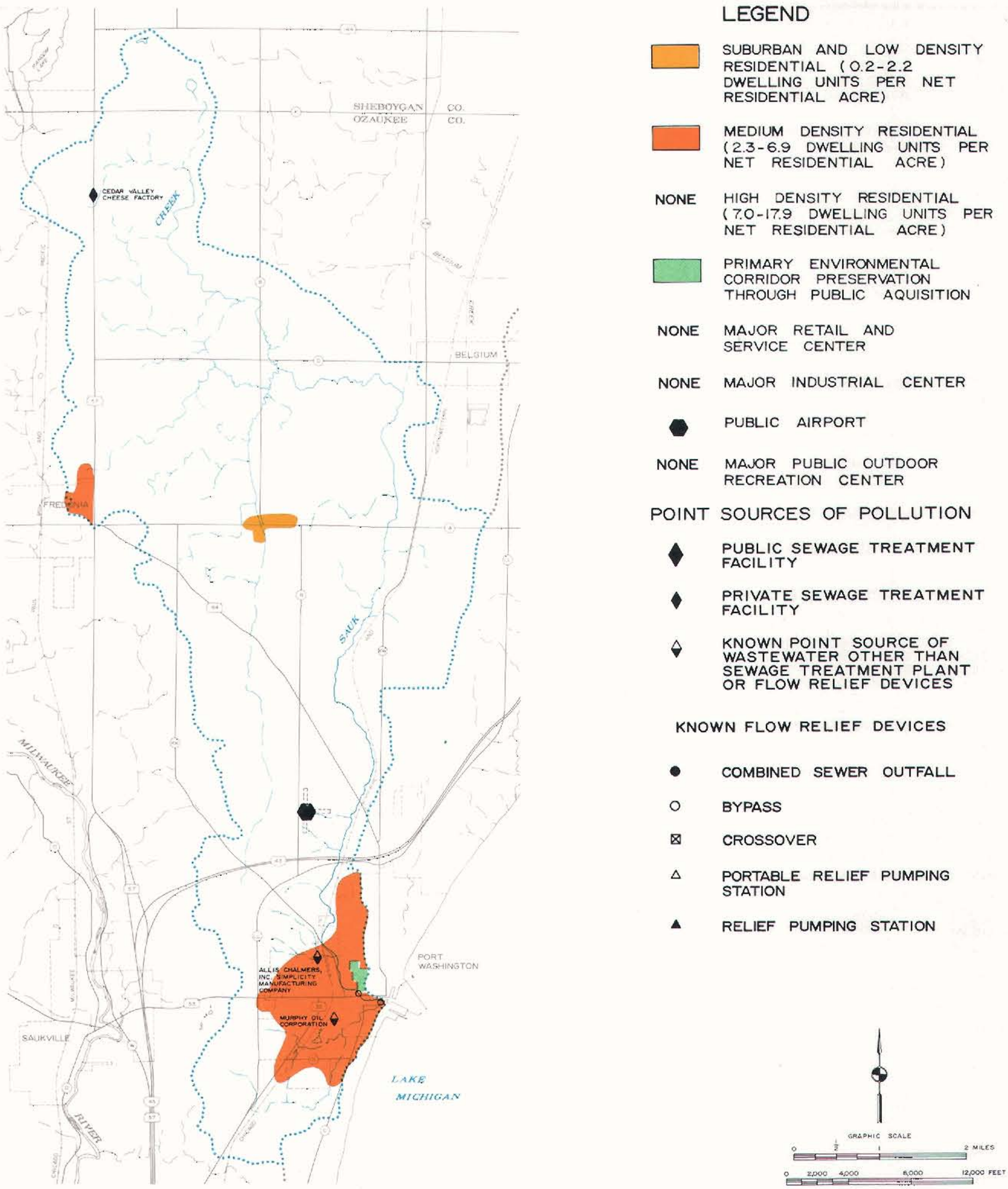
[d] *Includes: pasture, unused urban and rural lands.*

[e] *The total area of the Sauk Creek watershed represented in this table is different than the total area of the Sauk Creek watershed identified in the text and on Map 89. This is due to the fact that the area set forth on Map 89 includes only that portion of the Sauk Creek watershed lying within the civil boundaries that comprise the Southeastern Wisconsin Region. The area of the Sauk Creek watershed represented in this table represents an aggregation of subbasins, the boundaries of which do not always coincide with the civil boundaries of the Region.*

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service; County Soil and Water Conservation Districts; University of Wisconsin-Extension Service; and SEWRPC.

Map 89

THE LOCATION, BOUNDARIES, AND MAJOR STREAMS OF THE SAUK CREEK WATERSHED— SHOWING POINT SOURCES OF POLLUTION AND GENERALIZED LAND USES: 1975

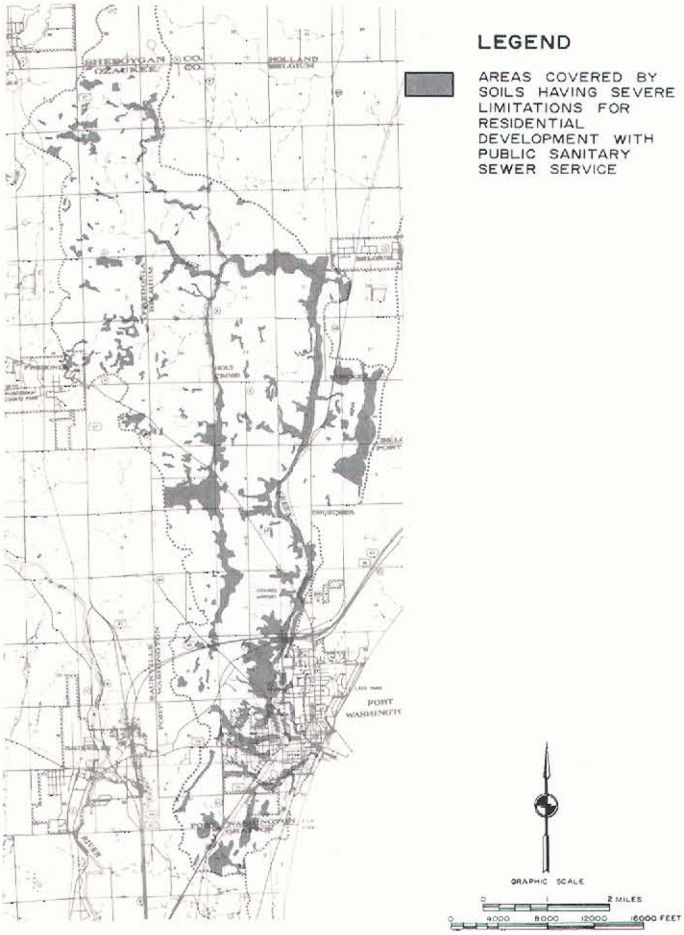


The Sauk Creek watershed is about 34 square miles in areal extent, or about 1 percent of the total area of the Region. The water quality in the watershed is affected by the various land uses as well as by the one private wastewater treatment plant, two flow relief devices, and two other point sources of wastewater as shown.

Source: SEWRPC.

Map 90

SUITABILITY OF SOILS FOR RESIDENTIAL DEVELOPMENT WITH PUBLIC SANITARY SEWER SERVICE IN THE SAUK CREEK WATERSHED

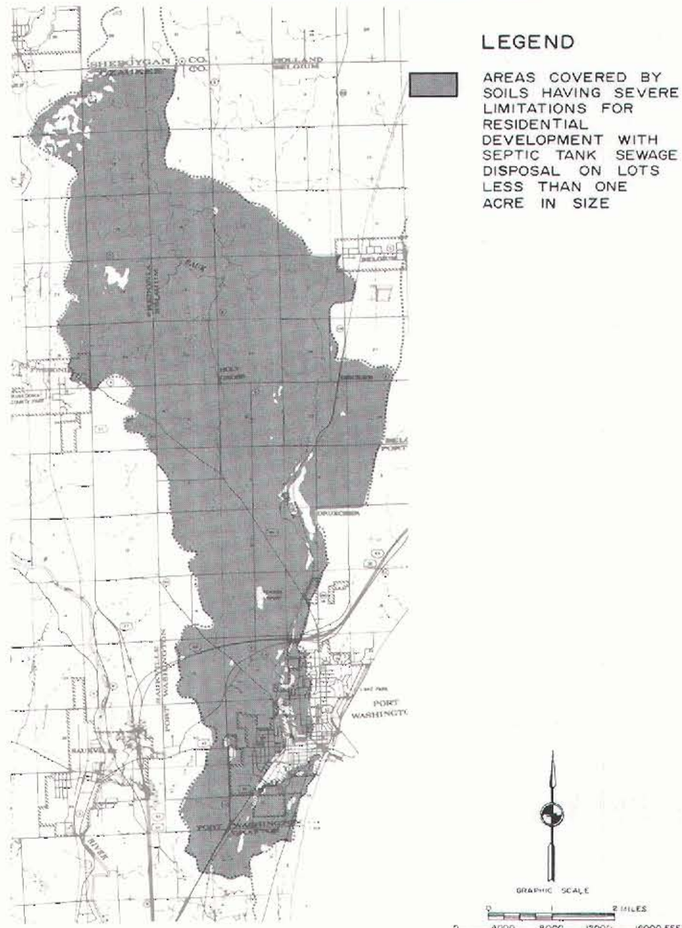


Of particular importance in comprehensive water quality planning is the recognition of the limitations inherent in the soil resource base. About 17 percent of the area of the Sauk Creek watershed is covered with soils which are poorly suited for residential development with public sanitary sewer service or, more precisely, residential development of any kind. These soils, which include wet soils having a high water table or poor drainage, organic soils which are poorly drained and provide poor foundation support, and soils which have a flood hazard, are especially prevalent in the riverine areas of the watershed.

Source: U. S. Soil Conservation Service and SEWRPC.

Map 91

SUITABILITY OF SOILS FOR SMALL LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE IN THE SAUK CREEK WATERSHED



Approximately 95 percent of the area of the Sauk Creek watershed is covered by soils poorly suited for residential development on lots having an area smaller than one acre and not served by public sanitary sewerage facilities. Reliance on septic tank sewage disposal systems in these areas, which are covered by relatively impervious soils or are subject to seasonally high water tables, can only result in eventual malfunctioning of such systems and the consequent intensification of water pollution and public health problems in the watershed.

Source: U. S. Soil Conservation Service and SEWRPC.

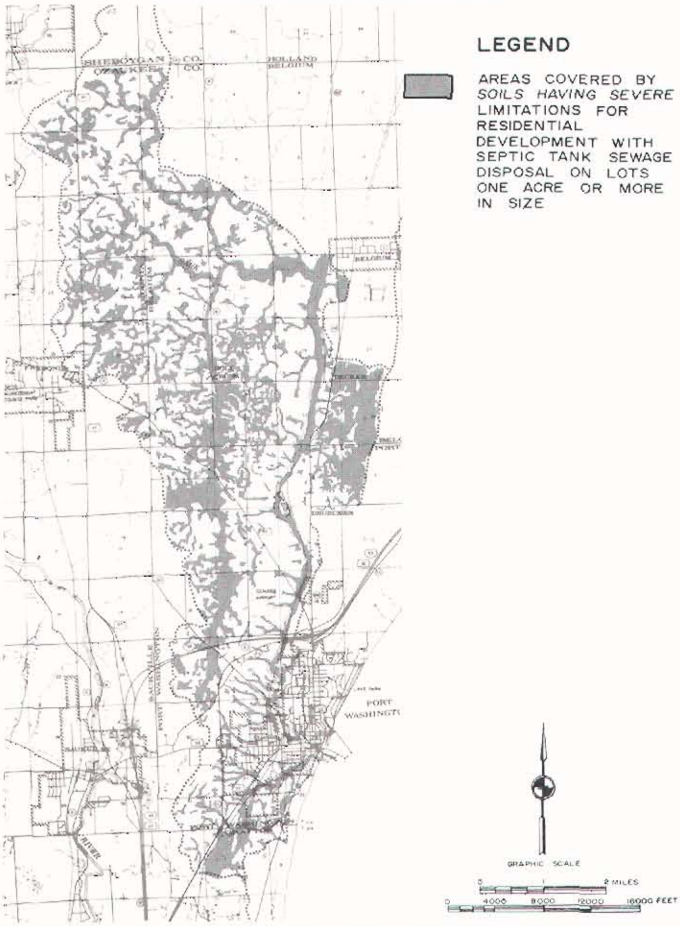
Particularly important to comprehensive water quality management planning are the soil suitability interpretations for specified types of urban development. Based upon the interpretations of the soils properties about 17 percent of the watershed area exhibits severe or very severe limitations for residential development with public sanitary sewer service, as shown on Map 90; almost the entire watershed, or about 95 percent, exhibits severe or very severe limitations for small lot (less than one acre in size) residential development without public sanitary sewer service, as shown on Map 91; and about 32 percent of the watershed exhibits severe or very severe limitations for large lot (one acre or larger in size) residential development without public sanitary sewer service, as shown on Map 92.

Municipal and Private Sewage Treatment Facilities

In 1975, portions of two sanitary sewerage systems served a total area of about 1.5 square miles within the watershed, or about 4 percent of the total area of the

Map 92

SUITABILITY OF SOILS FOR LARGE LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE IN THE SAUK CREEK WATERSHED



Approximately 32 percent of the area of the Sauk Creek watershed is covered by soils poorly suited for residential development on lots having an area of one acre or more and not served by public sanitary sewerage facilities. The inherent limitations of these soils for septic tank sewage disposal systems cannot be overcome simply by the provision of larger lots, and the use of such systems on these soils, which cannot absorb the sewage effluent, ultimately results in surface ponding and runoff of partially treated wastes into nearby watercourses.

Source: U. S. Soil Conservation Service and SEWRPC.

watershed, and a total population of about 6,310 persons, or approximately 86 percent of the total resident population of the watershed. No municipal sewage treatment facilities are located within the Sauk Creek watershed. There is one known private wastewater treatment facility operating in the Sauk Creek watershed, which serves the Cedar Valley Cheese Factory. Selected data on this privately operated wastewater treatment facility are presented in Table 125, and the plant location is shown on Map 89.

Sanitary Sewerage System Flow Relief Points

In 1975, there were two known sanitary sewer flow relief devices in the watershed, as listed in Table 126 and shown on Map 89. Both of these flow relief devices were sanitary sewerage system bypasses that discharge directly to Sauk Creek.

Other Known Point Sources

A total of two other known point sources of pollution were identified in the watershed in 1975. These other point sources consisted primarily of two outfalls through which industrial cooling, process, and storm water runoff were discharged directly or indirectly to the surface water system. One of these was identified as discharging only cooling water. The remaining outfall discharges other types of wastewaters. Industrial wastewater enters Sauk Creek and its major tributaries directly through industrial waste outfalls or indirectly through drainage ditches and storm sewers. Table 127 summarizes by receiving stream and civil division the characteristics of these other point sources, and Map 89 shows their locations. One of these other point source outfalls discharges indirectly to the Sauk Creek main stem and one outfall discharges directly to a tributary of Sauk Creek.

Privately Owned Onsite Sanitary Wastewater Treatment

In addition to being provided through the centralized sanitary sewerage service within the watershed, sanitary wastewater treatment and disposal is provided through approximately 317 privately owned onsite sewage disposal systems, consisting of 305 septic tanks and 12 holding tanks. These systems serve a total resident population of about 1,070 persons, or 14 percent of the total resident population of the watershed. Of this total, about 100 persons, or 9 percent, resided in concentrated areas of urban development having at least 32 housing units in a U. S. Public Land Survey quarter section. These scattered quarter sections of urban land use concentration totaled about 0.25 square mile of urban land use, or about 1 percent of the total area of the watershed.

Urban Storm Water Management Systems

As noted in Table 124, land cover categories associated with urban land uses as of 1975 comprised about 1,300 acres, or about 6 percent of the Sauk Creek watershed. The most important urban land cover category was residential land with about 3 percent.

There was one known urban storm water drainage system providing service to the subareas of the Sauk Creek watershed within the Region in 1975. This is the system operated by the City of Port Washington. The portion of the system that lies within the Sauk Creek watershed has a tributary drainage area of about 1.4 square miles, or about 4 percent of the total area of the watershed. Included within this storm water drainage area of the watershed are a total of 14 known storm water outfalls ranging in size from 12 to 72 inches in diameter, of which seven outfalls discharge to Sauk Creek and seven discharge to tributaries of Sauk Creek. There were no known storm water pumping facilities or storm water storage facilities in the watershed. The total annual

Table 125

SELECTED CHARACTERISTICS OF PRIVATELY OWNED WASTEWATER TREATMENT FACILITIES IN THE SAUK CREEK WATERSHED: 1975

Name	Civil Division Location	Type of Land Use Served	Type of Wastewater	Type of Treatment Provided	Disposal of Effluent	Reported Average Annual Hydraulic Discharge Rate[a] (gallons per day)	Average Hydraulic Design Capacity (gallons per day)	Reported Maximum Monthly Hydraulic Discharge Rate (gallons per day)
Cedar Valley Cheese Factory	Town of Fredonia	Industrial	Process and Cooling	Lagoon, Ridge and Furrow, and Spray Irrigation	Soil Absorption	N/A	N/A	25,000

NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data were obtained, in order of priority, from: quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System or under Section 101 of the Wisconsin Administrative Code or from the Wisconsin Pollutant Discharge Elimination System permit itself. In some cases when 12 months of flow data were not reported, the average annual and maximum monthly hydraulic discharge rates were estimated from the available monthly discharge data or from the flow data as reported in the permit.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 126

KNOWN SANITARY SEWERAGE SYSTEM FLOW RELIEF DEVICES IN THE SAUK CREEK WATERSHED BY RECEIVING STREAM AND CIVIL DIVISION: 1975

Receiving Stream	Civil Division	Combined Sewer Outfalls	Other Flow Relief Devices				Total
			Crossovers	Bypasses	Relief Pumping Stations	Portable Pumping Stations	
Sauk Creek. . . .	City of Port Washington	0	0	2	0	0	2
Total	--	0	0	2	0	0	2

Source: SEWRPC.

Table 127

CHARACTERISTICS OF OTHER KNOWN POINT SOURCES OF WATER POLLUTION IN THE SAUK CREEK WATERSHED: 1975

Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average Annual Hydraulic Discharge Rate (gallons per day)[a]	Reported Maximum Monthly Hydraulic Discharge Rate (gallons per day)[a]
OZAUKEE COUNTY								
Allis Chalmers, Inc. Simplicity Manufacturing Company	3524	City of Port Washington	Cooling	None	4	Sauk Creek via Storm Sewer	47,000	125,000
Murphy Oil Corporation	5171	City of Port Washington	Storm Water Runoff	Oil Separator	1	Tributary of Sauk Creek	76,500	26,500

NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data were obtained, in order of priority, from: quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System or under Section 101 of the Wisconsin Administrative Code or from the Wisconsin Pollutant Discharge Elimination System permit itself. In some cases when 12 months of flow data were not reported, the average annual and maximum monthly hydraulic discharge rates were estimated from the available monthly discharge data or from the flow data as reported in the permit.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 128

SUMMARY OF ESTIMATED AVERAGE ANNUAL POLLUTANT LOADINGS IN THE SAUK CREEK WATERSHED: 1975

Source	Extent[a]	Parameter	Load[b] Average Year Total Estimated Loading	Percent
Urban Point Sources				
Municipal Sewage Treatment Plants	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Private Sewage Treatment Plants	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Combined Sewer Overflow	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Industrial Discharges	2	Total Nitrogen	290.0	0.1
	2	Total Phosphorus	30.0	0.0
	2	Biochemical Oxygen Demand	1,260.0	0.1
	2	Fecal Coliform	0.0	0.0
	2	Sediment	0.0	0.0
Sanitary Sewer Flow Relief Devices	2	Total Nitrogen	80.0	0.0
	2	Total Phosphorus	30.0	0.0
	2	Biochemical Oxygen Demand	750.0	0.1
	2	Fecal Coliform	110,000.0	0.2
	2	Sediment	0.0	0.0
Urban Point Source Totals		Total Nitrogen	370.0	0.1
		Total Phosphorus	60.0	0.1
		Biochemical Oxygen Demand	2,010.0	0.1
		Fecal Coliform	110,000.0	0.2
		Sediment	0.0	0.0
Urban Diffuse Sources				
Residential	597	Total Nitrogen	2,390.0	0.5
	597	Total Phosphorus	190.0	0.3
	597	Biochemical Oxygen Demand	14,510.0	1.0
	597	Fecal Coliform	95,520.0	0.2
	597	Sediment	165.0	0.3
Commercial	218	Total Nitrogen	1,960.0	0.4
	218	Total Phosphorus	160.0	0.2
	218	Biochemical Oxygen Demand	21,280.0	1.5
	218	Fecal Coliform	71,940.0	0.1
	218	Sediment	80.0	0.1
Industrial	140	Total Nitrogen	1,180.0	0.2
	140	Total Phosphorus	100.0	0.1
	140	Biochemical Oxygen Demand	5,170.0	0.4
	140	Fecal Coliform	86,800.0	0.1
	140	Sediment	70.0	0.1
Extractive	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Transportation	175	Total Nitrogen	3,450.0	0.7
	175	Total Phosphorus	320.0	0.4
	175	Biochemical Oxygen Demand	19,770.0	1.4
	175	Fecal Coliform	79,060.0	0.1
	175	Sediment	2,605.0	4.7
Recreation	72	Total Nitrogen	170.0	0.0
	72	Total Phosphorus	0.0	0.0
	72	Biochemical Oxygen Demand	90.0	0.0
	72	Fecal Coliform	2,592.0	0.0
	72	Sediment	15.0	0.0
Construction	55	Total Nitrogen	3,300.0	0.6
	55	Total Phosphorus	2,480.0	3.4
	55	Biochemical Oxygen Demand	6,600.0	0.5
	55	Fecal Coliform	0.0	0.0
	55	Sediment	4,125.0	7.5
Septic Systems	1069	Total Nitrogen	6,090.0	1.2
	1069	Total Phosphorus	1,410.0	1.9
	1069	Biochemical Oxygen Demand	87,230.0	6.0
	1069	Fecal Coliform	1,069,000.0	1.8
	1069	Sediment	15.0	0.0
Urban Diffuse Source Totals		Total Nitrogen	18,540.0	3.6
		Total Phosphorus	4,660.0	6.4
		Biochemical Oxygen Demand	154,650.0	10.6
		Fecal Coliform	1,404,912.0	2.3
		Sediment	7,075.0	12.9
Urban Source Totals		Total Nitrogen	18,910.0	3.6
		TotalPhosphorus	4,720.0	6.5
		Biochemical Oxygen Demand	156,660.0	10.8
		Fecal Coliform	1,514,912.0	2.5
		Sediment	7,075.0	12.9
Rural Diffuse Sources				
Livestock Operations	9120	Total Nitrogen	259,010.0	49.7
	9120	Total Phosphorus	60,190.0	83.2
	9120	Biochemical Oxygen Demand	1,014,140.0	69.8
	9120	Fecal Coliform	58,368,000.0	97.5
	9120	Sediment	3,190.0	5.8
Cropland, Pasture and Unused Rural Land	19287	Total Nitrogen	241,300.0	46.3
	19287	Total Phosphorus	7,260.0	10.0
	19287	Biochemical Oxygen Demand	275,490.0	19.0
	19287	Fecal Coliform	0.0	0.0
	19287	Sediment	44,550.0	81.1
Silvicultural	969	Total Nitrogen	2,230.0	0.4
	969	Total Phosphorus	140.0	0.2
	969	Biochemical Oxygen Demand	4,460.0	0.3
	969	Fecal Coliform	6,395.4	0.0
	969	Sediment	120.0	0.2
Air Pollution to Surface Water	18	Total Nitrogen	160.0	0.0
	18	Total Phosphorus	10.0	0.0
	18	Biochemical Oxygen Demand	2,920.0	0.2
	18	Fecal Coliform	0.0	0.0
	18	Sediment	5.0	0.0
Rural Diffuse Source Totals		Total Nitrogen	502,700.0	96.4
		Total Phosphorus	67,600.0	93.5
		Biochemical Oxygen Demand	1,297,010.0	89.2
		Fecal Coliform	58,374,395.4	97.5
		Sediment	47,865.0	87.1
Diffuse Source Totals		Total Nitrogen	521,240.0	99.9
		Total Phosphorus	72,260.0	99.9
		Biochemical Oxygen Demand	1,451,660.0	99.9
		Fecal Coliform	59,779,307.4	99.8
		Sediment	54,940.0	100.0
Total Sources		Total Nitrogen	521,610.0	100.0
		Total Phosphorus	72,320.0	100.0
		Biochemical Oxygen Demand	1,453,670.0	100.0
		Fecal Coliform	59,889,307.4	100.0
		Sediment	54,940.0	100.0

[a] Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.

[b] Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year.

Source: SEWRPC.

average discharge from these outlets is estimated to be about 59 million gallons per year occurring on the average in 41 events.

Rural Storm Water Runoff

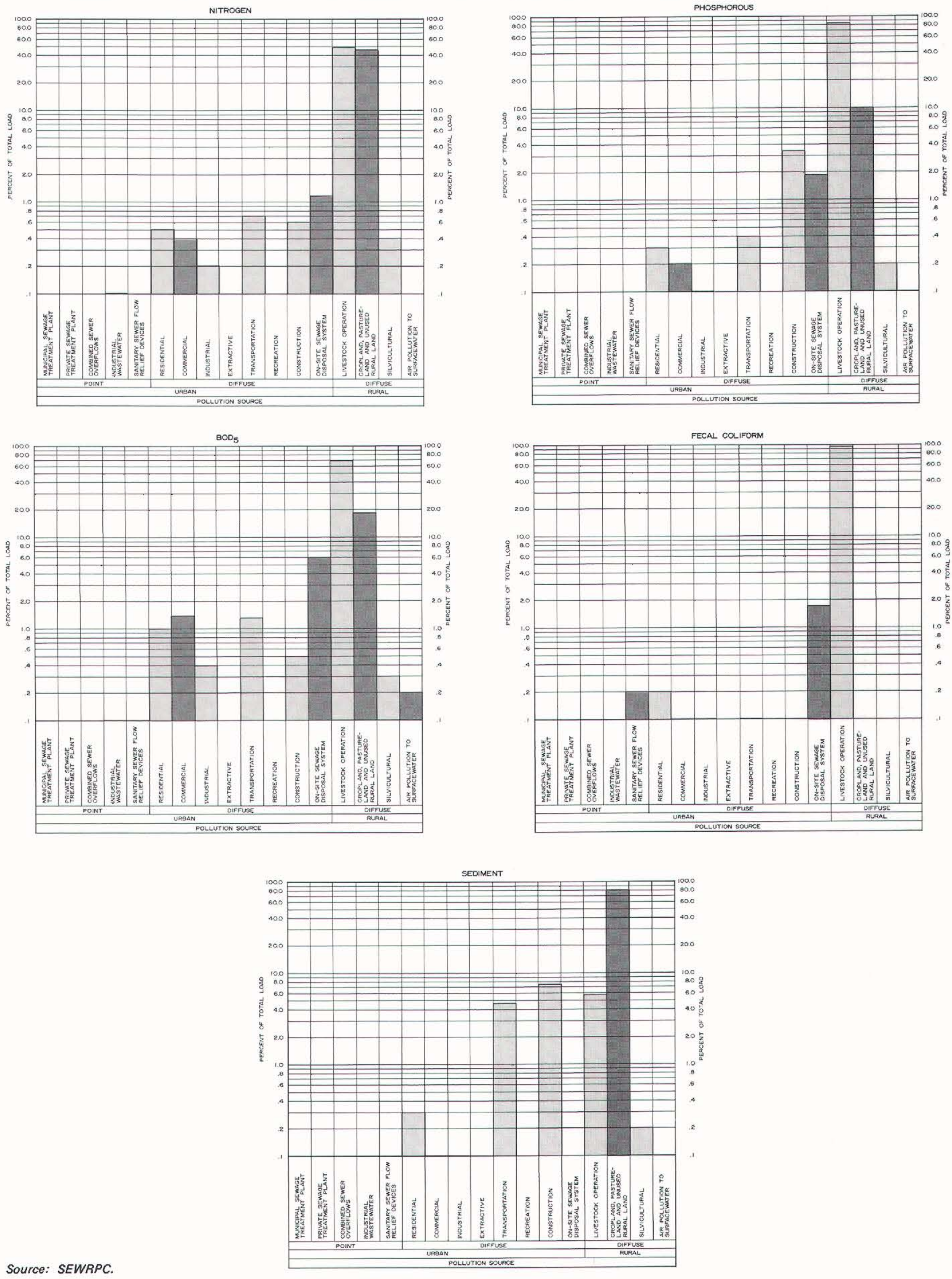
About 20,800 acres, or 94 percent of the total area of the watershed, are devoted to rural land use activities. The most important rural land cover categories were row crops with 37 percent, hay with 28 percent, other open space with 5 percent, and small grains with 12 percent of the watershed. As of May 1975, there were an estimated 110 domestic livestock operations—operations of 25 or more equivalent animal units—having a total of 9,120 equivalent animal units within the watershed. Of the 110 operations, 23, or 21 percent, were located within 500 feet of the surface water system of the watershed.

Pollution Loadings

A summary of the estimated average annual pollution loadings in the Sauk Creek watershed is presented in Table 128 and depicted in Figure 42. Urban sources of pollution are estimated to contribute 4 percent of the nitrogen, 7 percent of the phosphorus, 11 percent of the biochemical oxygen demand, 3 percent of the fecal

Figure 42

SUMMARY OF ESTIMATED AVERAGE ANNUAL POLLUTANT LOADINGS IN THE SAUK CREEK WATERSHED: 1975



Source: SEWRPC.

coliform, and 13 percent of the sediment which occur as water pollutants in the Sauk Creek watershed. Of the urban contribution, the point sources of pollution, which include two flow relief devices and one industrial discharge, contribute 2 percent of the nitrogen, 1 percent of the phosphorus, 1 percent of the biochemical oxygen demand, 7 percent of the fecal coliform, and virtually none of the sediment. Diffuse sources—including the estimated septic tank and construction-related contributions in the drainage area—account for the remaining 98 percent of the nitrogen, 99 percent of the phosphorus and biochemical oxygen demand, 93 percent of the fecal coliform, and nearly all of the sediment contributed from urban sources.

Of the total pollutant loads, rural pollution sources are estimated to contribute the remaining 96 percent of the nitrogen, 93 percent of the phosphorus, 89 percent of the biochemical oxygen demand, 97 percent of the fecal coliform, and 87 percent of the sediment which occur as water pollutants in the watershed. Of the rural pollution sources, none are point sources, since none of the livestock operations in the watershed are of sufficient size to fall within the definition used in this report. Other livestock feeding operations—inclusive of the disposal of manure on croplands—are estimated to contribute 52 percent of the nitrogen, 89 percent of the phosphorus, 78 percent of the biochemical oxygen demand, all of the fecal coliform, and 7 percent of the sediment from rural sources. The remainder of the estimated rural pollution load, or 48 percent of the nitrogen, 11 percent of the phosphorus, 22 percent of the biochemical oxygen demand, and 93 percent of the sediment, are contributed by other rural diffuse sources, namely storm water runoff from rural land uses and atmospheric loadings to surface waters.

SHEBOYGAN RIVER WATERSHED

The Sheboygan River watershed within southeastern Wisconsin is a natural surface water drainage unit with 11.4 square miles of its total area located within the northern portion of the Region. The boundaries of the basin, together with the location of Belgium Creek, the only major perennial stream, are shown on Map 93, along with the locations of the known point sources of pollution and the generalized land uses as of 1975. The main stem of Belgium Creek originates near the Village of Belgium and discharges outside the Region. About 97 percent of the total area of the watershed is still in rural land uses, with about 90 percent of this rural area in agricultural use. Most of the agricultural-related land use is dispersed throughout the watershed. Table 129 sets forth the extent and proportion of the major land cover categories within the watershed as they relate to water quality conditions in 1975.

The soils within the Sheboygan River watershed are generally silt loams. Most of the soils are relatively fertile and produce high crop yields if managed correctly. Sediment discharges from these soils may result in high nutrient levels in stream waters.

Table 129

AREAL EXTENT OF WATER QUALITY-RELATED LAND COVER IN THE SHEBOYGAN RIVER WATERSHED: 1975

Land Cover[a]	Square Miles	Acres	Percent
Urban			
Residential	0.16	100	1.21
Commercial[b]	0.03	20	0.24
Industrial			
Manufacturing	0.04	25	0.31
Landfills and Dumps	--	--	--
Extractive	--	--	--
Transportation			
Streets and Highways	0.14	90	1.10
Airfields	--	--	--
Railroad Yards and Terminals	--	--	--
Recreation			
Golf Courses	--	--	--
Parks and Other Recreation	0.01	6	0.08
Land Under Development			
Residential[c]	0.02	10	0.12
Commercial	--	--	--
Industrial	--	--	--
Transportation	--	--	--
Recreation	--	--	--
Rural			
Agricultural			
Small Grains	1.61	1,030	12.54
Hay	3.08	1,971	24.00
Row Crops	4.60	2,942	35.82
Specialty Crops	1.56	997	12.13
Sod Farm	--	--	--
Other Open Space[d]	0.32	202	2.45
Silvicultural			
Woodlands	1.07	685	8.34
Orchards and Nurseries	--	--	--
Natural and Man-Made Water Areas—Subject to Atmospheric Pollutant Contributions			
Ponds, Lakes, and Streams	0.06	40	0.49
Wetlands, Swamps, and Marshes	0.15	97	1.18
Total	12.85[e]	8,215	100.00

[a] *These special land cover categories, defined primarily according to their imperviousness and vegetative cover characteristics and effects on the quality of storm water runoff, were delineated at a scale of 1" = 400' on aerial photographs taken in May 1975 and were measured to the nearest full acre, using dot-counting overlays. The total acreages measured within hydrologic subbasins were then adjusted to the control totals measured by digitizer from base maps of hydrologic subbasins at a scale of 1" = 2000'. Both the "square miles" and the "percent" shown above were then computed and rounded to the nearest hundredth (0.01) of a percent.*

[b] *Includes: retail, communication, utilities, administrative, and institutional land uses.*

[c] *Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.*

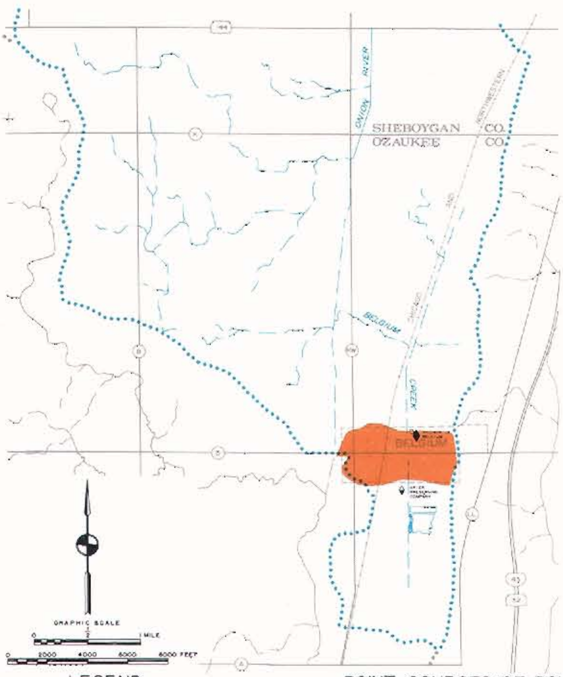
[d] *Includes: pasture, unused urban and rural lands.*

[e] *The total area of the Sheboygan River watershed represented in this table is different than the total area of the Sheboygan River watershed identified in the text and on Map 93. This is due to the fact that the area set forth on Map 93 includes only that portion of the Sheboygan River watershed lying within the civil boundaries that comprise the Southeastern Wisconsin Region. The area of the Sheboygan River watershed represented in this table represents an aggregation of subbasins, the boundaries of which do not always coincide with the civil boundaries of the Region.*

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service; County Soil and Water Conservation Districts; University of Wisconsin-Extension Service; and SEWRPC.

Map 93

THE LOCATION, BOUNDARIES, AND MAJOR STREAMS OF THE SHEBOYGAN RIVER WATERSHED—SHOWING POINT SOURCES OF POLLUTION AND GENERALIZED LAND USES: 1975

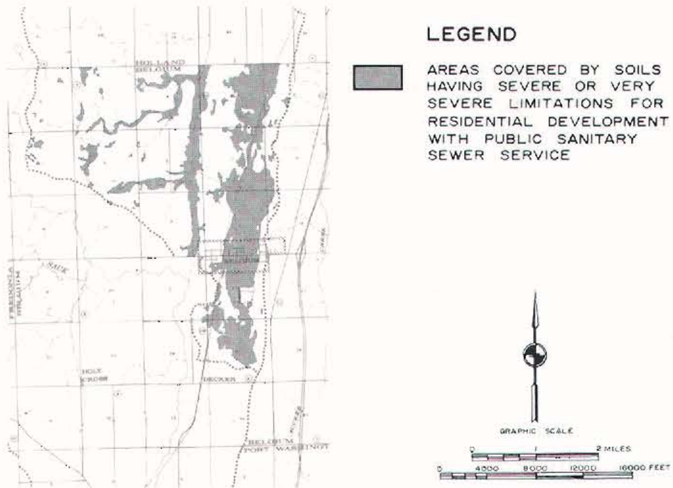


The Sheboygan River watershed is about 11 square miles in areal extent, or about 0.5 percent of the total area of the Region. The water quality in the watershed is affected by the various land uses as well as by the one public wastewater treatment plant, one private wastewater treatment plant, one flow relief device, and one other point source of wastewater as shown.

Source: SEWRPC.

Map 94

SUITABILITY OF SOILS FOR RESIDENTIAL DEVELOPMENT WITH PUBLIC SANITARY SEWER SERVICE IN THE SHEBOYGAN RIVER WATERSHED



Of particular importance in comprehensive water quality planning is the recognition of the limitations inherent in the soil resource base. About 26 percent of the area of the Sheboygan River watershed is covered with soils which are poorly suited for residential development with public sanitary sewer service or, more precisely, residential development of any kind. These soils, which include wet soils having a high water table or poor drainage, organic soils which are poorly drained and provide poor foundation support, and soils which have a flood hazard, are especially prevalent in the riverine areas of the watershed.

Source: U. S. Soil Conservation Service and SEWRPC.

Particularly important to comprehensive water quality management planning are the soil suitability interpretations for specified types of urban development. Based upon the interpretations of the soil properties, about 26 percent of the watershed is covered by soils that have severe or very severe limitations for residential development with public sanitary sewer service, as shown on Map 94; about 80 percent of the watershed is covered by soils that have severe or very severe limitations for small lot (less than one acre in size) residential development without public sanitary sewer, as shown on Map 95; and about 38 percent of the watershed is covered by soils that have severe or very severe limitations for large lot (one acre or larger in size) residential development, as shown on Map 96.

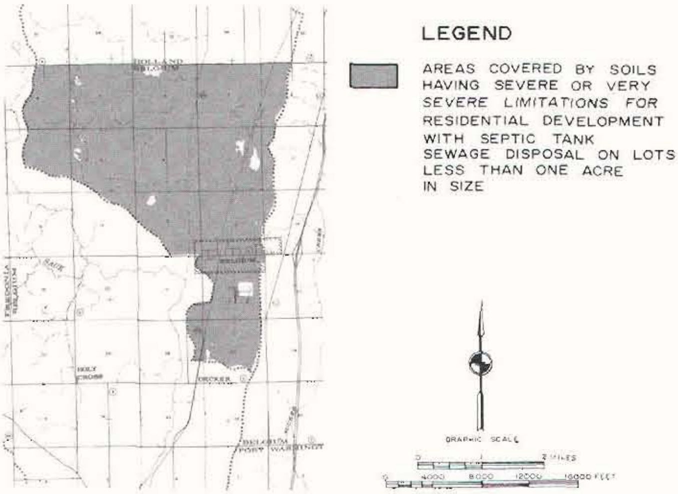
Municipal and Private Sewage Treatment Facilities

In 1975, a portion of one sanitary sewerage system served a total area of about 0.3 square mile within the watershed, or about 3 percent of the total area of the watershed, and a total population of about 900 persons, or approximately 78 percent of the total resident population of the watershed.

One municipally owned sewage treatment plant is located in the Sheboygan River watershed. The plant, which serves the Village of Belgium, discharges treated effluents directly to a tributary of the Onion River. Selected information on this municipal sewage treatment plant is set forth in Table 130, and the plant location is shown on Map 93. There is one known private wastewater treatment facility operating in the Sheboygan River watershed, which serves the Krier Preserving Company. Selected data

Map 95

SUITABILITY OF SOILS FOR SMALL LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE IN THE SHEBOYGAN RIVER WATERSHED

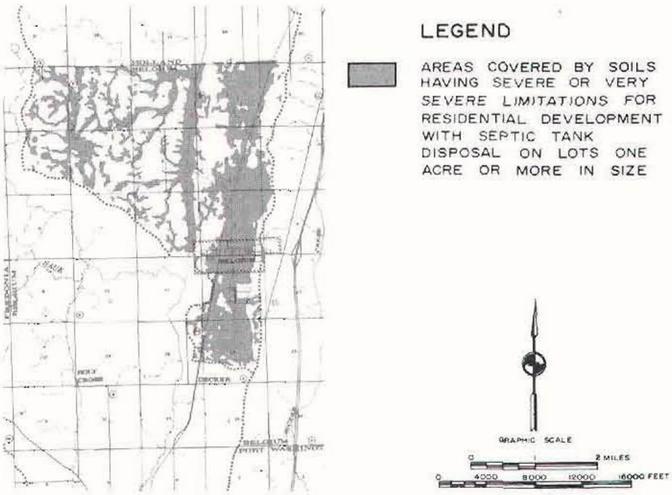


Approximately 80 percent of the area of the Sheboygan River watershed is covered by soils poorly suited for residential development on lots having an area smaller than one acre and not served by public sanitary sewerage facilities. Reliance on septic tank sewage disposal systems in these areas, which are covered by relatively impervious soils or are subject to seasonally high water tables, can only result in eventual malfunctioning of such systems and the consequent intensification of water pollution and public health problems in the watershed.

Source: U. S. Soil Conservation Service and SEWRPC.

Map 96

SUITABILITY OF SOILS FOR LARGE LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE IN THE SHEBOYGAN RIVER WATERSHED



Approximately 38 percent of the area of the Sheboygan River watershed is covered by soils poorly suited for residential development on lots having an area of one acre or more and not served by public sanitary sewerage facilities. The inherent limitations of these soils for septic tank sewage disposal systems cannot be overcome simply by the provision of larger lots, and the use of such systems on these soils, which cannot absorb the sewage effluent, ultimately results in surface ponding and runoff of partially treated wastes into nearby watercourses.

Source: U. S. Soil Conservation Service and SEWRPC.

on this privately operated wastewater treatment facility are presented in Table 131, and the location of this facility is shown on Map 93. This facility has two outfalls. One outfall discharges to a tributary of the Onion River via a drainage ditch and the other utilizes a soil absorption system.

Sanitary Sewerage System Flow Relief Points

In 1975, there was one known sanitary sewer flow relief device in the watershed, as listed in Table 132 and shown on Map 93. This device was a sanitary sewerage system bypass that discharged directly to a tributary of the Onion River.

Other Known Point Sources

One other known point source of pollution, with one outfall, was identified in the watershed in 1975. This outfall discharged cooling water indirectly to the surface water system. Table 133 summarizes by receiving stream and civil division the characteristics of this other point source, and Map 93 shows its location. This other point source outfall discharges wastes indirectly to the Onion River.

Privately Owned Onsite Sanitary Wastewater Treatment

In addition to the centralized sanitary sewerage service within the watershed, sanitary wastewater treatment and disposal is provided through approximately 71 privately owned onsite sewage disposal systems, all of which are septic tanks. These systems serve a total resident population of about 220 persons, or 22 percent of the total resident population of the watershed. There are no concentrated areas of urban development having at least 32 housing units in a U. S. Public Land Survey quarter section in the Sheboygan River watershed.

Urban Storm Water Management Systems

As noted in Table 129, land cover categories associated with urban land uses as of 1975 comprised 251 acres, or about 3 percent of the Sheboygan River watershed. The most important urban land cover category was residential land, comprising about 1 percent of the total area of the watershed.

The only known urban storm water drainage system providing service to the subareas of the Sheboygan River watershed within the Region in 1975 was the system

Table 130

SELECTED CHARACTERISTICS OF MUNICIPAL SEWAGE TREATMENT PLANTS IN THE SHEBOYGAN RIVER WATERSHED: 1975

Name	Total Area Served (square miles)	Estimated Total Population Served	Date of Construction and Major Modification	Type of Treatment	Level of Treatment Provided	Disposal of Effluent	Design Capacity: Population[a]	Design Capacity: Average Hydraulic (mgd)	Design Capacity: Peak Hydraulic (mgd)	Design Capacity: Average Organic	Design Capacity: Population[a] Equivalent	Existing Loading: Average Hydraulic (mgd)	Existing Loading: Average Per Capita (gpd)
Village of Belgium . .	0.36	900	1949, 1970	Activated Sludge Disinfection	Secondary Auxiliary	Tributary of Onion River	1,200	0.07	0.10	N/A	N/A	0.07	78

NOTE: N/A indicates data not available.

[a] *The population design capacity for a given sewage treatment facility was obtained directly from engineering reports prepared by or for the local unit of government operating the facility and reflects assumptions made by the design engineer. The population equivalent design capacity was estimated by the Commission staff by dividing the design BOD_5 loading in pounds per day, as set forth in the engineering reports, by an estimated per capita contribution of 0.21 pound of BOD_5 per day. If the design engineer assumed a different daily per capita contribution of BOD_5, the population equivalent design capacity will differ from the population design capacity shown in the table.*

Source: SEWRPC.

Table 131

SELECTED CHARACTERISTICS OF PRIVATELY OWNED WASTEWATER TREATMENT FACILITIES IN THE SHEBOYGAN RIVER WATERSHED: 1975

Name	Civil Division Location	Type of Land Use Served	Type of Wastewater	Type of Treatment Provided	Disposal of Effluent	Reported Average Annual Hydraulic Discharge Rate (gallons per day)[a]	Average Hydraulic Design Capacity (gallons per day)	Reported Maximum Monthly Hydraulic Discharge Rate (gallons per day)[a]
OZAUKEE COUNTY								
Krier Preserving Company	Town of Belgium	Industrial	Process	Lagoon	Tributary of Onion River via Drainage Ditch	Intermittent	N/A	N/A
			Process	Lagoon and Spray Irrigation	Soil Absorption	550,000	N/A	1,100,000

NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data were obtained, in order of priority, from: quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System or under Section 101 of the Wisconsin Administrative Code or from the Wisconsin Pollutant Discharge Elimination System permit itself. In some cases when 12 months of flow data were not reported, the average annual and maximum monthly hydraulic discharge rates were estimated from the available monthly discharge data or from the flow data as reported in the permit.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 132

KNOWN SANITARY SEWERAGE SYSTEM FLOW RELIEF DEVICES IN THE SHEBOYGAN RIVER WATERSHED BY RECEIVING STREAM AND CIVIL DIVISION: 1975

Receiving Stream	Civil Division	Combined Sewer Outfalls	Other Flow Relief Devices: Crossovers	Other Flow Relief Devices: Bypasses	Other Flow Relief Devices: Relief Pumping Stations	Other Flow Relief Devices: Portable Pumping Stations	Total
Onion River . . .	Village of Belgium	0	0	1	0	0	1
Total	--	0	0	1	0	0	1

Source: SEWRPC.

Table 133

CHARACTERISTICS OF OTHER KNOWN POINT SOURCES OF WATER POLLUTION IN THE SHEBOYGAN RIVER WATERSHED: 1975

Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average Annual Hydraulic Discharge Rate (gallons per day)[a]	Reported Maximum Monthly Hydraulic Discharge Rate (gallons per day)[a]
SHEBOYGAN COUNTY Krier Preserving Company	2033	Town of Belgium	Cooling	N/A	2	Tributary of Onion River via Drainage Ditch	29,600	30,000

NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data were obtained, in order of priority, from: quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System or under Section 101 of the Wisconsin Administrative Code or from the Wisconsin Pollutant Discharge Elimination System permit itself. In some cases when 12 months of flow data were not reported, the average annual and maximum monthly hydraulic discharge rates were estimated from the available monthly discharge data or from the flow data as reported in the permit.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

operated by the Village of Belgium. The drainage system lies totally within the Sheboygan River watershed and has a tributary drainage area of about 0.2 square mile, or about 2 percent of the total area of that portion of the watershed within the Region. Included within this drainage area are a total of two storm water outfalls, which are 15 and 24 inches in diameter respectively, and both of which discharge to a tributary of the Onion River. There are no known storm water pumping or storage facilities in the watershed. The total average annual discharge from these two storm water drainage outfalls is estimated to be about four million gallons per year occurring on the average in seven events.

Rural Storm Water Runoff

About 8,000 acres, or 97 percent of the total area of the watershed, are devoted to rural land use activities. The most important rural land cover categories were row crops with 36 percent, hay with 24 percent, small grains with 13 percent, woodlands with 8 percent, and specialty crops with 12 percent of the watershed. As of May 1975, there were an estimated 22 domestic livestock operations—operations of 25 or more equivalent animal units—having a total of 1,500 equivalent animal units within the watershed. Of the 22 operations, 17, or 77 percent, were located within 500 feet of the surface water system of the watershed.

Pollution Loadings

A summary of the estimated average annual pollution loadings in the Sheboygan River watershed is presented in Table 134 and depicted in Figure 43. Urban sources of pollution are estimated to contribute 5 percent of the nitrogen, 8 percent of the phosphorus, 14 percent of the biochemical oxygen demand, 3 percent of the fecal coliform, and 12 percent of the sediment which occur as water pollutants in the Sheboygan River watershed. Of the urban contribution, point sources of pollution are estimated to contribute 41 percent of the nitrogen, 18 percent of the phosphorus, 15 percent of the biochemical oxygen demand, almost none of the fecal coliform, and almost none of the sediment. Diffuse sources—including the estimated septic tank and construction-related contributions in the drainage area—account for the remaining 59 percent of the nitrogen, 82 percent of the phosphorus, 85 percent of the biochemical oxygen demand, almost all of the fecal coliform, and almost all of the sediment contributed from urban sources.

Of the total pollutant loads, rural pollution sources are estimated to contribute the remaining 95 percent of the nitrogen, 92 percent of the phosphorus, 86 percent of the biochemical oxygen demand, 97 percent of the fecal coliform, and 88 percent of the sediment which occur as water pollutants in the watershed. Of the rural pollution sources, none are point sources, since none of the livestock operations in the watershed are of sufficient size to fall within the definition used in this report. Other livestock feeding operations—inclusive of the disposal of manure on croplands—are estimated to contribute 30 percent of the nitrogen, 77 percent of the phosphorus, 58 percent of the biochemical oxygen demand, nearly all of the fecal coliform, and 3 percent of the sediment from rural sources. The remainder of the estimated rural pollution load, or 70 percent of the nitrogen, 23 percent of the phosphorus, 42 percent of the biochemical oxygen demand, almost none of the fecal coliform, and 97 percent of the sediment, are contributed by other rural diffuse sources, namely storm water runoff from rural land uses and atmospheric loadings to surface waters.

Table 134

SUMMARY OF ESTIMATED AVERAGE ANNUAL POLLUTANT LOADINGS IN THE SHEBOYGAN RIVER WATERSHED: 1975

Source	Extent[a]	Parameter	Load[b] Average Year Total Estimated Loading	Load[b] Average Year Percent
Urban Point Sources				
Municipal Sewage Treatment Plants . .	1	Total Nitrogen	3,280.0	2.2
	1	Total Phosphorus	210.0	1.5
	1	Biochemical Oxygen Demand	6,390.0	1.9
	1	Fecal Coliform	100.0	0.0
	1	Sediment	5.0	0.0
Private Sewage Treatment Plants	1	Total Nitrogen	0.0	0.0
	1	Total Phosphorus	0.0	0.0
	1	Biochemical Oxygen Demand	0.0	0.0
	1	Fecal Coliform	0.0	0.0
	1	Sediment	0.0	0.0
Combined Sewer Overflow	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Industrial Discharges	1	Total Nitrogen	20.0	0.0
	1	Total Phosphorus	0.0	0.0
	1	Biochemical Oxygen Demand	450.0	0.1
	1	Fecal Coliform	0.0	0.0
	1	Sediment	0.0	0.0
Sanitary Sewer Flow Relief Devices . .	1	Total Nitrogen	0.0	0.0
	1	Total Phosphorus	0.0	0.0
	1	Biochemical Oxygen Demand	0.0	0.0
	1	Fecal Coliform	0.0	0.0
	1	Sediment	0.0	0.0
Urban Point Source Totals		Total Nitrogen	3,300.0	2.2
		Total Phosphorus	210.0	1.5
		Biochemical Oxygen Demand	6,840.0	2.0
		Fecal Coliform	100.0	0.0
		Sediment	5.0	0.0
Urban Diffuse Sources				
Residential	100	Total Nitrogen	400.0	0.3
	100	Total Phosphorus	30.0	0.2
	100	Biochemical Oxygen Demand	2,430.0	0.7
	100	Fecal Coliform	16,000.0	0.2
	100	Sediment	25.0	0.1
Commercial	20	Total Nitrogen	180.0	0.1
	20	Total Phosphorus	20.0	0.1
	20	Biochemical Oxygen Demand	1,950.0	0.6
	20	Fecal Coliform	6,600.0	0.1
	20	Sediment	5.0	0.0
Industrial	25	Total Nitrogen	210.0	0.1
	25	Total Phosphorus	20.0	0.1
	25	Biochemical Oxygen Demand	920.0	0.3
	25	Fecal Coliform	15,500.0	0.2
	25	Sediment	10.0	0.0
Extractive	0	Total Nitrogen	0.0	0.0
	0	Total Phosphorus	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0
	0	Fecal Coliform	0.0	0.0
	0	Sediment	0.0	0.0
Transportation	90	Total Nitrogen	2,110.0	1.4
	90	Total Phosphorus	130.0	0.9
	90	Biochemical Oxygen Demand	14,310.0	4.3
	90	Fecal Coliform	60,300.0	0.6
	90	Sediment	1,915.0	8.8
Recreation	6	Total Nitrogen	10.0	0.0
	6	Total Phosphorus	0.0	0.0
	6	Biochemical Oxygen Demand	10.0	0.0
	6	Fecal Coliform	216.0	0.0
	6	Sediment	0.0	0.0
Construction	10	Total Nitrogen	600.0	0.4
	10	Total Phosphorus	450.0	3.2
	10	Biochemical Oxygen Demand	1,200.0	0.4
	10	Fecal Coliform	0.0	0.0
	10	Sediment	750.0	3.4
Septic Systems	216	Total Nitrogen	1,230.0	0.8
	216	Total Phosphorus	290.0	2.1
	216	Biochemical Oxygen Demand	17,630.0	5.3
	216	Fecal Coliform	216,000.0	2.2
	216	Sediment	5.0	0.0
Urban Diffuse Source Totals		Total Nitrogen	4,740.0	3.1
		Total Phosphorus	940.0	6.7
		Biochemical Oxygen Demand	38,450.0	11.5
		Fecal Coliform	314,616.0	3.2
		Sediment	2,710.0	12.4
Urban Source Totals		Total Nitrogen	8,040.0	5.3
		Total Phosphorus	1,150.0	8.2
		Biochemical Oxygen Demand	45,290.0	13.6
		Fecal Coliform	314,716.0	3.2
		Sediment	2,715.0	12.4
Rural Diffuse Sources				
Livestock Operations	1500	Total Nitrogen	42,600.0	28.2
	1500	Total Phosphorus	9,900.0	70.4
	1500	Biochemical Oxygen Demand	166,800.0	49.9
	1500	Fecal Coliform	9,600,000.0	96.8
	1500	Sediment	625.0	2.4
Cropland, Pasture, and Unused Rural Land	7142	Total Nitrogen	98,540.0	65.2
	7142	Total Phosphorus	2,890.0	20.6
	7142	Biochemical Oxygen Demand	112,460.0	33.7
	7142	Fecal Coliform	0.0	0.0
	7142	Sediment	18,510.0	84.7
Silvicultural	685	Total Nitrogen	1,580.0	1.0
	685	Total Phosphorus	100.0	0.7
	685	Biochemical Oxygen Demand	3,150.0	0.9
	685	Fecal Coliform	4,521.0	0.0
	685	Sediment	85.0	0.4
Air Pollution to Surface Water	40	Total Nitrogen	360.0	0.2
	40	Total Phosphorus	20.0	0.1
	40	Biochemical Oxygen Demand	6,480.0	1.9
	40	Fecal Coliform	0.0	0.0
	40	Sediment	15.0	0.1
Rural Diffuse Source Totals		Total Nitrogen	143,080.0	94.7
		Total Phosphorus	12,910.0	91.8
		Biochemical Oxygen Demand	288,890.0	86.4
		Fecal Coliform	9,604,521.0	96.8
		Sediment	19,135.0	87.6
Diffuse Source Totals		Total Nitrogen	147,820.0	97.8
		Total Phosphorus	13,850.0	98.5
		Biochemical Oxygen Demand	327,340.0	98.0
		Fecal Coliform	9,919,137.0	100.0
		Sediment	21,845.0	100.0
Total Sources		Total Nitrogen	151,120.0	100.0
		Total Phosphorus	14,060.0	100.0
		Biochemical Oxygen Demand	334,180.0	100.0
		Fecal Coliform	9,919,237.0	100.0
		Sediment	21,850.0	100.0

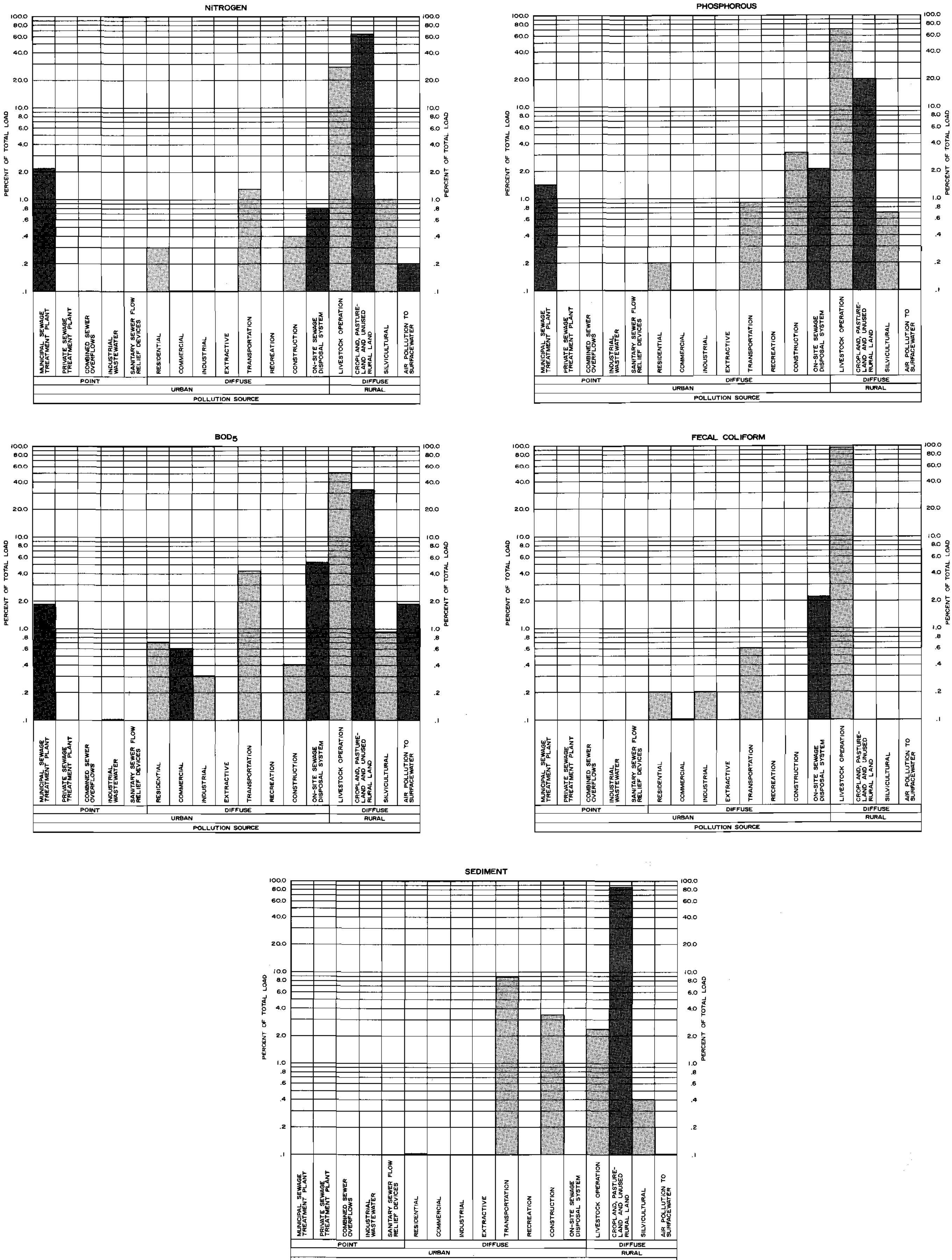
[a] *Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.*

[b] *Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year.*

Source: SEWRPC.

Figure 43

SUMMARY OF ESTIMATED AVERAGE ANNUAL POLLUTANT LOADINGS IN THE SHEBOYGAN RIVER WATERSHED: 1975



Source: SEWRPC.

SUMMARY

The quantitative evaluation of water pollution and of the potential for its abatement and control under alternative measures requires data on the locations, types, amounts, and characteristics of pollutants contributed by various sources. Accordingly, the Commission undertook in 1975 an inventory, by watershed, of the known sources of water pollution within the seven-county planning region. The inventory addressed as urban pollution sources: municipal wastewater treatment plant outfalls; sanitary sewerage system flow relief devices; combined sewer outfalls; private wastewater treatment plant outfalls; other point sources including industrial wastewater outfalls; privately owned, onsite sewage disposal systems; and storm water runoff from residential, commercial, industrial, extractive, transportation, recreation, and construction lands. The inventory addressed as rural pollution sources: domestic livestock operations; storm water runoff from croplands, pasture lands, and unused rural lands; storm water runoff from woodlands; and direct atmospheric fallout to surface waters.

Five pollutants were selected for use in the analyses of the kind and amount of pollutants contributed to the surface waters of the Region by the 11 categories of pollution sources. These five pollutants have been historically identified and studied both as important pollutants in themselves and as principal indicators of the presence of other polluting substances. The five specific pollutants utilized were total nitrogen, total phosphorus, five-day biochemical oxygen demand, sediment, and fecal coliform.

The boundaries of the 11 major inland watersheds within the Region and the locations and configuration of the main drainage channels of these watersheds are shown on Map 2 in Chapter I of this report, together with the generalized land use pattern in each watershed as of 1975. A twelfth major watershed within the Region is the drainage area directly tributary to Lake Michigan. This twelfth watershed has an area of about 105 square miles, or 4 percent of the total area of the Region. Of the 11 inland watersheds, 8, having a combined area of about 912 square miles, or about 34 percent of the total area of the Region, ultimately drain to Lake Michigan, and the remaining 3 watersheds, having a combined area of about 1,680 square miles, or about 62 percent of the total area of the Region, drain to the Mississippi River via the Fox, Illinois, and Rock Rivers. About 250 square miles, or 38 percent of the 683-square-mile Milwaukee River watershed, lie outside of the Region in Dodge, Fond du Lac, and Sheboygan Counties but drain to Lake Michigan through the Region.

In 1975 about 18 percent of the total area of the Region was in urban land uses. Most of the urban land uses are concentrated in the southeastern portion of the Region in the Kenosha, Milwaukee, and Racine urbanized areas, so that the proportion of the area of each watershed in urban use ranges from a high of about 87 percent in the Kinnickinnic River watershed to a low of about 3 percent in the Sheboygan River watershed. Table 135 sets forth

Table 135

AREAL EXTENT OF WATER QUALITY-RELATED LAND COVER IN THE REGION: 1975

Land Cover[a]	Square Miles	Acres	Percent
Urban			
Residential	285.91	172,239	10.01
Commercial[b]	48.81	31,190	1.81
Industrial			
Manufacturing	29.07	18,607	1.08
Landfills and Dumps	2.75	1,760	0.10
Extractive	12.62	8,080	0.47
Transportation			
Streets and Highways	22.24	14,240	0.83
Airfields	6.41	4,102	0.24
Railroad Yards and Terminals	2.46	1,575	0.09
Recreation			
Golf Courses	19.37	12,395	0.72
Parks and Other Recreation	32.88	21,040	1.22
Land Under Development			
Residential[c]	26.65	27,797	1.62
Commercial	0.32	250	0.01
Industrial	1.68	1,070	0.06
Transportation	1.47	937	0.05
Recreation	0.25	162	0.01
Rural			
Agricultural			
Small Grains	95.70	61,250	3.56
Hay	279.32	178,766	10.39
Row Crops	898.56	575,081	33.42
Specialty Crops	48.02	30,733	1.79
Sod Farm	9.27	5,934	0.35
Other Open Space[d]	329.70	211,008	12.26
Silvicultural			
Woodlands	220.26	140,967	8.19
Orchards and Nurseries	7.08	4,530	0.26
Natural and Man-Made Water Areas—Subject to Atmospheric Pollutant Contributions			
Ponds, Lakes, and Streams	101.50	64,963	3.78
Wetlands, Swamps, and Marshes	206.33	132,049	7.68
Total	2,688.63	1,720,725	100.00

[a] *These special land cover categories, defined primarily according to their impervious and vegetative characteristics and effects on the quality of storm water runoff, were delineated at a scale of 1" = 400' on aerial photographs taken in May 1975 and then measured to the nearest full acre using areal determination grids. The total acreages measured within each county were then adjusted to the preliminary control totals measured by the digitizer from base maps of hydrologic subbasins at a scale of 1" = 2000'. Both the "square miles" and the "percent" shown above were then computed and rounded off to the nearest hundredth (0.01). All lands under development categories are combined with their respective category rather than being shown separately. The final control number for the areal extent of the Region is represented by summing each of the watersheds within the Region and totals 2,689 square miles.*

[b] *Includes: retail, communication, utilities, administrative, and institutional land uses.*

[c] *Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.*

[d] *Includes: pasture, unused urban and rural lands.*

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service; County Soil and Water Conservation Districts; University of Wisconsin Extention Service; and SEWRPC.

the extent and proportion of the major land use and cover categories within the Region as of 1975. Residential uses comprise the major proportion of the urban uses, totaling about 63 percent of all such uses. Agricultural uses comprise the major proportion of the rural uses, totaling about 85 percent of all such uses.

Most of the soils of the Region are relatively fertile and produce high crop yields if properly managed. Sediment discharges from the soils may, however, result in high nutrient levels in receiving streams and lake waters. Based upon analyses of detailed operational soil survey maps and attendant interpretations of soil suitability for various rural and urban land uses, about 716 square miles, or about 27 percent of the Region, are covered by soils that have severe or very severe limitations for residential development with public sanitary sewerage service, as shown on Map 21 in Chapter III. About 1,637 square miles, or about 61 percent of the Region, are covered by soils having severe limitations or small lot (less than one acre in size) residential development without public sanitary sewer service as shown on Map 22 in Chapter III. About 1,181 square miles, or about 44 percent of the Region, are covered by soils that have severe or very severe limitations for large lot (one acre or more in size) residential development without public sanitary sewers, as shown on Map 23 in Chapter III.

Municipal and Private Sewage Treatment Facilities

In 1975 a total of 95 public sanitary sewerage systems served a combined area of about 353 square miles, or about 13 percent of the total area of the Region, and a total resident population of about 1,544,000 persons, or approximately 86 percent of the total resident population of the Region. Of this, all or parts of 41 public sanitary sewerage systems were drained to sewage treatment plants within the area of direct drainage to Lake Michigan and served an area of about 263 square miles, or about 75 percent of the areas served by centralized sanitary sewers in the Region, and a total resident population of about 1,267,900 persons, or about 82 percent of the total served. All or parts of 55 sanitary sewerage systems, serving a total of about 90 square miles and a resident population of 276,100 persons, were tributary to sewage treatment plants which discharged to perennial inland lakes and streams. Of these systems tributary to the inland portion of the Region, all or parts of 19 public sanitary sewerage systems, serving a combined area of about 31 square miles and a total resident population of about 103,400 persons, were within or tributary to the Great Lakes drainage basin; and 36 systems or parts of systems, serving a combined area of about 59 square miles and a total resident population of about 172,700 persons, were associated with the drainage area tributary to the Mississippi River.

Of the 353-square-mile area served by sanitary sewers, about 26.7 square miles, or about 8 percent, were served by combined sanitary-storm sewers. An estimated total of about 365,200 persons, or about 20 percent of the total resident population of the Region, resided in this combined sewer service area. About 4.7 square miles of the combined sewer service area, with a resident population of about 56,800 persons, were located within areas directly tributary to Lake Michigan. The remaining combined sewer service areas were located in inland watersheds drained by perennial streams which discharged to Lake Michigan. Thus, the combined sewer service areas, located in the older portions of the Cities of Kenosha, Milwaukee, and Racine and the Village of Shorewood, were all located in the Great Lakes Drainage Basin, and no combined sewer systems were found to exist in the Mississippi River drainage basin portion of the Region. Selected data for these combined sewer service areas are found in Table 136.

Table 136

SUMMARY OF COMBINED SEWER SERVICE AREA

Watershed	Area Served (square miles)	Resident Population Served
Kinnickinnic River. .	3.9	56,000
Menomonee River . .	8.4	68,500
Milwaukee River . . .	8.8	175,800
Pike Creek	--[a]	--[a]
Root River.	0.9	8,100
Subtotal	22.0	308,400
Direct Drainage to Lake Michigan	4.7	56,800
Total	26.7[b]	365,200

[a] *Negligible.*

[b] *This area includes approximately 22.4 square miles in the City of Milwaukee and the Village of Shorewood. This areal extent is less than the 27 square miles indicated for the combined sewer service area in SEWRPC Planning Report No. 13, A Comprehensive Plan for the Milwaukee River Watershed, and SEWRPC Planning Report No. 16, A Regional Sanitary Sewerage System Plan for Southeastern Wisconsin. The 22.4-square-mile size of the combined sewer service area was reported in the Milwaukee Metropolitan Sewerage District Report, Technical Analysis of Conveyance-Storage-Treatment Concept: A Working Document, Combined Sewer Overflow Pollution Abatement, July 1976. This reduced size takes into account a reduction in the industrial parks, freeways, parks, and other areas which have had separate sewers installed and are located within the outer limits of the combined sewer service area, thus creating small areas of separate sewers within the combined sewer service area.*

Source: SEWRPC.

Table 137

SUMMARY OF MUNICIPAL AND PRIVATE SEWAGE TREATMENT PLANT DISCHARGES IN THE REGION: 1975

Hydrologic Unit	Tributary Municipal Sewage Treatment Facilities		Number of Tributary Municipal Sanitary Sewerage Systems	Number of Municipal Treatment Facilities	Number of Private Treatment Facilities	Total Number of Treatment Facilities
	Tributary Area (square miles)	Tributary Population				
Des Plaines River Watershed	2.65	4,800	5	5	8	13
Fox River Watershed	40.87	116,400	19	16	21	37
Rock River Watershed	15.16	51,500	12	12	11	23
Mississippi River Drainage Basin Subtotal	58.68	172,700	36	33	40	73
Kinnickinnic River Watershed	0.00	0	0	0	0	0
Menomonee River Watershed	8.05	25,000	2	3	0	3
Milwaukee River Watershed	14.53	52,800	9	9	6	15
Minor Streams Directly Tributary to Lake Michigan						
Barnes Creek Subwatershed	0.00	0	0	0	0	0
Pike Creek Subwatershed	0.00	0	0	0	0	0
Sucker Creek Subwatershed	0.00	0	0	0	0	0
Oak Creek Watershed	0.00	0	0	0	0	0
Pike River Watershed	1.12	5,100	2	2	2	4
Root River Watershed	7.01	19,600	5	5	11	16
Sauk Creek Watershed	0.00	0	0	0	1	1
Sheboygan River Watershed	0.36	900	1	1	1	2
Great Lakes Perennial Streams Drainage Basin Subtotal	31.07	103,400	19	20	21	41
Direct Drainage to Lake Michigan through Intermittent Streams and Drainage Swales	263.58	1,267,900	41	8	6	14
Total[a]	353.33	1,544,000	96[b]	61	67	128

[a] *In addition to the Region total, there are four public sanitary sewerage systems and one private treatment facility in that portion of the Milwaukee River watershed that lies outside of the Region.*

[b] *The total for the Region is 95, but the City of Muskego is counted twice because it operates two treatment facilities; one of which discharges to the Great Lakes drainage basin (Root River watershed) and one of which discharges to the Mississippi River drainage basin (Fox River watershed).*

Source: SEWRPC.

As of 1975 there were 61 municipally owned sewage treatment plants in operation in the Region. Eight of these plants were located in the area of direct drainage to Lake Michigan. The remaining 53 were located in the inland areas of the Region. Of those in the inland areas, 20 were tributary to perennial streams of the Great Lakes drainage basin, and the remaining 33 were tributary to the Mississippi River drainage basin. In addition to the 61 publicly owned sewage treatment facilities, 67 private wastewater treatment facilities were found to exist in the Region. Six of these plants were located in the area of direct drainage to Lake Michigan. The remaining 61 were located in the inland areas of the Region. Of those in the inland areas, 21 were tributary to the perennial streams of the Great Lakes drainage basin, and the remaining 40 were tributary to the Mississippi River drainage basin. Selected data for the 128 municipal and private sewage treatment plants located in the Region are set forth in Table 137. The locations and service areas of the municipal sewage treatment plants along with the locations of the private sewage treatment facilities are set forth on Map 8 in Chapter III of this report.

Combined and Sanitary Sewerage System Flow Relief Points

In 1975 there were 619 known sanitary and combined sewer flow relief devices in the Region as listed in Table 138. Of this total, 126 were combined sewer outfalls, 110 were separate sewer bypasses, 40 were relief pumping stations, 72 were portable pumping stations, and 271 were sanitary and storm sewer crossovers. In addition, it should be noted that outside of—but tributary to—the Region, Commission inventories identified two separate sewer bypasses, with no relief pumping stations, portable pumping stations, or sanitary and storm sewer crossovers in that portion of the Milwaukee River watershed located outside of the Region. There were also four municipally owned sewage treatment plants and one private wastewater treatment facility located in the headwater area of the Milwaukee River watershed outside the Region.

Other Known Point Sources

In 1975 there were a total of 263 establishments discharging industrial cooling, process, rinse, wash, and backwash waters through 435 outfalls to the inland waters of the Region and to Lake Michigan. Of these, 248 outfalls, or about 57 percent, were identified as discharging only cooling water. Of the 435 outfalls, 67, or about 15 percent, were located in the direct drainage area of Lake Michigan. The remaining 368 were located in the inland portions of the Region. Of the outfalls located in the inland portions of the Region, 294, or about 80 percent, were in the Great Lakes drainage basin, and the remaining 74 were in the Mississippi River drainage basin portion of the Region.

In addition to the 435 outfalls, 16 facilities discharged via 17 discharge points to soil absorption systems for effluent disposal. Four, or 24 percent of these discharge points, were located in the Great Lakes drainage basin and the remaining 13 were located within the Mississippi

Table 138

KNOWN SANITARY SEWERAGE SYSTEM FLOW RELIEF DEVICES IN THE REGION: 1975

Hydrologic Unit	Combined Sewer Outfalls	Separate Sanitary Sewer Flow Relief Devices: Bypasses	Relief Pumping Stations	Portable Pumping Stations	Crossovers	Total
Des Plaines River Watershed	0	3	0	0	0	3
Fox River Watershed	0	13	0	7	0	20
Rock River Watershed	0	16	0	0	0	16
Mississippi River Drainage Basin Subtotal	0	32	0	7	0	39
Kinnickinnic River Watershed	23	4	2	4	19	52
Menomonee River Watershed	26	7	28	32	73	166
Milwaukee River Watershed	61	27	7	16	77	188
Minor Perennial Streams Directly Tributary to Lake Michigan Watershed						
Barnes Creek Subwatershed	0	0	0	0	0	0
Pike Creek Subwatershed	0	0	2	0	3	5
Sucker Creek Subwatershed	0	0	0	0	0	0
Oak Creek Watershed	0	2	0	0	0	2
Pike River Watershed	0	3	0	0	5	8
Root River Watershed	8	20	0	11	22	61
Sauk Creek Watershed	0	2	0	0	0	2
Sheboygan River Watershed	0	1	0	0	0	1
Great Lakes Drainage Basin Perennial Streams Subtotal	118	66	39	63	199	485
Direct Drainage to Lake Michigan through Intermittent Streams and Drainage Swales	8	12	1	2	72	95
Total[a]	126	110	40	72	271	619

[a] *In addition to the Region totals, that portion of the Milwaukee River watershed that lies outside of the Region has two flow relief devices which are both bypasses.*

Source: SEWRPC.

Table 139

OTHER KNOWN POINT SOURCES OF WASTEWATER IN THE REGION: 1975

Hydrologic Unit	Number of Known Facilities with Discharges to Surface Waters	Total Number of Outfalls Discharging to Surface Waters	Number of Outfalls Discharging Cooling Water Only	Number of Outfalls Discharging Other Types of Wastewater	Number of Known Facilities That Utilize Soil Absorption Systems	Number of Discharge Points to Soil Absorption Systems
Des Plaines River Watershed	6	6	3	3	0	0
Fox River Watershed	33	48	31	17	6	7
Rock River Watershed	17	20	12	8	6	6
Mississippi River Drainage Basin Subtotal	56	74	46	28	12	13
Kinnickinnic River Watershed	30	60	30	30	0	0
Menomonee River Watershed	48	78	37	41	1	1
Milwaukee River Watershed	68	117	81	36	1	1
Minor Streams Directly Tributary to Lake Michigan Watershed						
Barnes Creek Subwatershed	0	0	0	0	0	0
Pike Creek Subwatershed	1	1	1	0	0	0
Sucker Creek Subwatershed	0	0	0	0	0	0
Oak Creek Watershed	8	13	6	7	0	0
Pike River Watershed	4	6	6	0	0	0
Root River	11	18	13	5	2	2
Sauk Creek	2	2	1	1	0	0
Sheboygan River	1	1	1	0	0	0
Great Lakes Perennial Streams Drainage Basin Subtotal	173	294	176	118	4	4
Direct Drainage to Lake Michigan through Intermittent Streams and Drainage Swales	34	67	26	41	0	0
Total[a]	263[b,c]	435	248	187	16[c]	17

[a] *In addition to the Region total, there are a total of five known facilities located in that portion of the Milwaukee River watershed outside of the Southeastern Wisconsin Region with six outfalls discharging to surface waters—three outfalls discharging cooling water only and three outfalls discharging other types of wastewater. Also, one discharge point utilizes a soil absorption system.*

[b] *This includes multiple counting of three of the 263 different individual discharges, since these three have outfalls discharging to more than one watershed. These include Bucyrus Erie Company in the City of South Milwaukee discharging to Oak Creek and Lake Michigan; Ladish Company in the City of Cudahy discharging to the Kinnickinnic River, Lake Michigan, and Oak Creek; and the Wisconsin Electric Power Company-Heating Steam Systems in the City of Milwaukee discharging to the Menomonee River and the Milwaukee River.*

[c] *The Region total number of facilities is 273. The difference of six is due to double counting as described in footnote b, and to the fact that two facilities have one discharge each to surface waters and soil absorption systems.*

Source: SEWRPC.

River drainage basin portion of the Region. Table 139 summarizes the number, distribution, and selected characteristics of the point sources other than municipal and private wastewater treatment facilities identified in the Commission inventories.

Privately Owned Onsite Sanitary Wastewater Treatment

In addition to the centralized sanitary sewerage services provided within the Region, sanitary wastewater treatment and disposal was provided through an estimated 68,622 privately owned onsite sewage disposal systems, including 351 known holding tanks and about 44 known mound systems as of 1975, with the balance being traditional septic tank-soil absorption systems. These systems serve an estimated total resident population of about 246,000 persons, or about 14 percent of the total resident population of the Region. Of this total, about 113,000 persons, or about 46 percent, resided in concentrated areas of urban development having a density of at least 32 housing units per U. S. Public Land Survey quarter section. These scattered quarter sections of urban land use concentrations encompass a total of about 145 square miles of urban land use, or about 5 percent of the total area of the Region. In the inland portions of the Region, an estimated 66,671 privately owned onsite sewage disposal systems serve an approximate total resident population of about 239,822 persons. Of this total, about 21,169 systems serving about

Table 140

EXTENT OF USE OF PRIVATELY OWNED ONSITE SEWAGE TREATMENT SYSTEMS IN THE REGION: 1975

Hydrologic Unit	Number of Persons Served by Privately Owned Onsite Sewage Treatment Systems	Number of Privately Owned Onsite Sewage Treatment Systems	Number of Septic Tanks	Number of Holding Tanks	Number of Mound Systems	Number of Persons Residing in Unsewered Urban Concentrations	Area of Unsewered Urban Concentrations (square miles)
Des Plaines River Watershed	10,100	2,954	2,697	12	7	2,700	3.2
Fox River Watershed	97,600	33,528	28,106	145	15	52,800	69.7
Rock River Watershed	50,900	15,250	14,699	30	1	13,700	21.6
Mississippi River Drainage Basin Subtotal	158,600	51,732	45,502	187	23	69,200	94.5
Kinnickinnic River Watershed	0	0	0	0	0	0	0.0
Menomonee River Watershed	17,800	7,819	4,325	55	1	12,100	9.7
Milwaukee River Watershed	29,800	10,230	8,087	48	2	8,900	12.5
Minor Streams Directly Tributary to Lake Michigan Watershed							
Barnes Creek Subwatershed	1,700	497	515	4	3	1,300	1.0
Pike Creek Subwatershed	400	162	161	0	0	370	0.3
Sucker Creek Subwatershed	400	161	138	2	0	0	0.0
Oak Creek Watershed	1,200	873	308	1	0	1,100	1.0
Pike River Watershed	4,200	2,210	1,387	4	2	1,200	2.0
Root River Watershed	27,600	11,379	6,686	21	5	13,000	9.9
Sauk River Watershed	1,100	338	305	12	0	100	0.3
Sheboygan River Watershed	200	72	71	0	0	0	0.0
Great Lakes Perennial Streams Drainage Basin Subtotal	84,400	33,741	21,983	147	13	38,070	36.7
Direct Drainage to Lake Michigan through Intermittent Streams and Drainage Swales	4,400	1,727	1,137	17	8	830	1.1
Total	247,400[a]	87,200[b]	68,622[b]	351[c]	44[c]	108,100[c]	132.3[c]

[a] *In addition to the Region total, 44,700 persons were served by privately owned onsite sewage treatment systems in that portion of the Milwaukee River watershed that lies outside of the Region.*

[b] *In addition to the Region total, 2,448 estimated privately owned onsite sewage treatment systems existed in that portion of the Milwaukee River watershed that lies outside of the Region. All were assumed to be septic tanks.*

Source: SEWRPC.

81,700 persons were located in the Great Lakes drainage basin, and the remaining 45,502 systems serving about 158,100 persons were located within the Mississippi River drainage basin portion of the Region. Table 140 summarizes the numbers and distribution of privately owned onsite sewage disposal systems.

Urban Storm Water Management Systems

As noted in Table 135, urban land use as of 1975 comprised about 490 square miles, or about 18 percent of the total area of the Region. As already noted, residential land uses comprised about 63 percent of the total area in urban use. In the inland portions of the Region an estimated 436 square miles, or about 16 percent of the total inland area, were devoted to urban uses, with about 52 percent of the total inland area in urban use being devoted to residential land uses. Within the area of the Region located in the Mississippi River drainage basin, about 187 square miles, or about 11 percent, were devoted to urban uses, with about 51 percent of the total Mississippi River drainage basin area in urban use being devoted to residential land uses. For the portion of the Region located in the Great Lakes drainage basin, about 249 square miles, or about 21 percent, were devoted to urban uses, with about 53 percent of the total Great Lakes drainage basin area in urban use being devoted to residential land uses.

There were 55 known urban storm water drainage systems providing service in the Region in 1975. Of these, 11 discharged directly to Lake Michigan, while at least portions of all 55 systems were tributary to the perennial inland lakes and streams of the Region. All or part of 42 urban storm water drainage systems were located within the Great Lakes drainage basin and all or parts of 18 systems were located within the Mississippi River drainage basin. These include five systems which drain to both basins.

The urban storm water drainage systems within the Region encompassed a total tributary drainage area of about 183 square miles, or about 7 percent of the total area of the Region, and about 37 percent of the urban area of the Region. About 23.5 square miles, or about 13 percent of the total area served by urban storm water drainage systems, were located within the area directly tributary to Lake Michigan. The remaining 159.8 square miles were located within the inland areas of the Region. Of the inland area, 134.6 square miles, or about 84 percent, were located within the Great Lakes drainage basin. The remaining 25.2 square miles, or 16 percent, were located within the Mississippi River drainage basin.

The 55 known systems discharge through a total of over 1,300 known storm water outfalls. Of these outfalls, 82 were directly tributary to Lake Michigan; 998 were tributary to the inland lakes and streams of the Great Lakes drainage basin; and 278 were tributary to the inland lakes and streams of the Mississippi River drainage basin. The outfalls ranged in size from eight inches in diameter to a triple 90 by 54-inch box culvert. There were only two reported major storm water pumping facilities—other than highway and street underpass drainage pumping stations—and 13 known storm water storage facilities in the Region. The combined annual average discharge from these outfalls was estimated to total about 22.9 billion gallons, occurring in an average of about 70 events per year. By contrast, it should be noted that the combined sewerage systems overflowed an average of about 52 times per year. This reduced frequency of overflow reflects the ability of the combined sewers to accept the storm water runoff from relatively minor storm events without discharging to surface waters through the combined sewer outfalls. Table 141 summarizes the areas and distribution of the urban storm water drainage systems in the Region.

Table 141

URBAN STORM WATER DRAINAGE AREAS IN THE REGION: 1975

Hydrologic Unit	Area Served (square miles)	Number of Systems	Number of Outfalls	Outfall Size Range (inches)	Number of Storm Water Pumping Facilities	Number of Storm Water Storage Facilities	Annual Average Discharge (million gallons)
Des Plaines River Watershed	0.3	1	2	24-36	0	0	62
Fox River Watershed	19.3	16	210	8-78	0	3	1,144
Rock River Watershed	5.6	7	66	12-78	0	0	263
Mississippi River Drainage Basin Subtotal	25.2	24	278	8-78	0	3	1,469
Kinnickinnic River Watershed[a]	16.6	6	92	12-142 x 89 Box	0	0	2,768
Menomonee River Watershed[a]	42.8	10	343	12-Triple 90 x 54 Box	0	2	5,587
Milwaukee River Watershed[a]	38.7	13	316	12-60 x 144 Box	0	4	5,369
Minor Streams Directly Tributary to Lake Michigan Watershed							
Barnes Creek Subwatershed	0.0	0	0	0	0	0	0
Pike Creek Subwatershed	5.0	1	12	15-84	2	0	641
Sucker Creek Subwatershed	0.0	0	0	0	0	0	0
Oak Creek Watershed	9.7	4	85	12-78	0	0	1,133
Pike River Watershed	3.8	3	13	15-72 x 113 Box	0	1	246
Root River Watershed[a]	16.4	11	121	12-96	0	3	2,113
Sauk Creek Watershed	1.4	1	14	12-72	0	0	59
Sheboygan River Watershed	0.2	1	2	15-24	0	0	4
Great Lakes Perennial Streams Drainage Basin Subtotal	134.6	50	998	Triple 12-90 x 54 Box	2	10	17,920
Direct Drainage to Lake Michigan through Intermittent Streams and Drainage Swales[a]	23.5	11	82	10-126	0	3	3,467
Total	183.3	85[b]	1,358	Triple 8-90 x 54 Box	2	16	22,856

[a] These totals do not include the combined sewer service area portions of each watershed.

[b] For the entire Region this total is 55. However, some systems serve portions of several watersheds and are counted several times, once for each watershed served by the system.

Source: SEWRPC.

Rural Storm Water Runoff

In 1975, the rural areas of the Region totaled about 2,200 square miles, or about 82 percent of the total area of the Region. Based on the Commission 1975 land cover inventory, it is estimated that of the total rural land area, about 41 percent is devoted to clean-tilled row crops, about 13 percent is devoted to hay production, about 12 percent is devoted to small grain production, and about 34 percent devoted to woodlands, wetlands, and other open space. In 1975 there were an estimated 2,350 domestic livestock operations located within the Region having 25 or more equivalent animal units, an animal unit representing the equivalent of a 1,000-pound dairy cow. These operations housed a total of about 227,374 equivalent animal units. Of these, about 226,210, or about 99 percent, were located within the inland portion of the Region, and the remaining 1,164 were located in the direct drainage area of Lake Michigan. Approximately 69,150 equivalent animal units, or about 31 percent of the inland total, were located within the Great Lakes drainage basin, with the remaining 157,060 located in the Mississippi River drainage basin portion of the Region. An additional estimated 23,040 equivalent animal units were located in the headwater portion of the Milwaukee River watershed outside the Region. Of the 2,350 total operations, 963, or about 41 percent, were found to be located within 500 feet of a stream, lake, or other surface water body. Table 142 summarizes by watershed the number and distribution of domestic livestock operations.

Table 142

DOMESTIC ANIMAL OPERATIONS IN THE REGION: 1975

Hydrologic Unit	Number of Domestic Livestock Operations	Number of Equivalent Animal Units	Number of Operations Within 500 Feet of a Stream, Lake, or Other Surface Water Body
Des Plaines River Watershed	133	12,340	35
Fox River Watershed	698	77,420	299
Rock River Watershed	692	67,300	244
Mississippi River Drainage Basin Subtotal	1,523	157,060	578
Kinnickinnic River Watershed	0	0	0
Menomonee River Watershed	49	3,870	25
Milwaukee River Watershed	479	40,790	242
Minor Streams Directly Tributary to Lake Michigan Watershed			
Barnes Creek Subwatershed	1	10	0
Pike Creek Subwatershed	0	0	0
Sucker Creek Subwatershed	34	3,420	20
Oak Creek Watershed	2	110	1
Pike River Watershed	13	980	3
Root River Watershed	102	9,350	47
Sauk Creek Watershed	110	9,120	23
Sheboygan River Watershed	22	1,500	17
Great Lakes Perennial Streams Drainage Basin Subtotal	813	69,150	378
Direct Drainage to Lake Michigan through Intermittent Streams and Drainage Swales	14	1,164	7
Total	2,350	227,374[a]	963

[a] *In addition to the Region total, there were an estimated 23,040 equivalent animal units in that portion of the Milwaukee River watershed that lies outside of the Region.*

Source: SEWRPC.

Total Pollutant Loading

The total and relative contributions of pollutants from the known pollution sources within the Region are presented in summary form in Table 143 and Figure 44. The table sets forth the total and relative contribution of the various pollution source categories within the Region as a whole; within the direct drainage areas of Lake Michigan; and within the inland portions of the Region within the Great Lakes drainage basin and the Upper Mississippi River drainage basin. These pollutant loadings are discussed in more detail in Chapter VI of SEWRPC Technical Report No. 21, Sources of Water Pollution in Southeastern Wisconsin: 1975.

The estimated annual pollutant loads to all surface waters of the Region—including the inland lakes and streams and Lake Michigan as well as that portion of the Milwaukee River watershed located outside of the Region—include 45,648,200 pounds of nitrogen, 6,670,200 pounds of phosphorus, 113,103,900 pounds of biochemical oxygen demand, 3.2×10^{17} fecal coliform organisms, and 6,700,115 tons of sediment. Of this total, about 28 percent of the nitrogen, 26 percent of the phosphorus, 22 percent of the biochemical oxygen demand, 7 percent of the fecal coliform organisms, and 5 percent of the sediment are contributed directly to Lake Michigan as point source discharges or runoff from areas directly tributary to Lake Michigan through intermittent streams and drainage swales. The remaining 72 percent of the nitrogen, 74 percent of the phosphorus, 78 percent of the biochemical oxygen demand, 93 percent of the fecal coliform organisms, and 95 percent of the sediment are contributed to the inland lakes and perennial streams of the Region.

Of the direct contributions of pollutants to Lake Michigan, the point sources contribute an estimated 95 percent of the nitrogen, 93 percent of the phosphorus, 89 percent of the biochemical oxygen demand, 82 percent of the fecal coliform, and 12 percent of the sediment. Accordingly, the diffuse sources, such as urban and rural storm water runoff, contributed only 5 percent of the nitrogen, 7 percent of the phosphorus, 11 percent of the biochemical oxygen demand, 18 percent of the fecal coliform, and 88 percent of the sediment to Lake Michigan.

Point sources contribute only an estimated 7 percent of the nitrogen, 14 percent of the phosphorus, 8 percent of the biochemical oxygen demand, 40 percent of the fecal coliform, and 0.2 percent of the sediment to the inland lakes and streams of the Region. Urban diffuse sources contributed an estimated 14 percent of the nitrogen, 41 percent of the phosphorus, 30 percent of the biochemical oxygen demand, 6 percent of the fecal coliform, and 53 percent of the sediment contributed to inland lakes and streams. Rural diffuse sources contribute an estimated 78 percent of the nitrogen, 45 percent of the phosphorus, 63 percent of the biochemical oxygen demand, 52 percent of the fecal coliform, and 47 percent of the sediment.

For the inland lakes and perennial streams located within the Great Lakes drainage basin, point sources contributed only about 10 percent of the nitrogen, 16 percent of the phosphorus, 13 percent of the biochemical oxygen demand, 67 percent of the fecal coliform, and 0.4 percent of the sediment. Urban diffuse sources produce an estimated 19 percent of the nitrogen, 42 percent of the phosphorus, 37 percent of the biochemical oxygen demand, 6 percent of the fecal coliform, and 58 percent of the sediment contributed to inland lakes and streams. Rural diffuse sources contribute about 70 percent of the nitrogen, 40 percent of the phosphorus, 45 percent of the biochemical oxygen demand, 29 percent of the fecal coliform, and 41 percent of the sediment.

For the inland lakes and streams located within the Mississippi River drainage basin, point sources contribute only about 6 percent of the nitrogen, 12 percent of the phosphorus, 3 percent of the biochemical oxygen demand, 0.3 percent of the fecal coliform, and less than one-tenth of 1 percent of the sediment. Urban diffuse sources produce an estimated 12 percent of the nitrogen, 40 percent of the phosphorus, 24 percent of the biochemical oxygen demand, 8 percent of the fecal coliform, and 50 percent of the sediment. Rural diffuse sources contribute about 82 percent of the nitrogen, 48 percent of the phosphorus, 72 percent of the biochemical oxygen demand, 91 percent of the fecal coliform, and 50 percent of the sediment.

The comparison of significant pollution sources indicates that the proportion of the pollutant load to the streams and lakes attributable to a specific source category ranges from about 10 to more than 95 percent in the various inland watersheds of the Region. Significant sources have been defined as those which potentially contribute at least 10 percent of a given pollutant within a watershed. These significant pollution sources to inland lakes and streams are summarized by watershed in Table 144.

Municipal and private sewage treatment plants and sewage flow relief devices are estimated to contribute more than 10 percent of the total phosphorus load in the Fox River, Kinnickinnic River, Menomonee River, Milwaukee River, Rock River, and Root River watersheds. In the Menomonee and Kinnickinnic River watersheds, municipal and private sewage treatment plants and flow relief devices account for more than 10 percent of the total loads of all pollutants except sediment. In the Milwaukee River watershed, the Root River watershed, the Pike Creek subwatershed, and the Pike River watershed, these sanitary sewage-related point sources are together estimated to contribute more than 10 percent of the fecal coliform load.

Point source industrial discharges account for 10 percent or more of the total phosphorus and biochemical oxygen demand loads only in the Kinnickinnic River watershed. This is in marked contrast to what might be expected in a highly urbanized and industrialized region. This desir-

Table 143

ESTIMATED TOTAL OF AVERAGE ANNUAL LOADS OF POLLUTANTS TO RECEIVING WATERS (INCLUDING LAKE MICHIGAN) OF SOUTHEASTERN WISCONSIN: 1975

Source	Parameter	Inland Lakes and Streams: Great Lakes Drainage Basin[a] Load	Percent of Total	Inland Lakes and Streams: Mississippi River Drainage Basin[a] Load	Percent of Total	Inland Lakes and Streams: Total Inland Lakes and Streams[a] Load	Percent of Total	Lake Michigan—Direct Drainage and Direct Point Source Contributions Load	Percent of Total	Total Region Including Lake Michigan[a] Load	Percent of Total
Urban Point Sources											
Municipal Sewage Treatment Plants	Total Nitrogen (pounds per year)	719,730	5.8	1,198,230	5.8	1,917,960	5.8	11,979,700	93.1	13,897,660	30.4
	Total Phosphorus (pounds per year)	108,090	5.4	351,830	11.7	459,920	9.3	1,568,840	91.0	2,028,760	30.4
	Biochemical Oxygen Demand (pounds per year)	769,610	2.0	1,352,910	2.7	2,122,520	2.4	21,198,620	84.4	23,321,140	20.6
	Fecal Coliform (counts per year)	2.89×10^{14}	15.2	1.0×10^{14}	0.0	2.9×10^{16}	9.8	9.0×10^{14}	4.1	2.95×10^{16}	9.2
	Sediment (tons per year)	500	0.0	1,120	0.0	1,620	0.0	21,445	6.8	23,065	0.3
Private Sewage Treatment Plants	Total Nitrogen (pounds per year)	81,000	0.7	20,360	0.1	101,360	0.3	13,150	0.1	114,510	0.3
	Total Phosphorus (pounds per year)	28,860	1.4	9,290	0.3	38,150	0.8	620	0.0	38,770	0.6
	Biochemical Oxygen Demand (pounds per year)	92,590	0.2	47,570	0.1	140,160	0.2	244,380	1.0	384,540	0.3
	Fecal Coliform (counts per year)	2.2×10^{13}	0.0	4.0×10^{13}	0.0	6.2×10^{13}	0.0	--	0.0	6.2×10^{13}	0.0
	Sediment (tons per year)	55	0.0	30	0.0	85	0.0	130	0.0	215	0.0
Combined Sewer Overflow	Total Nitrogen (pounds per year)	275,460	2.2	0	0.0	275,460	0.8	49,210	0.4	324,670	0.7
	Total Phosphorus (pounds per year)	137,740	6.9	0	0.0	137,740	2.8	24,610	1.4	162,350	2.4
	Biochemical Oxygen Demand (pounds per year)	2,754,690	7.3	0	0.0	2,754,690	3.1	492,060	2.0	3,246,750	2.9
	Fecal Coliform (counts per year)	8.8×10^{16}	46.3	0	0.0	8.8×10^{16}	29.4	1.6×10^{16}	72.7	1.04×10^{17}	32.5
	Sediment (tons per year)	4,130	0.2	0	0.0	4,130	0.1	740	0.2	4,870	0.1
Industrial Discharges	Total Nitrogen (pounds per year)	106,870	0.9	9,600	0.1	116,470	0.4	175,250	1.4	291,720	0.6
	Total Phosphorus (pounds per year)	37,280	1.9	4,000	0.1	41,280	0.8	7,530	0.4	48,810	0.7
	Biochemical Oxygen Demand (pounds per year)	1,405,280	3.7	18,420	0.1	1,423,700	1.6	230,730	0.9	1,654,430	1.4
	Fecal Coliform (counts per year)	3.3×10^{12}	0.0	0	0.0	3.3×10^{12}	0.0	--	0.0	3.3×10^{12}	0.0
	Sediment (tons per year)	5,625	0.2	440	0.0	6,065	0.1	16,780	5.3	22,845	0.3
Sanitary Sewer Flow Relief Devices	Total Nitrogen (pounds per year)	20,210	0.2	1,380	0.0	21,590	0.1	7,230	0.1	28,820	0.1
	Total Phosphorus (pounds per year)	6,740	0.3	460	0.0	7,200	0.1	2,410	0.1	9,610	0.1
	Biochemical Oxygen Demand (pounds per year)	201,910	0.5	13,760	0.1	215,670	0.2	72,310	0.3	287,980	0.2
	Fecal Coliform (counts per year)	3.1×10^{15}	1.7	0.2×10^{15}	0.2	3.3×10^{15}	1.1	1.1×10^{15}	5.0	5.0×10^{15}	1.6
	Sediment (tons per year)	95	0.0	5	0.0	100	0.0	35	0.0	135	0.0
Point Source Total	Total Nitrogen (pounds per year)	1,203,270	9.8	1,229,500	6.0	2,432,840	7.4	12,224,540	95.0	14,657,380	32.1
	Total Phosphorus (pounds per year)	318,710	15.9	365,580	11.9	684,290	13.8	1,604,010	93.1	2,288,300	34.2
	Biochemical Oxygen Demand (pounds per year)	5,224,080	12.9	1,432,660	2.8	6,656,740	7.6	22,238,100	88.6	28,894,840	25.5
	Fecal Coliform (counts per year)	1.2×10^{17}	66.7	3.0×10^{14}	0.3	1.2×10^{17}	40.3	1.8×10^{16}	81.8	1.4×10^{17}	43.7
	Sediment (tons per year)	10,405	0.4	1,595	0.0	12,000	0.2	39,130	12.3	51,130	0.8
Urban Diffuse Sources											
Residential	Total Nitrogen (pounds per year)	337,880	2.7	252,730	1.2	590,610	1.8	44,820	0.4	635,430	1.4
	Total Phosphorus (pounds per year)	27,670	1.4	19,580	0.7	47,250	1.0	3,590	0.2	50,840	0.8
	Biochemical Oxygen Demand (pounds per year)	2,101,170	5.6	1,486,770	2.9	3,587,940	4.1	272,280	1.1	3,860,220	3.4
	Fecal Coliform (counts per year)	1.4×10^{15}	0.8	1.0×10^{15}	0.9	2.4×10^{15}	0.8	1.8×10^{14}	0.8	2.6×10^{15}	0.8
	Sediment (tons per year)	23,565	0.9	16,670	0.4	40,235	0.6	3,055	1.0	43,290	0.6
Commercial	Total Nitrogen (pounds per year)	148,630	1.2	72,490	0.4	221,120	0.7	14,100	0.1	235,220	0.5
	Total Phosphorus (pounds per year)	12,400	0.6	6,040	0.2	18,440	0.4	1,170	0.1	19,610	0.3
	Biochemical Oxygen Demand (pounds per year)	1,611,770	4.3	786,070	1.5	2,397,840	2.7	152,880	0.6	2,550,720	2.3
	Fecal Coliform (counts per year)	5.1×10^{14}	0.3	3.0×10^{14}	0.3	8.1×10^{14}	0.3	4.0×10^{13}	0.2	8.5×10^{14}	0.3
	Sediment (tons per year)	6,145	0.2	3,000	0.1	9,145	0.1	585	0.2	9,730	0.1
Industrial	Total Nitrogen (pounds per year)	83,140	0.7	42,840	0.2	125,980	0.4	12,640	0.1	138,620	0.3
	Total Phosphorus (pounds per year)	6,930	0.3	3,570	0.1	10,500	0.2	1,050	0.1	11,550	0.2
	Biochemical Oxygen Demand (pounds per year)	365,160	1.0	188,220	0.4	553,380	0.6	55,520	0.2	608,900	0.5
	Fecal Coliform (counts per year)	6.3×10^{14}	0.4	3.0×10^{14}	0.3	9.3×10^{14}	0.3	7.0×10^{13}	0.3	1.0×10^{15}	0.3
	Sediment (tons per year)	4,820	0.2	2,490	0.1	7,310	0.1	735	0.2	8,045	0.1
Extractive	Total Nitrogen (pounds per year)	123,120	1.0	358,620	1.7	481,740	1.5	0	0.0	481,740	1.0
	Total Phosphorus (pounds per year)	92,360	4.7	268,970	9.0	361,330	7.3	0	0.0	361,330	5.4
	Biochemical Oxygen Demand (pounds per year)	246,240	0.7	717,240	1.4	963,480	1.1	0	0.0	963,480	0.8
	Fecal Coliform (counts per year)	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Sediment (tons per year)	153,900	6.1	448,275	11.6	602,175	9.4	0	0.0	602,175	9.0

Table 143 (continued)

Source	Parameter	Inland Lakes and Streams: Great Lakes Drainage Basin[a] Load	Percent of Total	Inland Lakes and Streams: Mississippi River Drainage Basin[a] Load	Percent of Total	Inland Lakes and Streams: Total Inland Lakes and Streams[a] Load	Percent of Total	Lake Michigan—Direct Drainage and Direct Point Source Contributions Load	Percent of Total	Total Region Including Lake Michigan[a] Load	Percent of Total
Transportation	Total Nitrogen (pounds per year)	423,960	3.4	139,920	0.7	563,880	1.7	146,770	1.0	710,650	1.6
	Total Phosphorus (pounds per year)	31,350	1.6	10,400	0.4	41,750	0.8	8,780	0.5	50,530	0.8
	Biochemical Oxygen Demand (pounds per year)	2,752,400	7.3	884,990	1.8	3,637,390	4.1	997,260	4.0	4,634,650	4.1
	Fecal Coliform (counts per year)	1.2×10^{15}	0.6	3.0×10^{14}	0.2	1.5×10^{15}	0.5	4.2×10^{14}	1.8	1.9×10^{15}	0.6
	Sediment (tons per year)	348,115	13.8	117,770	3.1	465,885	7.3	133,595	42.1	599,480	8.9
Recreation	Total Nitrogen (pounds per year)	51,970	0.4	47,910	0.2	99,880	0.3	4,420	0.0	104,300	0.2
	Total Phosphorus (pounds per year)	1,920	0.1	1,780	0.1	3,700	0.1	120	0.0	3,820	0.1
	Biochemical Oxygen Demand (pounds per year)	21,560	0.1	19,790	0.1	41,350	0.0	2,500	0.0	43,850	0.0
	Fecal Coliform (counts per year)	3.9×10^{13}	0.0	3.0×10^{13}	0.0	6.9×10^{13}	0.0	6.2×10^{12}	0.0	7.5×10^{13}	0.0
	Sediment (tons per year)	3,485	0.1	3,195	0.1	6,680	0.1	405	0.1	7,085	0.1
Construction	Total Nitrogen (pounds per year)	751,800	6.1	1,061,220	5.2	1,813,020	5.5	88,080	0.7	1,901,100	4.2
	Total Phosphorus (pounds per year)	563,870	28.9	795,920	26.6	1,359,790	27.5	66,060	3.8	1,425,850	21.4
	Biochemical Oxygen Demand (pounds per year)	1,503,600	4.0	2,122,440	4.2	3,626,040	4.1	176,160	0.7	3,802,200	3.4
	Fecal Coliform (counts per year)	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Sediment (tons per year)	939,750	37.1	1,326,525	34.4	2,266,275	35.5	110,100	34.7	2,376,375	35.5
Septic Systems	Total Nitrogen (pounds per year)	373,490	3.0	408,690	2.0	782,180	2.4	30,010	0.2	812,190	1.7
	Total Phosphorus (pounds per year)	86,050	4.4	93,810	3.1	179,860	3.6	7,090	0.4	186,950	2.8
	Biochemical Oxygen Demand (pounds per year)	5,322,860	14.1	5,799,120	11.5	11,121,980	12.6	427,300	1.7	11,549,280	10.2
	Fecal Coliform (counts per year)	6.5×10^{15}	0.4	7.1×10^{15}	6.5	1.3×10^{16}	4.5	1.0×10^{15}	4.5	1.4×10^{16}	4.4
	Sediment (tons per year)	910	0.0	1,000	0.0	1,910	0.0	75	0.0	1,985	0.0
Urban Diffuse Source Totals	Total Nitrogen (pounds per year)	2,301,990	18.7	2,376,420	11.6	4,678,410	14.3	310,830	2.4	4,989,240	10.9
	Total Phosphorus (pounds per year)	822,550	42.2	1,200,070	40.0	2,022,620	40.9	87,860	5.1	2,110,480	31.6
	Biochemical Oxygen Demand (pounds per year)	13,924,760	37.1	12,004,640	23.8	25,929,400	29.5	2,083,900	8.3	28,013,300	24.8
	Fecal Coliform (counts per year)	1.0×10^{16}	6.0	9.0×10^{15}	8.1	1.9×10^{16}	6.4	1.7×10^{15}	7.3	2.0×10^{16}	6.4
	Sediment (tons per year)	1,480,690	58.4	1,918,925	49.8	3,399,615	53.3	248,470	78.3	3,648,085	54.4
Urban Sources Total	Total Nitrogen (pounds per year)	3,505,260	28.5	3,605,990	17.6	7,111,250	21.7	12,535,370	97.6	19,646,620	43.0
	Total Phosphorus (pounds per year)	1,141,260	58.5	1,565,650	52.2	2,706,910	54.7	1,691,870	98.2	4,398,780	65.9
	Biochemical Oxygen Demand (pounds per year)	19,148,840	50.1	13,437,300	26.7	32,586,140	37.0	24,322,000	96.9	56,908,140	50.3
	Fecal Coliform (counts per year)	1.3×10^{17}	72.2	9.4×10^{15}	8.5	1.4×10^{17}	46.8	2.0×10^{16}	90.9	1.7×10^{17}	50.1
	Sediment (tons per year)	1,491,095	58.9	1,920,520	49.8	3,411,615	53.4	287,680	90.7	3,699,295	55.2
Rural Diffuse Sources Livestock Operations	Total Nitrogen (pounds per year)	2,618,190	21.3	4,460,510	21.8	7,078,700	21.6	109,480	0.9	7,188,180	15.7
	Total Phosphorus (pounds per year)	608,460	30.4	1,036,590	34.6	1,645,050	33.3	25,440	1.5	1,670,400	25.0
	Biochemical Oxygen Demand (pounds per year)	10,251,520	27.2	17,465,070	34.6	27,716,590	31.5	428,680	1.7	28,145,270	24.9
	Fecal Coliform (counts per year)	6.0×10^{16}	29.4	1.0×10^{17}	90.9	1.6×10^{17}	53.2	2.5×10^{15}	11.4	1.6×10^{17}	49.9
	Sediment (tons per year)	32,270	1.2	54,970	1.4	87,240	1.4	1,350	0.4	88,590	1.3
Crop Land and Pasture Land and Unused Rural Land	Total Nitrogen (pounds per year)	5,999,860	48.8	11,809,760	57.6	17,809,620	54.3	144,720	1.1	17,954,340	39.3
	Total Phosphorus (pounds per year)	190,470	9.8	357,570	11.9	548,040	11.1	4,380	0.3	552,420	8.3
	Biochemical Oxygen Demand (pounds per year)	6,891,040	18.4	12,252,350	24.2	19,143,390	21.8	171,230	0.7	19,314,620	17.1
	Fecal Coliform (counts per year)	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Sediment (tons per year)	999,670	39.5	1,847,820	48.0	2,847,490	44.6	26,840	8.5	2,874,330	42.9
Silvicultural	Total Nitrogen (pounds per year)	127,200	1.0	250,480	1.2	377,680	1.2	14,990	0.1	392,670	0.9
	Total Phosphorus (pounds per year)	7,750	0.4	15,240	0.5	22,990	0.5	1,000	0.1	23,990	0.4
	Biochemical Oxygen Demand (pounds per year)	254,350	0.7	500,970	1.0	755,320	0.9	34,970	0.1	790,290	0.7
	Fecal Coliform (counts per year)	4.0×10^{13}	0.0	7.0×10^{13}	0.0	1.1×10^{14}	0.0	1.6×10^{12}	0.0	1.1×10^{14}	0.0
	Sediment (tons per year)	6,935	0.2	13,665	0.4	20,600	0.3	1,000	0.3	21,600	0.3
Air Pollution to Surface Water	Total Nitrogen (pounds per year)	55,350	0.4	372,760	1.8	428,110	1.3	38,310	0.3	466,420	1.0
	Total Phosphorus (pounds per year)	3,110	0.2	20,940	0.7	24,050	0.5	470	0.0	24,520	0.4
	Biochemical Oxygen Demand (pounds per year)	1,007,310	2.7	6,785,040	13.4	7,792,350	8.9	153,250	0.6	7,945,600	7.0
	Fecal Coliform (counts per year)	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Sediment (tons per year)	2,065	0.0	13,925	0.4	15,990	0.3	310	0.1	16,300	0.2

Table 143 (continued)

Source	Parameter	Inland Lakes and Streams: Great Lakes Drainage Basin[a] Load	Percent of Total	Inland Lakes and Streams: Mississippi River Drainage Basin[a] Load	Percent of Total	Inland Lakes and Streams: Total Inland Lakes and Streams[a] Load	Percent of Total	Lake Michigan—Direct Drainage and Direct Point Source Contributions Load	Percent of Total	Total Region Including Lake Michigan[a] Load	Percent of Total
Rural Diffuse Source Totals	Total Nitrogen (pounds per year)	8,800,600	70.3	16,893,510	82.1	25,694,110	78.3	307,500	2.4	26,001,610	57.0
	Total Phosphorus (pounds per year)	809,790	40.5	1,430,340	47.5	2,240,130	45.3	31,300	1.8	2,271,430	34.1
	Biochemical Oxygen Demand (pounds per year)	18,399,220	45.4	37,008,430	72.1	55,407,650	63.0	788,130	3.1	56,195,780	49.7
	Fecal Coliform (counts per year)	0.6×10^{17}	29.4	1.0×10^{17}	90.9	1.6×10^{17}	53.2	2.5×10^{15}	11.4	1.6×10^{17}	49.9
	Sediment (tons per year)	1,036,940	41.1	1,934,380	50.2	2,971,320	46.6	29,500	9.3	3,000,820	44.8
Total Diffuse Source	Total Nitrogen (pounds per year)	11,102,590	90.2	19,269,930	94.0	30,372,520	92.6	618,330	4.8	30,990,850	67.8
	Total Phosphorus (pounds per year)	1,632,340	83.7	2,630,410	87.8	4,262,750	86.2	112,070	6.5	4,374,820	65.5
	Biochemical Oxygen Demand (pounds per year)	32,328,980	86.1	49,008,070	97.1	81,337,050	92.4	2,872,000	11.4	84,209,050	74.5
	Fecal Coliform (counts per year)	6.9×10^{16}	38.3	1.0×10^{17}	90.9	1.7×10^{17}	59.7	4.2×10^{15}	19.1	1.7×10^{17}	56.3
	Sediment (tons per year)	2,521,630	99.6	3,849,305	99.9	6,370,935	99.8	277,970	87.6	6,648,905	99.2
Total	Total Nitrogen (pounds per year)	12,305,860	100.0	20,499,500	100.0	32,805,360	100.0	12,842,870	100.0	45,648,230	100.0
	Total Phosphorus (pounds per year)	1,951,050	100.0	2,995,990	100.0	4,947,040	100.0	1,723,160	100.0	6,670,200	100.0
	Biochemical Oxygen Demand (pounds per year)	37,553,060	100.0	50,440,730	100.0	87,993,790	100.0	25,110,130	100.0	113,103,920	100.0
	Fecal Coliform (counts per year)	1.8×10^{17}	100.0	1.1×10^{17}	100.0	3.0×10^{17}	100.0	2.2×10^{16}	100.0	3.2×10^{17}	100.0
	Sediment (tons per year)	2,532,035	100.0	3,850,900	100.0	6,382,935	100.0	317,180	100.0	6,700,115	100.0

[a] *Includes pollution loadings from the approximate 264 square miles of the Milwaukee River watershed located outside of the Region.*

Source: SEWRPC.

able situation in southeastern Wisconsin is in large part attributable to the treatment of industrial wastes in municipal sewage treatment plants, a practice developed by design over many years of wastewater management planning and plan implementation.

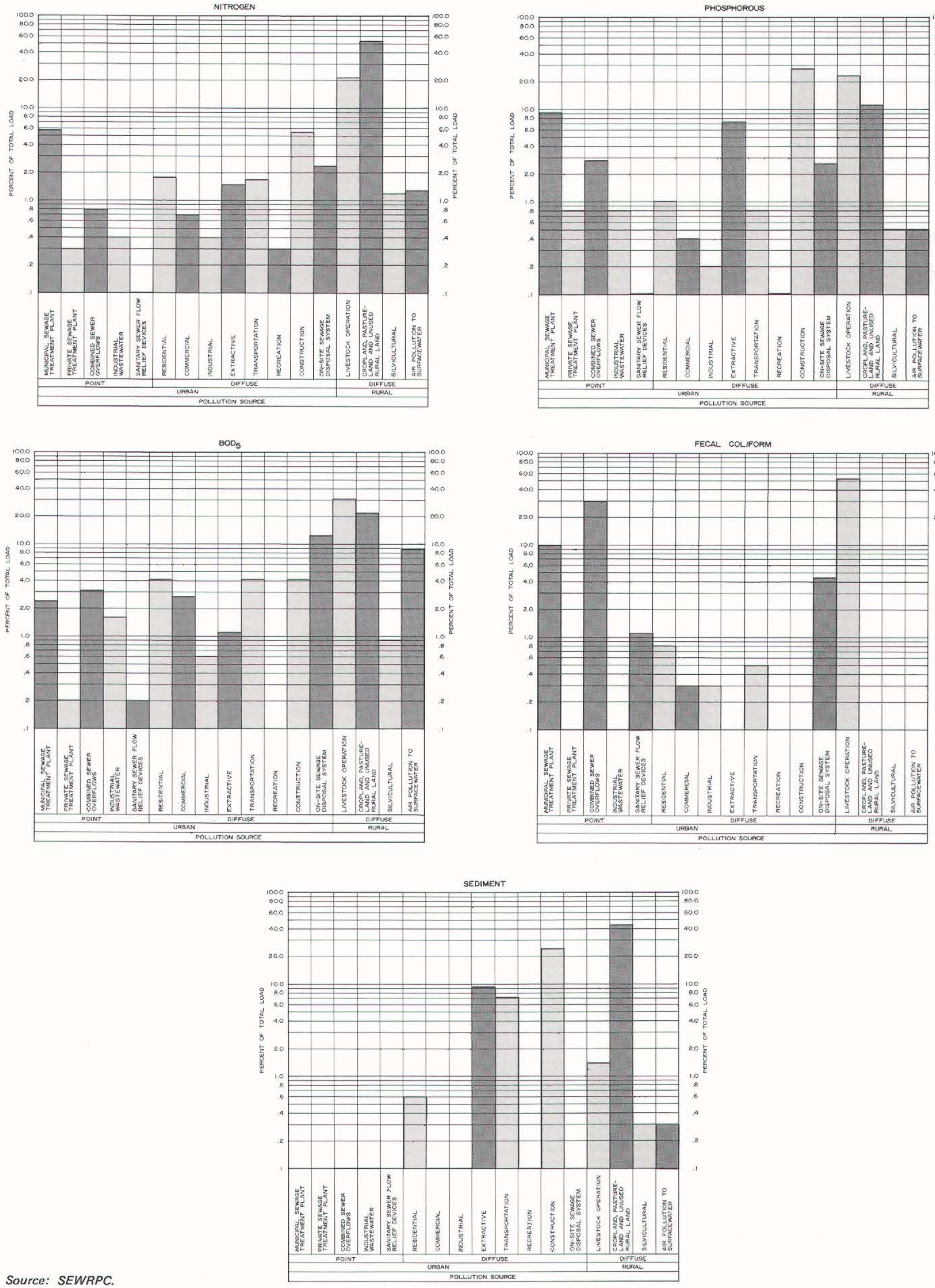
Based on the estimated total pollution loads, the primary urban diffuse sources are construction-related activities, septic systems, transportation activities, and residential land uses. Construction-related activities accounted for 10 percent or more of the total phosphorus and sediment load to all watersheds except the Sauk Creek and Sheboygan River watersheds, both predominantly agricultural. Septic systems are estimated to contribute more than 10 percent of the total biochemical oxygen demand load to the Des Plaines River, Fox River, Menomonee River, Oak Creek, Pike River, and Root River watersheds and Barnes Creek and Pike Creek subwatersheds. In addition, septic systems contributed more than 10 percent of the total fecal coliform load in the Des Plaines River, Oak Creek, Pike River, and Root River watersheds and Barnes Creek and Pike Creek subwatersheds; and more than 10 percent of the total phosphorus and nitrogen load in the Root River watershed and Barnes Creek subwatershed. Transportation-related activities are important sources of total sediment in the Kinnickinnic River, Menomonee River, and Oak Creek watersheds; of total nitrogen in the Kinnickinnic River and Menomonee River watersheds; and of total biochemical oxygen demand in the Menomonee River and Oak Creek watersheds. Residential land uses are important contributors of total nitrogen and biochemical oxygen demand in the Kinnickinnic River watershed and Pike Creek subwatershed.

Livestock operations—including the disposal of manure on cropland—are estimated to contribute more than 10 percent of the total nitrogen, phosphorus, biochemical oxygen demand, and fecal coliform loads in the Des Plaines River, Fox River, Milwaukee River, Rock River, Root River, Sauk Creek, and Sheboygan River watersheds and Sucker Creek subwatershed. In addition, livestock operations are significant sources of fecal coliform in the Oak Creek and Pike River watersheds. Rural storm water runoff is a significant contributor of nitrogen, phosphorus, biochemical oxygen demand, and sediment to the Des Plaines River, Fox River, Milwaukee River, Pike River, Rock River, Root River, Sauk Creek, and Sheboygan River watersheds; and of nitrogen, biochemical oxygen demand, and sediment to the Oak Creek watershed and Barnes Creek and Sucker Creek subwatersheds.

In summary, the estimated contributions from the inventoried pollution sources indicate that urban sources of pollution are predominant in the Kinnickinnic River, Menomonee River, and Oak Creek watersheds and Barnes Creek and Pike Creek subwatersheds; whereas rural sources are predominant in the Des Plaines River, Fox River, Milwaukee River, Rock River, Sauk Creek, and Sheboygan River watersheds and Sucker Creek subwatershed. The pollution sources in the Pike River and Root River watersheds are about equally divided between rural and urban sources.

Figure 44

PERCENTAGE DISTRIBUTION OF POLLUTANT LOADS TO SURFACE WATERS IN SOUTHEASTERN WISCONSIN: 1975



Source: SEWRPC.

Table 144

SIGNIFICANT SOURCES OF WATER POLLUTION IN THE MAJOR WATERSHEDS OF SOUTHEASTERN WISCONSIN: 1975

Watershed	Nitrogen		Phosphorus		Biochemical Oxygen Demand		Fecal Coliform		Sediment	
	Source	Estimated Contribution as Percent of Total Estimated Load	Source	Estimated Contribution as Percent of Total Estimated Load	Source	Estimated Contribution as Percent of Total Estimated Load	Source	Estimated Contribution as Percent of Total Estimated Load	Source	Estimated Contribution as Percent of Total Estimated Load
Des Plaines River	Cropland, Pasture and Unused Rural Land	67	Livestock	44	Livestock	35	Livestock	88	Cropland, Pasture and Unused Rural Land	65
	Livestock	21	Construction	21	Cropland, Pasture and Unused Rural Land	30	Septic Systems	11	Construction	22
			Cropland, Pasture and Unused Rural Land	18	Septic Systems	20				
Fox River	Cropland, Pasture and Unused Rural Land	54	Livestock	30	Livestock	31	Livestock	88	Cropland, Pasture and Unused Rural Land	41
	Livestock	20	Construction	30	Cropland, Pasture and Unused Rural Land	22			Construction	38
			Municipal Sewage Treatment Plants	12	Septic Systems	14			Extractive	14
			Extractive	11	Atmospheric Contributions to Surface Waters	15				
			Cropland, Pasture and Unused Rural Land	11						
Kinnickinnic River	Combined Sewer Overflow	25	Combined Sewer Overflow	38	Industrial Discharges	43	Combined Sewer Overflow	97	Construction	46
	Residential	18	Industrial Discharges	24	Combined Sewer Overflow	24			Transportation	31
	Transportation	17	Construction	21	Residential	10				
Menomonee River	Cropland, Pasture and Unused Rural Land	23	Construction	36	Septic Systems	26	Combined Sewer Overflow	84	Transportation	47
	Transportation	20	Combined Sewer Overflow	18	Transportation	16			Construction	35
	Construction	11			Combined Sewer Overflow	16			Cropland, Pasture and Unused Rural Land	10
Milwaukee River	Cropland, Pasture and Unused Rural Land	50	Livestock	43	Livestock	41	Livestock	38	Cropland, Pasture and Unused Rural Land	51
	Livestock	27	Construction	23	Cropland, Pasture and Unused Rural Land	23	Combined Sewer Overflow	33	Construction	35
			Cropland, Pasture and Unused Rural Land	11			Municipal Sewage Treatment Plants	26		
Minor Streams Directly Tributary to Lake Michigan										
Barnes Creek	Cropland, Pasture and Unused Rural Land	40	Construction	71	Septic Systems	62	Septic Systems	91	Construction	76
	Construction	31	Extractive	12	Construction	16			Extractive	13
	Septic Systems	17	Septic Systems	12	Cropland, Pasture and Unused Rural Land	10			Cropland, Pasture and Unused Rural Land	11
Pike Creek	Cropland, Pasture and Unused Rural Land	32	Construction	78	Residential	22	Septic Systems	27	Construction	81
	Construction	28			Industrial Discharges	10	Sewage Flow Relief Devices	24	Cropland, Pasture and Unused Rural Land	11
	Residential	14			Septic Systems	16	Industrial	21		
					Commercial	15				
					Construction	14				

CONCLUSIONS

The areawide water quality management planning program for southeastern Wisconsin has identified all known sources of water pollution within the Region and has estimated the absolute and relative pollutant channel loads contributed by each of these sources to the surface waters of the Region. The resulting data provide a basis for the development of alternative plans for the abatement of water pollution in the Region. However, the relative magnitudes of the channel loads of the pollutants do not of themselves indicate whether water use objectives and supporting standards are violated, or even whether they can be achieved by the alternative actions considered. These questions by which the relationship of pollution sources to the in-stream water quality is established must be addressed in a review—such as that presented in Chapter IV of this volume of the report—of the in-stream water quality sample data, and an assessment of present and future water quality conditions with and without control measures—an assessment presented in Chapter IV of Volume Two of this report.

The following conclusions, however, may be drawn about the existing sources of water pollution in southeastern Wisconsin:

1. Of the total estimated pollutant loading on the surface waters of southeastern Wisconsin, about 28 percent of the nitrogen, 26 percent of the phosphorus, 22 percent of the biochemical oxygen demand, 7 percent of the fecal coliform, and 5 percent of the sediment are contributed directly to Lake Michigan. The remaining 72 percent of the nitrogen, 74 percent of the phosphorus, 78 percent of the biochemical oxygen demand, 93 percent of the fecal coliform, and 95 percent of the sediment are contributed to the inland lakes and streams. Of this total to inland lakes and streams, the waters of the Mississippi River drainage basin receive an estimated 62 percent of the nitrogen, 61 percent of the phosphorus, 57 percent of the biochemical oxygen demand, 37 percent of the fecal coliform,

Table 144 (continued)

Watershed	Nitrogen: Source	Nitrogen: Estimated Contribution as Percent of Total Estimated Load	Phosphorus: Source	Phosphorus: Estimated Contribution as Percent of Total Estimated Load	Biochemical Oxygen Demand: Source	Biochemical Oxygen Demand: Estimated Contribution as Percent of Total Estimated Load	Fecal Coliform: Source	Fecal Coliform: Estimated Contribution as Percent of Total Estimated Load	Sediment: Source	Sediment: Estimated Contribution as Percent of Total Estimated Load
Minor Streams Tributary to Lake Michigan (cont)										
Sucker Creek	Livestock Cropland, Pasture and Unused Rural Land	47 42	Livestock Construction[b]	59 32	Livestock Cropland, Pasture and Unused Rural Land	65 19	Livestock	98	Construction[b] Cropland, Pasture and Unused Rural Land	49 43
Oak Creek	Cropland, Pasture and Unused Rural Land Construction	47 20	Construction	69	Septic Systems Cropland, Pasture and Unused Rural Land Transportation Residential	15 18 18 14	Septic Systems Livestock Residential Industrial	35 21 17 12	Construction Cropland, Pasture and Unused Rural Land Transportation	61 18 14
Pike River	Cropland, Pasture and Unused Rural Land	72	Construction Cropland, Pasture and Unused Rural Land	49 17	Septic System Cropland, Pasture and Unused Rural Land	27 34	Municipal Sewage Treatment Plants Septic Systems Livestock	51 17 25	Cropland, Pasture and Unused Rural Land Construction	49 42
Rock River	Cropland, Pasture and Unused Rural Land Livestock	61 24	Livestock Construction Municipal Sewage Treatment Plants Cropland, Pasture and Unused Rural Land	41 23 13 13	Livestock Cropland, Pasture and Unused Rural Land Atmospheric Contributions to Surface Water	41 27 13	Livestock	96	Cropland, Pasture and Unused Rural Land Construction	56 31
Root River	Cropland, Pasture and Unused Rural Land Livestock Septic Systems	60 12 10	Construction Livestock Septic Systems Cropland, Pasture and Unused Rural Land	34 19 11 13	Septic Systems Cropland, Pasture and Unused Rural Land Livestock	35 22 16	Livestock Combined Sewer Overflow Septic Systems	42 30 19	Cropland, Pasture and Unused Rural Land Construction	46 38
Sauk Creek	Livestock Cropland, Pasture and Unused Rural Land	50 46	Livestock Cropland, Pasture and Unused Rural Land	83 10	Livestock Cropland, Pasture and Unused Rural Land	70 19	Livestock	98	Cropland, Pasture and Unused Rural Land	81
Sheboygan River	Cropland, Pasture and Unused Rural Land Livestock	65 28	Livestock Cropland, Pasture and Unused Rural Land	70 21	Livestock Cropland, Pasture and Unused Rural Land	50 34	Livestock	97	Cropland, Pasture and Unused Rural Land	85
Region	Cropland, Pasture and Unused Rural Land Livestock	54 22	Livestock Construction Cropland, Pasture and Unused Rural Land	33 28 11	Livestock Cropland, Pasture and Unused Rural Land Septic Systems	32 22 13	Livestock Combined Sewer Overflow Municipal Sewage Treatment Plants	53 29 10	Cropland, Pasture and Unused Rural Land Construction	45 36

[a] Defined as those sources contributing 10 percent or more of the potential load of the pollutant.

[b] Construction activities are identified as a significant pollution source in the Sucker Creek Watershed because of the construction of Hwy I-43.

Source: SEWRPC.

and 60 percent of the sediment. The remaining pollutant load—38 percent of the nitrogen, 39 percent of the phosphorus, 43 percent of the biochemical oxygen demand, 63 percent of the fecal coliform, and 40 percent of the sediment—is contributed to the inland waters of the Great Lakes drainage basin. The majority of the pollutant loading to the inland waters is from nonpoint sources, while the majority of the direct pollutant loading to Lake Michigan is from point sources.

2. Based on the estimated annual pollutant loads, the inventory findings indicate the importance of the diffuse sources of pollution in the Region and support the need to develop and implement diffuse source abatement plans for both the rural and urban areas of the Region.

3. Based on the estimated annual pollutant loads, point sources of pollution do not comprise the dominant pollution source in the inland lakes and streams of the Region. Moreover, point source contributions can be expected in the future to be further reduced in their magnitude as a result of local, state, and federal requirements; increased expenditures; and improved wastewater treatment technologies.

4. Of the point sources of pollution, the sanitary wastewaters discharged from municipal and private sewage treatment plants and from sanitary and combined sewage flow relief devices together constitute the most important sources of pollution in terms of the annual contributions of all pollutants considered. On a regional basis, industrial wastewater discharges are only minor sources

of water pollution, contributing from less than 0.1 percent to about 1.4 percent of the total for the pollutants discussed in this chapter. These sources can, however, constitute important sources of such "exotic" substances as poisonous metals and dangerous chemicals. For the major watersheds, industrial sources are of minor significance, except with regard to biochemical oxygen demand and phosphorus in the Kinnickinnic River watershed. For more localized stream reaches, selected industrial waste discharges can be expected to be important, and thus will be identified by stream reach on the basis of forecast water quality conditions simulated for future loads and control strategies through the use of the Commission's hydrologic-hydraulic water quality simulation model.

5. Storm water runoff from croplands, pasture, and unused rural lands is the largest single contributor of nitrogen and sediment to the inland lakes and streams of the Region, and is a significant source of phosphorus and biochemical oxygen demand. Livestock operations are the largest single source of phosphorus, biochemical oxygen demand, and fecal coliform.

6. Runoff to inland lakes and streams from urban and suburban construction activities is the second largest single contributor of phosphorus, the most recognized direct cause of eutrophic waters and the largest urban source of sediment.

7. Livestock operations and septic systems are major diffuse source contributors of fecal coliform, and together account for an estimated 58 percent of the fecal coliform organisms potentially reaching the surface waters. Improperly installed or malfunctioning septic systems are important urban sources of surface water pollution, especially those in the poorly suited soils which predominate in the eastern half of the Southeastern Wisconsin Region. In addition, flow relief devices, which contribute 30 percent of the total fecal coliform load to inland lakes and streams, and municipal sewage treatment plants, which contribute 10 percent of the total fecal coliform load to inland lakes and streams, account for nearly all of the remaining fecal coliform loads in the Region.

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Chapter VI

LEGAL STRUCTURES AFFECTING WATER QUALITY MANAGEMENT

INTRODUCTION

In any sound planning and engineering effort, it is necessary to investigate the legal, as well as the physical, economic, and social factors affecting the problem under consideration. In the formulation of an areawide water quality planning and management program for southeastern Wisconsin, ascertaining various federal, state, and local authorities affecting water quality management can be as important as the technical feasibility or the benefits and costs of the proposed plans. If legal constraints bearing upon the planning problem are ignored during plan formulation, serious and important difficulties may be encountered during plan implementation.

Both statutory and case law as well as regulations relating directly to water quality planning and management have been enacted at the federal, state, and local levels of government to prevent and abate water pollution. In addition, particularly with respect to state statutory law, there are legal considerations which relate to the various institutional structures for areawide water quality management.

This chapter, then, is intended to provide a brief overview of the various federal, state, and local authorities affecting water quality management. It should be stressed that this area of the law is rapidly changing as new statutes, administrative rules, and court decisions are enacted, providing for greater protection of our water resources. Attention is first directed at federal, state, and local authorities affecting water quality management, and then at private steps which may be undertaken for water pollution control. As a final section of this chapter, specific issues relating to implementation of the areawide water quality management plan are discussed. Throughout this chapter, emphasis is placed on discussions of statutory and case law in an effort to determine authority relating to implementation of areawide water quality plans. In addition, a brief summary of the overall statutory mechanism is presented.

In recognition of the importance to sound planning of an understanding of the legal and regulatory framework affecting plan implementation, the Southeastern Wisconsin Regional Planning Commission completed two companion analyses of existing law in southeastern Wisconsin. The findings of the initial legal study, conducted under the direction of the late J. H. Beuscher of the University of Wisconsin Law School, were set forth in the first edition of SEWRPC Technical Report No. 2, Water Law in Southeastern Wisconsin, published in January 1966. This initial water law study included an inventory of existing powers and responsibilities of the various levels and agencies of government involved in water resources management, as well as of the structure of public and private water rights which must necessarily be considered in the formulation of a comprehensive areawide plan.

Because of the dynamic nature of water law, including not only case law decisions but increasing intervention into the area of water law by both the U. S. Congress and the Wisconsin State Legislature, the Commission updated the findings of the legal study set forth in SEWRPC Technical Report No. 2. The results of this updated study of water law have been set forth in the second edition of SEWRPC Technical Report No. 2, Water Law in Southeastern Wisconsin, published in April 1977 and prepared as a part of the areawide water quality planning and management program. The reader is urged to consult this report's extensive discussion of private and public water rights including the following areas: legal classifications of water, principal divisions of water law including riparian and public rights law, groundwater law and diffuse surface water law, and authority of local governments to construct water control facilities. An understanding of the above topics provides a base with which to initiate a discussion of the federal, state, and local laws and regulations necessary for the implementation of an areawide water quality management plan.

In subsequent planning programs for the Fox, Menomonee, and Milwaukee River watersheds, the Commission summarized the legal factors bearing upon the water-related problems of the respective watersheds, updating as necessary the pertinent aspects of statutory and administrative law presented in the original water law report. These summaries are set forth in Chapter XIV of SEWRPC Planning Report No. 12, A Comprehensive Plan for the Fox River Watershed, Volume One, Inventory Findings and Forecasts, April 1969; Chapter XV of SEWRPC Planning Report No. 13, A Comprehensive Plan for the Milwaukee River Watershed, Volume One, Inventory Findings and Forecasts, December 1970; Chapter X of SEWRPC Planning Report No. 26, A Comprehensive Plan for the Menomonee River Watershed, Volume One, Inventory Findings and Forecasts, October 1976; and Chapter VII of SEWRPC Planning Report No. 16, A Regional Sanitary Sewerage System Plan for Southeastern Wisconsin, February 1974.

It is important to note that sound areawide water quality and management planning can only be properly conducted within the framework of an areawide land use plan. The second report dealing with the legal aspects of planning and plan implementation in southeastern Wisconsin was a survey of existing planning law also conducted for the Commission by Professor Beuscher and published in SEWRPC Technical Report No. 6, Planning Law in Southeastern Wisconsin, October 1966. As part of the areawide water quality planning and management effort, the Commission has updated this study of planning law, and the results have been set forth in the Second Edition of SEWRPC Technical Report No. 6, Planning Law in Southeastern Wisconsin, April 1977. This report deals with the specific powers for local and regional planning and plan implementation, primarily with respect to land use planning.

FEDERAL WATER QUALITY MANAGEMENT

The federal government has long been involved in water quality management efforts, although it is only in relatively recent years that the U. S. Congress has acted to secure the establishment of water use objectives and supporting standards for navigable waters. The 1899 Refuse Act prohibited the discharge of any refuse matter of any kind, other than that flowing from streets and sewers, into any navigable waters of the United States, or tributaries thereto, without first obtaining a permit from the Secretary of the Army. The Secretary was directed to make a specific finding that the discharge of any refuse matter would not adversely affect anchorage and navigation; however, no finding on water quality was required. This act and the permits issued thereunder were largely ignored until enactment of the National Environmental Policy Act of 1969, which required all federal agencies to consider the environmental impact in the administration of all public laws, and the Water Quality Improvement Act of 1970, which required applicants for federal permits to file a certification from the appropriate state that the proposed discharge would not violate any applicable state-adopted water quality standard. The remainder of this section will include a discussion of those federal authorities affecting water quality management and areawide plan implementation for both point and nonpoint sources of pollution.

The Federal Water Pollution Control Act Amendments of 1972 (FWPCA)

The original Federal Water Pollution Control Act (FWPCA) was enacted into law in 1948, but in 1972 and 1977 it underwent significant alteration through a series of comprehensive amendments.[1] In instituting these changes to the Act, Congress set as its objective:

> To restore and maintain the chemical, physical and biological integrity of the nation's waters.[2]

In seeking to fulfill that objective the Congress set as a national goal the elimination of all discharges of pollutants into the nation's navigable waters by 1985, and an interim water quality goal providing for waters suitable for the support of indigenous populations of fish, shellfish, and other aquatic life and for the support of water-based recreation by 1983 wherever attainable. The latter goal is sometimes characterized as calling for "fishable and swimmable" waters. The 1972 Act also provided—through an elaborate scheme under five broad titles—the mechanisms and incentives for reaching these ambitious goals. The first of these five titles contains the goals and objectives, along with provisions for grants for various research and related programs. Title II provides for assistance to the individual states and their local units of government in developing and implementing waste treatment management plans and practices and it authorizes federal grants for the construction of treatment works. Title III enumerates various procedures and time deadlines for the establishment of water quality standards and effluent limitations. It additionally requires various review and monitoring processes for the program and provides the basis for federal enforcement. Title IV deals with permits and licenses, setting in place the National Pollutant Discharge Elimination System, which is one of the primary control and implementation mechanisms. Authorization is also given here for the individual states to administer the permit program if the state program is federally approved. Wisconsin has had its permit program approved and a discussion of the procedures under the state program follows later in this chapter. And finally, Title V contains general provisions for administrative and judicial review.

Point Source Discharges: The regulatory framework contained within the FWPCA is designed to have an impact on two major classes of point source dischargers. A point source is defined in the Act as:

> any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged.[3]

Further distinction is made between those persons who discharge directly into navigable waters and those who discharge into publicly owned treatment works.

Water Quality Standards and Effluent Limitations: Since 1965 the FWPCA has required states to adopt water use objectives and supporting water quality standards for all interstate waters. The Act as revised in 1972 incorporates by reference in Section 303(a) all existing interstate water quality standards that have been approved by the Administrator of the Environmental Protection Agency (EPA). In addition, the Act provides for adoption of intrastate water use objectives and supporting water quality standards and submittal of such objectives and standards to the EPA for approval. Wisconsin, through the Natural Resources Board and

[1] *USCA Sec. 1251 et seq., 86 Stat. 816. The 1977 amendment later offered, as the short title of the Federal Water Pollution Control Act, as amended, the title "Clean Water Act," or "CWA."*

[2] *Sec. 101(a).*

[3] *Sec. 502(14).*

the Department of Natural Resources, has adopted interstate and intrastate water use objectives and supporting water quality standards. These standards as they relate to the streams and watercourses of southeastern Wisconsin are presented in detail later in this chapter. Under the FWPCA, state governors are required to hold public hearings at least every three years for the purpose of reviewing the adopted water use objectives and supporting water quality standards and, in light of such hearings, appropriately modify and readopt such objectives and standards.

In addition, Sections 301 and 302 of the Act require the establishment of effluent limitations and water quality-related effluent limitations. Section 301 establishes a deadline of July 1, 1977 for the enactment of specific effluent limitations for all point sources of water pollution other than publicly owned treatment works. Such limitations must relate to the type of pollution source and must require the application of the "best practicable water pollution control technology currently available," as defined by the EPA Administrator.[4] Any waste source which discharges into a publicly owned treatment works must comply with applicable pretreatment requirements also to be established by the EPA Administrator. All publicly owned treatment works in existence on July 1, 1977 must meet effluent limitations based upon a secondary level of treatment, as defined by the EPA Administrator.[5] Any waste treatment plants constructed with federal grant funds after June 30, 1974 must apply the "best practicable waste treatment technology"[6] over the life of the works. In addition to these requirements based on generally achievable technology, any more stringent effluent limitations necessary to meet water quality standards are also required to be met under the provisions of Section 301. The 1977 amendments authorize the EPA Administrator to grant to an industrial discharger an extension to the July 1, 1977 deadline—established in the 1972 amendments—to not later than April 1, 1979. The conditions of this extension include: 1) that good faith be demonstrated on the part of the industrial discharger; 2) that commitments be made by the discharger to achieve compliance by April 1, 1979; and 3) that the required facilities be under construction. Municipal treatment works may receive an extension of the July 1, 1977 deadline to not later than July 1, 1983. Required conditions for granting the extension include a lack of available federal construction assistance or a demonstration that construction cannot be completed within the specified timing of the Act.

The 1977 amendments made several significant modifications to the provisions of the 1972 amendments, which required point sources of water pollution other than publicly owned treatment works to achieve by 1983 the levels of control associated with the "best available technology economically achievable." Congress deferred the deadline established in the 1972 amendments to July 1, 1984—a 12-month extension—and classified pollutants into one of three categories: "toxic" pollutants, "conventional" pollutants, and "nonconventional" pollutants—categories which are to be defined by the U. S. EPA through the establishment of lists of pollutants. Section 307 directs the Administrator to promulgate the "best available technology economically achievable" effluent limitations for 21 basic industries covering 65 specific toxic pollutants by July 1, 1980.[7] Section 301 directs that all nonmunicipal toxic pollutant dischargers must apply by July 1, 1984 the "best available technology economically achievable." The term "conventional pollutants" is defined in Section 304(a)(4) to include biological oxygen demand, suspended solids, fecal coliform and pH (hydrogen ion concentration). This list may be enlarged by the Administrator. Point source dischargers other than publicly owned treatment works must apply by July 1, 1984 the "best conventional pollutant control technology."[8] The EPA Administrator is directed to complete by July 1, 1980 the issuance of the definitions of the best conventional pollutant control technology. All pollutants other than those classified as toxic pollutants or conventional pollutants are placed in the category labeled nonconventional pollutants. The deadline for achieving the "best available technology economically achievable" for nonconventional pollutants is not later than three years after the date for which the

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[4] *The EPA issues guidelines for the "best practicable control technology currently available" on an industry-by-industry basis. For a complete description of the "best practicable control technology currently available" and a list of those industries for which such standards have been promulgated see 40 CFR 401-460.*

[5] *The EPA definition of secondary treatment is found in Volume 41, Federal Register 30.788 (1976). Generally, secondary treatment refers to that level of treatment resulting in an effluent quality of less than 30 mg/l of five-day biochemical oxygen demand and 30 mg/l of suspended solids and 85 percent removal of those substances based on a monthly average of samples analyzed daily.*

[6] *The "best practicable waste treatment technology" is described by the EPA in Alternative Waste Management Techniques for Best Practicable Waste Treatment, Technical Information Report, U. S. Environmental Protection Agency, 1974.*

[7] *The EPA issues guidelines for the "best available technology economically achievable" on an industry-by-industry basis. For a complete description of the "best available technology economically achievable" and a lsit of those industries for which such standards have been promulgated see 40 CFR 401-460. In the 1977 amendments, Congress formalized the settlement derived from the case of Natural Resources Defense Council v. Train which committed the EPA to promulgate "best available technology economically achievable" guidelines for 21 basic industries covering 65 specific toxic pollutants.*

[8] *The term "best conventional pollutant control technology" will be defined and applied in future EPA regulations.*

pertinent effluent limitations are established, or not later than July 1, 1984, whichever is later, but in no event later than July 1, 1987. The Administrator must issue effluent guidelines establishing the "best available technology economically achievable" for nonconventional pollutants on an industry-by-industry basis.

By July 1, 1983 all publicly owned treatment works must be applying the "best practicable waste technology" over the life of the works. Section 301 provides that any effluent limitation established to meet the July 1, 1983 or July 1, 1984 goals must be reviewed every five years and, if necessary, revised to implement the national goal of eliminating the discharge of all pollutants. The 1977 amendments authorize the Administrator to promulgate regulations supplemental to any effluent limitations specifying the best management practices to control plant site runoff, spillage or leaks, sludge or waste disposal, and drainage from raw material storage that the Administrator determines are associated with the industrial manufacturing or treatment process with a class or category of industrial point sources contributing significant amounts of such pollutants to navigable waters.[9]

Section 302 of the Act provides the EPA Administrator with the authority to set even more stringent effluent limitations for point sources or groups of point sources of water pollution upon a finding that the effluent limitations established under Section 301 relating to the 1984 goals would not result in the attainment or maintenance of a water quality which would protect public water supplies, accommodate agricultural and industrial uses and the protection and propagation of a balanced fish and wildlife population, and allow human recreational activities in and on a specific portion of the navigable waters. No authority is given in this section to the states, indicating that upon specific findings the EPA Administrator can apply direct federal action to assure the achievement of water use objectives and supporting water quality standards. Before such direct federal effluent limitations can be set, however, the balance between the economic and social benefits and costs of such limitations must be determined at an administrative hearing.

As part of the continuing state planning process discussed below, each state is required by Section 303(d) of the Act to identify any waters within its boundary for which effluent limitations required under Section 301 are not stringent enough to achieve applicable adopted water use objectives and supporting water quality standards. The state is then required to establish a priority ranking for such waters taking into account the severity of the pollution and the uses proposed to be made of the waters. For each such identified water, the state is then to establish a total maximum daily load for appropriate pollutants. Such a daily load is to be established at a level necessary to implement the water quality standards. Any loadings for such waters, as approved by the EPA Administrator, are required to be incorporated into the state water quality continuing planning process required under Section 303(3) of the Act.

Section 306 of the Act provides national standards of performance with respect to the discharge of pollutants. The EPA Administrator is required to publish a list of categories of pollution sources and regulations establishing federal standards of performance for newly established sources of pollution within each industrial category. The term "standard of performance" is defined to mean:

> a standard for the control of the discharge of of pollutants which reflects the greatest degree of effluent reduction which the Administrator determines to be achievable through the application of the best available demonstrated water pollution control technology, processes, operating methods, or other alternatives, including, where practicable, a standard permitting no discharge of pollutants.[10]

In essence, then, this section requires the establishment of national levels of performance with respect to new sources of water pollution within industrial categories, new sources being defined as:

> any source the construction of which is commenced after the publication of proposed regulations presenting a standard of performance under this section which will be applicable to such source.[11]

Thus, for example, any newly established firm processing dairy products would be required to meet the same standard of performance with respect to the discharge of water pollutants anywhere in the United States irrespective of the assimilative capacity of the receiving water body. The practical effect of this section is to eliminate "shopping around" on the part of industries for specific locations in the country which may be able to require less stringent water pollution control standards than other areas because of the availability of a large dilution potential. The Administrator may delegate to each state the authority for applying and enforcing the national standards of performance.

Section 307 of the Act requires the EPA Administrator to establish toxic and pretreatment effluent standards. The Administrator must publish a list of the 65 pollutants that are deemed by the U. S. Congress to be toxic, and subject to Section 307, and subsequently to publish proposed effluent limitations which may include a discharge prohibition for such pollutants. From time to time, the Administrator may revise the toxic pollutants list. In addition, the Administrator is required to establish national pretreatment standards for the discharge of pollutants into publicly owned treatment works. The

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[9] *Sec. 304(e).*

[10] *Sec. 306(a)(1).*

[11] *Sec. 306(a)(2).*

standards must cover pollutants that are not susceptible to treatment at the public facility or that would interfere with the proper operation of the public facility. Any state or local pretreatment requirements that are not in conflict with any national pretreatment standards are allowed to remain in effect. This section also specifies that individual industrial users of municipal waste treatment plants are not required to obtain a discharge permit under Section 402 of the Act, as discussed below. Any discharge permit issued to a municipal waste treatment plant must, however, identify industrial contributors and the quality and quantity of effluent introduced by them. This section of the Act further provides that any violation of pretreatment standards may be subject to enforcement actions undertaken by the EPA Administrator directly against the contributor. Finally, industrial users must give notice of any change in the quality or quantity of the effluent discharged into a municipal sewerage system to the state or federal agency issuing a permit for a publicly owned treatment works so that that agency will have an opportunity to examine the impact of the proposed discharge so as to determine whether there might be a violation of the municipal waste discharge permit.

Section 308 of the Act requires the EPA Administrator, or a state upon approval of the EPA Administrator, to establish an effective monitoring system related to all point sources of pollution. Owners or operators of any point source, whether discharging directly to surface waters or into a municipal sanitary sewerage system, must establish and maintain records; make reports; install, maintain, and use monitoring equipment or methods; provide sampling of effluents in a manner prescribed by the EPA or the state; and provide any other relevant information that may be required.

With respect to water quality standards and effluent limitations, Section 304 of the Act grants to the EPA Administrator the authority to develop and publish appropriate guidelines applicable to the establishment of the aforementioned water quality standards and effluent limitations. These guidelines are to address the following:

1. Criteria for the biological, physical, and public health considerations of water quality.

2. Information on factors necessary to restore and maintain the chemical, physical, and biological integrity of all navigable waters; on the factors necessary for the protection and propagation of fish life and for recreational activities in and on the waters; on the measurement and classification of water quality; and on the identification of pollutants suitable for maximum daily load measurement correlated with the achievement of water quality objectives.

3. Guidelines for adopting or revising effluent limitations.

4. Information on the degree of effluent reduction attainable through the application of secondary waste treatment or alternative waste treatment management techniques and systems; and on the nature and extent of nonpoint sources of pollution and control of such sources.

5. Wastewater pretreatment guidelines.

6. Test procedures for the analysis of pollutants.

7. Uniform application forms and other minimum requirements for the acquisition of information from owners and operators of point sources of pollution.

8. Minimum procedural and related elements of any state permit program for waste discharges including monitoring, reporting, and enforcement provisions.

Pollutant Discharge Permit System: As noted earlier, Title IV of the Federal Water Pollution Control Act Amendments deals with permits and licenses. Section 402 established a National Pollutant Discharge Elimination System. Under this system, the EPA Administrator, or a state upon approval of the EPA Administrator, may issue permits for the discharge of any pollutant or combination of pollutants. In effect, this section supersedes the permit system established but little utilized for water quality purposes under the Refuse Act of 1899. All permits for the discharge of pollutants are now issued under the Federal Water Pollution Control Act, and no longer are any to be issued under the Refuse Act. All permits must contain conditions on data and information collection and reporting. In essence, this section provides that all dischargers discharging wastes into navigable waters must obtain a federal permit, or a state permit where such authority is delegated to the state.

In order for the EPA Administrator to authorize a state to issue permits, the state must submit a proposed permit program showing the necessary capability. The EPA Administrator must approve a state permit program unless he finds that the state does not have authority to adequately carry out all requirements of the Federal Water Pollution Control Act. One intent of the permit system is to set forth, where appropriate, a schedule of compliance dates by which various requirements shall be achieved.

Section 401 of the Act provides that any applicant for federal approval for the construction or operation of facilities which may result in any discharge into navigable waters must provide the federal licensing or permit agency with a state certification that the discharge will comply with all provisions of the FWPCA. In addition, such state certification must set forth any effluent limitations or monitoring requirements necessary to assure compliance with the Act, as well as any additional state requirements. All such limitations or requirements set forth in the state certification automatically become conditions of any federal license or permit.

Section 405 of the Act prohibits the disposal of sewage sludge in any manner which would result in pollutants entering the navigable waters of the United States except in accordance with a special permit issued by the EPA Administrator. The Administrator is required to promulgate regulations governing the issuance of permits for sewage sludge disposal. Any state may administer its own permit program for the disposal of sewage sludge upon approval of the EPA Administrator.

Two major areas of federal control over a state-administered permit process have been retained. The first allows the EPA within 90 days of its notification of the application for a permit, or within 90 days of the date of transmittal of the proposed permit itself, to object in writing to the issuance of such permit. If the EPA Administrator elects that course of action, no permit shall be issued. The second check upon the state permit program, and the more significant one, allows the EPA Administrator to withdraw the program authority—after a public hearing notifying the state and after a 90-day period for corrective action—if the state is not fulfilling its program obligations.

Enforcement: The major enforcement provisions of the FWPCA are found in Section 309. If the EPA Administrator finds that any person is in violation of Sections 301, 302, 306, 307, 308, 318, or 405 of the Act or is in violation of any permit conditions or limitations which implement any of these sections in a permit issued under Section 402 of this Act by EPA or by a state, he shall issue an order requiring such person to comply with such sections or requirement.[12] An individual who violates an order of the Administrator will be subject to a civil penalty not to exceed $10,000 per day of violation.

The alternative to the issuance of an order is to seek permanent or temporary injunctive relief for any violations of the sections listed above. Separate penalties of not less than $2,500 nor more than $25,000 per day of violation or imprisonment for up to a year may be imposed on persons who willfully or negligently violate permit conditions or limitations.

Inspections and Monitoring: In order to assist in meeting the objectives of the Act and the development of any of the previously discussed standards, as well as for the purposes of ascertaining whether any person is in violation of the standards, the owner or operator of any point source discharge may be required to implement certain monitoring processes and keep certain records and specific information on the operation. In addition, Section 308 of the FWPCA grants the EPA Administrator, or authorized representative, the right to entry and inspection of premises where an effluent source is located. For example, a state has such rights under the Act if the Administrator finds that its procedures for monitoring, inspection, and entry are comparable to those of the Environmental Protection Agency.

[12] *Sec. 309.*

Continuing Statewide Water Quality Management Planning Process: The Federal Water Pollution Control Act provides in Section 303(e) that each state must have a continuing planning process consistent with the objectives of the Act. States are required to submit a proposed continuing planning process to the EPA Administrator for his approval. The Administrator is prohibited from approving any state discharge permit program for any state which does not have an approved continuing planning process under Section 303(e). The state continuing planning process must result in water quality management plans for the navigable waters within the state which include at least the following items: effluent limitations; compliance schedules; elements of any areawide water quality plan; maximum daily loads for all waters where Section 301 effluent limitations are not sufficient to meet water quality standards; adequate authority for intergovernmental cooperation; implementation schedules; residual waste disposal; and an inventory and priority ranking of waste treatment works construction needs.

In effect, the Section 303(e) state planning process calls for the preparation of comprehensive water quality management plans for natural drainage basins or watersheds. Such basin plans, however, are likely to be less comprehensive in scope than the comprehensive plans prepared for the Root, Fox, Milwaukee, and Menomonee River watersheds by the Southeastern Wisconsin Regional Planning Commission. The 303(e) basin plans are to incorporate, as appropriate, any metropolitan or regional plans on specific facility development, such as the regional sanitary sewerage system plan. In addition, such basin plans should reflect appropriate findings and recommendations of any comprehensive—"Level B"—basin plan prepared by the Water Resources Council under the federal Water Resources Planning Act.[13] In fulfillment of these requirements, the Wisconsin Department of Natural Resources, Environmental Standards Division published in July 1975 the Southeastern Wisconsin River Basins Water Quality Management Basin Plan as a supplement to the regional sanitary sewerage system plan.

[13] *The structure of these federal water quality planning requirements was apparently conceived on the basis of an "idealized" development pattern consisting of a single sanitary sewer service area served by a single sewage treatment plant, the service area being wholly located within a larger single hydrologic drainage basin. This conceptual model does not fit the Southeastern Wisconsin Region at all. The application of these laws and guidelines becomes far more complex in this Region, where entire watersheds and portions of other watersheds fall within the larger sanitary sewer service area of the Milwaukee-Metropolitan District and where sanitary sewer service areas and even storm water drainage patterns frequently cross watershed divides and serve multiple communities, and may have the existing capability to drain to more than one sewage treatment plant.*

Thus, the statewide planning process of Section 303(e) is envisioned largely as an integration of the various basin, watershed, and regional planning elements prepared throughout the state by federal, state, regional, and local units and agencies of government. This state planning process should also become the vehicle for coordinating all state and local activities directed at securing compliance with the requirements of the Federal Water Pollution Control Act.

Areawide Waste Treatment Planning and Management: Title II of the Federal Water Pollution Control Act, as amended, deals broadly with federal grants for the construction of waste treatment works. One of the major provisions in this title is found in Section 208 and deals with the development and implementation of areawide waste treatment management plans such as the plan described in this report. Such plans are to be the basis for EPA approval of grants to local units of government for the construction of waste treatment works. Section 208 and the supporting regulations call for a formal review by each state governor of the boundaries suitable for areawide water quality planning, and for the formal designation of these areas and of the agencies to conduct the planning. The designation process includes formal hearings, public notification, and local comment. If the governor does not act either by designating—or affirmatively determining not to designate—Section 208 planning areas, the chief elected officials of local governments within a metropolitan area may take the initiative and by agreement designate boundaries for a Section 208 planning area and further designate an appropriate planning agency. In either case, the EPA Administrator must approve all designations of Section 208 planning areas and planning agencies. The state is required to act as the planning agency for any portion of a state not formally designated as a Section 208 planning region.

Within one year after the date of designation of any planning organization to conduct Section 208 areawide waste treatment planning, the planning agency must have in operation an approved continuing, areawide waste treatment management planning process consistent with the objectives of the federal grant program for waste treatment works construction. The agency must prepare an areawide waste treatment management plan for the region and submit such plan to the governor. The governor must then certify the plan and submit it to the EPA Administrator no longer then two years after the planning process is placed into operation.

The areawide plan prepared under the Section 208 planning process and documented in this report is required to include and identify at least the following elements:

1. Identification of the waste treatment works necessary to meet the anticipated municipal and industrial waste treatment needs for the area for a 20-year period. This identification must include an analysis of alternative waste treatment systems, an identification of any requirements for the acquisition of land for treatment purposes, the identification of any necessary waste water collection and urban storm water drainage systems, and the development of a program to provide the necessary financial arrangements for the development of any treatment works. The 1977 amendments add the requirement to identify open space and recreation opportunities that can be expected to result from improved water quality including potential use of lands associated with treatment works and increased access to water-based recreation.

2. Establishment of construction priorities and time schedules for all treatment works included in the plan.

3. Establishment of a regulatory program to provide for the location, modification, and construction of any facilities within the planning area which may result in pollutant discharges and to ensure that any industrial or commercial wastes discharged into any treatment works meet applicable pretreatment requirements.

4. Identification of all agencies necessary to construct, operate, and maintain the facilities included in the plan and to otherwise carry out the recommendations in the plan.

5. Identification of all measures necessary to carry out the plan, including identification of the means of financing; the period of time necessary to carry out the plan; the cost of carrying out the plan; and an assessment of the economic, social, and environmental impact of carrying out the plan.

6. Identification of agricultural- and silvicultural-related nonpoint sources of pollution and the procedures and methods, including land use controls necessary to control to the maximum extent feasible such pollution sources.

7. Identification of mine-related sources of pollution, construction-related sources of pollution, and salt water intrusion, and the methods and procedures to control to the maximum extent feasible such pollution sources.

8. Recommendations for the control of the disposition of all residual wastes generated in the planning area which may affect water quality, such as sludge.

9. Identification of a process to control the disposal of pollutants on land or in subsurface excavations.[14]

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[14] *These requirements are found in Section 208 of the Act and 40 CFR 131.11(J).*

All areawide waste treatment management plans must be updated annually and certified annually by the governor to the EPA Administrator as being consistent with any applicable basin plans prepared under Section 303(3) of the Act.

At the time an areawide waste treatment management plan is submitted by the governor to the EPA Administrator, the governor must designate, after consultation with the appropriate areawide planning agency, one or more waste treatment management agencies to carry out the plan. Once a waste treatment management agency having appropriate authority has been so designated, and once a Section 208 areawide waste treatment management plan has been approved by the EPA Administrator, the Administrator is prohibited from issuing any federal grant for the construction of a publicly owned treatment works except to the designated management agency and for treatment works found to be in conformity with the areawide plan. In addition, no permit may be issued under Section 402 of the Act for any point source of water pollution found to be in conflict with any approved Section 208 plan.

Section 208(j) of the Act was created by the 1977 amendments to provide for a system of agricultural cost-sharing for the purpose of installation and maintenance of measures incorporating the best management practices to control nonpoint souce pollution for improved water quality in those areas with certified plans. Practices are to be consistent with adopted 208 plans. The Secretary of Agriculture acting through the U. S. Soil Conservation Service is authorized to enter into agreements of not less than five nor more than 10 years with owners and operators having control of rural lands. The landowner or operator shall agree to the following:

1. To implement a plan approved by the local soil conservation district;

2. To forfeit any rights to further payments or grants upon violation of the contract at any stage;

3. To forfeit all rights to further payments or grants and refund all payments or grants received upon transfer of his right and interest in the farm; and

4. To refrain from practices which would tend to defeat the purposes of the contract.

The Secretary of Agriculture shall provide technical assistance and authorize cost-sharing for those practices which he deems to be appropriate and in the public interest. The portion of cost including labor to be shared shall not exceed 50 percent of the total cost. However, the Secretary may authorize a greater percent of cost-sharing where he determines that:

> (1) the main benefits to be derived from the measures are related to improved offsite water quality, and (2) the matching share requirement would place a burden on the landowner which would probably prevent him from participating in the program.[15]

The Secretary of Agriculture must give priority to those areas and sources which have the most significant effect on water quality. In addition, the Secretary is directed, where practicable, to enter into agreements with local soil conservation districts, state soil and water conservation agencies, or state water quality agencies to administer all or part of the program. Finally, $200 million and $400 million were authorized to be appropriated for fiscal years 1979 and 1980, respectively, to carry out this program.

Federal Grants for Waste Treatment Works Construction: One of the basic goals of the Federal Water Pollution Control Act is to provide for federal funding of publicly owned waste treatment works. As noted above, the Act requires that such funding be based upon an approved areawide waste treatment management plan designed to provide for control of all point and nonpoint sources of water pollution. The Act further encourages at specific treatment works waste treatment management which provides for the recycling of potential pollutants through the production of agriculture, silviculture, or aquaculture products for revenue; the confined and contained disposal of any pollutants not recycled; the reclamation of wastewater; and the ultimate disposal of sludge in an environmentally safe manner.

Section 201 of the Act provides that the EPA Administrator cannot approve any grant after July 1, 1973, unless the applicant demonstrates that the sewage collection system discharging into the sewage treatment facility is not subject to excessive infiltration or clear water inflow. Special grants for the evaluation of clear water problems in sewer collection systems are to be made available under new guidelines to be published by the Administrator.

Section 201 prohibits the Administrator from issuing any grants for any fiscal year beginning after September 30, 1978 unless the grant applicant satisfactorily demonstrates that he has fully studied and evaluated:

> innovative and alternative wastewater treatment processes and techniques which provide for reclaiming and reuse of water, otherwise eliminate the discharge of pollutants, and utilize recycling techniques, land treatment, new or improved methods of waste treatment management for municipal and industrial waste (discharged into municipal systems) and the confined disposal of pollutants, so that pollutants will not migrate to cause water or other environmental pollution. . . .[16]

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[15] *Sec. 208(j)(2).*

[16] *Sec. 201(g)(5).*

In addition, the 1977 amendments add the requirement that grant applicants must analyze the potential recreation and open space opportunities in the planning of proposed treatment works.

Federal funding for waste treatment grants has been set at 75 percent of the construction costs. Grants of 85 percent were provided by Section 202(a)(2) for those treatment works utilizing innovative or alternative wastewater treatment processes and techniques. In addition, the 1977 amendments specify that at least 25 percent of the funds allocated to a state each year shall be applied to pipe-related projects including sewer rehabilitation, collectors and interceptors and the correction of combined sewer overflows. The Federal Water Pollution Control Act authorizes contract authority whereby the Administrator may commit the federal government to payment of its portion of the treatment facility at the time of approval of plans, specifications, and estimates. In previous years, the first payment of a federal grant to a municipality occurred when 25 percent of the actual construction of the facility was completed. Under this program, which is modeled after the Federal Highway Act, each stage in the construction of a waste treatment facility may be considered as a separate project. An applicant for a grant may stage in any manner the overall project and prepare plans, specifications, and estimates for each stage. Actual payment may be based upon approval of such plans, specifications, and estimates for each stage.

Various limitations and conditions on any federal waste treatment work grant are set forth in Section 204 of the Act. As noted, any treatment works proposed to be funded must be included in any Section 208 areawide waste treatment management plan and must conform with any applicable state plan developed under Section 303(3). Furthermore, the state must certify that the works to be funded are entitled to priority over other works in the state. In addition, the size and capacity of the works must relate directly to the specific needs to be served by the works, accounting for sufficient reserve capacity. Finally, the applicant must adopt a system of user charges to assure that each recipient of waste treatment services will pay a proportionate share of the operation and maintenance costs, including replacement costs, of any waste treatment services provided, and that industrial users of the treatment works will pay to the applicant at least the federal share of the cost of that portion of the construction of the works which is allocable to the treatment of industrial wastes.

The 1977 amendments allow ad valorem tax schedules to be utilized as a method of imposing user charges among residential users provided that each class of user carries its proportionate share of operation and maintenance costs and that within the class of industrial users charges to each user are proportionate to its wastewater discharge.[17]

[17] *Sec. 204(b)(5).*

The EPA has published guidelines to be used by local governments in setting up schedules of service charges for industrial and other users of waste treatment works. Such guidelines establish classes of users; criteria against which to determine the adequacy of charges imposed on all classes and categories of users reflecting all factors including strength, volume, and flow characteristics; and model systems of user charges. Of the amount recovered for industrial-related costs of treatment facilities, the applicant may retain that share which was not provided by federal grants-in-aid plus the portion needed for future reconstruction and expansion to a maximum of 50 percent of the recovered amount. Of the retained portion which is intended to be used by the grantee for future reconstruction and expansion, at least 80 percent must be placed in a federally insured account. The remaining 20 percent may be used as the applicant sees fit. The 1977 amendments exempt small users from the industrial cost recovery system by authorizing the Administrator to exempt from EPA requirements any industry with daily discharges of less than 25,000 gallons, provided wastes would not interfere with treatment processes or contaminate sewage sludge. In addition, the Administrator was directed to prepare a study for Congress, and a corresponding 18-month moratorium on the application of cost recovery requirements was instituted.[18]

Permits for Dredged or Fill Material: One major exception outside the procedural framework for controlling discharges into the waters of the nation is the separate permit system administered by the U. S. Army, Corps of Engineers.[19] The Act delegates to the Secretary of the Army acting through the Chief of Engineers the authority to issue permits after having given notice and holding a public hearing for the discharge of dredged or fill material into the navigable waters at specified disposal sites. The disposal sites chosen must meet certain guidelines established by the Administrator of the EPA who will consider among other things the effect on human health, marine life, and aesthetic, recreational, and economic values.[20] Final approval for a specified disposal site will reside in the EPA.[21] That approval may be denied if it is determined that:

> the discharge of such material . . . would have an unacceptable adverse effect on municipal water supplies, shellfish beds and fishing areas (including spawning and breeding areas), wildlife or recreational areas.[22]

[18] *Sec. 204(b)(6).*

[19] *Sec. 404.*

[20] *Secs. 404(b) and 404(c).*

[21] *Sec. 404(e).*

[22] *Sec. 404(b).*

Before the Administrator makes this determination however, Section 404(c) requires that the Secretary of the Army be consulted, and furthermore that the Administrator set forth in writing the reasons for the final determination.[23] The 1977 amendments authorize states with EPA approval to administer portions of the Section 404 permit program. In addition, the Corps of Engineers is authorized to issue general permits for terms not exceeding 10 years allowing minor activities to proceed without individual permits.

In responding to the requirement for issuance of permits under this section, the Corps of Engineers has published interim final regulations designed to meet its mandate under the FWPCA. The new regulations extend the Corps' regulation of disposal of dredge and fill materials to waters not previously under its jurisdiction including wetlands and wholly intrastate waters. This is due to the Congressional decision to assert federal jurisdiction over all waters of the United States. While these regulations are still subject to modification, their overall thrust and the Corps' enlarged mandate to regulate the discharges of dredged or fill material in the nation's waters will clearly remain. Moreover, the FWPCA provides a checkoff to the individual states over the permits issued by the Corps for discharges of dredged or fill material. Under Section 401 of the FWPCA no permits may be issued unless the state has also granted a water quality certification.

Nonpoint Source Pollution: The earlier discussion of Section 208 of the FWPCA indicated that the plans for areawide waste treatment must include certain procedures and methods for controlling nonpoint sources of pollution such as agricultural runoff. Only in the Section 208 planning requirement does the Act speak directly to nonpoint sources of pollution. Any 208 plan must include:

> a process to (i) identify, if appropriate, agriculturally and silviculturally related nonpoint sources of pollution, including runoff from manure disposal areas, and from land used for livestock and crop production, and (ii) set forth procedures and methods (including land use requirements) to control to the extent feasible such sources.[24]

Also identified as necessary plan elements are processes to identify mine-related sources of pollution and construction activity-related sources of pollution, and a process to control the disposition of residual waste which could affect water quality. In addition, Section 208 must include an identification of necessary urban storm water runoff systems. As stated earlier, the 1977 Amendments created an agricultural cost-sharing program directed toward improving water quality to be administered by the U. S. Department of Agriculture using certified 208 plans as the basis for prioritization, project selection, practices, design, and evaluation.

Finally, Section 304(e) of the Act requires the Administrator to issue guidelines for identifying and evaluating the nature and extent of nonpoint sources of pollution. In addition, the Administrator is to identify processes, procedures, and methods to control pollution resulting from agricultural, silvicultural, mining, and construction activities. Each state is required by Section 305(b)(i)(E) to submit an annual report to the Administrator that includes a description of the nature and extent of nonpoint sources of pollution and recommendations of the programs and expenditures necessary to control such sources of pollution.

National Environmental Policy Act

Perhaps the most far-reaching national legislation in recent years is the National Environmental Policy Act of 1969 (NEPA). This Act broadly declares a national policy to encourage a productive and enjoyable relationship between man and his environment; to promote efforts which will prevent or eliminate damage to the environment; and to enrich the understanding of the ecological systems and natural resources important to the nation. This Act has broad application to any project requiring federal action, including the construction of sewerage facilities aided by federal grants. The mechanism to serve the intent of the National Environmental Policy Act of 1969 is the preparation of an environmental impact statement (EIS) for a project. Such a statement must include documentation of the environmental impact of the proposed project; any adverse environmental effects which cannot be avoided should the project be constructed; any alternatives to the proposed project; the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity; and any irreversible and irretrievable commitments of resouces which would be involved in the proposed action should it be implemented. Draft copies of all environmental impact statements must be made available for review by appropriate federal, state, and local agencies and by the general public. As discussed later in this chapter, the State of Wisconsin has a similar environmental policy act covering governmental action of all kinds within the state, whether or not it is federally aided.

The Federal Water Pollution Control Act as amended in 1972 relates the provisions of that Act to the National Environmental Policy Act of 1969. Section 511 of the Federal Water Pollution Control Act specifically exempts all actions of the EPA Administrator from the requirements of the National Environmental Policy Act of 1969, except the issuance of federal grants for publicly owned treatment works as authorized by Section 201 of the Act, and the issuance of any permit under Section 402 for the discharge of any pollutant by a newly established source as defined in Section 306. Thus, with but two exceptions—construction grants for sewerage facilities, including sewage treatment plants, and discharge permits for new sources of pollution—all actions taken by the

[23] *Sec. 404(c).*

[24] *Sec. 208(b)(2)(F).*

EPA Administrator under this Act are exempt from the preparation of environmental impact statements. Specific guidelines and procedures for the preparation of environmental impact statements for sewerage facilities and plans associated with such facilities are set forth in Title 40, Part 6, of the Code of Federal Regulations (40 CFR Part 6). These guidelines clearly distinguish between an environmental assessment, an environmental review, an environmental impact statement, a negative declaration of environmental impact, and an environmental impact appraisal, all being terms applying to specific governmental actions related to the assessment of environmental impacts.

An "environmental assessment" is defined by the EPA as a written analysis submitted to the EPA describing the environmental impacts of actions undertaken or proposed to be undertaken with the financial support of the EPA. An "environmental review" is defined by the EPA as a formal evaluation by the EPA to determine whether a proposed EPA action—such as approving an areawide sewerage system plan or a federal grant-in-aid for the construction of sewerage facilities—may have a significant impact on the environment. An "environmental impact statement" is defined by the EPA as a report prepared by the EPA which identifies and analyzes in detail the environmental impacts of a proposed EPA action. A "negative declaration of environmental impact" is defined by the EPA as a written announcement prepared subsequent to the environmental review which states that the EPA has decided that the preparation of an environmental impact statement will not be necessary because the review determined that the proposed action will not significantly affect the environment. An "environmental impact appraisal" is defined by the EPA as an abbreviated document containing a negative declaration of environmental impact.

Section 208(2)(E) of the Federal Water Pollution Control Act of 1972 requires any areawide water quality management plan to include "the identification of . . . the economic, social and environmental impact of carrying out the plan . . . ." Such an assessment must be prepared by the designated planning agency and must include the following:

1. A description of the existing environment without the implementation of the water quality management plan alternatives.

2. A description of the probable future environment without the implementation of the water quality management plan alternatives.

3. The sources of information used in the assessment.

4. An evaluation of alternative elements of the plan.

5. The environmental impacts of the proposed implementation of the water quality management plan.

6. A description of the steps which will be used to minimize any adverse effects.

Based upon this assessment, the EPA will be able to conduct an environmental review and make a determination as to whether or not an environmental impact statement is required. Should such a statement be required, the EPA itself is responsible for its preparation and circulation in draft and final forms. It is anticipated that any required environmental impact statements will be based in large part upon the locally prepared environmental assessments provided to the EPA.

The Safe Drinking Water Act

A bill enacted into law in late 1974 which parallels some aspects of the Federal Water Pollution Control Act of 1972 is the Safe Drinking Water Act.[25] Under the provisions of the Act, the EPA and those states with federally approved programs are vested with the authority to regulate contaminants which may have an adverse effect on the health of persons who use public water systems. In addition, this Act provides a regulatory program to prevent the degradation of underground sources of water. The State of Wisconsin is currently seeking federal approval of the state safe drinking water program.

Public water systems as defined under the federal statute include both privately and publicly owned systems which provide piped water to the public for human consumption and have at least 15 service connections or regularly serve 25 individuals. These public water systems are subject to EPA regulations restricting contaminant levels in water supplies. Contaminants which are restricted are those which adversely affect human health at given levels of concentration. The end result of this regulatory process will be the establishment of maximum contaminant levels or the use of treatment techniques for each contaminant of the drinking water which may affect the health of the consuming public. States may be granted primary enforcement responsibility if they adopt regulations that are as stringent as those posited by the Environmental Protection Agency and exhibit adequate implementation and enforcement capabilities. Failure on the part of the state to properly enforce the drinking water regulations may permit the EPA or any individual to commence a civil action in the appropriate United States District Court to require compliance with a national primary water regulation. If the District Court finds a willful violation of a regulation or other requirement, it may impose on the violator a fine of up to $5,000 for each day of violation.

In passing the Safe Drinking Water Act, Congress has provided for the creation of an underground injection program which is designed to complement the public water system program by preventing the subsurface emplacement of fluids which may contaminate the

[25] *42 USCA Sec. 300f et seg., 88 Stat. 1661 (1974).*

public drinking water supply. As with the public water system program, the intent of the legislators was that the states implement and enforce the underground injection program. In order for a state to achieve primary responsibility, it must institute a program which meets certain regulations established by the EPA for the issuance of permits for all underground injections. By December 16, 1977, all underground injections will be prohibited unless they are operating with a permit issued under such a program. Prior to granting of a permit, an applicant must prove that the injection will not endanger drinking water sources to the satisfaction of the state. Enforcement procedures are similar to those found in the public water system program.

Coastal Zone Management Act

In 1972 Congress passed and the President signed the Coastal Zone Management Act (CZMA)[26] in recognition of the competing demands upon coastal lands and waters that they bordered and the institutional arrangements for planned uses of these lands. A policy was established encouraging individual states to exercise authority over the coastal areas to preserve, protect, and restore the resources of the nation's coastal zones. Participation in the coastal zone management program by the states is strictly voluntary. Three types of activities are eligible for funding under the Act, including the development of a management program; the administration and implementation of the management program; and the acquisition of the estuarine sanctuaries.

The development and administration of the program pursuant to the CZMA envisions a strong intergovernmental sharing of responsibility. The Act provides that the Secretary of Commerce shall not approve a state management program unless that state has considered the view of federal agencies principally affected by the program. Nor may the state allocate federal funds received under the Act to local governments unless they are in compliance with the state's coastal management program. The state management program must also describe the organizational structure designed to implement the program including the responsibilities of local, areawide, state, and interstate agencies in the management process.

Section 307(f) stipulates how the CZMA will be related to existing requirements of water and air pollution programs:

> Notwithstanding any other provision of this chapter, nothing in this chapter shall in any way affect any requirement (1) established by the Federal Water Pollution Control Act, as amended, or the Clean Air Act, as amended, or (2) established by the Federal Government or by any state or local government pursuant to such Acts. Such requirements shall be incorporated in any program developed pursuant to this chapter and shall be the water pollution control and air pollution control requirements applicable to such program.[27]

The major provision for setting in motion the Congressional policy of enhancing the resources of the coastal zone is the formulation and implementation of a management program. Certain basic elements to be included in any state management program are the following:

1. An identification of the boundaries of the coastal zone subject to the management program.
2. A definition of what shall constitute permissible land and water uses within the coastal zone which have a direct and significant environmental and economic impact on the coastal waters.
3. An inventory and designation of areas of particular concern within the coastal zone, including areas of unique, scarce, fragile, or vulnerable natural habitat; areas of high natural productivity; and areas of substantial recreational value.
4. An identification of the means by which the state proposes to exert control over the land and water uses, including a listing of relevant constitutional provisions, legislative enactments, regulations, and judicial decisions.
5. Broad guidelines on priority of uses in particular areas.
6. A description of the organizational structure proposed to implement the management program.

Jurisdictionally, the coastal zone and areawide water quality management programs might overlap in some areas. The Coastal Zone Management Act defines the coastal zone as:

> the coastal waters (including the lands therein and thereunder) strongly influenced by each other . . . . The zone extends inland from the shorelands only to the extent necessary to control shorelands, the uses of which have a direct and significant impact on the coastal waters.[28]

An analysis of the water quality of Lake Michigan was considered to be beyond the scope of the initial areawide water quality management planning program. However, the quality of streamwater tributary to Lake Michigan and point source municipal discharges affects the waters of the coastal zone. Any meaningful attempt to manage the lands and waters within the coastal zone must, there-

[26] *16 USCA Sec. 1451-1464, 86 Stat. 1280 (1972).*

[27] *16 USCA Sec. 1456.*

[28] *16 USCA Sec. 1453.*

fore, consider inland water quality management actions. Coordination of the coastal zone management program and areawide water quality planning program is necessary if either program is to be successful.

Federal Flood Insurance Program

A program to enable property owners to purchase insurance to cover losses caused by floods was established by the U. S. Congress in the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.[29] Taking note that many years of installation of flood protection works had not reduced losses caused by flood damage, the Congress sought to develop a reasonable method of sharing the risk of flood losses through a program of flood insurance while at the same time setting in motion local government land use control activity that would seek to ensure on a nationwide basis that future development of floodplains would be held to a minimum. Participation in the national flood insurance program is on a voluntary community-by-community basis. A community must act affirmatively to make its residents eligible to purchase flood insurance. For its part, the community must enact land use controls which meet federal standards for floodland protection and development. For practical purposes, once a community enacts floodland regulations that meet state requirements set forth in Chapter NR 116 of the Wisconsin Administrative Code, it will have been deemed to meet all federal requirements for similar controls.

The flood insurance program relates to areawide water quality planning and management in several areas. Section 1315 of the Flood Insurance Act provides that flood insurance shall not be sold or renewed unless the community has adopted adequate land use control measures consistent with federal criteria. In the area of treatment and collection facilities, federal regulations require all public utilities, including sewer and water systems, to be elevated, located, and constructed to minimize or eliminate flood damage. With regard to water supply system and sanitary sewerage systems, federal regulations require that new or replacement systems:

> be designed to minimize or eliminate infiltration of flood waters into the systems and discharges from the systems into flood waters and require onsite disposal systems to be located so as to avoid impairment of them or contamination from them during flooding.[30]

Communities with special flood hazards are required to review subdivision proposals and other proposed new developments to assure that adequate drainage is provided so as to reduce exposure to flood damage. This requirement may be directly related to efforts to contain nonpoint source pollution due to soil erosion inherent in the subdivision process. In this respect, storm water management alternatives must be developed to achieve both water quality and flood prevention objectives. Finally, communities are required to consider state and local water pollution requirements in adopting land use controls under the flood insurance program. States are required to include as part of their participation in the program requirements that:

> proposed uses of floodplain and mudslide prone areas conform to standards established by state environmental and water pollution control agencies to assure that proper safeguards are being provided to prevent pollution.[31]

Federal Clean Air Act

Sections 105 and 106 of the Clean Air Act provide grants for the support of air pollution planning and control programs. These grants are available to air pollution control agencies for the purpose of developing comprehensive air quality plans for an air quality control region. Areawide water quality, land use, and air quality planning are intimately related. Water quality conditions may be directly influenced by decisions made in an air quality planning effort and vice versa. Various technologies employed in the wastewater treatment and disposal process may seriously affect the ambient air quality of a given air quality control region. Water quality management techniques may have measurable effects on air quality. Considerations affecting community growth may also create conflicts between areawide water quality management plans and air quality planning. The decision to extend sewers or the construction of new or enlarged waste treatment facilities may act as an inducement for residential and/or industrial growth. This induced development may further degrade air quality. In addition, stringent air quality standards may result in greater amounts of residual wastes and sludges which when inadequately disposed of may create serious ground and surface water pollution.

The Resource Conservation and Recovery Act of 1976

With the passage of this act in late 1976, federal involvement in solid waste was expanded. The Act states that:

> while the collection and disposal of solid wastes should continue to be primarily the function of state, regional, and local agencies, the problems of waste disposal . . . have become a matter national in scope and in concern and necessitate Federal action through financial and technical assistance and leadership in the development, demonstration, and application of new and improved methods and processes to reduce the amount of waste and unsalvageable materials and to provide for proper economical solid waste disposal practices.[32]

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[29] *42 USCA Sec. 4001 35 et seg. 82 Stat. 572 (1973).*

[30] *Id.*

[31] *Id.*

[32] *42 USCA 6901, 90 Stat. 2796 (1976).*

The act further states that inadequate and environmentally unsound solid waste practices result in pollution of the waters. Particular reference is made to the fact that as a result of the passage of the Clean Water and Air Acts, greater amounts of solid waste in the form of sludge and other treatment residues have been generated. In addition, sludge generated from any municipal, commercial, or industrial wastewater treatment plant is included within the definition of solid waste for purposes of the application of the Resource Conservation and Recovery Act. Section 8002(g) of the Resource Conservation and Recovery Act authorizes the EPA Administrator to undertake comprehensive sludge studies that examine the following aspects of sludge management: the effects of air and water pollution legislation on the creation of volumes of sludge; sludge disposal methods including the cost, efficiency, and effectiveness of such methods; alternative methods for the use of sludge including agricultural applications and energy recovery from sludge; and methods to reclaim areas which have been used for the disposal of sludge.

The mechanics of this act are similar to those found in other resource acts. The Administrator within one year of enactment is to publish suggested guidelines for solid waste management that include information on the technological and economic feasibility of the current state-of-the-art and appropriate methods which provide at a minimum for the protection of ground and surface waters. In addition, the Administrator is authorized to prescribe regulations necessary to implement the provisions of the Act.

The Resource Conservation and Recovery Act of 1976 distinguishes between hazardous and nonhazardous wastes. The EPA Administrator is given 18 months to promulgate criteria for administering hazardous wastes and shall specifically identify those wastes which have been to date designated as hazardous. In addition, the Administrator is to establish standards which shall apply to generators of hazardous waste as may be necessary to protect human health and the environment including standards for handling, storage, transportation, and disposal of such hazardous wastes. Within 18 months of the date of enactment, a permit must be obtained by those persons owning or operating a facility for the treatment, storage, or disposal of hazardous wastes. In addition, if individual states wish to administer and enforce a hazardous waste program, they may do so as long as such a program meets minimum standards as established by the Administrator. No state may be allowed to impose any requirements less stringent than those federal requirements relating to hazardous wastes. The EPA Administrator is given authority to issue compliance orders where a violation of standards relating to hazardous wastes occurs. If a continual violation occurs, a civil fine of $25,000 for each day of violation may be imposed. In the case of certain violations involving intent, criminal sanctions are available.

The Resource Conservation and Recovery Act of 1976 provides for the development and implementation of state or regional solid waste plans. The governor of each state is to designate the boundaries of those areas appropriate for regional solid waste management. Within 18 months of the date of enactment, the EPA Administrator is to promulgate regulations to assist in the development of state plans. The Act is quite specific in the consideration to be used for state plans: the state together with appropriate local officials shall designate an agency to develop the plan for a particular area. Strict procedures are to be followed in obtaining state and federal approval of the plan.

It is readily apparent that solid waste disposal and its attendant legislation have a direct bearing on the areawide water quality management effort. Although it will be several years before many of the mandates of the Resource Conservation and Recovery Act of 1976 are implemented, it is nevertheless important to view those portions of the areawide water quality management program dealing with solid waste management in light of this Act. The governor of a state is to give particular attention to agencies already designated under Section 208 of the Federal Water Pollution Control Act vis-a-vis planning conducted under the Resource Conservation and Recovery Act of 1976.[33]

Toxic Substances Control Act

The recently enacted Toxic Substances Control Act[34] will regulate thousands of synthetic compounds presently in commercial use and others introduced each year. The goal of the toxic substances act is to acquire sufficient information to identify and evaluate potential hazards from chemical substances and to regulate the production, use, distribution, and disposal of such substances.

The new law authorizes the Environmental Protection Agency to require testing of various types of chemicals both old and newly introduced. These tests will attempt to determine if an unreasonable risk to either health or the environment results from usage of these chemicals. In the case of a new chemical initially being marketed, 90 days premarket notice must be given to the Environmental Protection Agency. This notice must include the name, formula, intended uses, and volume of production and, where testing is required, any available test data.

The Environmental Protection Agency is given enforcement responsibilities under the new Act. The Environmental Protection Agency is given authority to take restrictive actions to prevent unreasonable risks to human health and the environment. Some of these actions include requiring additional testing during the premarket period for new chemicals; restrictive action ranging from specific labeling to outright bans; and authority to seek an injunction to restrain an imminent hazard. In addition, a total ban within one year of the manufacture, process, or distribution in commerce or use in other than a totally enclosed system of any poly-

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[33] *Id.*

[34] *15 USCA 2601, 90 Stat. 2004 (1976).*

chlorinated biphenyl (PCB) was mandated under the Act. This ban is of particular importance to the Great Lakes and surrounding land areas.

Federal Environmental Pesticide Control Act of 1972
This legislation requires that persons may not distribute, sell, hold for sale, deliver, or receive any pesticide without that pesticide being first registered with the Administrator of the Environmental Protection Agency. Pesticides will be classified as being for general use, restricted use, or both as part of the registration process. For application of restricted use pesticides, a certified application is necessary. It is important that any areawide water quality management plan be cognizant of the restrictions placed on pesticides by the Federal Environmental Pesticide Control Act of 1972. Pesticide as used in this statute has a broad definitional basis including substances used as plant regulators, defoliants, and desiccants. In addition, the term pesticide encompasses substances intended to prevent, destroy, or repel any pests such as insects, rodents, fungi, and weeds. Improper use of pesticides may result in severe pollution and health hazards due to the excess pesticides being transported by surface water runoff or leaching. In any water quality management plan, due consideration must be given to a program of controlled use of pesticides vis-a-vis nonpoint agricultural pollution. In addition, serious consideration must be given to minimal usage of those pesticides currently in the restricted class as determined by the Environmental Protection Agency as mandated by the Federal Environmental Pesticide Control Act of 1972.

Federal Agricultural Authorities
The federal government has long been active in cooperating with rural agencies in the conservation of soil and water resources. Three divisions of the U. S. Department of Agriculture have been given the responsibility for implementation of these federal programs. The Soil Conservation Service (SCS) assists conservation districts, communities, watershed groups, and other agencies in the areas of erosion control and water management problems. As part of its mandate, the SCS provides the following assistance: conduct of soil surveys, extension of technical assistance to district cooperators, conduct of river basin surveys, and conduct of watershed planning, flood prevention, and resource development and conservation programs. The Agricultural Stabilization and Conservation Service (ASCS) was established to administer a variety of programs dealing directly with the farmer. Among the many activities of the ASCS are the following: agricultural conservation programs including restoring soil fertility and reducing wind and water erosion; forestry incentives programs; and a water bank program and cropland adjustment program. A third agency involved in agricultural and rural land improvement is the Farmers Home Administration (FHA). The activities of the FHA include soil and water loans, watershed and flood prevention loans, and resource conservation and development loans.

Consolidated Farm and Rural Development Act: The Consolidated Farm and Rural Development Act authorizes loans to farm owners or tenants for purposes of land and water development and conservation. In addition, loans are authorized to be made to rural communities or associations for the purpose of establishing:

> soil conservation practices, shifts in land use, the conservation, development, use and control of water, and the installation or improvement of drainage or waste disposal facilities . . . all primarily serving farmers, ranchers, farm tennants . . . .[35]

Loan programs under the Act are administered by the Farmers Home Administration.

Food and Agriculture Act of 1962: Loans may be made to local organizations and individuals to provide for soil and water development and conservation facilities and related special equipment. The Farmers Home Administration is responsible for the administration of the loan program. Loans under this Act may not be made until the Soil Conservation Service and the grantee organization or individual have agreed upon the project plan.

Watershed Protection and Flood Prevention Act: The declaration of policy for this Act states that erosion, flood water, and sediment damages in the watersheds of rivers and streams of the United States constitute a menace to the national welfare. Various projects are authorized by this Act. Section 6 provides for the investigation and survey of river basins as a basis for the development of coordinated water resource programs. In addition, the Soil Conservation Service is authorized to cooperate with states and their political subdivisions in a program of watershed planning. The Soil Conservation Service is authorized to furnish assistance to state and local governments for watershed protection projects. Such assistance includes technical and financial assistance for the installation of works of improvement specified in approved work plans. Such improvement works may include land treatment measures and structural devices such as floodwater retarding structures, stream channel improvements, and sediment control structures. Section 8 of this Act authorizes watershed protection and flood prevention loans. Such loans may be utilized to provide the local share of the cost of watershed projects. Loan programs under this Act are administered by the Farmers Home Administration. No loan may be made until the Soil Conservation Service and local entity have agreed upon the project.

Water Bank Act: The objective of the Water Bank Act is to provide grants to conserve, preserve, and improve wetlands of the nation and thereby conserve surface waters. As a result of these conservation measures, wind and soil erosion and runoff will be reduced significantly. Agreements may be entered into with owners of wetlands identified in a local conservation plan. As part of such an agreement, the owner pledges to place specific lands in the water bank program for a time certain; not to drain, burn, or destroy the wetland character; and to effectuate

[35] *USCA Sec. 1926.*

the conservation plan for the lands covered by the agreement. In return for such action, the owner is to receive annual payments from the Agricultural Stabilization and Conservation Service. The program may be terminated and payments stopped when such owner violates any part of the agreement. Such agreements are binding for 10 years in length with opportunity for renewal.

Soil Conservation and Domestic Allotment Act: The Soil Conservation and Domestic Allotment Act authorizes the SCS to provide technical and consultive assistance to individuals and local units of government in the planning, developing, and application of local soil and water conservation plans. SCS personnel may provide technical services to land users, prepare and revise conservation plans, make field investigations and recommendations on land use, and provide useful information to local governing units in the formulation and enactment of sanitary and building codes, land use regulations, and zoning ordinances. In addition, this legislation authorizes an agricultural conservation program administered by the Agricultural Stabilization and Conservation Service. Such a program involves cost-sharing with farmers, ranchers, and woodland owners to carry out approved soil, water, forestry, and wildlife conservation practices. Such agreements extend from three to 10 years.

STATE WATER POLLUTION CONTROL MACHINERY

Responsibility for water quality management in Wisconsin is centered in the Wisconsin Department of Natural Resources (DNR). Pursuant to the State Water Resources Act of 1965, the Department of Natural Resources acts as the central unit of state government to protect, maintain, and improve the quality and management of the ground and surface waters of the State. A major water quality management authority not located in the Wisconsin Department of Natural Resources is the authority to regulate private septic tank sewage disposal systems, a function that joins general plumbing supervision as the responsibility of the Wisconsin Department of Health and Social Services, Division of Health. Functions generally related to the abatement of diffuse or nonpoint sources of pollution are found in the State Department of Agriculture, State Board of Soil and water Conservation Districts, and the Department of Local Affairs and Development. Attention in this section of the chapter will be focused on those specific functions of state agencies which bear directly upon water pollution control and, hence, upon the preparation of the areawide water quality management plan. Attention will also be given to the regulation of septic tank systems in the State, diffuse source pollution regulation, and the Wisconsin Environmental Policy Act which requires the preparation of environmental impact statements for all significant actions.

Chapter 144 of the Wisconsin Statutes—Water, Ice, Sewage, and Refuse

A major portion of the basic authority and accompanying responsibilities relating to the water pollution control function of the Department of Natural Resources is set forth in Chapter 144 of the Wisconsin Statutes which states:

> the Department of Natural Resources shall serve as the central unit of state government to protect, maintain and improve the quality and management of the Waters of the State, ground and surface, public and private . . . .

The purpose of this Act is to grant necessary powers and to organize a comprehensive program under a single state agency for the enhancement of the quality management and protection of the waters of the state.[36] In accordance with its basic purpose as the central unit of state government to protect, maintain, and improve the quality and management of the waters of the State, Section 144.025(2)(a) authorizes the Department to formulate a long-range comprehensive state water resources plan for each region in the State. This section of the statutes also authorizes the Department to formulate plans and programs for the prevention and abatement of water pollution and for the maintenance and improvement of water quality. Such plans are generally prepared on a watershed or basin basis.

Water Use Objectives and Water Quality Standards: The Wisconsin Department of Natural Resources is required under Section 144.025(2)(b) of the Wisconsin Statutes to adopt rules relating to water use objectives and supporting water quality standards that are applicable to all of the waters of the State. Such authority is essential if the State is to meet the requirement of the Federal Water Pollution Control Act that such objectives and standards be established for all navigable waters in the United States. Such water use objectives and supporting water quality standards were initially adopted by the Wisconsin Resource Development Board, the predecessor to the DNR, for interstate waters in Wisconsin on June 1, 1967, and for intrastate waters on September 1, 1968. On October 1, 1973, the Wisconsin Natural Resources Board adopted revised water use objectives and supporting water quality standards which were set forth in Wisconsin Administrative Code Chapters NR 102, 103, and 104. On October 1, 1976, Administrative Code Chapter NR 104 was further revised. On September 9, 1977, Chapters NR 102 and 104 were further revised by emergency rule. The new objectives and standards are generally more stringent than the old with respect to both the water use objectives established for the streams and lakes in the Southeastern Wisconsin Region and the supporting water quality standards.

Revised water quality standards have been formulated for the following major water uses: environmental and ecological preserves use; recreational use; restricted recreational use; public water supply; warmwater fishery; trout fishery; salmon spawning fishery; limited fishery (intermediate aquatic life); and marginal aquatic life. The

[36] *Sec. 144.025(1).*

environmental and ecological preserves use category is applied by the DNR on a case-by-case basis, and at present no waters of southeastern Wisconsin are so designated. The revised state standards are set forth in Table 145. These standards are statements of the physical, chemical, and biological characteristics of the water that must be maintained if the water is to be suitable for the specified uses. Chapter 144 recognizes that different standards may be required for different waters or portions thereof. It states that in all cases the:

> standards of quality shall be such as to protect the public interest which includes the protection of the public health and welfare and the present and prospective future use of such waters for public and private water supplies, propagation of fish and aquatic life and wildlife, domestic and recreational purposes and agricultural, commercial, industrial, and other legitimate uses.[37]

Minimum Standards: All waters must meet certain conditions at all times and under certain flow conditions. Chapter NR 102.02 of the Wisconsin Administrative Code stipulates that:

> (a) Substances that will cause objectionable deposits on the shore or in the bed of a body of water shall not be present in such amounts as to interfere with public rights in waters of the state. (b) Floating or submerged debris, oil, scum, or other material shall not be present in such amounts as to interfere with public rights in waters of the state. (c) Materials producing color, odor, taste, or unsightliness shall not be present in such amounts as to interfere with public rights in waters of the state. (d) Substances in concentrations or combinations which are toxic or harmful to humans shall not be present in amounts found to be of public health significance, nor shall substances be present in amounts which are actually harmful to animal, plant or aquatic life.

Recreational Use: Waters to be used for recreational purposes should be aesthetically attractive, free of substances that are toxic upon ingestion or irritating to the skin upon contact, and void of pathogenic organisms. The first two conditions are satisfied if the water meets the minimum standards for all waters as previously described, whereas the third condition requires that a standard be set to ensure the safety of a water from the standpoint of health. The concentration of fecal bacteria is the parameter now used for this purpose. Since the fecal coliform count is only an indicator of a potential public health hazard, the Wisconsin standards specify that a thorough sanitary survey to assure protection from fecal contamination be the chief criterion for determining recreational suitability.

Restricted Recreational Use: This objective applies to continuous and noncontinuous streams for restricted use downstream from an area of intense urban densities or where wastewater has a predominant influence. A significant characteristic of this category is the maximum fecal coliform level of 1,000 per 100 milliliters (ml) based on not less than five samples per month or 2000/100 ml in more than 10 percent of all samples during any month. The restricted recreational use objective is used to signify conditions which may be hazardous to health upon whole or partial body contact. The term "restricted recreational use" is not utilized in the Wisconsin Administrative Code, Chapter NR 104, but has been utilized in SEWRPC interpretations to characterize the basic water use objectives established by the Wisconsin Department of Natural Resources for certain reaches of stream which have been severely polluted, and accordingly have been exempted by the State from the more stringent criteria associated with the maintenance of fish and other aquatic life and recreation.

Public Water Supply: The principal criterion of quality standards in raw water intended to be used for public water supply is that the water, after appropriate treatment, be able to meet Wisconsin Department of Natural Resources drinking water standards established in 1974. The DNR standards of raw water to be used for water supply include an allowable pH range and maximum limits on temperature, dissolved solids, and fecal coliform.

Warmwater Fishery: As indicated in Table 145, this objective is intended to result in water quality adequate to support fish and aquatic life and whole body contact recreational use. The most significant characteristics of this category are the inclusion of an 89°F maximum temperature and a minimum dissolved oxygen requirement of 5.0 milligrams per liter (mg/l).

Trout Fishery: Standards for water to be used for the preservation and enhancement of fish and aquatic life generally are specified in terms of parameters that affect the physiologic condition of the fish, the food chain that sustains the fish, and the aquatic environment. The DNR standards for the trout fishery are set forth in Table 145. This category requires that no significant artificial temperature increases occur where natural trout reproduction occurs, and requires minimum dissolved oxygen levels of not less than 7.0 mg/l during spawning seasons.

Salmon Spawning Fishery: This standard is applicable to those continuous streams used by stocked salmonids for spawning runs. No significant artificial temperature increases from background levels will be allowed where natural salmon spawning occurs. In contrast to the trout fishery objective, a minimum dissolved oxygen level of 5.0 mg/l is allowed. This level is not to be lowered below natural background levels during periods of habitation.

Limited Fishery (Intermediate Aquatic Life): This water use objective is applied to continuous and noncontinuous streams for intermediate aquatic life not supporting a balanced aquatic community. This intermediate aquatic life objective is one of the variance categories provided by

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[37] *Sec. 144.025(2)(b).*

Table 145

APPLICABLE WATER USE OBJECTIVES AND WATER QUALITY STANDARDS FOR LAKES AND STREAMS WITHIN THE SOUTHEASTERN WISCONSIN REGION: 1977

Water Quality Parameters	Individual Water Use Objectives[a,b,c]								Combinations of Water Use Objectives Adopted for Southeastern Wisconsin Inland Lakes and Stream					
				Fish and Aquatic Life										
	Recreational Use	Restricted Use[q]	Public Water Supply	Warmwater Fishery	Trout Fishery	Salmon Spawning Fishery	Limited Fishery[w,x] (Intermediate Aquatic Life)	Marginal Aquatic Life[d,w]	Restricted Use and Minimum Standards[b]	Marginal Aquatic Life Recreational Use, and Minimum Standards[b]	Limited Fishery (Intermediate Aquatic Life), Recreational Use, and Minimum Standards[b]	Warmwater Fishery and Aquatic Life, Recreational Use, and Minimum Standards[b]	Trout Fishery and Aquatic Life, Recreational Use, and Minimum Standards[b]	Salmon Spawning Fishery and Aquatic Life, Recreational Use, and Minimum Standards[b]
Maximum Temperature (°F)	--[e]	--[e]	--[e]	89[e,h]	--[e,f]	--[e,f]	89[e]	89[e]	--[e]	--[e]	89[e]	89[e]	--[e,f]	--[e,f]
pH Range (S.U.)	--	6.0-9.0[g]	6.0-9.0[g]	6.0-9.0[g]	6.0-9.0[g]	6.0-9.0[g]	6.0-9.0[g]	6.0-9.0[g]	6.0-9.0[g]	6.0-9.0[g]	6.0-9.0[g]	6.0-9.0[g]	6.0-9.0[g]	6.0-9.0[g]
Minimum Dissolved Oxygen (mg/l)	--	2.0	--	5.0[h]	6.0[i]	5.0[j]	3.0	2.0	2.0	2.0	3.0	5.0[h]	6.0[i]	5.0[j]
Maximum Fecal Coliform (counts per 100 ml)	200-400[k]	1,000-2,000[l]	200-400[k]	--	--	--	--	200-400[k]	1,000-2,000[l]	200-400[k]	200-400[k]	200-400[k]	200-400[k]	200-400[k]
Maximum Total Residual Chlorine (mg/l)	--	--	--	0.5	0.002[y]	0.002[y]	0.5	0.5	--	0.5	0.5	0.002[y]	0.002[y]	0.002[y]
Maximum Unionized Ammonia-Nitrogen (mg/l)	--	--	--	0.02[u]	0.02[u]	0.02[u]	0.2[v]	--	--	--	0.2[v]	0.02[u]	0.02[u]	0.02[u]
Maximum Nitrate-Nitrogen (mg/l)	--	--	10	--	--	--	--	--	--	--	--	--	--	--
Maximum Total Dissolved Solids (mg/l)	--	--	500-750[m]	--	--	--	--	--	--	--	--	--	--	--
Other[r,s,t]	--	--	--[n]	--[p]	--[o,p]	--[p]	--[p]	--	--[q]	--	--[p]	--[p]	--[o,p]	--[p]

[a] *Includes SEWRPC interpretations of all basic water use categories established by the Wisconsin Department of Natural Resources plus those combinations of water use categories applicable to the Southeastern Wisconsin Region. It is recognized that, under both extremely high and extremely low flow conditions, instream water quality levels can be expected to violate the established water quality standards for a reasonable length of time without damaging the overall health of the stream. It is important to note the critical differences between the official state and federally adopted water quality standards—composed of "use designations" and "water quality criteria"—and the water use objectives and supporting standards of the Regional Planning Commission. The U. S. Environmental Protection Agency and the Wisconsin Department of Natural Resources, being regulatory agencies, utilize water quality standards as a basis for enforcement actions and compliance monitoring. This requires that the standards have a rigid basis in research findings and in field experience. The Commission, by contrast, must forecast regulations and technology far into the future, documenting the assumptions used to analyze conditions and problems which may not currently exist anywhere, much less in or near southeastern Wisconsin. As a result, more recent—and some times more controversial—study findings must sometimes be applied. This results from the Commission's use of the water quality standards as criteria to measure the relative merits of alternative plans.*

[b] *All waters shall meet the following minimum standards at all times and under all flow conditions: substances that will cause objectionable deposits on the shore or in the bed of a body of water shall not be present in such amounts as to interfere with public rights in waters of the State. Floating or submerged debris, oil, scum, or other material shall not be present in such amounts as to interfere with public rights in the waters of the State. Materials producing color, odor, taste, or unsightliness shall not be present in amounts found to be of public health significance, nor shall substances be present in amounts which are acutely harmful to animal, plant, or aquatic life.*

[c] *Standards presented in the table are applicable to lakes over 50 acres in surface area and to major streams of the Region.*

[d] *Includes all effluent channels used predominantly for waste carriage and assimilation, wetlands, and diffuse surface waters and includes selected continuous and noncontinuous streams as specified by the DNR on the basis of field surveys and identified as "marginal surface waters." (See Wisconsin Administrative Code, Chapter NR 104.02(3)(b).)*

[e] *There shall be no temperature changes that may adversely affect aquatic life. Natural daily and seasonal temperature fluctuations shall be maintained. The maximum temperature rise at the edge of the mixing zone above the existing natural temperature shall not exceed 5°F for streams and 3°F for lakes.*

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

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

[h] *Dissolved oxygen and temperature standards apply to continuous streams and the epilimnion of stratified lakes and to the unstratified lakes; the dissolved oxygen standard does not apply to the hypolimnion of stratified inlake lakes. Trends in the period of anaerobic conditions in the hypolimnion of deep inland lakes should be considered important to the maintenance of their natural water quality, however.*

Table 145 (continued)

[i] *Dissolved oxygen shall not be lowered to less than 7.0 mg/l during the trout spawning season.*

[j] *The dissolved oxygen in the Great Lakes tributaries used by stocked salmonids for spawning runs shall not be lowered below natural background during the period of habitation.*

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

[l] *Shall not exceed a monthly geometric mean of 1,000 per 100 ml based on not less than five samples per month nor a monthly geometric mean of 2,000 per 100 ml in more than 10 percent of all samples during any month.*

[m] *Not to exceed 500 mg/l as a monthly average nor 750 mg/l at any time.*

[n] *The intake water supply shall be such that by appropriate treatment and adequate safeguards it will meet the established Drinking Water Standards.*

[o] *Streams classified as trout waters by the DNR (Wisconsin Trout Streams, publication 213-72) shall not be altered from natural background by effluents that influence the stream environment to such an extent that trout populations are adversely affected.*

[p] *Unauthorized concentrations of substances are not permitted that alone or in combination with other materials present are toxic to fish or other aquatic life. The determination of the toxicity of a substance shall be based upon the available scientific data base. References to be used in determining the toxicity of a substance shall include, but not be limited to, Quality Criteria for Water. EPA-440/9-76-003, U. S. Environmental Protection Agency, Washington, D. C., 1976, and Water Quality Criteria 1972. EPA-R3-73-003, National Academy of Sciences, National Academy of Engineering, U. S. Government Printing Office, Washington, D. C., 1974. Questions concerning the permissible levels, or changes in the same, of a substance, or combination of substances, or undefined toxicity to fish and other biota shall be resolved in accordance with the methods specified in Water Quality Criteria 1972 and Standard Methods for the Examination of Water and Wastewater, 14th Edition, American Public Health Association, New York, 1975, or other methods approved by the Department of Natural Resources.*

[q] *The parametric values presented are those typically assigned; although the term "restricted" best describes the intended use, the specific chemical parameters may vary from one such reach of stream to another, since these criteria are established by the Wisconsin Department of Natural Resources on a case-by-case basis, as noted in Wisconsin Administrative Code Chapter NR 104.*

[r,s] *Waters important to overall environmental integrity including trout streams, scientific areas, wild and scenic areas, endangered species habitat, and waters of high recreational potential all are subject to further pollution analysis and special standards and effluent criteria. See Wisconsin Administrative Code Chapter NR 104.02(4)(a), whereby this is to be determined by the Wisconsin Department of Natural Resources on a case-by-case basis. No waters in southeastern Wisconsin are designated under this category as of 1977.*

[t] *Lake Michigan thermal discharge standards, which are intended to minimize the effects on aquatic biota, apply to facilities discharging heated water directly to Lake Michigan, excluding that from municipal waste and water treatment plants and vessels or ships. Such discharges shall not raise the temperature of Lake Michigan at the boundary of the mixing zone established by the Wisconsin Department of Natural Resources by more than 3°F and, except for the Milwaukee and Port Washington Harbors, thermal discharges shall not increase the temperature of Lake Michigan at the boundary of the established mixing zones during the following months above the following limits:*

January, February, March	*45°F*	*July, August, September*	*80°F*
April	*55°F*	*October*	*65°F*
May	*60°F*	*November*	*60°F*
June	*70°F*	*December*	*50°F*

After a review of the ecological and environmental impact of thermal discharges in excess of a daily average of 500 million BTU per hour, mixing zones are established by the Department of Natural Resources. Any plant or facility, the construction of which is commenced on or after August 1, 1974, shall be so designed that the thermal discharges therefrom to Lake Michigan comply with mixing zones established by the Department. In establishing a mixing zone, the Department will consider ecological and environmental information obtained from studies conducted subsequent to February 1, 1974, and any requirements of the Federal Water Pollution Control Act Amendments of 1972, or regulations promulgated thereto.

[u] *This level of un-ionized ammonia is assumed to be present at the temperature range of 70-75°F and pH of 8.0 standard units, which are generally the critical conditions in the Region, and at ammonia-nitrogen concentrations of about 0.4 mg/l or greater, and has been recommended by the USEPA as a water quality standard for the protection of fish and other aquatic life of the types found in the natural waters of the Region.*

[v] *This level of un-ionized ammonia is assumed to be present at the temperature range of 70-75°F and pH of 8.0 standard units, which are generally the critical conditions in the Region, and at ammonia-nitrogen concentrations of about 3.5 mg/l or greater, and has been identified by the USEPA as a maximum concentration for the protection of tolerant species of insect life and forage minnows and other aquatic life of the types found in the Region.*

[w] *May include explicitly designated agricultural drainage ditches.*

[x] *Includes selected continuous and noncontinuous streams as specified by the DNR on the basis of field surveys and identified as "surface waters not supporting a balanced aquatic community (intermediate aquatic life)."*

[y] *Based on the level recommended in Quality Criteria for Water EPA-440/9-76-003, U. S. Environmental Protection Agency, Washington, D.C., 1976.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Wisconsin Administrative Code Section NR 104.02(3). The most significant characteristics of this intermediate aquatic life objective are the maximum temperature of 89°F, minimum dissolved oxygen level of 3.0 mg/l, and maximum un-ionized ammonia-nitrogen level of 0.2 mg/l. The relationship of this objective to the warmwater fishery objective is demonstrated in Table 146.

Marginal Aquatic Life: This objective applies to continuous and noncontinuous streams and all effluent channels, wetlands, and surface waters. Marginal uses supporting only very tolerant life forms are allowed. The most significant standards supporting the marginal aquatic life objective, as shown in Table 145, are a maximum temperature of 89°F, minimum dissolved oxygen level of 2.0 mg/l, maximum fecal coliform level of 200/100 ml based on not less than five samples per month or 400/100 ml in more than 10 percent of all samples during any month, and a maximum total residual chlorine level of 0.5 mg/l. The relationship of this objective to the warmwater fishery objective is demonstrated in Table 146.

Application of the Water Use Objectives to the Region: The application of these eight basic water use objectives required specification of the hydrologic conditions under which the water quality standards are to be met. The water use objectives state that compliance with the supporting standards is to be evaluated on the basis of stream flow as low as the 7 day-10 year low flow, which is defined as the minimum 7-day mean low flow expected to occur once on the average of every 10 years. That is, for a given water use objective, the stream water quality is to be such as to satisfy the supporting standards for all stream flow conditions at or above the 7 day-10 year low flow. The revised objectives, as shown on Map 97, specify that most of the surface waters within the Region should meet the standards for recreational use and preservation of a warmwater fishery. It should be noted that the water use objectives and standards are subject to periodic revision either as additional data are accumulated on the validity of the water use objectives or as new data or techniques are developed that permit the standards to be expressed in more precise, quantitative, and statistically valid terms.

After hearings have been held and pollution has been found to have occurred, the Department is given authority to issue general orders pursuant to Section 144.025(2)(c) for the construction, installation, use, and operation of systems, methods, and means for preventing and abating water pollution. This section also provides that the Department may adopt specific rules relating to the installation of water pollution abatement systems. In addition, special pollution abatement orders directing particular polluters to secure appropriate operating

Table 146

CHEMICAL AND PHYSICAL PARAMETERS ASSOCIATED WITH WISCONSIN DEPARTMENT OF NATURAL RESOURCES' SURFACE WATER RESOURCES HYDROLOGIC-HYDRAULIC CLASSIFICATION SYSTEM FOR WATER USE OBJECTIVES AND WATER QUALITY STANDARDS

Applicable Standards for Selected Water Quality Parameters	Fish and Aquatic Life and Recreational Use Water Use Objectives			Variances from Fish and Aquatic Life and Recreational Use Water Use Objectives: Intermediate	Variances from Fish and Aquatic Life and Recreational Use Water Use Objectives: Marginal
	Applicable Hydrologic-Hydraulic Classifications				Diffused Surface Waters
	Trout Streams	Lakes and Flowages	Continuous Streams	Continuous Streams Noncontinuous Streams	Wet Lands Wastewater Effluent Channels Continuous Streams Noncontinuous Streams
General	No objectionable shore or bottom deposits floating or submerged debris, oil, unsightly color, odor, taste, or toxic concentrations of chemicals.				
Minimum Dissolved Oxygen	6.0 mg/l (spawning time: 7.0 mg/l)	5.0 mg/l	5.0 mg/l	3.0 mg/l	1.0 mg/l
pH (standard units)	6.0-9.0	6.0-9.0	6.0-9.0	6.0-9.0	6.0-9.0
pH Change-Maximum (standard units)	0.5	0.5	0.5	--	--
Mixing Zone Temperature (rise-maximum)	0°F	3°F	5°F	--	--
Chlorine (maximum)	--	--	--	0.50 mg/l	0.50 mg/l
NH_3-N (warm temperature)	--	--	--	3.0 mg/l	--
NH_3-N (cold temperature)	--	--	--	6.0 mg/l	--
Fecal Coliform Bacteria (maximum permissible monthly average)	200/100 ml	200/100 ml	200/100 ml	200/100 ml	200/100 ml

Source: Wisconsin Department of Natural Resources and SEWRPC.

Map 97

DNR-ADOPTED WATER USE OBJECTIVES FOR MAJOR STREAMS (1976) AND SEWRPC INITIAL RECOMMENDED WATER USE OBJECTIVES FOR MAJOR LAKES (1977) WITHIN THE REGION

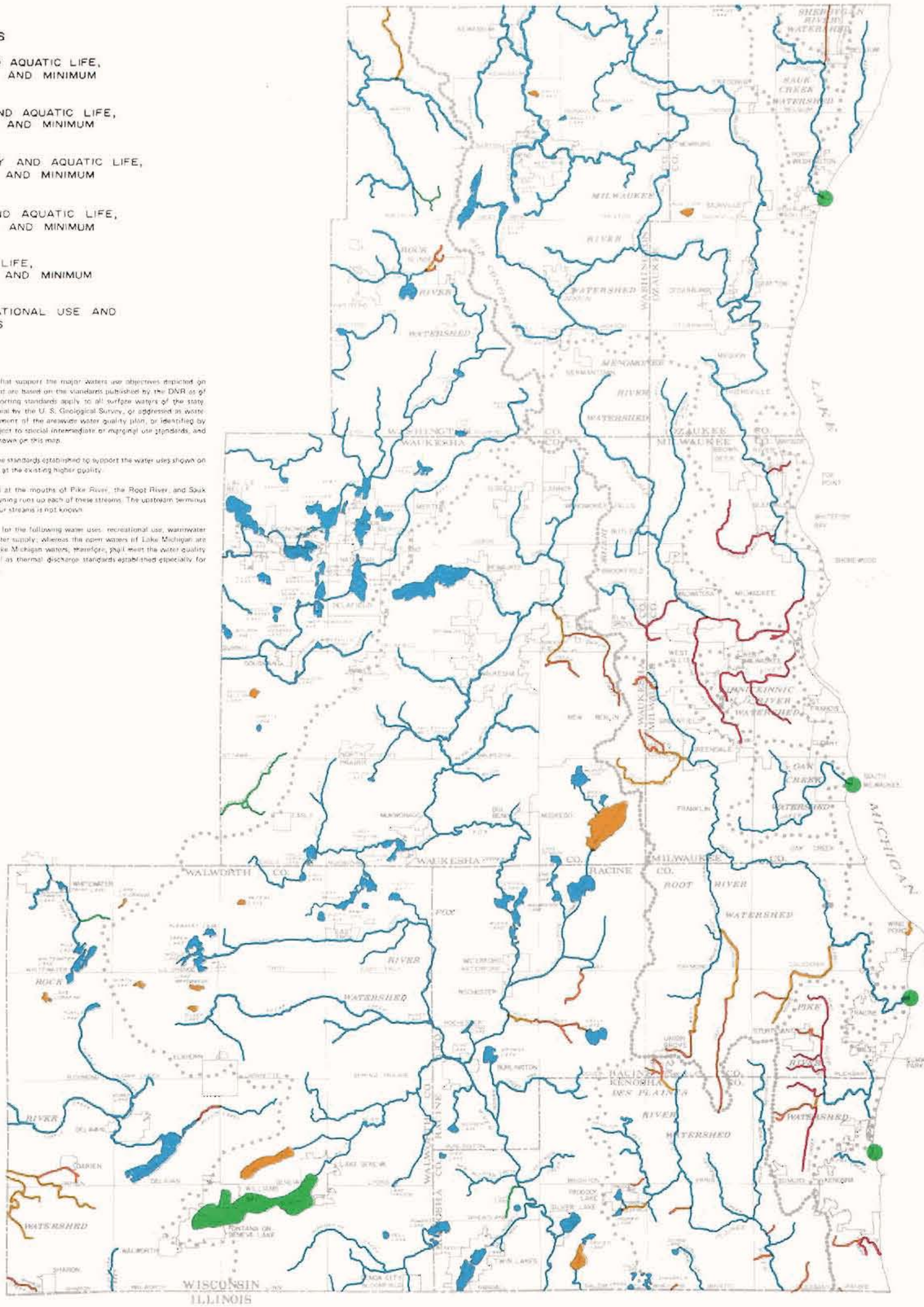
LEGEND

WATER USE OBJECTIVES

- TROUT FISHERY AND AQUATIC LIFE, RECREATIONAL USE AND MINIMUM STANDARDS
- SALMON FISHERY AND AQUATIC LIFE, RECREATIONAL USE AND MINIMUM STANDARDS
- WARMWATER FISHERY AND AQUATIC LIFE, RECREATIONAL USE AND MINIMUM STANDARDS
- LIMITED FISHERY AND AQUATIC LIFE, RECREATIONAL USE AND MINIMUM STANDARDS
- MARGINAL AQUATIC LIFE, RECREATIONAL USE AND MINIMUM STANDARDS
- RESTRICTED RECREATIONAL USE AND MINIMUM STANDARDS

NOTES

1. The adopted water quality standards that support the major waters use objectives depicted on this map are set forth in Table 145 and are based on the standards published by the DNR as of June 1977. These objectives and supporting standards apply to all surface waters of the state. Only those streams identified as perennial by the U. S. Geological Survey, or addressed as waste water receiving streams in the development of the areawide water quality plan, or identified by the DNR in field surveys as being subject to special intermediate or marginal use standards, and those lakes at least 50 acres in size are shown on this map.
2. Where existing water quality exceeds the standards established to support the water uses shown on this map, the waters shall be maintained at the existing higher quality.
3. Salmon are released in Oak Creek and at the mouths of Pike River, the Root River, and Sauk Creek. The salmon also make their spawning runs up each of these streams. The upstream terminus of the spawning runs in each of these four streams is not known.
4. All Lake Michigan waters are intended for the following water uses: recreational use, warmwater fishery and aquatic life, and public water supply; whereas the open waters of Lake Michigan are intended to support a trout fishery. Lake Michigan waters, therefore, shall meet the water quality standards supporting these uses as well as thermal discharge standards established especially for Lake Michigan as set forth in Table 145.



Water use objectives and supporting water quality standards for all surface waters in the Region are established by the Wisconsin Department of Natural Resources and are reviewed and revised, as appropriate, at least every three years under the provision of the Federal Water Pollution Control Act, as amended. In accordance with the national goal of having water quality suitable for "protection and propagation of fish, shellfish, and wildlife and . . . for recreation in and on the water," most of the lakes and streams within the Region are presently designated for maintenance of a warmwater fishery and for recreational use. In addition to enhancing human use of the water resources, the maintenance of a fishery provides in-place biological monitoring to assure that toxic conditions are not occurring in the lakes and streams, and thereby provides a confirmation that public health is not endangered by water pollutants harmful to both human and aquatic life. In addition to a generalized classification of lakes by the State, an analysis was made—with the assistance of the Southeast District staff of the Wisconsin Department of Natural Resources—of the physical character of the major inland lakes to identify those lakes for which a long-term, stable, warmwater, sport fishery probably cannot be maintained because of recurrent winter-kills. The relatively short-range DNR water use objectives shown above served as a point of departure for the development of the objectives, principles, and standards for the areawide water quality management planning program, as discussed and mapped in Volume Two, Chapter II of this report. The planning study resulted in recommended changes in water use objectives as summarized in textual form—and in a pictoral map form—in Volume Three, Chapter II of the recommended plan.

Source: Wisconsin Department of Natural Resources and SEWRPC.

results at sewage treatment facilities in order to control water pollution are authorized to be issued by the Department in Section 144.025(2)(d). Such orders may prescribe a specified time for compliance with provisions of the order. This provision of the statutes was widely utilized by the Department to secure the proper operation and maintenance of sanitary sewerage systems, including sewage treatment facilities, in particular prior to the passage of Chapter 74 of the laws of 1971 establishing Chapter 147 and the Wisconsin Pollutant Discharge Elimination System. At the present time, Chapter 147 usually serves as the basis for water quality regulation. Orders issued under Chapter 144 were directed not only at municipal units of government that operate sewage treatment plants, but also at private corporations and individuals who in any way discharge wastes to the surface or groundwaters of the State. In cases of noncompliance with any pollution abatement order, the Department has seldom used the authority, under Section 144.025(2)(s), to take any action directed by the order and to collect the costs thereof from the owner to whom the order was directed. Such charges become a lien against the property involved.

Research and Demonstration Projects: The Department is also authorized to conduct research and demonstration projects on sewerage and waste treatment matters. It is also authorized to establish pilot sewage treatment plants and other facilities and to purchase land or equipment in connection therewith. Furthermore, the Department is required upon request and without charge to consult with and advise owners of waste sources as to the most appropriate method of waste disposal. The Department is given the authority under Section 144.025(2)(j) to enter into agreements with other states, subject to approval by the Governor, relative to pollution control on any interstate waters and to carry out such agreements by appropriate orders to owners of waste sources. Such authority becomes important in the Southeastern Wisconsin Region, where many interstate waters are involved including Lake Michigan and the waters of the Fox River and Rock River watersheds.

Treatment Plant Operator Certification: In Section 144.025(2)(1) of the Wisconsin Statutes, the Department is given the authority to establish an examining program for the certification of sewage treatment plant operators. Pursuant to this authority the Department has adopted Chapter NR 114 of the Wisconsin Administrative Code, which provides for a Board of Certification for sewage treatment plant operators and examinations for such operators. All sewage treatment plants in the State are classified by size and type. Sewage treatment plants are placed in one of five classifications: Class I plants consist of those facilities designed for or treating more than 3.0 million gallons per day and employing sufficiently complicated processes to warrant this classification. Class II plants are those in the 1.0 to 3.0 million gallons per day category with the requisite degree of complexity of operations. Class III plants are those in the 0.1 to 1.0 million gallons per day range with the requisite degree of complexity. Class IV plants are all other plants which treat sanitary sewage. Finally, Class V plants are those which treat only industrial wastes. In general, the larger the sewage treatment plant, the greater the educational and experience requirements and the more complex the examination for the sewage treatment plant operator. All persons operating sewage treatment plants must hold valid certificates issued pursuant to this Code.

Septic Tank Regulation: In performing its functions of the maintenance and promotion of public health, the Wisconsin Division of Health is charged with the responsibility for regulating installation of private septic tank sewage disposal systems. Such systems often contribute to the pollution of surface waters and groundwaters. Section 144.03 of the Wisconsin Statutes requires that:

> before any septic tank may be purchased or installed, the owner of the property on which the septic tank is to be installed shall obtain a permit for such installation from the county clerk or other persons designated by the State Board of Health.[38]

Pursuant to Chapter 236 of the Wisconsin Statutes, the Division of Health reviews plats of all land subdivisions not served by public sanitary sewerage systems and may object to such plats if sanitary waste disposal facilities are not properly provided for in the layout of the plat. The Division has promulgated regulations governing lot size and elevation in Chapter H-65 of the Wisconsin Administrative Code. Basic regulations governing the installation of septic tank systems are set forth in Chapter H-62 of the Wisconsin Administrative Code. The Department of Natural Resources, however, must approve the provisions of the state plumbing code which sets specifications for septic tank systems and their installation. The Department also may prohibit the installation or use of septic tanks in any area of the State where the Department finds that the use of septic tanks would impair water quality. All septic tanks purchased or installed in the State must be registered by permit pursuant to Section 144.03 of the Wisconsin Statutes. This permit is issued by the county clerk and the application and fee are forwarded to the Wisconsin Department of Health and Social Services.

Municipal Wastewater Treatment Policy: The Wisconsin Department of Natural Resources, pursuant to statutory authority set forth in Sections 144.025(2)(b)(c) and 144.04 of the Wisconsin Statutes and Chapters NR 108 and NR 110 of the Wisconsin Administrative Code, is responsible for reviewing and approving plans and specifications for all sanitary sewerage facilities. This plan review authority includes plans for new sewage treatment plants and additions or alterations to existing sewage treatment facilities, if such additions or alterations significantly affect the quality or quantity of the effluent or the location of the outfall. In addition, Section 201 of

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[38] *Sec. 144.03.*

the Federal Water Pollution Control Act Amendments of 1972 requires that the best practicable waste treatment technology be utilized which results in:

> integrating facilities for sewage treatment and recycling with facilities to treat, dispose of, or utilize other industrial and municipal wastes, including but not limited to solid waste and waste heat and thermal discharges. Such integrated facilities shall be designed and operated to produce revenues in excess of capital and operation and maintenance costs and such revenues shall be used by the designated regional management agency to aid in financing other environmental improvements programs.[39]

This review procedure provides the mechanism whereby the Department can assure that all sewage treatment plants, whether municipal or industrial, are designed to implement the adopted water use objectives. Of particular importance are secondary treatment requirements; phosphorus removal requirements; and departmental policies with respect to the proliferation of waste treatment plants, the location of waste stabilization lagoons, and sanitary sewer extensions.

Under Section 144.025(2)(r), the Department is given specific authority to order the installation of a sanitary sewerage system within a specified time upon a finding that the absence of a municipal sanitary sewerage system or treatment plant tends to create a nuisance or menace to public health. The Department has used this general authority in the Region, particularly where widespread failure of private septic tank sewage disposal systems has occurred. In addition, Section 144.025(2)(q) authorizes the Department to prohibit the installation or use of septic tanks in any area of the State where their usage would impair water quality. Similarly, the Department is authorized to require a sewerage system, including a sewage treatment plant, of any governmental unit to be so planned and constructed that it may be connected with that of any other governmental unit. After an appropriate public hearing, the Department may order the proper connections to be made. Section 144.07(1m) provides that any such order cannot become effective for 30 days following its issuance. Within that time period, the governing body of a city or village subject to such an order may commence an annexation proceeding to annex the unincorporated territory that may be subject to the order. If the result of the referendum for annexation is in favor of annexation, the territory involved is annexed to the city or village and sewer service is extended in compliance with the order. If the result of the referendum is against the annexation, the connection order is deemed to be null and void. If a city or village does not commence an annexation proceeding within the 30-day period, the order becomes effective at the end of that time.

[39] *PL 92-500, Sec. 201 (1972).*

Secondary Treatment Requirements: The Wisconsin Department of Natural Resources requires that all municipal sewage treatment plants in the Region provide at least secondary treatment and that the effluents be disinfected before discharge to the surface waters. Effluent restrictions on publicly owned treatment facilities apply to five-day biochemical oxygen demand (BOD_5) and suspended solids (SS). Existing treatment facilities must remove at least 85 percent of BOD_5 and suspended solids and produce an effluent quality of less than 30 mg/l of BOD_5 and SS on a monthly average of samples analyzed daily. For new treatment facilities, the minimum level of treatment is 90 percent BOD_5 removal and 90 percent suspended solids removal. In addition, Wisconsin Administrative Code Chapter NR 110.15(6) requires that sewage treatment systems be designed based on a BOD_5 contribution of 0.17 pound per capita per day and an SS contribution of 0.20 pound per capita per day.

As noted above, the Wisconsin Department of Natural Resources requires that municipal sewage treatment plant effluents be disinfected before discharge to surface waters. Disinfection is to be accomplished in a manner to provide a minimum time of contact between the sewage and the disinfecting agent of 30 minutes at peak daily design flow, or of 60 minutes at average daily design flow. As a further requirement, if chlorine is used as the disinfecting agent, the maximum allowable residual chlorine in the effluent is 0.5 milligram per liter, and the membrane filter fecal coliform limit is 400 organisms per 100 milliliters. Under DNR staff proposals which were reviewed and rejected by the Natural Resources Board in 1977, disinfection would not be required between October 15 and April 15 of each year except in selected reaches of streams where heavy recreational or other public use occurs year-round or in reaches of streams 20 or less miles above a public water supply. The proposal was advanced in recognition of the questionable benefit of the costs of year-round disinfection to assure safety of full-body contact recreation even during winter conditions, when such contact would not likely occur. Also cited was a growing body of research literature which indicates that carcinogenic substances hazardous to human and other life are formed through the chemical combination of chlorine with other organic substances present in the receiving waters. The DNR staff proposal also suggested that dechlorination follow disinfection by chlorine addition for those effluents which are discharged to salmon or trout waters.

Phosphorus Removal Requirements: In its review of new or modified municipal and industrial sewage treatment facilities, the Wisconsin Department of Natural Resources applies minimum phosphorus removal criteria if the treated waste is to be discharged to a stream tributary to Lake Michigan; that is, east of the subcontinental divide. These criteria represent Wisconsin's response to the pollution abatement recommendations made by the Federal Lake Michigan Enforcement Conference, which include a stipulation that municipal and industrial effluents in areas tributary to Lake Michigan achieve an overall reduction of at least 80 percent of the total phosphorus. The DNR requires that phosphorus removal facilities be provided at all municipal wastewater treatment plants serving a population equivalent of greater than 2,500 in Lake Michigan and Lake Superior drainage basins. Such facilities must be designed to achieve a monthly average phosphorus concentration in the effluent of not more than 1.0 mg/l of total phosphorus. Where the 1.0 mg/l cannot be achieved on a monthly average, the system shall be operated to remove at least 85 percent of the influent phosphorus on an annual average.

The phosphorus removal criteria are minimum requirements and do not preclude the Department of Natural Resources from requiring waste dischargers to remove additional phosphorus if conditions, such as potential overfertilization of surface waters, warrant such removals. It should also be emphasized that the Department phosphorus removal criteria are strictly applicable to municipal and industrial sewage treatment plants located east of the subcontinental divide and that similar criteria are not in effect for that portion of the seven-county Planning Region west of the subcontinental divide. This does not mean, however, that phosphorus removal is not required to protect the water resources of the latter portion of the Region, but instead indicates that a formal policy with regard to phosphorus removal in that portion of the Region has yet to be formulated by the Department of Natural Resources. The Department may require any wastewater discharger—regardless of population, volume, or type of waste discharge, or geographic location—to remove excess amounts after a determination that such excess amounts of phosphorus must be removed in order to avoid overfertilization of surface waters.

Proliferation of Waste Treatment Plants: In conjunction with efforts at the federal level to encourage areawide concepts of pollution control as expressed in the recommendations of the Lake Michigan Enforcement Conference and in the Federal Water Pollution Control Act, the Department of Natural Resources adopted a policy statement relating to the proliferation of waste treatment plants. This policy statement seeks to promote the use of unified sewage collection systems serving contiguous areas and the connection of newly developing areas to existing treatment facilities where such action is feasible and clearly in the public interest. Concomitantly, the statement discourages the proliferation of small sewage treatment facilities in contiguous areas, together with encouraging abandonment of multiple plants in favor of joint treatment where technically and economically feasible and desirable. The policy would also discourage the construction of sewage treatment facilities not designed in accordance with an adopted areawide plan and would withhold state grants-in-aid for the construction of nonconforming treatment plants. It must be recognized, however, that to the extent that the regional land use plan is not implemented, resulting in a more highly diffused and lower density land use pattern, greater proliferation of small sewage treatment facilities may occur. The nonproliferation policy is, therefore, very closely related to implementation of the adopted regional land use plan.

Location of Waste Stabilization Lagoons: The Department of Natural Resources has an administrative policy in regulating the location of waste stabilization lagoons. All proposed waste stabilization lagoon sites that are not to be aerated must be located a minimum of 1,500 feet from all existing occupied dwellings. The Department recommends that the bottom elevation of the lagoon be at least three feet above the groundwater table and five feet above the bedrock strata. Requirements are similar for aerated lagoon sites except that the distance from occupied dwellings is reduced to a minimum of 750 feet.

Sewer Extension Policy

Wisconsin Administrative Code Chapter NR 110.05 was amended by the Department of Natural Resources in 1976 providing a revised policy concerning sanitary sewer extension. A "sewer extension" was defined to include collection (lateral and branch) sewers intended to serve previously unsewered areas, and "relief" and other trench sewers. Requests for sewer extensions may be granted if the sewer will be tributary to a system which experiences no dry or wet weather bypassing and where the treatment plant discharges an effluent in compliance with monthly average effluent limitations for biochemical oxygen demand and suspended solids content as set by Administrative Code Chapter NR 110. Requests for sanitary sewer extensions shall be denied if the sewer will be tributary to a sewerage system which contains any bypasses or overflows which operate in dry weather or if the treatment plant discharges or provides an effluent which is not in compliance with the monthly average effluent limitations for biochemical oxygen demand and suspended solids content. These two conditions may be waived if the owner of the treatment works or sewerage system submits to the Wisconsin DNR an acceptable program for assuring appropriate effluent quality and no dry weather bypassing or overflowing by July 1, 1982. In addition, Chapter NR 110.05(4) requires denial of extension requests if the sewer will be tributary to a sewerage system which contains any wet weather bypasses or overflows. However, approval may be granted where an acceptable program is submitted to the Wisconsin Department of Natural Resources assuring correction of the bypasses or overflows, including a time schedule for completion of the corrective work and proof of financial ability. Variances from the requirements of Chapter NR 110.05(3) and (4) may be granted upon the determination by the Wisconsin Department of Natural Resources of any of the following:

(a) That construction of the subdivision, commercial establishment, institutional facility or industrial plant had commenced prior to May 24, 1976 as evidenced by the issuance of a building permit.

(b) That the area to be served was developed prior to May 24, 1976 and that the sewer extension will eliminate use of existing private waste disposal systems which pose a threat to the public health or safety provided that connections to the sewer are allowed only for the existing development.

(c) That the sewers to be installed will result in the elimination of existing dry weather overflows or bypasses, or will result in the abandonment of an existing inadequate sewage treatment plant.

(d) That the proposed extension is a revision to a sewer previously approved by the Department, providing that the revision results in no increase in the anticipated waste discharge to the sewer system.

(e) That the facilities to be served are intended primarily to provide educational, humanitarian, or charitable community services.

(f) That the program, time schedule, and the commitment to proceed are established in a court approved stipulation, order or judgement.[40]

As a final condition of approval, the Wisconsin Department of Natural Resources may require that an applicant for a sewer extension restrict the number of connections made to such a sewer. Failure of the applicant to comply with any of the above-cited requirements shall cause a denial of any subsequent extension requests.

Sewer extension under Chapter NR 110.05 has been controversial and has had major impacts upon both large and small urban areas of the Region. A lawsuit between the Milwaukee-Metropolitan Sewerage Commissions and the Wisconsin Department of Natural Resources concerning the problem of sewer extensions and the inadequate treatment capacity at the plants operated by the Milwaukee-Metropolitan Sewerage District resulted in a judicially approved stipulation being signed by both parties. This stipulation is discussed later in this chapter.

A second suit was filed by the Wisconsin Environmental Decade against the Wisconsin Department of Natural Resources challenging the DNR sewer extension policy as contained in the 1976 revision of Wisconsin Administrative Code Chapter NR 110.05. This challenge was based on the contention that Wisconsin never properly repealed the former sewer extension policy which did not allow for variances, since inadequate procedures for environmental assessment were followed in establishing the new policy. The Dane County Circuit Court ruled in favor of the challenge presented by the Environmental Decade. This circuit court ruling was appealed by the Wisconsin Department of Natural Resources to the Wisconsin Supreme Court. The Wisconsin Supreme Court subsequently reversed the Circuit Court opinion and the Wisconsin Department of Natural Resources as of April 1978, was issuing sewer extensions on a case-by-case basis utilizing Administrative Code Chapter NR 110.05 as a guideline.

[40] *Wisconsin Administrative Code Chapter NR 110.05(5).*

In another action relating to sewer extension policy, the Wisconsin Department of Natural Resources, responding to public concern over the land use implications of sewer extension policy, sought to broaden the criteria upon which it may review proposed sewer extensions. In the 1978 Budget Review Bill, the Wisconsin State Legislature amended Section 144.04 to provide the option for the Department of Natural Resources to disapprove plans which are not in conformance with an approved areawide waste treatment management plan prepared pursuant to Section 208 of the Federal Water Pollution Control Act, as amended. Thus, service areas developed as part of a comprehensive land use planning program, became an authorized consideration—in addition to the engineering and public health factors previously addressed—in the review and approval of sanitary sewer extensions.

Joint Sewerage Systems

Section 144.07(1) of the Wisconsin Statutes grants authority to the Department of Natural Resources to require that a sewerage or disposal system be planned and constructed so that it may be jointly owned or operated by one or more municipalities. The Department may order connections to the system. In addition, cities, villages, town sanitary districts, and town utility districts may construct a joint system without being so required by the Department of Natural Resources.

Enforcement Authority

The Department of Natural Resources may require certified records to be kept and supplied to the Department by owners of water pollution-related facilities. In addition, agents of the Department may enter both buildings and premises of owners supplying the public with water, ice, and sewerage systems and private properties to collect information, samples, and records as needed to ascertain if the rules and order of the Department are complied with.

Grants-in-Aid Authority

Section 144.21 of the Wisconsin Statutes provides for state assistance for the construction and financing of pollution prevention and abatement facilities. The state program is administered by the Department of Natural Resources. As of January 1978, all funds had been allocated, and additional funding had been provided for both municipal point source and for nonpoint controls under the "Wisconsin Fund" established in the 1978 Budget Review Bill and created in Section 25.44 of the Statutes. The fund is financed from general state revenues as 0.1 percent of the equalized value of all taxable property in the State and from the general fund revenues derived from other Department of Natural Resources environmental activities, including various monitoring fees, permit fees, and charges. The 1978 Review Bill also created Sections 144.24, 144.25, and 144.60 establishing financial aids programs for point source water pollution control, nonpoint source water pollution control, and solid waste management, respectively. In these programs, the Department of Natural Resources is charged as the lead agency for integrating the effort with other state environmental programs, developing administrative rules, and administering the programs.

Navigable Waters Protection

Section 144.26 of the Wisconsin Statutes declares that to aid in the fulfillment of the state's role as a trustee of its navigable waters, it is in the public interest to authorize municipal shore land zoning regulations designed to efficiently use, conserve, and protect the state's water resources.

The Department of Natural Resources is to make studies, establish policies, and make plans for the development of the state's water resources. In addition, annual grants-in-aid for the administration and regulation of the county shoreland, subdivision, and zoning regulations which include control of uses of lands under abutting or lying close to navigable waters shall be made to any county upon a finding that such ordinances are properly administered and enforced. Finally, the Department is to prepare a comprehensive plan to be used as a guide for the application of municipal shoreland ordinances. The plan shall be based on a use classification of navigable waters and their shorelands throughout the State or within counties and such a plan shall be governed by the following standards:

1. Domestic uses shall be generally preferred.

2. Uses not inherently a source of pollution within an area shall be preferred over uses that are or may be a pollution source.

3. Areas in which the existing or potential economic value of public, recreational, or similar uses exceeds the existing or potential economic value of any other use shall be classified primarily on the basis of the higher economic use value.

4. Use locations within an area tending to minimize the possibility of pollution shall be preferred over use locations tending to increase that possibility.

5. Use dispersions within an area shall be preferred over concentrations of uses or their undue proximity to each other.[41]

Effluent Reporting and Monitoring System

Section 144.54 of the Wisconsin Statutes directs the Department of Natural Resources to require by rule that persons discharging industrial wastes or toxic and hazardous substances as liquid wastes or as air contaminants submit a report on such discharges to the Department. The law further specifically exempts municipalities from the rules and establishes an annual monitoring fee to recover the cost of administering the program. In response to this statutory mandate, the Department prepared and adopted Chapter NR 101 of the Wisconsin Administrative Code setting forth specific rules by which the reporting and monitoring program is to be conducted. Of particular importance to water quality management are the effluent reports required in this section.

[41] *Sec. 144.26(5)(a).*

The rules require every person discharging industrial wastes or toxic and hazardous substances to file an effluent report with the Department if: 1) treated or untreated effluent is discharged directly to surface waters; 2) a minimum of 10,000 gallons of effluent per day, one or more days a year, is discharged to a land disposal system or to a municipal sewerage system; 3) less than 10,000 gallons per day is discharged to a land disposal system or a municipal sewerage system but the Department finds that reporting is necessary to protect the environment; and 4) more than 1,000,000 British thermal units are contributed per day, one or more days per year, to the effluent discharged to surface waters. Certain discharges are exempted from reporting, primarily if the discharge contributes none of the particular industrial wastes or toxic and hazardous substances specified in the code. In addition, agricultural land runoff from land used exclusively for crop production need not be reported. Generally, the reports required by the Department must provide specific locations where effluent is being discharged to either surface waters, a sanitary sewerage system, or a land disposal system; estimates of the annual and average daily quantity of effluent discharged; concentrations and quantities of industrial wastes or toxic and hazardous substances contributed to the effluent in excess of the required reporting level; temperatures and volumes of thermal discharges; pH range of effluent; and a brief description of the manner and amount of raw materials used to produce wastes being reported.

Air Quality and Solid Waste Disposal

Sections 144.30 through 144.45 of the Wisconsin Statutes deal with the statutory authority to prevent air pollution and regulate solid waste disposal. Increasingly, it has been found that various types of air pollution may have a significant effect on surface water quality. In addition, improper landfill disposal of solid wastes may have highly adverse effects on surface water and groundwater quality. In general, the Department of Natural Resources possesses the authority necessary to deal with air pollution and solid waste problems. The Department may promulgate air pollution rules, disseminate information, hold hearings, and issue orders relating to the enforcement of air pollution statutes and rules. In addition, the Department of Natural Resources is granted authority to prepare and adopt minimum standards for the location, design, construction, sanitation, operation, and maintenance of solid waste disposal sites and facilities. Counties may prepare countywide solid waste plans which are submitted to the Department of Local Affairs and Development for approval.

Chapter 147—Pollutant Discharge Permit System

The purpose of Chapter 147 was to grant to the Department of Natural Resources the authority necessary to establish, administer, and maintain a pollutant discharge elimination system. This Wisconsin Pollutant Discharge Elimination System (WPDES) was established by the Wisconsin Legislature in direct response to the requirements of the Federal Water Pollution Control Act Amendments of 1972 as discussed earlier. While the federal law envisioned requiring a permit only for the discharge of pollutants into navigable waters, in Wisconsin permits are required for discharges from point sources of pollution to all surface waters of the State and to land areas where pollutants may percolate or seep to, or be leached to groundwaters. Section 147.01 of the Wisconsin Statutes states the general policy of the State vis-a-vis the pollution discharge elimination system:

> It is the policy of this state to restore and maintain the chemical, physical, and biological integrity of its waters to protect public health, safeguard fish and aquatic life and scenic and ecological values, and to enhance the domestic, municipal, recreational, industrial, agricultural and other uses of water.[42]

Stated goals are to eliminate the discharge of pollutants by 1985 and achieve an interim goal of water quality suitable for protection and propagation of fish and wildlife and human recreation by 1983.

Section 147.02 of the Wisconsin Statutes requires a permit for the legal discharge of any pollutant into the waters of the State, including groundwaters. Rules relating to the pollutant discharge elimination system are set forth in Chapter NR 200 of the Wisconsin Administrative Code.

Discharges for which permits are required include the following:

1. The direct discharge of any pollutant to any surface water.
2. The discharge of any pollutant, including cooling waters, to any surface water through any storm sewer system not discharging to publicly owned treatment works.
3. The discharge of pollutants other than from agriculture for the purpose of disposal, treatment, or containment on land areas, including land disposal systems, such as ridge and furrow, irrigation, and ponding systems.

Certain discharges are exempt from the permit system, including discharges to publicly owned sewerage works; discharges from vessels; discharges from properly functioning marine engines; discharges of domestic sewage to septic tanks and drain fields, which are regulated under another section of the Wisconsin Administrative Code; the disposal of septic tank pumpage and other domestic waste, also regulated by another section of the Wisconsin Administrative Code; and the disposal of solid wastes, including wet or semiliquid wastes, when disposed of at site licensed pursuant to another section of the Wisconsin Administrative Code.

The Department of Natural Resources may issue permits for the discharge of pollutants only on the condition that such discharges meet the following criteria when applicable: effluent limitations; standards of performance for new sources; effluent standards; effluent prohibitions; and pretreatment standards. In addition, more stringent standards may be set to comply with federal or state laws, water quality regulations, or maximum daily loads. Standards for various processes are stated in Administrative Code Chapters NR 200 to 297. The Department of Natural Resources may also prescribe conditions for permits to insure compliance with the above-stated requirements. The Administrative Code indicates that permits may include the following conditions:

> The discharge of any pollutant more frequently than or at a level in excess of that identified authorized by the permit shall constitute a violation of the terms and conditions of the permit; facility expansions, production increases or process modifications which result in new or increased discharges of pollutants at frequencies or levels in excess of the maximum discharges described in the permit shall be reported to the Department; the permittee shall permit authorized representatives of the Department to enter upon any premises in which an effluent source is located or in which any records are required to be kept for the purposes of examination. The permittee shall at all times maintain and efficiently operate any facilities or systems installed by the permittee to achieve compliance with the terms and conditions of the permit. Where a toxic effluent standard or prohibition including any scheduled compliance specified in such effluent standard is established and such a toxic pollutant is present in the permittees discharge and, if such standard or prohibition is more stringent than any limitation upon such pollutant in the permit, the Department shall revise the permit to include the more stringent standard.

In addition, all rules promulgated by the Wisconsin Department of Natural Resources pursuant to the Wisconsin Pollution Discharge Elimination System shall comply with the requirements of the Federal Water Pollution Control Act.

Chapter 147 permits are not to have a term of more than five years. Any permit is subject to future modification, suspension, or revocation by the Department of Natural Resources. Other duties of the Department include promulgating a list of categories of point sources and applicable effluent limitations, appropriate water quality limitations, standards of performance for each category of sources, and pretreatment standards.

Any discharge exceeding established limits will constitute a violation of the permit and must be reported to the Wisconsin Department of Natural Resources. Whenever the Department of Natural Resources receives information that any person is violating any section of Chapter 147 pertaining to discharge permits or any rule adopted pursuant to it, the Department of Natural Resources is to refer the matter to the Wisconsin Depart-

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[42] *Sec. 147.01(1).*

ment of Justice. Under Chapter 147, civil and criminal remedies are provided when persons violate its provisions or rules promulgated according to it. Among these are: civil action for temporary or permanent injunction; forfeitures of up to $10,000 per day of violation; fines ranging up to $50,000 per day of violation; and imprisonment of up to one year in a county jail.

The establishment of the Wisconsin pollution discharge permit system is a significant step both in terms of the data provided concerning point sources of pollution and in terms of the regulatory aspects of the permit system, including a listing of the treatment requirements and a schedule of compliance setting forth dates by which various stages of the requirements imposed by the permit shall be achieved. It is envisioned that the water quality management plans prepared pursuant to the terms of the Federal Water Pollution Control Act will be fully reflected in the permits issued under the pollutant discharge elimination system. As such, the pollutant discharge permit system becomes the primary vehicle for implementation of the basic goal of the Federal Water Pollution Control Act; namely, achieving the water use objectives for the receiving waters.

Groundwater Quality Law

Although Public Law 92-500 did not include requirements for groundwater quality management, Chapter 147 of the Wisconsin Statutes includes provisions for the protection of groundwater. The term "waters of the state" is defined by Section 147.015 to include water in wells and groundwaters. With the exceptions noted earlier in this chapter, the Wisconsin pollutant discharge elimination system applies to groundwaters. Section 144.025(2)(e) regulates the withdrawal of water from all wells exceeding 100,000 gallons a day. The Department of Natural Resources must determine whether the withdrawal will adversely affect or reduce the availability of water to any public utility. In general, Wisconsin does not have extensive groundwater regulatory controls. Wisconsin Common Law dealing with groundwater relates for the most part to allocation and usage of groundwater among individuals. In the recent case of State v. Michels Pipeline Construction Inc.,[43] the Wisconsin Supreme Court adopted the "American rule" relating to groundwater usage. In short, this rule declares that it is a privilege to use the waters beneath the land and that this privilege does not represent an unqualified right to groundwater. When injury does occur, cost will be allocated depending upon the relative position of the parties and their capacity to bear the additional costs. An extensive discussion of groundwater law in Wisconsin may be found in Chapter IV of SEWRPC Technical Report No. 2 (Revised Edition), Water Law in Southeastern Wisconsin.

Continuing Planning Process

Section 147.25 of the Wisconsin Statutes requires the Department of Natural Resources to establish a continuing water pollution control planning process for all waters of the State. Such a plan must include the following: adequate effluent limitations and compliance schedules; incorporation of all areawide, basin and state land use plans; maximum daily pollutant loads; revision procedures; implementation procedures; water treatment residual waste disposal controls; and priority ranking of needs of waste treatment facility construction. The abovementioned priority system is set out in Chapter NR 160 of the Wisconsin Administrative Code. Factors utilized in determining the priority ranking include existing water quality, existing health hazards, assimilative capacity of reviewing streams, the need for advanced wastewater treatment, population, and the type of project.

Sludge Disposal

Section 147.02 states that the disposal of sludge from a treatment facility without a permit is unlawful. Section 147.01 includes sludge within the definition of pollutant and thus falling within Chapter 147 permit requirements. Wisconsin Administrative Code Chapter NR 110.27 relating to sludge handling and disposal requires a procedure to monitor the types, quantities, and disposal sites of sludge generated at sewage disposal plants. Discharge permit conditions will include requirements for each sludge generation site concerning the handling and ultimate disposal of the sludge. To date, Technical Bulletin No. 88, Guidelines for the Application of Wastewater Sludge to Agricultural Land in Wisconsin, written by the Wisconsin Department of Natural Resources, is the applicable guideline for surface disposal of sludge on agricultural land sites. Technical Bulletin 88 discusses the properties of sludge, alternative handling methods, factors which determine environmentally acceptable loading rates, current application technology and site selection, management, and monitoring. This bulletin does not consider specifics of all possible site properties, handling options, and management variables. General recommendations of Technical Bulletin 88 are the following:

1. Raw sludge should not be applied to agricultural land.

2. Sludge should be applied to soils consistent with the nitrogen needs of the crops being sown.

3. At least two feet and preferably greater than four feet of soil should exist between the sludge application zone and bedrock, any impermeable layer or the water table.

4. To ensure adequate protection of water supplies, the sludge application site should be a minimum of 1,000 feet from the nearest public water supply well and 500 feet from the nearest private water supply well.

5. Sludge should not be applied to soil in the year the area is used for any raw crops or other vegetables which are consumed uncooked.

[43] *State v. Michels Pipeline Construction, Inc., 63 Wis. 2d 278, 219 N.W. 2d 308 (1974).*

6. If sludge is surface applied to sloping land, runoff should be minimized by use of contour strips, terraces, and boundaries.

7. Pasture land should not be used for milk cow feeding for two months following sludge application. Other animals should not graze pasture land or be fed green crop material for at least two weeks after sludge application.

8. Metal loadings must be kept within acceptable limits to minimize the potential of crop damage or food chain accumulation. The soil pH must be maintained at 6.5 or greater.

9. Application systems must be such that they minimize the runoff potential and odor problems while remaining cost effective.

10. Sludge application sites should be at least 500 feet from the nearest residence. If sludge is injected or incorporated into the soil, a reduction in this distance is possible.

11. Site management must be such that nutrient deficiency and soil acidity problems do not occur, public access is limited, and crop yields are maximized.

12. Site monitoring should be the responsibility of the municipality.[44]

Chaper 30—Navigable Waters, Harbors, and Navigation

This chapter of the Wisconsin Statutes addresses a wide variety of concerns. All lakes and streams within the State which are navigable in fact are declared to be navigable and public waters by Section 30.10 of the Wisconsin Statutes. In the administration of Chapter 30, the Department of Natural Resources routinely considers the potential water pollution affects of waterways modifications and management activities. This chapter regulates the following areas dealing with navigability: establishment of bulkhead lines; structures and deposits in navigable waters; cutting and removal of weeds in navigable waters; regulation of wharves and piers; diversion of water from lakes and streams; enlargement and protection of streams; removal of material from beds of navigable waters; and changing stream courses. Section 30.125 declares it to be a nuisance to cut weeds from any navigable waters and not remove such weeds. Chapter 30 of the Wisconsin Statutes also deals with the development and operation of harbors including: municipal authority to make harbor improvements; financing harbor improvements; and the powers and duties of harbor commissions. In addition, Chapter 30 includes various sections dealing with the regulation of boating including the following: traffic rules for boating; restrictions on speed and use of outboard motors; and provisions for local regulations of boating. A major boating regulation which relates directly to water quality is the requirement contained in Section 30.71 of the Wisconsin Statutes regulating boats equipped with toilets and the subsequent disposal of land. No boats equipped with toilets may be operated on Wisconsin outlying or inland waters unless the toilet wastes are retained for shore disposal by means of facilities constructed and operated in accordance with rules adopted by the Department of Health and Social Services.

Chapter 31—Regulation of Dams and Bridges Affecting Navigable Waters

The Department of Natural Resources is the Wisconsin agency authorized to regulate the placement, development, and construction of dams and bridges affecting navigable waters. Before any dam affecting navigable waters may be constructed, a permit must first be obtained. Upon receipt of an application for a permit, a public hearing will be conducted by the Department of Natural Resources. In addition, no owner of any dam may abandon or alter such dam without first obtaining a permit from the Department. Finally, any dam which is not in compliance with the provisions of Chapter 31 and regulations established by the Department of Natural Resources is deemed to be a nuisance and the construction or maintenance of such dam may be enjoined or abated. As with Chaper 30, Chapter 31 is administered by the Department of Natural Resources, with consideration of water quality changes which might be induced by the construction, modification, or removal of any dam or bridge.

Aquatic Nuisance Control

Before any aquatic nuisance control project is commenced, a permit must be obtained from the Wisconsin Department of Natural Resources. Section 144.025(2)(i) requiring that all applications for chemicals for the control of aquatic nuisances be supervised by a representative of the Wisconsin Department of Natural Resources. This requirement concerning Department supervision may be waived if 1) the area to be treated is less than one acre, 2) the treatment area is limited to the waters adjacent to the applicant's own shoreline, 3) the total treatment is limited to 10 percent of the total lake shoreline, 4) chemicals used are endothal, diquat, or 2, 4-D, and 5) products used are registered by the Wisconsin Department of Agriculture for aquatic use. All chemicals used to control aquatic nuisances must be labeled for such use by the Environmental Protection Agency and requested for aquatic use by the Wisconsin Department of Agriculture. Finally, the use of chemicals is exempt from the provisions of Wisconsin Administrative Code Chapter NR 107 when used in water tanks

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[44] *Technical Bulletin No. 88, Guidelines for the Application of Wastewater Sludge to Agricultural Land in Wisconsin, Department of Natural Resources, p. 29, 1975. For a more detailed and comprehensive review of digal structures affecting sludge management, see SEWRPC Planning Report No. 29, A Regional Sludge Management Plan for Southeastern Wisconsin, 1977.*

used for potable water supplies, swimming pools, and groundwater and wastewater holding tanks.

State Environmental Policy Act

The Wisconsin Legislature in April 1972 created Section 1.11 of the Wisconsin Statutes relating to governmental consideration of environmental impact. In many ways, the state legislation parallels the National Environmental Policy Act of 1969 discussed earlier in this chapter. Under this state legislation, all agencies of the State must include a detailed environmental impact statement in every recommendation or report on proposals for legislation or other major actions which would significantly affect the quality of the human environment. The contents of this statement parallel the contents required in the federal environmental impact statements. The Wisconsin Environmental Policy Act requires that all major state actions significantly affecting the environment be analyzed under the procedures of Section 1.11 of the Wisconsin Statutes, except for those actions exempted under Section 147.30.

> Regulatory actions taken by the department to eliminate or control environmental pollution shall be exempt from the provisions of s. 1.11 other than:
>
> (1) Involvement in federal financial assistance grants for the construction of publicly owned treatment works;
>
> (2) Financial assistance under s. 144.21; and
>
> (3) Issuance of permits or approvals for new sources of environmental pollution.[45]

Nonpoint Sources of Pollution

In any discussion of an institutional framework on a state level concerned with nonpoint or diffuse sources of pollution, those state regulatory authorities relating to the use and management of the land surface must be discussed as they may affect water quality. An important relationship exists between state and local authorities concerning this topic. In the usual case, it is the state which provides general standards and some technical assistance, while the county, city, or village administers a locally prepared ordinance which is suitable for specific conditions. The following discussion examines existing state legal structures relating to the control of nonpoint or diffuse water pollution.

Chapter 236: Chapter 236 of the Wisconsin Statutes was enacted primarily to regulate the subdivision of the land. A subdivision is defined in Section 236.02(8) as a division of land for the purpose of sale. Such division creates five or more parcels of land 1.5 acres each in area, or five or more parcels of 1.5 acres each or less are created by successive subdivisions within a period of five years. Section 236.03 requires that any division of land which falls within the definition of subdivision must be surveyed, approved, and recorded. An elaborate scheme of plat approval is then presented. As a condition of this approval, if the land lies within 500 feet of the ordinary high water mark of any navigable stream, lake, or other body of navigable water or if the land involves lake or stream shorelands, the Department of Natural Resources may require assurance of adequate drainage areas for private sewage disposal systems, setback requirements, and provision for public sewage disposal facilities.

Chapter 236 then goes on to list surveying, layout, and final plat requirements. Plats must be sent by the clerk of the approving authority to the Department of Local Affairs and Development and, if the subdivision is not sewered, to the Department of Health and Social Services for compliance with proper sanitary code requirements. In addition, a plat must be submitted to the State Highway Commission for review if the subdivision abuts a state trunk highway. Finally, authority is given to municipalities, towns, or counties to enact ordinances which govern the subdivision or other division of land which are more restrictive than those requirements contained in Chapter 236.

The overall purpose of Chapter 236 is the utilization of land in an orderly and systematic manner. Proper platting of land will ensure that growth will not extend to areas not capable of absorbing large amounts of growth. Specific provision is made in Chapter 236 governing those subdivisions which lie in close proximity to navigable bodies of water. In such cases, adequate drainage areas for private sewage systems, set back restrictions, or provisions by the subdivision owner for public sewage disposal facilities must be provided.

Chapter 92—State Board of Soil and Water Conservation Districts: Chapter 92 of the Wisconsin Statutes provides for the creation of the State Board of Soil and Water Conservation Districts (BSWCD). The state board acts primarily as a coordinator and advisor to the local county Soil and Water Conservation Districts. The BSWCD possesses the authority to: offer appropriate assistance to county soil and water conservation districts, disseminate useful information to local districts, secure the cooperation of other government agencies, coordinate the programs of the county soil and water conservation districts including the apportionment of project cost-sharing funds up to 50 percent of the local district's yearly cost, and coordinate small watershed projects as provided by Public Law 83-566. In addition, the BSWCD is given authority to "approve or disapprove the plans or programs of the districts and disapprove any such plans or programs or any portion thereof found by a regional planning commission to contradict or be in variance with its approved plan or program."[46]

The Board of Soil and Water Conservation Districts (BSWCD) is also charged with the important role in state programs of cost-sharing with land owners the expense of agricultural nonpoint source controls. Specifically,

[45] *Sec. 147.01(1).*

[46] *Sec. 92.04(4)(L).*

Section 92.21 of the Statutes was created and $265,000 was appropriated on a one-time basis to be disbursed by the BSWCD through the local soil and water conservation districts. In the administration of the continuing appropriations for the "Wisconsin Fund," the Board of Soil and Water Conservation Districts (BSWCD) is charged to assist the Department of Natural Resources in developing administrative rules; assist each local management agency with technical, financial, and educational aspects of the program; and to assist in administering the grants locally. This program is one of four important cost-sharing programs for agricultural land management practices. The other three, discussed elsewhere in this report, are the long-standing U. S. Department of Agriculture, Agricultural Conservation Practices (ACP) program; the Rural Clean Water Program established under Section 208(j) of the Federal Clean Water Act; and the "Wisconsin Fund."

Floodplain Regulation: Section 87.30 of the Wisconsin Statutes authorizes state promulgation of floodplain regulations. Counties, cities, and villages are given the initial opportunity to enact a reasonable and effective floodplain zoning ordinance under threat of a state-imposed ordinance in the event the county, village, or city is reticent to take such action. Proper administrative procedures must be followed by the Department of Natural Resources in the adoption of a floodplain zoning ordinance applicable to a local unit of government. An affected county, city, or village shall be given an opportunity to contest action by the Department of Natural Resources in promulgating a floodplain zoning ordinance.

Any ordinance adopted by a county, city, or village may also be reviewed for its adequacy. Once a floodplain ordinance is adopted by the State, this ordinance shall have the same effect as if adopted by a county, city, or village. Enforcement and administration of the ordinance is the duty of the particular county, city, or village. Any structure placed or maintained within a floodplain in violation of an ordinance adopted pursuant to Section 87.30 of the Wisconsin Statutes is a public nuisance and may be enjoined or abated by an action instituted by the appropriate county, city, or village. In addition, a fine of not more than $50 may be imposed.

Shoreland Regulation: Counties are given authority to zone unincorporated lands within 1,000 feet of a navigable lake, pond, or flowage, or 300 feet of a river or stream or to the landward side of the floodplain, whichever distance is greater. Any shoreland zoning ordinance enacted pursuant to Section 59.971 of the Wisconsin Statutes must be consistent with any comprehensive zoning plan or general zoning ordinance enacted by the county. Such a zoning ordinance may be enacted to effectuate the purposes of Section 144.26 of the Wisconsin Statutes relating to the protection of navigable waters and shorelands. If a county does not adopt a shoreland zoning ordinance or if an adopted ordinance fails to meet reasonable minimum standards, the Department of Natural Resources is authorized to adopt an ordinance applicable to the county. The Department of Natural Resources shall follow the procedures specified in the adoption of a floodplain zoning ordinance mentioned earlier in this chapter. In addition, the Department of Natural Resources shall consider the following criteria in promulgating a shoreland zoning ordinance: preservation of healthful aquatic recreation conditions; demands of water traffic; building setbacks; preservation of shore growth and cover; conservancy uses; and residential and commercial development.

Inland Lake Protection: The Wisconsin legislature authorized the State of Wisconsin to initiate a conjunctive state and local program of lake protection and rehabilitation. An Inland Lakes Protection and Rehabilitation Council was created to advise the Department of Natural Resources on matters pertaining to inland lake rehabilitation and protection. Among the duties of this Council are the following:

> Recommendating a classification system for the selection of eligible lakes for study or treatment and for determining priority of treatment among eligible lakes; taking into consideration such factors as amount of public use and private development, potential for adequate pollution and erosion controls within the drainage basin, special environmental values, potential for future successful management, and other factors.[47]

In addition, the Council may recommend standards and guidelines for lake rehabilitation plans.

The Department of Natural Resources is to adopt any necessary rules and regulations relating to lake protection and rehabilitation projects and administration. The Department of Natural Resources shall also conduct inventories and studies and provide assistance to Local Inland Lake Protection and Rehabilitation Districts in the formulation of lake rehabilitation plans. These plans shall examine sources of pollutants or nutrients, causes of lake degradation, and remedial courses of action to prevent continued degradation. In addition, the Department of Natural Resources has final approval authority over any inland lake rehabilitation and protection plan formulated by the local Inland Lake Protection and Rehabilitation District. In reviewing such plans, the Department of Natural Resources is to consider the following areas: environmental impacts, necessary permits, comments of the Soil and Water Conservation District and regional planning commission and any other areas which the Department by rule deems necessary. Upon approval by the Department of Natural Resources of the rehabilitation or maintenance project the following implementation measures may be undertaken by the Public Inland Lake Protection and Rehabilitation District: aeration, nutrient diversion, nutrient removal, erosion control, sediment manipulation, and bottom treatments. In addition, state aid is available for such projects up to 90 percent of the total costs. The Department of Natural Resources has review authority over application for such state financial assistance.

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[47] *Sec. 33.05(1).*

Pesticide Regulation: The Wisconsin Department of Agriculture is empowered by Chapter 94 of the Wisconsin Statutes to regulate pesticides. All pesticides distributed, sold, or offered for sale within the State of Wisconsin must be registered annually with the Department of Agriculture. In addition, Department regulations have been adopted which control the use, sale, labeling, distribution, and storage of pesticides within the State. Specific pesticides are prohibited or restricted to the extent that they may be sold only with a permit. The Department of Agriculture is also authorized to adopt rules and regulations regarding the application, use, and disposal of those pesticides authorized for use within the Region. Section 29.29(4) authorizes the Department of Natural Resources to adopt rules governing the use of any pesticide which the Department finds to be a serious hazard to wildlife. Such rules are not effective until approved by the Pesticide Review Board, an interagency board advisory to the Wisconsin Department of Agriculture and composed of representatives of the Department of Natural Resources, the University of Wisconsin, and the Wisconsin Department of Agriculture.

Water Conservation: In 1978, the Wisconsin State Legislature passed Chapter 275 of the Laws of 1977 creating Sections 145.25 and 145.02(5) of the Wisconsin Statutes, which prohibit the sale, purchase, or installation of nonwater-conserving plumbing fixtures, and require all new or replacement plumbing fixtures, except for kitchen facilities, to meet water conservation standards. The law was published on May 1, 1978, and takes effect January 1, 1979. Under this section, the Wisconsin Department of Health and Social Services is to promulgate rules requiring in any public or private building a maximum flow rate of three gallons per minute in showerheads and a maximum volume of four gallons per flush in water closets. In private homes, a maximum flow rate of three gallons per minute is prescribed for faucets in washbasins, and other water conservation measures established by administrative rules are also required to be achieved. In addition, public restrooms are to be equipped only with low-volume, hand-activated urinals with automatic shut-off valves allowing for no more than 1.5 gallons of water delivery, and with lavatory faucets with automatic shut-off valves allowing for no more than one gallon of water delivery after the handle of the valve is released. Selected exemptions from any of these requirements are allowed to provide for public health and safety, a two-year period for clearance of previously acquired inventories of plumbing fixtures, any market shortages of the prescribed fixtures, and specially designed sewer systems requiring higher rates of flow.

Low Phosphorus Detergents: A limit of 0.5 percent phosphorus by weight for more detergent products sold in Wisconsin was enacted in Chapter 375 of the Laws of 1977, signed by Acting Governor Martin J. Schreiber on May 11, 1978, and became effective May 20, 1978. Special exemptions are provided for medical and surgical cleaning substances, for water conditioners, for industrial process cleaning substances, and for cleaning dairy and related equipment. Under this law, the phosphorus ban would be in effect from July 1, 1979 through June 30, 1981. By January 1, 1982, the Department of Natural Resources is to report to the legislature on the effect of this ban.

LOCAL WATER QUALITY MANAGEMENT

Federal and state authorities relating to the control of point and nonpoint sources of pollution were discussed above. It is also important to identify existing authorities of local units of government. This is particularly necessary because Section 208(c)(2)(A-I) of the Federal Water Pollution Control Act mandates that designated management agencies must possess certain pollution abatement authority including the ability to carry out appropriate portions of an areawide waste treatment management plan; to manage effectively waste treatment works and related facilities; directly or by contract to design and construct new works and to operate and maintain new and existing works required by the areawide plan; to assure in the implementation of the areawide waste treatment plan that each participating community pays its proportionate share of the treatment costs; to refuse to receive wastes from any municipality or subdivision thereof which does not comply with any provisions of an approved plan; and to accept industrial wastes for treatment. The ability of local units to incur long-term and short-term indebtedness will be discussed in Chapter VII of this report. A detailed examination of local units is necessary because areawide water quality plan implementation is dependent upon the designation of qualified management agencies. Specific authority to implement the areawide plan must be identified. In addition, any areas where adequate authority is lacking must be identified.

The following section assesses the ability of four general-purpose units of government including towns, villages, cities, and counties and eight special-purpose units of government including soil and water conservation districts, inland lake protection and rehabilitation districts, drainage districts, metropolitan sewerage districts, the Milwaukee Metropolitan Sewerage District, joint sewerage districts, utility districts, and town sanitary districts. Each unit of government is discussed with respect to the following criteria: the authority to plan, construct, operate, and maintain new and existing treatment facilities for the control of point source pollution; the authority to accept industrial wastes; the authority to refuse to receive wastes from any municipality or subdivision thereof which does not comply with any provision of an approved areawide water quality management plan; the authority to insure that each participating community pays its proportionate share of any treatment costs; the authority to plan, construct, operate, and maintain facilities or structures for the control and abatement of nonpoint source pollution; and the authority to enact and enforce regulations for the control and abatement of nonpoint source pollution.

The importance of this analysis should not be understated. It is clear that any agency which is to be designated must possess sufficient authority to implement relevant portions of the water quality management plan. If sufficient authority is not present, suggested legislative and administrative amendments will be set forth. This initial inventory of the strengths and weaknesses of existing local units of government will support the specific analyses and designation of management agencies.

Towns

Town government, together with county government, is one of two general-purpose units of government which have jurisdiction in Wisconsin's unincorporated areas. A major distinction between towns and cities or villages is that authority for towns is effectively limited to those areas where such authority is specifically enumerated in the Wisconsin Statutes. Wisconsin Statutory Law currently allows town electors to give the town board all of the powers of a village board except those authorities which may conflict with originally prescribed town powers. Town government has general statutory authority to act effectively in point source pollution abatement and control. A general restricting factor is that annual town meeting approval is usually required before any expenditures are incurred, unless the town board has been given specific statutory authority for that expenditure.

Authority to Plan, Construct, Operate, and Maintain New and Existing Waste Treatment Facilities for the Control of Point Source Pollution: Section 66.077 of the Wisconsin Statutes provides that any town:

> may construct, acquire, or lease, or extend and improve a plant and equipment within or without its corporate limits for the furnishing of water to the municipality or to its inhabitants, and for the collection, treatment, and disposal of sewage, including the lateral, main, and intercepting sewers, and all equipment necessary in connection therewith.

An opinion of the Wisconsin Attorney General states that this section does not require that a town establish a joint sewer and water system but, rather, that a town may establish only a sewer system.[48] In addition, Section 66.076 of the Wisconsin Statutes provides towns with authority to:

> construct, acquire, or lease, extend or improve any plant and equipment within or without its corporate limits for the collection, treatment, and disposal of sewage including the lateral, main and intercepting sewers necessary in connection therewith . . . ."

Towns have the option of providing sewerage services for all or part of a town through the creation of a utility district or a town sanitary district. A more extensive discussion of these two special purpose units of government is presented later in this chapter.

Town boards in counties with populations greater than 150,000 are authorized, upon receipt of a petition signed by two-thirds of the property owners of a particular block or street, to construct sewers within the approved area. As was mentioned earlier, Section 60.18(12) authorizes a town board to be vested with and exercise village board powers. Village powers in this area are discussed below; however, it is clear that villages have authority to lay out, open, change, or extend sanitary and storm sewers. In addition, any town board exercising the powers of a village in providing sewerage service must comply with those procedures and statutes regulating similar conduct by the village board. Finally, town boards are authorized by Section 60.29(30) to extend treatment facilities to unincorporated villages. Such town boards must be authorized to exercise village powers before such facilities are extended to unincorporated villages.

Authority to Accept Industrial Wastes: Towns are authorized to deal with commercial and industrial establishments for purpose of abating or preventing water pollution. Section 66.33 provides for the following contracts or agreements: the collection, treatment, and disposal of sewage and industrial wastes; the municipal usage of industrial or commercial sewage collection, treatment, or disposal facilities; and the coordination of sewage collection, treatment, and disposal facilities of municipalities and industrial or commercial establishments.

Authority to Refuse to Receive Wastes from Any Municipality or Subdivision Thereof Which Does Not Comply with Any Provision of an Approved Areawide Water Quality Management Plan: There is no specific grant of authority enabling towns to refuse to accept wastes from any municipality or subdivision thereof; however, the planning and zoning authority possessed by a town may achieve this function. Section 60.74 authorizes towns to adopt a zoning ordinance which may regulate or restrict the location and size of industries and residences. In addition, towns may utilize village and city planning authorities under Sections 62.23 and 61.30 of the Wisconsin Statutes. The town may, through the use of these statutes, limit the general location and extent of sewers, water conduits, and other public utilities.

Authority to Plan, Construct, Operate, and Maintain Facilities or Structures for the Control or Abatement of Nonpoint Source Pollution: There are a large number of specific authorizations granting towns the authority to plan, construct, operate, and manage nonpoint source abatement facilities. Included in these authorities are the following: storm sewers, shoreland acquisition and stream improvement projects, industrial pollution control projects, dam and shore protection walls, lake improvements, and watershed protection projects.

Towns in counties with a population of 150,000 or more have authority to provide storm sewers under Section 60.29(19), and any town may provide storm sewers through the utilization of village board powers specified in Section 61.36. Although Section 60.29 mentions only sewers, it may be assumed that storm sewers were included because Section 60.64 provides

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48 *63 Op Atty. Gen. 343 (1974).*

towns with specific authority to finance projects for storm sewers. In addition, towns exercising village powers may engage in storm sewer projects. Where a town sanitary district has been created, storm sewers are also authorized. Utility districts may also be created for the provision of sewers. Once again, only the term sewers is used. Village authority under Section 61.36 specifically authorizes villages, and towns which assume village authorities, to lay out, widen, or extend roads, streets, alleys, and storm sewers.

Electors at town annual meetings are authorized to empower town boards to:

> acquire by gift, grant, device, donation, purchase, or condemnation or otherwise a sufficient tract or tracts of land for the reservation for public use of river fronts, lakeshores . . . and maintain as a wood lot and to preserve and reforest the same under regulations approved by the Department of Natural Resources.[49]

This could be important for potential wetland and fragile stream bank acquisitions. A town vested with village powers may, pursuant to Section 61.36, alter, open, or straighten watercourses. In addition, any property rights in lands or waters including rights of access and use may be purchased for the public good, which would presumably include watercourse improvements. Section 62.25(18), authorizing cities to improve lakes and rivers flowing through such cities to protect the public health and welfare may be utilized by a town when such town has adopted village board powers. Towns without village authority are authorized only to enter upon land to remove any obstruction from a nonnavigable stream.

Section 66.521 authorizes towns to undertake industrial pollution control projects including the development of sewage and solid waste disposal facilities. In addition, towns are given authority to construct, equip, acquire, improve, repair, or enlarge industrial pollution control projects. Section 66.521(3) includes financing authority for the above-mentioned projects.

Section 30.30(3)(a) authorizes a town by itself or in cooperation with another community to construct and maintain shore protection and dock walls along the shore of any waterway within the town. In addition, this section authorizes a town to order the repair or extension of a privately owned shore protection wall if such repair, improvement, or construction is required to promote health, safety, or welfare. Finally, towns are empowered to acquire property for shore protection purposes.

Towns are authorized by Section 31.38 to maintain and construct dams across a lake or a stream adjoining or within the town limits. No construction works may be initiated without securing the appropriate federal and state approvals. For any project involving the construction, repair, or alteration of any dam, a town is authorized to purchase or condemn land for such purposes.

Section 60.29(44) authorizes a town board to appropriate an annual sum of money to be used by the town for conservation of natural resources. The town may either expend these funds or any bona fide nonprofit organization may be eligible for a grant. If the latter, the organization must provide the town with plans and details of such work. In addition, no work resulting from these appropriations may be undertaken on any of the lakes and streams without the consent and approval of the Wisconsin Department of Natural Resources.

Electors at the annual town meeting are authorized by Section 60.18(21) of the Wisconsin Statutes to raise money for developing watershed protection areas or projects beneficial to the town. Such funds may be expended by the town or paid to any federal or state agency or to the county soil and water conservation district (SWCD) for such purposes. Section 60.18(22) includes a similar authorization for a town to raise money for soil and water conservation purposes or to pay all or part of the appropriation to the SWCD. Finally, towns are authorized by Section 66.34 to contract to do soil conservation work on privately owned land. No contract may involve more than $1,000 for any one person nor shall the amount of work done for any one person exceed $1,000 annually.

Towns are empowered to undertake lake improvement projects by Section 60.29(29) either on their own initiative or whenever a petition is presented to the town board requesting such improvement projects signed by a majority of riparian owners on said lake. When a petition is presented, the town shall assess the benefits and damages accruing to the riparian property. In no case shall the amount assessed exceed the benefits to a particular piece of property.

Authority to Enact and Enforce Regulations for the Control and Abatement of Nonpoint Source Pollution: Towns possess many different types of statutory authorization by which they are able to enact regulatory measures to control nonpoint sources of pollution. Included among these authorities are zoning, subdivision, solid waste, offensive industry, and boating regulations. For a more extensive review of these authorities, the reader is advised to consult SEWRPC Technical Report No. 2, Revised Edition, Water Law in Southeastern Wisconsin and SEWRPC Technical Report No. 6, Revised Edition, Planning Law in Southeastern Wisconsin.

Generally, town zoning authority is present when the county has not enacted a zoning ordinance. When a town possesses this authority, it may enact zoning measures by which nonpoint sources of pollution may be controlled. Specifically, the town may:

> regulate, restrict and determine the areas within which agriculture, forestry and recreation may be conducted, the location of roads . . . the

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[49] *Sec. 60.18(15).*

percentage of lot which may be occupied, size of yards, courts and other open spaces, the density and distribution of population, and the location of buildings designed for specified uses . . . .[50]

In addition, the town may establish an official map showning areas outside of incorporated cities and villages which the town board deems is best suited for the restrictions mentioned above. It must be remembered, however, that the town board must petition the county board to adopt a zoning ordinance for that area before the town may adopt its own ordinance. If after one year the county board has failed to act, then the town may proceed with the zoning regulations.

Town boards are required by Section 60.74(4) to adopt an ordinance prescribing rules and regulations which it deems necessary for the enforcement of its zoning measures including appropriate fines and penalties. Existing uses of buildings or premises for industry or trade shall not be prohibited; however, any alterations of or additions to any existing buildings or structures for the purpose of carrying on any prohibited trade or new industry within the district where such buildings or structures are located may be prohibited.

A town's park commission shall have the authority to recommend zoning district boundaries. If no park commission is in existence, the town board shall appoint a five-member town zoning committee. Either the zoning committee or park commission shall hold hearings on proposed zoning ordinance changes. Town boards exercising village authority may adopt zoning ordinances. These town-created ordinances must be approved by a vote of the town electors at the annual town meeting if the county within which the town is located already has a zoning ordinance. A third source of zoning authority is a regional planning program.

Town boards participating in such a program under Section 60.29(41) may:

> adopt town zoning ordinances in the manner provided in Section 61.35 notwithstanding any provision of this section or Section 60.75 provided that:
>
> a) such adopted ordinance conforms to the regional plan.
>
> b) such ordinance is approved by the county board in counties having a county ordinance.
>
> d) the electors of the town have had an opportunity to approve or disapprove such ordinance at a regular annual meeting and have not disapproved it.[51]

Any county zoning ordinance passed pursuant to the provisions of Chapter 59 of the Wisconsin Statutes shall not be effective within any town until it has been approved by the town board. A county ordinance becomes effective in such towns as of the date of filing of an adopted resolution. In addition, in the event of a conflict between a town and county zoning ordinance, the countywide ordinance controls except where a town ordinance has been passed by a town board possessing village board powers or a town is part of a regional planning program. A town also has approval authority over any comprehensive revisions or amendments to the countywide zoning ordinance which affect the particular town. Where a town fails to approve a comprehensive revision within a year of the passage of the ordinance by the county board, both the existing ordinance and the revision shall have no force. Section 59.971 specifically exempts any county shoreland zoning ordinance from the town approval requirement. However, any existing town shoreland zoning ordinance containing requirements stricter than that of the county ordinance will remain in force. Section 87.30 does not contain an exemption from the town approval requirements. A recent Attorney General opinion has stated that town approval is not required for a state promulgated ordinance.

Villages and cities are empowered to enact extraterritorial zoning ordinances within adjacent towns. Villages and cities may enact an interim extraterritorial zoning ordinance designed to preserve existing uses. Notice is first given to county and town clerks. A joint extraterritorial zoning committee is created with three members from each affected town, and together with the city or village plan commission the extraterritorial zoning committee prepares an extraterritorial plan, amendments, and regulations. A city or village governing body may not adopt a proposal unless it is first adopted by a majority vote of the joint extraterritorial committee. A recent case has upheld the concept of interim zoning and held that county board approval of an interim extraterritorial zoning ordinance was not necessary for that ordinance to be valid.[52] It is not certain as to whether town or county board approval on a permanent extraterritorial zoning ordinance is required although there is a strong argument to be made against requiring county board approval based on the reasoning of the above-cited case.

Chapter 236 of the Wisconsin Statutes provides authority for towns which have established planning agencies to adopt subdivision control ordinances which are more restrictive than the state requirements as found in Chapter 236. Such ordinances may have any of the following purposes: promotion of the public health, safety, and general welfare; furthering the orderly layout of residential areas; and encouraging the most appropriate and efficient land use. In addition, Chapter 236 grants towns the authority to approve or disapprove plats for the subdivision of land. A plat submitted for approval must be in compliance with any applicable town ordinance.

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[50] *Sec. 60.74(1)(a)(1).*

[51] *Sec. 60.74(8).*

[52] *Walworth County v. City of Elkhorn, 27 Wis. 2d 30 (1965).*

Section 60.70 of the Wisconsin Statutes prohibits the placement of any weeds, sod, brush, machinery, or other waste or rubbish in any highway located in a town without the written permission of the town board. In addition, the transport of rubbish or garbage into or within any town for the purpose of dumping or otherwise disposing without first securing a permit from the town board is prohibited. Municipalities do not need such a permit if they own their own disposal grounds and confine their disposal methods to sanitary landfill or incineration. Finally, towns are granted approval authority in Section 66.052(1) of the Wisconsin Statutes over city or village ordinances governing refuse, ash, or garbage disposal within the town and within one mile of the city or village.

Villages

Villages are general-purpose units of government created under the procedure set forth in Chapter 66 of the Wisconsin Statutes. The governing body is the village board headed by a village president. Under the Wisconsin Constitution, villages are granted home rule authority which empowers villages to determine their local affairs subject only to the limitation of the Constitution.

Authority to Plan, Construct, Operate, and Maintain New and Existing Waste Treatment Facilities for the Control of Point Source Pollution: Villages are given specific authority to purchase land to be utilized for sewerage or waste disposal purposes by Section 61.34(3) of the Wisconsin Statutes. In addition, Section 61.36 of the Wisconsin Statutes authorizes the construction of sanitary and storm sewers and the improvement or repair of the same. Section 61.39 of the Statutes states that villages may utilize city authority found in Section 62.18 relating to sewers. That section provides villages with authority to construct sewerage systems, including sewage disposal plants.

Section 66.077 provides villages with the authority to construct waste treatment facilities including lateral, main, and intercepting sewers, and any other necessary structures. If the village wishes, it may by resolution provide for a combined water-sewerage system. If these facilities are combined, the villages must follow any statutes relating to water utilities. Villages owning a public utility may provide for nonpartisan management through the creation of a board of three, five, or seven commissioners to supervise the operation and management of the utility. Villages which have organized combined sewer-water utilities may serve persons or places outside of their corporate limits including adjoining municipalities under authority provided by Sections 66.069(2)(a). Such additional area must be specified by ordinance, but need not be contiguous. In addition, a village may by ordinance fix the limits of utility service areas outside of village boundaries. Such areas may be enlarged by subsequent ordinance. Section 66.076 provides additional authority for villages to construct, acquire, lease, or improve any plant for the treatment and disposal of sewage. Lateral, main, and intercepting sewers are also authorized. Villages may also arrange for sewage treatment and disposal service to be furnished by joint sewerage systems.

Villages may establish utility districts of which one function would be the provision of sewers. A three-fourths vote of all the members of a village board shall be required to establish a utility district after a required hearing is held. Any contract for public construction approved by the village board of which the estimated cost will exceed $5,000 must be let out to the lowest public bidder. If no acceptable bids are submitted, the village may elect to perform the work and furnish materials for the particular project. The village is required to keep an accurate account of the costs of performing the construction itself.

Authority to Accept Industrial Wastes: Villages are authorized to deal with commercial and industrial establishments for the purpose of abating or preventing water pollution. Section 66.33 provides for the following contracts or agreements: the collection, treatment, and disposal of sewage and industrial wastes; municipal usage of industrial or commercial sewage collection, treatment, or disposal facilities; and the coordination of sewage collection, treatment, and disposal facilities of municipalities and industrial or commercial establishments. In addition, Section 66.33(4) authorizes a village to enter into long-term or short-term contracts with industrial establishments or other establishments providing sewage or other facilities to abate or reduce the pollution of waters caused by industrial discharges.

Sections 66.52 and 66.521 authorize villages to carry out industrial projects designed to promote a village's industrial development. Projects include pollution control facilities and sewage and solid waste facilities.

Authority to Refuse to Receive Wastes from Any Municipality or Subdivision Thereof Which Does Not Comply with Any Provision of an Approved Areawide Water Quality Management Plan: There is no specific grant of authority enabling villages to refuse to accept wastes from any municipality or subdivision thereof; however, the planning and zoning authorities possessed by a village may achieve this function. Section 61.35 states that city planning powers may be utilized by villages as found in Section 62.23. Village planning, official map, zoning, and subdivision regulation powers may be utilized to control the provisions of sewer services and facilities within the village and surrounding service areas.

Section 62.23 provides villages with the authority to devise a master plan which shall include the location of both public and private sewer systems. The village plan commission is to make the appropriate determinations to control the provision of sewerage service within the village. Village zoning authority may be used to promote the health, safety, welfare, and morals of the community and may effect the provision of sewerage facilities. This authority may be utilized to regulate the size, density, and location of buildings within a village. In addition, village zoning authority may be extended to include land within 1.5 miles of corporate limits. Within the extraterritorial area, a village may exercise the same zoning power as it exercises within the village boundaries.

Section 62.23 authorizes villages to enact an ordinance establishing an official map. Subsection 6(g) states that for any village which has established an official map:

> no public sewer or other municipal street utility or improvement shall be constructed in any street, highway, or parkway until such street, highway, or parkway is duly placed on the official map.[53]

A final means by which a village may control the provision of sewer services is through the use of a subdivision control ordinance which contains standards which are stricter than those provided in Chapter 236. With a subdivision control ordinance, a village may prohibit land division in those designated areas to prevent undue concentration of population and to provide adequate transportation of water and sewerage facilities.

Authority to Plan, Construct, Operate, and Maintain Facilities or Structures for the Control Abatement of Nonpoint Source Pollution: In addition to a broad grant of home rule authority with which villages may construct, plan, and manage nonpoint pollution abatement projects and programs to promote the health, safety, and welfare of the people, villages have many specific grants of statutory authority in this area. A short discussion of some of the major authorities is needed.

Perhaps the most important grant of authority is found in Section 66.34 where a village may:

> contract to do soil conservation work on privately owned lands but no such contract shall involve more than $1,000 for any one person, nor shall the amount of work done for any one person exceed $1,000 annually.[54]

Section 66.049 authorizes villages to remove garbage, ashes, and rubbish from the village. Section 66.521 provides villages with the authority to maintain industrial projects dealing with solid waste.

Section 61.36 authorizes villages to lay out, open, change, widen, or extend storm sewers; establish, open, and construct drains, canals, or storm sewers; and alter, widen, or straighten watercourses. In addition, Section 61.34(3) and (3m) authorizes acquisition of easements in water and land for the improvement of watercourses.

Villages having navigable waters within or adjoining village boundaries may exercise authority vis-a-vis those navigable waters. Villages may construct dock walls along any navigable waterway within the village. The village is also authorized to acquire land necessary for shore protection and such acquisition may be by condemnation proceedings. In addition, Section 31.38 authorizes villages to construct, maintain, and repair dams on streams adjoining or within the limits of the village.

Authority to Enact and Enforce Regulations for the Control or Abatement of Nonpoint Source Pollution: As was mentioned earlier, villages have several regulatory authorities with which to adopt and enforce regulations for the control of nonpoint source pollution. Included in this list are planning, zoning, official map, building code, subdivision control, boating, and pier authority. For an extensive discussion of each of these regulatory authorities, the reader is urged to consult SEWRPC Technical Report No. 2, Revised Edition, Water Law in Southeastern Wisconsin, and SEWRPC Technical Report No. 6, Revised Edition, Planning Law in Southeastern Wisconsin. It is important to note that villages possess city powers to zone, plan, and regulate buildings and to adopt official maps. A village board may create a village plan commission whose function it is to prepare and adopt a master plan for the village's physical development. Any areas outside a village boundary may be included if they bear a relationship to the development of the village. Where a regional planning commission is established, areas outside of a village may not be included in any village plan unless county board approval is granted. Briefly, the village master plan may include the location, character, and extent of the following: transportation facilities, public building sites, public utilities, and the comprehensive zoning plan. The general purpose of this master plan is to provide a coordinated and adjusted development of the municipality which will best promote the public health, safety, and morals. The grant of zoning authority is to be utilized to promote the health, safety, morals, or general welfare of the village. The village board may divide the village into districts and may regulate and restrict within those districts the use of buildings, structures, or land. A Village Board of Zoning Appeals must be created. Such a board will determine if any exceptions to the zoning ordinance are to be made and hear appeals from persons aggrieved by a decision of the zoning administrator. A village may exercise extraterritorial zoning authority in an unincorporated area within 1.5 miles of that village's corporate limits. Interim zoning ordinances are permissible within the extraterritorial zone to preserve existing uses while a comprehensive zoning plan is being developed. An interim zoning ordinance has an effective time of two years but may be extended. A joint extraterritorial zoning committee may be created and may consist of citizen members of the village plan commission and members of town boards of affected areas. The village plan commission must work with the joint extraterritorial committee in preparing the zoning plan and regulations. An ordinance which provides for adoption of the extraterritorial plan may also provide for enforcement and administration. A town which prior to the adoption of the extraterritorial plan had issued building permits may continue to do so subject to approval of the village building inspector prior to their issuance.

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[53] *Sec. 62.23(6)(a).*

[54] *Sec. 66.34.*

Village boards are granted authority in Section 62.23(6) to establish an official map of the village. This map is to be prepared and adopted in order to promote the public health, safety, and general welfare. Once an official map has been adopted, no highway, street, parkway, park, playground, sewer, or other municipal street utility may be located without being in conformance with the official map. Section 62.23(9) provides villages with the authority to regulate the construction, alteration, and repair of buildings. To enforce the regulations concerning buildings, the village may withhold building permits, impose forfeitures, seek injunctive relief, and provide for a building inspector. It shall be unlawful to erect a structure without first obtaining a building permit from the building inspector and such building inspector must adhere to a general building code as set forth by the village board. Section 62.23(8) states that the governing body may cause an illegal structure to be removed or vacated. The village board may establish setback requirements and prohibit by ordinance construction on any parts of lots or parcels of land for purposes of protecting the public health, safety, or welfare. A village board is empowered to exercise eminent domain authority to carry out any ordinance enacted under Section 62.23(11).

Villages are required by Section 87.30 to adopt a reasonable and effective floodplain zoning ordinance. The Department of Natural Resources, after proper request is made and public hearing held, shall determine the floodplain limits within the village boundaries if the village has failed to do this. Once this floodplain determination is made, the Department shall adopt a floodplain ordinance as soon as practicable. Any floodplain determination or floodplain ordinance shall have the same effect as if it were adopted by the village board. Section 87.30 provides that every structure or development built or maintained within a floodplain in violation of a floodplain zoning ordinance is a public nuisance and may be enjoined by a citizen, municipal, or state suit. Each day of violation is a separate offense punishable by a fine of up to $50. Villages are not required to adopt shoreland zoning ordinances but may enact these ordinances if they utilize city planning and zoning authorities as found in Section 62.23(7).

Villages which have established a planning agency may adopt subdivision ordinances which are more restrictive than the requirements of Chapter 236. A village board is granted approval authority in Section 236.02 over plats for the subdivision of land within a village. Village approval of the plat is based on compliance with criteria cited in Section 236.13 including requirements of Chapter 236, any village ordinances, a village master plan, and the official village map. In addition, a village board has authority to require that a subdivider install necessary public improvements or execute a bond to insure that improvements will be installed within a reasonable time. The village board may require that additional structures and devices be installed including sewers, grading, and other improvements. Village board approval authority is limited to those statutory objections cited in Section 236.13.

Cities

Cities are general-purpose units of government granted home rule power. They have a broad range of specifically enumerated authorities and a wide range of general authorities. A very detailed incorporation procedure for cities is prescribed by statute. Generally, cities are divided into four classes for the exercise and administration of different authorities, with first-class cities having greater than 150,000 population, second-class cities having greater than 39,000 and less than 150,000 population, third-class cities having greater than 10,000 and less than 39,000 population, and fourth-class cities having less than 10,000 population.

Authority to Plan, Construct, Operate, and Maintain New and Existing Waste Treatment Facilities for the Control of Point Source Pollution: Cities are granted wide authority to deal with point source pollution. Section 62.18(1) authorizes cities to construct systems of sewerage including disposal plants, additions, alterations and repairs, and new systems when necessary. In addition, Section 66.076(1) provides authority to construct, acquire, lease, or improve any plant within the city limits for the collection, treatment, and disposal of sewage wastes including lateral, main, and intercepting sewers where necessary. All public works in the city are superintended by the board of public works.

Section 66.072 authorizes cities of the third and fourth class to establish utility districts, and any sewer expenses are to be paid from the funds of that district. These funds are provided by property taxed within the districts, and serve the function of apportioning the costs among those areas where the services provided are greatest. Cities may also create sewer districts and special sewer taxes to pay for the extension or improvement of the sewer system in such districts.

Cities of the fourth class may provide sewerage service under Section 66.077 including disposal plants and lateral, main, and intercepting sewers. All statutory requirements relating to the maintenance of water utilities will be applied to any joint system including creation of a board of commissioners to provide management of the facility. Any city which has a combined sewer-water utility may provide sewerage to areas outside of that city. Cities may by ordinance fix the limits of service in such unincorporated areas. Any area within an unincorporated area receiving such service may be extended by subsequent ordinance. Cities may provide sewerage services to areas outside of their corporate limits and may interconnect facilities with another municipality whether contiguous or not.

The Metropolitan Sewerage District of the County of Milwaukee operates through the Sewerage Commission of the City of Milwaukee, which was established pursuant to Chapter 608, Laws of Wisconsin 1913, and the Metropolitan Sewerage Commission of the County of Milwaukee, which operates and exists pursuant to the provisions of Section 59.96 of the Wisconsin Statutes. The Sewerage Commission of the City of Milwaukee consists of five members who are appointed by the Mayor, subject to confirmation by the Common Council. The Sewerage Commission of the City of Milwaukee may build treatment plants and main and interceptor sewers, and may improve watercourses within its area of operation, which is the City of Milwaukee. In order to coordinate the activities of the two Commissions, the Statute provides that Metropolitan Sewerage Commission must secure the approval of the Sewerage Commission of the City of Milwaukee before engaging in any work. When the Metropolitan Sewerage Commission of the County of Milwaukee has completed the work, it then turns over all of the facilities to the Sewerage Commission of the City of Milwaukee for operation and maintenance. Rules and regulations adopted by the Sewerage Commissions of the City and of the County pursuant to the Statutes further provide for coordination of the sewer improvement programs in the District by requiring that all cities and villages lying within the District and in contract service areas adjacent to the District submit their sewerage system and construction plans to the District for approval before connecting to the main and intercepting system owned by the District. The two Commissions have the power to promulgate and enforce reasonable rules for the supervision, protection, management, and use of the entire sewerage system.

Authority to Accept Industrial Wastes: Cities are authorized by Section 66.33 to accept aid and contribution from commercial and industrial establishments for the collection, treatment, and disposal of industrial wastes, the use and operation by the city of treatment facilities owned by the industrial establishment, and the coordination of municipal sewerage facilities with the commercial disposal facilities. Section 66.33(4) authorizes cities to construct, equip, and finance industrial pollution control facilities, sewage facilities, and solid and liquid waste facilities.

Authority to Refuse to Receive Wastes from Any Municipality or Subdivision Thereof Which Does Not Comply with Any Provision of an Approved Areawide Water Quality Management Plan: Cities may use various zoning and planning authorities to control the provision of sewage services to recalcitrant areas. There is no specific grant of power to cities by which a city may refuse to receive wastes from any area not in compliance with the areawide plan. Various planning, zoning, subdivision control, and other regulatory authorities may be utilized. These authorities will be discussed in much greater detail in the section dealing with nonpoint source pollution control.

A city master plan may include the general location of utilities including sewers and any extensions or change of use proposed for these facilities. The city may by ordinance or resolution provide an official map of the city showing streets, highways, parks, and parkways. No sewer may be placed in any street, highway, or parkway until that street, highway, or parkway is part of the official map.

City subdivision regulations may be enacted if they are more restrictive than those of Chapter 236. In addition, cities may regulate the division of land to promote the public health, safety, and welfare of its community. Cities also have plat approval authority. The approval of a preliminary or final plat shall be conditioned on a city ordinance and any local master plan or city map.

City zoning authority may be utilized to promote the health, safety, morals, or general welfare of the community. Under this authority, cities may divide a city into districts and regulate within these districts the construction, alteration, or use of buildings, structures, or land. In addition, a city may exercise extraterritorial zoning authorities in adjacent unincorporated areas. Through the use of the zoning power, cities may encourage the most productive use of land to facilitate adequate utility service. Section 66.052 provides a city with authority to:

> direct the location, management and construction of, and license . . . regulate or prohibit any industry, thing or place where any nauseous offensive or unwholesome business is carried on . . . .[55]

Section 66.052(2) provides cities with the authority to regulate the disposal of refuse, ashes, or garbage within one mile of the city corporate limits.

In summary, it is clear that a city has extensive authority by which it may control development of industrial, commercial, and domestic facilities. Such control allows a city to regulate the provision of sewerage disposal and conveyance systems effectively, giving the city authority to refuse wastes from an area not in compliance with the areawide plan.

Authority to Plan, Construct, Operate, and Maintain Facilities or Structures for the Control and Abatement of Nonpoint Source Pollution: Cities may carry out a large number of nonpoint source pollution abatement projects and programs. Broad home rule powers provide cities with adequate authority to undertake projects for the purpose of promoting public health, safety, and welfare. Cities are also given specific authority to undertake projects and programs contributing to the abatement of nonpoint source pollution, particularly the urban variety. Such specific grants of authority include storm sewers, garbage removal, soil conservation, industrial pollution control projects, property acquisition, and lake and stream improvements including the development of shore walls and the construction and maintenance of dams. Brief mention will be made of these authorities because they have been discussed in those sections of this chapter concerning villages and towns.

Cities are not given specific authority to construct or maintain a system of storm sewers. Section 62.18 provides cities with the authority to construct sewerage

[55] *Sec. 66.052(1).*

systems and appurtenances thereto. In addition, cities of the third or fourth class have authority under Section 66.072 to create public utility districts and such districts are empowered to provide sewerage services. These two grants of authority coupled with home rule authority to act for the public health, safety, and welfare would indicate that storm sewers were intended.

Section 66.049 provides cities with authority to remove rubbish and garbage from such places as the city council shall direct. The cost of removal may be provided by general assessments or general taxes. Presumably this section would also apply to street cleaning and sweeping activities and the placement of materials on curbs and in gutters.

As was mentioned earlier, cities, villages, and towns may participate in industrial pollution projects. Such projects may consist of providing sewage and liquid and solid waste disposal facilities and pollution control facilities, including necessary environmental studies and monitoring systems. Pollution control facilities were defined to include facilities which are reasonably expected to abate, reduce, or aid in the preservation or control of air or water pollutants. Such facilities may supplement or replace existing property or equipment.

Cities are authorized by Section 62.23(18) to undertake lake and river improvement projects. Such projects may be undertaken to aid navigation and to protect the public health. In addition, a city may establish a public inland lake protection district if the city encompasses all the frontage of a lake within its boundaries. If the lake frontage lies in several municipalities, a contract as provided by Section 66.30 may be drawn up.

A city may construct shore protection walls and dams along the shore or across any lake or stream adjoining or within the city. Shore protection walls may be provided to eliminate menaces to navigation or to promote the public health, safety, and welfare. In the event of private shore ownership, a resolution may be passed by the board of commissioners or the city council directing such private owner to make suitable repairs. Any dam construction must first receive DNR approval.

Authority to Enact and Enforce Regulations for the Control and Abatement of Nonpoint Source Pollution: Cities possess planning, zoning, and other powers to control this type of pollution. For an extensive discussion of these authorities, the reader is advised to consult SEWRPC Technical Report No. 2, Revised Edition, Water Law in Southeastern Wisconsin and SEWRPC Technical Report No. 6, Revised Edition, Planning Law in Southeastern Wisconsin.

Cities possess the authority to create a plan commission whose function it shall be to make and adopt a master plan for the physical development of the city. The master plan may include the location and extent of utilities including sewerage facilities. Section 62.23(3) states that the purpose and effect of an adoption of a master plan shall be solely to aid the city plan commission. The plan commission shall be referred such matters as the city council desires, including the location of public buildings, acquisitions and usage of land for streets or other public purposes, and the location or alteration of public utilities.

Section 62.23 provides a general grant of zoning authority for cities for the purpose of promoting health, safety, morals, or the general welfare. City councils may divide cities into districts and regulate the use of buildings, structures, and land within each district. Zoning regulations shall be in accordance with a comprehensive plan and shall be designed to promote health and general welfare and facilitate adequate provision of transportation, water, sewerage, and other public requirements. A city may enact interim zoning ordinances to preserve existing uses while a comprehensive zoning plan is being prepared. Such interim ordinances are effective for no more than two years. Cities must also provide for a board of zoning appeals and such board is authorized to make special exceptions to the terms of the zoning ordinance in appropriate cases and subject to appropriate safeguards. The city council may provide enforcement measures for any zoning ordinance and may provide for punishment by fine and imprisonment and civil penalties. In addition, for any building constructed in violation of a zoning ordinance, a city may bring actions to enjoin the construction or cause such structure to be vacated or removed.

Extraterritorial zoning authority may be exercised by cities within three miles of the corporate limits of a city of the first, second, or third class and 1.5 miles of a fourth-class city. A city council may enact, without reference to a zone commission, an interim zoning ordinance designed to preserve existing zoning or uses in all or part of the extraterritorial zoning jurisdiction. A resolution must be adopted by the city council specifying the area to be zoned through the use of extraterritorial zoning authority. A joint extraterritorial zoning committee is established as was the case with village extraterritorial zoning. This joint extraterritorial committee is responsible for the preparation of the plan and regulations. Only the members of the joint committee are allowed to vote on the plan for extraterritorial zoning.

Cities are required to enact a reasonable and effective floodplain zoning ordinance. If a city fails to adopt such an ordinance, the DNR may fix the limits of the floodplain subject to serious flood damage within the city, and thereafter adopt a floodplain zoning ordinance. A floodplain zoning ordinance adopted by the DNR has the same effect as if adopted by the city and it is the duty of the city to enforce this ordinance. Any structure maintained in violation of a floodplain zoning ordinance is declared to be a nuisance. Cities are not required to enact shoreland zoning ordinances but do possess sufficient authority to adopt such an ordinance under Section 62.23(7) for the purpose of promoting the health, safety, and general welfare of the community.

Section 62.23(9) provides cities with the authority to regulate the construction of buildings. A broad authority is provided cities to enact regulations based on safety and public health considerations. This section may be enforced through the use of building permits, forfeitures, and building inspection.

City councils may by ordinance provide for the establishment of an official map of the city. Such an official map is established to conserve and promote the public health, safety, and general welfare. No public sewers or other municipal improvements may be constructed in any street, highway, or parkway until such is located on the official map. In addition, no building permits may be granted unless a street, highway, or parkway giving access to the structure is located on the official map.

Cities may adopt subdivision control ordinances which are more restrictive than provisions of Chapter 236. City ordinances may include provisions regulating divisions of land into parcels less than 1.5 acres or divisions of less than five parcels. In addition, the city may prohibit the subdivision of land in areas where such a prohibition will further the objectives stated in Section 236.45(1), including promotion of the public health, safety, and general welfare of the city, and will further the orderly layout and use of land and provide the best possible environment.

Before a final plat of a subdivision may be recorded, the plat must have the approval of the city within which the subdivision is located. If the subdivision is located within the extraterritorial zoning jurisdiction of the city, the city has plat approval authority unless it waives this right. Plat approvals are subject to any city ordinance and the city master plan. In addition, a city may require the installation of public improvements which are reasonably necessary. The city may further require that facilities be built according to city specification and be subject to city inspection.

As was mentioned earlier, towns, villages, and cities may adopt regulations which are not inconsistent with Chapter 30 for the operation of boats on lakes within municipal jurisdiction. Such regulations may be adopted in the interest of a city's public health, safety, or welfare and may pertain to equipment, use, or operation of boats. Such local regulations are subject to advisory review by the DNR. Because the grant of authority to cities is broad in that such regulations may be adopted to protect the public health, safety, or welfare, boating regulations may be applicable to abatement of pollution from operation of boats and resultant shore erosion.

A city may establish bulkhead lines by ordinance subject to DNR approval. Such lines are to be established in the public interest. The establishment of the bulkhead lines greatly affects potential dredge and fill usage of wetlands adjacent to a lake or stream. Without a DNR permit, it is unlawful to deposit materials upon the bed of any navigable water where no bulkhead line is established or beyond a lawfully established bulkhead line.

Section 66.052 provides cities with the authority to:

> direct the location, management and construction of and license . . . regulate or prohibit any industry, thing or place where any nauseous, offensive or unwholesome business is carried on . . . .

Any business conducted in violation of any city ordinance enacted pursuant to Section 66.052 is declared to be a public nuisance. Subsection 2 authorizes cities to enact regulations governing areas where refuse and garbage may be dumped in an adjoining town within one mile of the city. Such regulations are subject to town board approval.

<u>Counties</u>

Counties are general-purpose units of government whose governing body is a county board composed of representatives elected from districts within the county. Unlike cities and villages, most counties are without home rule authority. However, counties with a population of 250,000 or more may exercise home rule authority. Counties are, however, empowered to do many things in the abatement of point and nonpoint source pollution.

<u>Authority to Plan, Construct, Operate, and Maintain New and Existing Waste Treatment Facilities for the Control of Point Source Pollution:</u> Section 59.07 authorizes counties to acquire property for the purpose of sewerage and waste disposal for county institutions. In addition, Section 59.07 provides counties with the authority to:

> construct, purchase, acquire, lease, develop, improve, extend, equip, operate, and maintain all county buildings, structures and facilities hereinafter in this subsection referred to as projects including without limitation . . . regional projects, sewerage disposal plants and systems and including all property, real and personal, pertinent or necessary for such purposes.[56]

Counties may use their zoning authority found in Section 59.97 to create a county development plan for the physical development of the unincorporated areas of the county or incorporated areas that have by resolution agreed to be included within such a plan. Such a plan may include goals and objectives for future resource development including public and private use of land, sanitary and storm sewers, and other measures designed to reduce stream and lake pollution.

Section 59.07(58) authorizes counties of 500,000 population or more to provide for the transmission and disposal of sewage from any county buildings and general waste disposal facilities utilizing land sites, incineration, and commercial byproducts. Section 59.96 authorizes the

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[56] *Sec. 59.07(1)(d).*

formation of a metropolitan sewerage commission administered by three sewerage commissioners. This sewerage commission has basic authority to plan, construct, maintain, and operate waste treatment facilities for the abatement of point source pollution. Counties of less than 500,000 population may create metropolitan sewerage districts under Section 66.22. Both types of metropolitan sewerage districts will be discussed in greater detail later in this chapter.

Authority to Refuse to Receive Waste from Any Municipality or Subdivision Thereof Which Does Not Comply with Any Provision of an Approved Areawide Water Quality Management Plan: Counties are not specifically granted authority to refuse to receive wastes from any area which fails to comply with the areawide plan. Zoning and planning authorities may, however, be used to affect the provision of sewerage services within the unincorporated areas of a county.

A county development plan may be created for the physical development of the unincorporated areas of a county. Such a plan may include goals and objectives for future physical development including placement of sanitary and storm sewers. Such a master plan is to be adopted by resolution and shall serve as a guide for public and private actions.

For purposes of promoting the public health, safety, and welfare, a county board may—with the cooperation of adjacent units of government—enact zoning ordinances for unincorporated areas of the county. A county may be divided into different districts within which certain activities are permitted, including agriculture, industry, business, and residential activities. Such a county ordinance does not become effective in any town until it has been approved by the respective town boards. In a county without a zoning ordinance, a town wishing to enact such an ordinance must first petition the county board to adopt a zoning measure. If the county board fails to adopt such an ordinance, the town may proceed. Because all of Milwaukee County is within incorporated units of government, there is no county zoning.

Counties are authorized to adopt building and sanitary codes and adopt any necessary rules and regulations providing for enforcement of these codes. Such codes shall not apply within villages, cities, or towns that have adopted building or sanitary codes.

Counties have subdivision and plat approval authority. Section 236.45 provides counties with authority to adopt subdivision ordinances which are more restrictive than provisions of Chapter 236. Such ordinances may be enacted to facilitate adequate provision of sewerage facilities. In addition, Section 236.46 authorizes counties to prepare county regional plans for the future platting of lands in the county's unincorporated areas. Counties also possess subdivision plat approval authority. If the county planning agency employs an engineer or planner, the county planning agency may exercise approval authority. The basis for this approval may be any county ordinance. In addition, counties may require that a subdivision make and install any public improvements.

Counties, through the use of the above authorities, may control development and the provision of sewerage service. For the most part, without a cooperative agreement, the county may exercise this authority only in unincorporated areas.

Authority to Plan, Construct, Operate, and Maintain Facilities or Structures for the Control and Abatement of Nonpoint Source Pollution: Counties are authorized to engage in several nonpoint source pollution abatement projects. For counties with home rule authority, these projects may be undertaken for the purpose of promoting the public health, safety, and welfare. Other authorities include soil and water conservation projects, lake and river improvements, property acquisitions, watershed protection, and solid waste management.

A county may contract to do soil conservation work on privately owned lands. Such contract may not involve more than $1,000 for any one person nor shall the amount of work done for any one person exceed $1,000 annually. In addition, Section 59.872 authorizes the county board to:

> appropriate funds to a soil and water conservation district, which includes lands within the county, to be used by the supervisors of the district in the administration of district affairs and in controlling erosion within the district.[57]

A more extensive discussion of soil and water conservation districts as authorized by Chapter 92 follows in this chapter.

A county is authorized to construct, maintain, or repair shore protection walls or may require an owner of property where a shore protection wall is located to maintain or repair such a wall if this is required to eliminate menaces to navigation or to promote the public health, safety, or welfare. In addition, Section 30.30(1) authorizes counties to engage in harbor improvements including filling, excavating, and dredging of waterways as it determines to be necessary.

Section 59.07(30) authorizes counties to appropriate money to assist in creating watershed protection areas or projects beneficial to the county. Such projects may benefit all or a portion of such county. In addition, funds may be appropriated to any agency of the federal or state government or to a soil and water conservation district.

Any county board may establish a solid waste management system or participate in a system jointly with other counties, cities, villages, or towns. In counties

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[57] *Sec. 59.872.*

having a population of less than 500,000, a solid waste management board may be created pursuant to Section 59.07(135) of the Wisconsin Statutes. Such a board may develop solid waste plans, acquire lands for use in solid waste management systems; collect, transport, destroy, or transform wastes including agricultural, municipal, industrial, and domestic wastes or refuse materials; acquire any necessary equipment; and appropriate funds and levy taxes. Section 59.07(52) provides authority for counties with a population of 500,000 or more to dispose of waste by acquiring lands by leave, purchase, or eminent domain and by using the same as dumpage sites.

Authority to Enact and Enforce Regulations for the Control and Abatement of Nonpoint Source Pollution: Counties may regulate nonpoint source pollution mostly through their zoning, planning, and subdivision authority. In addition, counties may regulate solid wastes, boating, sanitary conditions, and buildings. For a more extensive discussion of county authorities in the above areas, the reader is referred to SEWRPC Technical Report No. 2, Revised Edition, Planning Law in Southeastern Wisconsin.

All counties with the exception of Milwaukee County may enact zoning ordinances and divide the county into districts for the purpose of promoting the public health, safety, and general welfare in unincorporated areas. Such zoning ordinances may determine, establish, regulate, and restrict areas within which agriculture, forestry, industry, trades business, and recreation may be conducted. In addition, placement of fill, erection of structures, and the location of buildings may be prohibited in or along natural watercourses, streams, and creeks. Any county zoning ordinance must first be approved by a town board before it becomes effective within that town. Counties are authorized to adopt shoreland zoning ordinances for all unincorporated areas 1,000 feet from a lake, pond, or flowage or 300 feet from a river. Any adopted shoreland zoning ordinance shall not be subject to town board approval; and if any town ordinance is more restrictive, it shall continue as the town shoreland ordinance. If a county does not adopt a shoreland zoning ordinance, or if such an ordinance does not meet reasonable standards in accomplishing shoreland protection objectives, the Department of Natural Resources may adopt an ordinance.

Section 87.30 authorizes a county to adopt a floodplain zoning ordinance. If a county, city, or village does not adopt a floodplain ordinance, the Department of Natural Resources may adopt a floodplain zoning ordinance for the recalcitrant county. The Department may also adopt a floodplain ordinance if the county ordinance is not a reasonable and effective ordinance. Any structure built or maintained within a floodplain is declared to be a public nuisance.

County boards may also enact land use regulations for lands outside the limits of incorporated villages and cities through the county soil and water conservation district supervisors. A more extensive discussion is found later in this chapter in the section concerning the role of the soil and water conservation districts.

As was mentioned earlier, counties may prepare and adopt county regional plans. Such plans may determine the future platting of lands within the county not within incorporated villages and cities. In addition, counties may enact subdivision control ordinances for unincorporated areas which are stricter than the requirements contained in Chapter 236. The subdivision regulation is to promote the public health, safety, and general welfare of the county. Additional purposes are to relieve congestion in streets and highways; to further the orderly use of land; and to provide adequate transportation, water, and sewerage facilities. If the county planning agency has employed an engineer or planner, the county planning commission may exercise subdivision approval authority over plat submissions in areas within the extraterritorial authority of the municipality. Finally, approval of a plat shall be conditioned upon compliance with any town ordinance.

As was mentioned earlier, counties are granted authority by Section 59.07(135) to participate in and conduct solid waste management systems. In addition, counties may charge and assess reasonable fees for services rendered by the county waste disposal system. This section further authorizes county employees to enter properties and conduct tests and investigations to determine site suitability for solid waste management. Permission from the property owner is required. A county is authorized to utilize eminent domain authority to acquire easements or other interests in lands.

Section 59.07(51) authorizes a county to adopt building and sanitary codes. These codes do not apply in incorporated areas where such codes are already in effect. Counties are responsible for the enforcement of such codes in unincorporated areas.

Soil and Water Conservation Districts

Soil and water conservation districts (SWCD) are special-purpose units of government which derive their authority from Chapter 92. The basic legislative policy surrounding the creation of these districts was:

> to provide for the conservation of the soil and soil resources of this state, and for the control and prevention of soil erosion, and for the prevention of flood water and sediment damages, and for furthering agricultural phases of the conservation, development, utilization and control of water . . . and promote the health, safety and general welfare of the people of this state.[58]

A soil and water conservation district is established by county board resolution pursuant to authority granted by the State through Chapter 92, upon a finding that the conservation of soil, water, or related resources presents

[58] *Sec. 92.02.*

a problem of public concern and that a substantial proportion of land occupiers of the county favor such a district. After an SWCD is created, the county agricultural and extension committee become the supervisors of the SWCD. In addition, two supervisors may be appointed who are not members of the county board. The SWCD supervisors are the governing body of that district and are empowered to employ such staff as they may require. The geographic jurisdiction of the SWCD corresponds to the county that created the district.

Authority to Plan, Construct, Operate, and Maintain New and Existing Waste Treatment Facilities for the Control of Point Source Pollution: The authority to abate and control water pollution lies primarily in the area of nonpoint source control. The authority to manage, design, construct, maintain, and operate wastewater treatment facilities is not specifically granted to the SWCD. Statutory language gives the SWCD broad authority to carry out flood prevention and control measures and development, utilization, and conservation of navigable waters within the district. In addition, the SWCD is given authority to construct and maintain necessary structures for the performance of the above-stated tasks. Such broad statutory language might be interpreted as providing authority to abate and control point source pollution via wastewater treatment facilities. Historically, the SWCD has not engaged in this type of activity and it is doubtful that they will in the future in that this function is supervised by other, better-suited management agencies.

Authority to Plan, Construct, and Maintain Facilities or Structures for the Control or Abatement of Nonpoint Source Pollution: Section 92.08(4) provides the SWCD with the authority to:

> Develop and amend comprehensive plans for the conservation of soil, water and related resources within the district, which plans shall specify in such detail as may be possible, the acts, procedures, performances and avoidances which are necessary or desirable for the effectuation of such plans; and to publish such plans and information and bring them to the attention of occupiers of lands within the district.[59]

In addition, any county included in a regional planning program shall promote plans which are not at variance with regional plans. Included in such plans shall be inventories of renewable natural resources, resource needs projections, an annual work plan, and a long-range resource conservation plan which shall be published by a SWCD as its resource conservation program.

In addition to the planning function described above, the SWCD may carry out preventive and control measures after obtaining the approval of the land occupier. The measures may include but are not limited to:

[59] *Sec. 92.08(4).*

> Engineering operations, such as terraces, terrace outlets, desilting basins, floodwater retarding structures, floodways, dikes and ponds, methods of cultivation, the growing of vegetation, changes in use of land or lands owned or controlled by this state or any of its agencies . . . .[60]

In addition, the SWCD is given broad authority to construct or improve and maintain any structures which might be authorized by Chapter 92 of the Wisconsin Statutes. The SWCD is authorized to purchase, lease, grant, or bequest real or personal property or rights therein for purposes of watershed protection, flood prevention, fish and wildlife improvements, and recreational improvements. Eminent domain authority is available to the SWCD under Chapter 32 of the Wisconsin Statutes.

The SWCD may render technical assistance to land occupiers and other government agencies. Specific mention is made of SWCD assistance to incorporated cities and villages. Such assistance may consist of providing standards and technical assistance for the control of erosion, runoff, and sedimentation.

It is uncertain as to whether this provision requires the SWCD to secure approval from both the land owner and the city or village before assistance may be given or whether it is merely a permissive grant of authority to the SWCD to make assistance available within the incorporated areas. The former condition is important in rapidly urbanizing areas where the type of assistance available from the SWCD could play a major role in addressing the problem of urban nonpoint source pollution.

Authority to Enact and Enforce Regulations for the Control and Abatement of Nonpoint Source Pollution: Any regulatory authority possessed by the SWCD is limited to those areas of the district lying outside of incorporated areas. Section 92.09 concerns the adoption of land use regulations. A preliminary requirement is that any such regulations should be in conformance with plans described earlier. Land use regulations which may be considered should include provisions for the following:

> Engineering operations, including the construction of terraces, terrace outlets, soil-saving dams, sediment traps, dikes, ponds, diversion channels, and other necessary structures;
>
> Particular methods of cultivation including contour cultivating, contour furrowing, lister furrowing, sowing, planting, strip-cropping, seeding, and planting of lands to water conservancy and erosion preventing plants, planting of trees and grasses, and forestation and reforestation;
>
> Specific cropping programs and tillage practices to be observed;

[60] *Sec. 92.08(1).*

> The retirement from cultivation of highly erosive areas or of areas on which erosion may not be adequately controlled if cultivation is carried on;
>
> Such other means, measures, operations, and programs as may assist conservation of soil resources and prevent or control said erosion, runoff, and sedimentation;
>
> The protection of lands exposed by grading, filling, clearing, mineral extraction, and similar activities including limitations on the size of the area to be exposed and the length of time and season during which it may be exposed, and the establishment of temporary waterways, storm drains, temporary debris basins, terraces, and other structural and nonstructural methods to control erosion runoff and sedimentation.

When regulations are proposed, the SWCD supervisors shall hold public meetings or public hearings within the affected area. Following these meetings, the SWCD supervisors shall draft a proposed ordinance embodying the regulations. Before a full county board vote is taken, the ordinance must be approved in a referendum by a simple majority of electors residing in the area to be affected who vote in the referendum. After the referendum, the ordinance must be approved by the county board.

Any land use ordinance which is approved in the above-described manner shall contain regulations which are uniform throughout the area affected by the ordinance except that lands may be classified with reference to such factors as:

> soil type, degree of slope, degree of erosion, runoff and sedimentation threatened or existing, present or future uses, and other relevant factors and may provide regulations varying with the type or class of land affected but uniform as to all lands within each class or type. [61]

Affected occupiers of land shall have copies of the ordinances made available to them.

A land use ordinance of the above type shall be enforced by the SWCD supervisors who have authority to enter lands affected by such an ordinance to determine whether the ordinance requirements are being complied with. In addition, the county board is to supply administrative procedures, assistance, and personnel which it deems necessary to enforce the ordinance.

Forfeitures and injunctive relief are available to the SWCD as a means of securing compliance. Section 92.11 authorizes the SWCD supervisors to petition the court to require a defendant landowner to perform work required or otherwise bring the condition of the lands covered by the ordinance into compliance with the ordinance.

[61] *Sec. 92.08(6).*

A court may dismiss the above-cited petition or may require the defendant to perform the work or operations within a specified time. In the event the defendant does not comply with reasonable diligence, the SWCD supervisors may enter the land and perform the work or operations. Where the occupier of the land is not the owner, the owner shall be made a party defendant. In addition, the court shall have authority to enter a judgment for the costs and expenses of bringing the action and any work performed thereto.

<u>Public Inland Lake Protection and Rehabilitation Districts</u>

Public inland lake protection and rehabilitation districts are special-purpose units of government created by Chapter 301 of the Laws of 1973. In its initial declaration of intent, the Wisconsin Legislature summarized in Section 33.001 of the Wisconsin Statutes the underlying philosophy behind the creation of these special-purpose districts:

> The legislature finds environmental values, wildlife, public rights in navigable waters, and the public welfare are threatened by the deterioration of public lakes; that the protection and rehabilitation of the public inland lakes of this state are in the best interest of the citizens of this state; that the public health and welfare will be benefited thereby; that the current state effort to abate water pollution will not undo the eutrophic and other deteriorated conditions of many lakes; and that the positive public duty of this state as trustee of waters requires affirmative steps to protect and enhance this resource and protect environmental values. [62]

The lake districts may be created for the purpose of undertaking a lake protection and rehabilitation program. Municipalities may create lake districts by resolution if the municipality encompasses all the frontage of a lake within its boundaries. The governing body of the creating municipality shall perform all the functions of the board of commissioners. A second method of creating a lake district is for a town board to convert a town sanitary district which encompasses all of the frontage of a lake within its boundaries into a lake district. In addition, where the sanitary district does not encompass all of the lake frontage, the commissioners of the sanitary district may petition to include the additional lake frontage.

Town sanitary districts having boundaries coterminous with a lake district may merge with the lake district. Finally, a county board of any county may establish lake districts within the county, provided approval is granted by any affected village board or city council. A petition requesting the establishment of a lake district signed by at least 51 percent of the land owners or the owners of 51 percent of land within the proposed district must be

[62] *Sec. 33.001.*

filed with the County Clerk and addressed to the county board. In addition, the county board must provide proper notice and hearings. After such hearings, the county board shall create the lake district if it finds that the proposed district is necessary to promote the public health, convenience, or welfare and that formation of the proposed district will not contribute to long-range environmental pollution.

Upon the establishment of a lake district by the county, Section 33.27 requires the county board to appoint three property owners within the district, at least one of whom is to be a district resident, to serve as commissioners until the first annual meeting. In addition, within 30 days the governing body of the largest town, city, or village within the district having the largest valuation shall appoint a commissioner. The regular board of commissioners after the annual meeting shall consist of a supervisor-county board member of the soil and water conservation district or an individual nominated by that body, a member of the governing body of the highest valuation town, city, or village within the district, and three electors owning property within the district.

Two or more contiguous lake districts may be merged after a resolution of two-thirds of the members of each board of commissioners and ratification by a majority of electors of each district. A lake district may be enlarged through the attachment of contiguous territory either through a petition signed by an owner of adjoining property and a majority vote of the Commissioners or by a motion of the Commissioners to initiate attachment proceedings after the requisite hearings and notice to the affected land owners. The county board will base its determination of the attachment motion on the same criteria utilized to determine the initial creation of the district. Territory may be detached from the district following a petition of an owner or motion of the Commissioners and upon a finding that the land in question is not benefited by continued inclusion within the district. A lake district may be dissolved upon a two-thirds vote of the district membership at the district annual meeting to petition the county board for dissolution. In the event that the territory comprising an entire lake district is incorporated as a city or village or annexed, the lake district shall survive. If less than the entire territory of a lake district is annexed or incorporated, that affected portion shall survive as a part of the district with the following conditions: the lake district may only exercise powers granted by Chapter 33 and consent of the incorporating unit must be granted for the district to exercise sanitary district powers.

Authority to Plan, Construct, Operate, and Maintain New and Existing Waste Treatment Facilities for the Control of Point Source Pollution: Chapter 33 does not specifically authorize lake districts to exercise authority in the area of waste treatment facilities. As part of a Section 33.29(1)(d) lake protection and rehabilitation plan, adequate authority might be found to construct and operate waste treatment facilities. Section 33.15(14) limits the types of implementation work to be performed by the lake district and such work may consist of aeration, nutrient diversion, nutrient removal or inactivation, erosion control, sediment control, and bottom control. The list is not limited by its specific enumerations. Both nutrient removal and diversion might be interpreted as authority to manage municipal waste treatment facilities. It is clear, however, that a lake protection and rehabilitation district which has not by resolution undertaken to exercise town sanitary district powers is limited in its authorities over point source pollution.

For those districts that have opted to exercise the powers of a town sanitary district, district authorities become much greater for point source pollutant control. Sanitary districts possess the authority to construct surface or storm sewers, drainage improvements, sanitary sewers, and facilities for garbage and refuse disposal. In addition, the following sanitary district powers may be exercised by the lake district: the provision of chemical treatment of waters for the suppression of swimmers itch, algae, other aquatic growths and the installation of improvements necessary for the promotion of the public health or welfare of the inland lake district.

Authority to Plan, Construct, Operate, and Maintain Facilities or Structures for the Control and Abatement of Nonpoint Source Pollution: It was the initial mandate of lake districts to deal with problems of lake rehabilitation and protection. Prior to recent legislation, a lake district did not possess a great deal of authority to deal with nonpoint source pollution. Chapter 197 of the Laws of 1975, however, provides that a lake district can exercise the town sanitary district authorities discussed above. Districts are not allowed to exercise such authorities unless the governing bodies of affected municipalities consent.

If state aid is desired, lake district projects are divided by Section 33.11 into study, planning, and implementation phases. A feasibility study is undertaken by the district to determine causes of lake degradation and any remedial action needed. A plan shall be developed by the lake district commissioners and forwarded to the Department of Natural Resources, Soil and Water Conservation District, and regional planning agency for the area. A hearing shall be scheduled by the DNR at which time the DNR shall consider any environmental impacts, required permits, comments made by the soil and water conservation district and regional planning agency, and any other areas which the Department deems necessary. No plan may be formally adopted by the lake district until the DNR has approved it. After such approval is granted, the district may implement the adopted plan through the use of aeration, nutrient diversion, nutrient removal, erosion control, sediment manipulation, and bottom treatments. Lake district commissioners are empowered to:

1. Initiate and coordinate surveys and research designed to gather data related to lake, shorelands, and the drainage basin.

2. Plan lake rehabilitation projects.

3. Secure cooperation of officials of general-purpose units of government for the purpose of enacting any ordinances deemed necessary.

4. Adopt and implement any lake protection and rehabilitation plans.

5. Maintain liaison with state governmental officials.

6. Control fiscal matters of the district subject to the directives of the annual meeting.

In addition to the above authorities, if a lake district has by resolution adopted sanitary district authorities, the district has the authority to construct, maintain, and operate storm water sewers.

Authority to Enact and Enforce Regulations for the Control and Abatement of Nonpoint Source Pollution: At this time, lake districts have no authority to enact regulations providing for the abatement of nonpoint sources of pollution. Section 33.29(1)(c) authorizes the lake district commissioners to seek cooperation of general-purpose units of government for the purpose of enacting necessary ordinances. Such cooperation must be secured without any statutory power to force such cooperation or coordination of effort.

Utility Districts

Utility districts may be created by towns, villages, and cities of the third and fourth class. A majority vote of town boards and a two-thirds vote of village and city councils is required before a utility district may be created. A similar vote is necessary to vacate, alter, or consolidate utility districts. Before a utility district may be established a hearing must be held. In addition, when a town board establishes a utility district in an area within which a sanitary district is located, the town board may dissolve the sanitary district and all functions, assets, and liabilities of the sanitary district will be assumed by the utility district. Such a replacement of the town sanitary district may occur where all of the town sanitary district is located within the newly created utility district. The governing body of a utility district is the town or village board or the city council which created the utility district. A utility district does not constitute a separate unit of government nor does it have separate governing authority.

Authority to Plan, Construct, Operate, and Maintain New and Existing Waste Treatment Facilities for the Control of Point Source Pollution: Utility districts are not authorized to exercise independent authority to plan, design, construct, or operate waste treatment facilities for the abatement of point source pollution. A town, village, or city may provide certain services through a utility district. Traditionally, utility districts are created to allocate costs of a population served by various utilities. Section 66.072 authorizes towns, villages, and cities of the third and fourth class to establish utility districts, and thereafter expenses of sewers not chargeable to private property shall be paid out of a utility district fund. Any authority to plan, design, construct, or manage treatment facilities for the abatement of nonpoint source pollution is given to the town, village, or city. Utility districts act to allocate costs for sewers to a particular district served.

Authority to Accept Industrial Wastes: Towns, villages, and cities of the third and fourth class are authorized by Section 66.33 of the statutes to contract with industrial and commercial establishments for the treatment and collection of commercial and industrial wastes. Section 66.072 pertaining to utility districts uses the term sewer to indicate a permissive function of the utility district and does not prohibit the conveyance of industrial, commercial, or domestic municipal wastes.

Authority to Refuse to Receive Wastes from Any Municipality or Subdivision Thereof Which Does Not Comply with Any Provision of an Approved Areawide Water Quality Management Plan: Ample authority is possessed by villages, cities, and towns to refuse service to recalcitrant areas. Utility districts may not exercise independent authority in this regard. A complete discussion of the authority of towns, cities, and villages to refuse service is found elsewhere in this chapter.

Authority to Plan, Construct, Operate, and Maintain Facilities or Structures for the Control or Abatement of Nonpoint Source Pollution: Wisconsin Statutes make no mention of any authority possessed by a utility district to abate nonpoint source pollution. If the term sewer as used in Section 66.072(1) is interpreted to include both sanitary and storm sewers, utility districts would be authorized to incur any expense related to such a storm sewer project. Because utility districts have no independent authority, they possess no authority to enact and enforce regulations designed to promote the abatement of nonpoint source pollution. Any regulatory activity within the utility district directed at nonpoint source pollution must be initiated and enforced by the town, village, or city which created such utility district.

Town Sanitary Districts

Town sanitary districts are special-purpose units of government created by town boards and governed by appointed or elected sanitary district commissioners. Such districts may be created for the purpose of constructing storm sewers, drainage improvements, sanitary sewers, and a system of garbage or refuse disposal. Town sanitary districts may be created, governed, and maintained in any town or part thereof but shall not include any territory included within an incorporated village or city. Any town board may establish a town sanitary district after a petition requesting such establishment is signed by 51 percent of the people owning real estate or the owners of 51 percent of the land within the territory proposed to be organized into such a district. Upon receipt of the petition, the town board shall arrange for a hearing at which time interested property owners may offer comment. If at the hearing it is the opinion of the town board that the public health, comfort, or welfare will be promoted by the establishment of such a district and that the property to be included will benefit, the town board shall declare the district organized. The Wisconsin Department of

Natural Resources and the Department of Health and Social Services shall be notified of the hearing and represented at the hearing. A town sanitary district may be consolidated with a contiguous town sanitary district.

Section 60.315 provides authority for the creation of a town sanitary district without the petition mentioned above. Upon certification by the DNR that private sewage disposal or private water supply systems are located and operated in such a manner so as to cause a health hazard or pollute surface waters and that no local action has been taken to correct the situation, the town board may order the establishment of the town sanitary district.

If the town board fails to create a town sanitary district within 45 days of DNR certification, the DNR shall create a town sanitary district. In lieu of creating a town sanitary district, a town board may create a utility district. Ten percent of the persons owning real estate or owners of 10 percent of the land may upon proper petition secure a review of town board or DNR action.

Town sanitary districts may be altered as provided in Section 60.31. If the entire area of a sanitary district is incorporated as a city or village or is annexed by a city or village, the sanitary district is to be dissolved. If less than an entire town sanitary district is incorporated or dissolved, there shall be a division of assets and liabilities. A water or sewerage system shall be operated and owned by the sanitary district, city, or village in whatever jurisdiction the majority of the system lies. If the responsibility for continuing the system is vested in the town sanitary district, the town sanitary district shall continue the operation until the majority of patrons reside in the city or village. Any city or village required to operate the system shall not be required to serve an area outside its corporate limits greater than the original town sanitary district. A town sanitary district may be dissolved by a procedure similar to that by which it was created including review proceedings initiated by 10 percent of the property owners.

Authority to Plan, Construct, Operate, and Maintain New and Existing Waste Treatment Facilities for the Control of Point Source Pollution: The town sanitary district is empowered by Section 60.306 to project, plan, construct, and maintain a system of sewerage including sanitary, surface, or storm sewers and provide for sewage collection. The town sanitary district commission may require installation of private sewage systems. In addition, the Commission is empowered to make rules and regulations and issue orders to promote and preserve public sanitation. The town sanitary district commission is also authorized to exercise authorities found in Section 66.076 including the authority to construct, lease, acquire, or improve any plant or equipment for the collection, treatment, and disposal of sewage.

Authority to Accept Industrial Wastes: Town sanitary districts are authorized by Section 66.33 of the statutes to enter into contracts or agreements with commercial, industrial, and other establishments for the collection, treatment, and disposal of commercial and industrial waste; the use by the town sanitary district of industrial or commercial disposal facilities; and the coordination of disposal and treatment facilities with industrial and commercial establishments. In addition, town sanitary districts may enter into long-term or short-term contracts with industrial establishments providing sewerage facilities to abate industrial pollution whenever it may be in the public interest to enter into such contracts.

Authority to Plan, Construct, Operate, and Maintain Facilities or Structures for the Control or Abatement of Nonpoint Source Pollution: Town sanitary districts are given authority to construct and maintain systems of storm sewers; however, the districts are not given authority to treat storm water. In addition, town sanitary districts may establish drainage improvements. Sections 60.30 and 60.306 authorize a town sanitary district to provide garbage or refuse disposal. Town sanitary districts have very limited authority to plan, manage, construct, and operate facilities for the control and abatement of nonpoint source pollution. A town board may by resolution approve the formation of an inland lake protection and rehabilitation district coterminous with the boundaries of a town sanitary district which encompasses all the frontage of a lake within the town sanitary district. The management functions of the public inland lake protection and rehabilitation district shall be delegated to the town sanitary district board. A discussion of authorities possessed by the public inland lake protection and rehabilitation district is found earlier in this chapter.

Authority to Enact and Enforce Regulations for the Control or Abatement of Nonpoint Source Pollution: The town sanitary district commission has authority to make rules and regulations and issue orders to promote and preserve public sanitation. Such rules and regulations may be enacted to accomplish goals and objectives of the sanitary district. Sanitary districts have no other authority by which to enact and enforce ordinances and regulations for the abatement of nonpoint source pollution.

Metropolitan Sewerage Districts

Metropolitan sewerage districts are special-purpose units of government designed primarily to abate urban point source pollution. Wisconsin statutes provide for two types of metropolitan sewerage districts. Section 59.96 applies to counties of more than 500,000 population and Sections 66.20 through 66.26 apply to metropolitan districts for all other counties. A separate discussion of each type is necessary because of the differences in statutory authorizations.

Proceedings to create a Chapter 66 metropolitan sewerage district may be initiated by resolution of the governing body of a municipality. Upon adoption of this resolution, the Department of Natural Resources is to receive a copy at which time the DNR must schedule and conduct a public hearing. Within 90 days the DNR must order or deny the creation of the district. A district shall be created if the territory identified is conducive to the fiscal and physical management of a unified system and if the formation of the district will promote the public health and welfare. Before any area of a village or city may be included in such a district, consent must be given by the DNR.

The governing body of a metropolitan sewerage district having territory in only one county is a five-member commission appointed for staggered five-year terms by the county board. If more than one county is involved, the smaller counties shall each appoint one commissioner with the remainder being appointed by the largest participating county.

Authority to Plan, Construct, Operate, and Maintain New and Existing Waste Treatment Facilities for the Control of Point Source Pollution: A metropolitan sewerage district is authorized to plan and construct within the district interceptor and main sewers and treatment plants and to provide for the treatment, disposal, or recycling of sewage. In addition, the metropolitan sewerage district may acquire necessary property and construct, enlarge, improve, maintain, and operate any facilities necessary for the performance of the functions of the commission. A metropolitan sewerage commission is authorized to:

1. Employ the necessary professional staff.
2. Contract with regional or areawide planning agencies.
3. Conduct necessary research.
4. Adopt necessary rules for the supervision, protection, and management and use of the system including denial of the provision of sewerage to areas not in compliance with adopted master or development plans of a municipality.
5. Require pretreatment and prohibit the discharge into the system of certain harmful substances.
6. Acquire ownership of existing facilities as needed.

Authority to Accept Industrial Wastes: As was mentioned earlier, Section 66.33 authorizes metropolitan sewerage districts to enter into agreements and contracts with industrial and commercial establishments for the collection, treatment, and disposal of industrial wastes. In addition, contracts may authorize the use of industrial facilities by a metropolitan sewerage district and provide for coordinated efforts between a metropolitan sewerage district and commercial or industrial establishment for collection, treatment, or disposal facilities. Metropolitan sewerage districts are also authorized to enter into long-term and short-term contracts providing for the abatement or reduction of water pollution caused by industrial discharges.

Authority to Refuse to Receive Wastes from Any Municipality or Subdivision Thereof Which Does Not Comply with Any Provision of an Approved Areawide Water Quality Management Plan: Section 66.24(1)(d) authorizes the commission to set rules restricting or denying provision of sewerage services. These rules may restrict or deny the provision of utility service to lands which are described in adopted development of master plans of a community as not being fit for urban or suburban development. In addition, the commission has authority in Section 66.24 over grants and denials of connections into the sewerage system.

Authority to Plan, Construct, Operate, and Maintain Facilities or Structures for the Control or Abatement of Nonpoint Source Pollution: A metropolitan sewerage commission has limited authority to abate nonpoint source pollution at the source through the implementation of land management practices. Commission authority is limited to the areas of storm water and solid waste management. A metropolitan sewerage district commission may construct and maintain storm sewers and facilities designed to collect, treat, and dispose of storm water. Section 66.24(8) authorizes a metropolitan sewerage district to engage in solid waste management. In addition, a metropolitan sewerage district may exercise all solid waste authorities found in Section 59.07(135). However, county board approval is not required for district management of solid wastes contained in sewage or storm water transmitted or treated by the district.

Section 59.07(135) authorizes a metropolitan sewage commission to:

1. Develop plans for solid waste management.
2. Collect, transport, dispose of, destroy, or transform wastes.
3. Acquire lands or easements by purchase, lease, or donation.
4. Acquire necessary equipment.
5. Contract with private collectors.
6. Utilize and dispose of by sale any or all products of the solid waste system.

Authority to Enact and Enforce Regulations for the Control and Abatement of Nonpoint Source Pollution: The metropolitan sewerage district is authorized to adopt rules and regulations for the supervision and management of the systems and facilities operated by the commission. In addition, the violation of any rule or orders issued by the commission is declared to be a public nuisance.

Section 66.24(8) authorizes a metropolitan sewerage district to utilize county solid waste authorities found in Section 59.07(135)(h) to adopt and enforce ordinances necessary for the conduct of a solid waste management system. This authority does not extend to the Milwaukee Metropolitan Sewerage District created under Section 59.96 of the Wisconsin Statutes.

Sewerage Commission of the City of Milwaukee and the Metropolitan Sewerage Commission of the County of Milwaukee

The Metropolitan Sewerage District of the County of Milwaukee operates through the agencies of the Sewerage Commission of the City of Milwaukee, which was established pursuant to Chapter 608, Laws of Wisconsin 1913, and of the Metropolitan Sewerage Commission of the County of Milwaukee, which operates and exists pursuant to the provisions of Section 59.96 of the Wisconsin Statutes. The Metropolitan Sewerage Commission of the County of Milwaukee consists of three members, all appointed by the Governor. The Sewerage Commission of the City of Milwaukee consists of five members who are appointed by the Mayor, subject to confirmation by the Common Council. The Sewerage Commission of the City of Milwaukee may build treatment plants and main and interceptor sewers, and may improve watercourses within its area of operation, which is the City of Milwaukee. In order to coordinate the activities of the two Commissions, the statute provides that the Metropolitan Sewerage Commission must secure the approval of the Sewerage Commission of the City of Milwaukee before engaging in any work. When the Metropolitan Sewerage Commission of the County of Milwaukee has completed the work, it then turns over all of the facilities to the Sewerage Commission of the City of Milwaukee for operation and maintenance. Rules and regulations adopted by the Sewerage Commissions of the City and of the County pursuant to the Statutes further provide for coordination of the sewer improvement programs in the Metropolitan Sewerage District of the County of Milwaukee by requiring all cities and villages lying within the District and in contract service areas adjacent to the District to submit their sewerage system and construction plans to the District for approval before they connect to the main and intercepting system owned by the District. The two Commissions have the power to promulgate and enforce reasonable rules for the supervision, protection, management, and use of the entire sewerage system.

Milwaukee-Metropolitan Sewerage District

Section 59.96 provides authority for the creation of a metropolitan sewerage district in any county having a population of 500,000 or more where the city council of a city of the first class within that county has declared by resolution that such a commission is created. Upon the establishment of such a district, the district is to be a corporate municipal body with powers to sue and be sued. Management of the Milwaukee Metropolitan Sewerage System is under the direction of the Metropolitan Sewerage Commission of Milwaukee County and the City of Milwaukee Sewerage Commission. Day-to-day administration is provided by a Chief Engineer and General Manager.

Authority to Plan, Construct, Operate, and Maintain New and Existing Waste Treatment Facilities for the Control of Point Source Pollution: Metropolitan sewerage districts are created for the most part to solve point source problems. Section 59.96 authorizes the metropolitan sewerage district to plan and construct main sewers, disposal facilities, and intercepting sewers for the collection, transmission, and treatment of house, industrial, and other sanitary sewerage. In addition, the metropolitan sewerage district may improve any watercourse within the district by deepening, widening, or changing when necessary to carry off surface drainage water. The metropolitan sewerage district is authorized to drain water from watercourses and may provide drains, conduits, or storm sewers. Before any water diversion is allowed, the metropolitan sewerage district must apply for a DNR permit. The metropolitan sewerage district may install and maintain sewage systems in any street, road, alley, or public highway or over, upon, or under any bed of a river in said county.

A Chapter 59 metropolitan sewerage district may acquire by gift or lease or purchase any land or property situated in the county but outside the city of the first class which may be required for the purpose of planning, constructing, and maintaining main sewers. A metropolitan sewerage district is authorized to utilize Chapter 32 eminent domain authorities. A Chapter 59 metropolitan sewerage district must submit all plans for any facilities to be constructed to the sewerage commission of the city of the first class. In addition, any sewer extensions, alterations, or installations must be approved by the city of the first class. A metropolitan sewerage commission may within the county construct treatment plants necessary for the treatment of sewage coming from within or without the district. In addition, the metropolitan sewerage commission may contract with any town, city, village, sanitary district, or other metropolitan sewerage district to provide for the treatment, transmission, or disposal of sewage from the contract areas.

In 1970, the State of Illinois filed suit against the City of Milwaukee, the two Milwaukee sewerage commissions, and the Cities of Kenosha, Racine, and South Milwaukee, charging that the named defendants discharged poorly treated sewage into Lake Michigan thereby causing harm to Lake Michigan and to Illinois residents. In 1972, the United States Supreme Court ruled that Illinois had standing to sue but must initiate the suit in a Federal District Court rather than the United States Supreme Court. Illinois then filed suit in the United States District Court in Chicago. The suit was filed under federal and Illinois common laws of nuisance. On July 29, 1977, Federal District Judge John Grady ruled that the sewage discharges pose a health hazard to residents of Illinois and ordered the City of Milwaukee and the two Milwaukee sewerage commissions to institute a multiyear cleanup program. The judge specifically ordered Milwaukee to correct sewer overflows and install advanced waste treatment systems, and applied standards of 5.0 milligrams per liter (mg/l) of biochemical oxygen demand (BOD) and 5.0 mg/l of suspended solids for future discharges by the defendants into Lake Michigan. In addition, Judge Grady ordered the defendants to draw up by September 9, 1977, a timetable for compliance, which is set forth as finally accepted by the County on November 14, 1977 in Table 147, and compared therein to the stipulated settlement with the State of Wisconsin Department of Natural Resources, as discussed below. The Cities of Kenosha, Racine, and South Milwaukee were dropped as defendants from the suit after they agreed to install advanced waste treatment systems contingent upon federal aid and the condition that other dischargers to Lake Michigan meet the same restrictions. The federal order against Milwaukee was supposed to be complied with regardless of the availability of federal aid.

A Task Force on Metropolitan Sewerage Commission Development was created in 1976 by the Milwaukee County Executive to advise the Milwaukee County Executive and the Milwaukee County Board on the need for funds requested by the Metropolitan Sewerage Commission for capital expenditures. The original issues to be studied by the Task Force included the following: availability of federal funds for contemplated projects; engineering feasibility of projects; accuracy of cost estimates; and feasibility of budget requests.[63] As noted earlier in this chapter, a stipulation was agreed to in 1977 by the Sewerage Commission of the City of Milwaukee, the Metropolitan Sewerage Commission of the County of Milwaukee, and the Wisconsin Department of Natural Resources relative to a suit by the DNR concerning inadequate sewage treatment by the joint commissions. The resulting requirements are set forth in summary fashion in Table 147. As part of this stipulation, wasteload restrictions and apportionment of allowable incremental

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[63] *As part of this initial inquiry, the Task Force approved a report entitled, SEWRPC Staff Analysis of Milwaukee Metropolitan Sewerage District Capital Projects. This report called for a multiyear capital improvement program totaling about $670 million.*

Table 147

SUMMARY OF POLLUTION ABATEMENT REQUIREMENTS FOR THE MILWAUKEE-METROPOLITAN SEWERAGE DISTRICT AS OF JUNE 1978

Requirement	Terms of the Stipulation of May 25, 1977 with the State of Wisconsin, in Case No. 152-342 in the Circuit Court of Dane County, Wisconsin, Honorable Judge William C. Sachtjen Presiding	Terms of the Stipulation with the State of Illinois and the Judgment Order of November 14, 1977, in the U. S. District Court, Northern District of Illinois, Eastern Division, Honorable Judge John F. Grady Presiding
Wastewater Sludge Management Program	Complete by July 1, 1982.	No specific requirement.
Elimination of Wet Weather Flow Relief from Separate Sanitary Sewerage System.	Complete relief sewers by July 1, 1983; expansion sewers by July 1, 1982; and dry weather bypassing by July 1, 1982.	Complete all by July 1, 1986; and eliminate bypassing at sewage treatment facilities by December 31, 1986.
Sewer System Rehabilitation	Submit report on sewer system evaluation survey by July 1, 1980; and complete rehabilitation by July 1, 1986.	Eliminate all overflows by July 1, 1986.
Combined Sewer Overflow Abatement	Complete design by July 1, 1981; and complete the abatement facilities and meet water quality standards by July 1, 1993.	Complete facilities for conveyance, storage, and treatment in three stages, with screening and chlorination of overflows. Storage capacity stages required are 700 acre-feet by December 31, 1985; 1,240 acre-feet by December 31, 1987; and 2,605 acre-feet by December 31, 1989.
Wastewater Treatment Processes	Complete secondary treatment and phosphorus removal by July 1, 1982.	Complete advanced wastewater treatment and phosphorus removal (coagulation, sedimentation, and filtration are specified) by December 31, 1986.
Effluent Limits	Monthly averages of 30 mg/l of biochemical oxygen demand, 30 mg/l of suspended solids, 1 mg/l of phosphorus, 400 counts per 100 ml of fecal coliform. Weekly averages of 45 mg/l of biochemical oxygen demand, and 45 mg/l of suspended solids.	30-day moving averages of 5 mg/l of biochemical oxygen demand, 5 mg/l of suspended solids; monthly average of 1 mg/l of phosphorus; daily maximum of 10 mg/l of biochemical oxygen demand, 10 mg/l of suspended solids; grab-samples not to exceed 40 counts per 100 ml of fecal coliform; free chlorine residual required at all times.

Source: Milwaukee-Metropolitan Sewerage District and SEWRPC.

flows were required. The Task Force on Metropolitan Sewerage Commission Development was delegated the responsibility to develop an allocation formula for the distribution of incremental waste loadings expressed in terms of flow, biochemical oxygen demand, and suspended content.[64] In addition, the stipulation contained agreements concerning timetables for the construction and improvement of conveyance and treatment facilities of the Milwaukee Metropolitan Sewerage District.

Authority to Accept Industrial Wastes: Section 66.33 authorizes a metropolitan sewerage commission to enter into contracts for the collection, treatment, and disposal of industrial wastes and sewage. Further contractual provisions may include the use of industrial or commercial treatment facilities by the metropolitan sewerage district and the coordination of sewage collection, treatment, or disposal facilities of a municipality with those of a commercial or industrial establishment. Finally, Section 66.33 authorizes a metropolitan sewerage commission to accept contributions and other aid from commercial, industrial, and other establishments for the purpose of aiding in the prevention of water pollution.

Authority to Refuse to Receive Wastes from Any Municipality or Subdivision Thereof Which Does Not Comply with Any Provision of an Approved Areawide Water Quality Management Plan: Section 59.96(6)(c) authorizes a Chapter 59 metropolitan sewerage commission to:

> require any town, city or village in such county, or any occupant of any premises outside of said city of the first class, located in such county, engaged in discharging sewage effluent from sewage plants, sewage refuse, factory waste, into any river or canal within such county within the drainage area hereinafter provided for to so change or rebuild any such outlet, drain or sewer as to discharge said sewage, waste, or trade waste into the sewers of such city, town or village or into said main sewers by it and established under such regulations as the commission may determine.[65]

In addition, a metropolitan sewerage commission may promulgate and enforce reasonable rules and regulations designed to promote the best results from the construction, operation, and maintenance of the sewerage system. Section 59.96(8) authorizes the apportionment of the costs of transmission, treatment, and disposal of sewage for any repair or construction costs among each city, town, or village contributing to the district system.

[64] *As part of this inquiry, the Task Force approved a document entitled, SEWRPC Staff Analysis of Alternative Apportionments of Incremental Sewage Allotment in the Milwaukee Metropolitan Area for the Advisory Task Force on Metropolitan Sewerage Commission Development.*

[65] *Sec. 59.95(c).*

Authority to Plan, Construct, Operate, and Maintain Facilities or Structures for the Control or Abatement of Nonpoint Source Pollution: The authority of a Chapter 59 metropolitan sewerage commission to plan, design, construct, maintain, and operate nonpoint source abatement facilities is limited to the construction and installation of a storm sewer system.

Authority to Enact and Enforce Regulations for the Control and Abatement of Nonpoint Source Pollution: A metropolitan sewerage commission is authorized by Section 59.96(6)(i) to make, promulgate, and enforce any reasonable rules and regulations for the management, supervision, and protection of the sewerage system of the district. Presumably, these regulations would affect and relate to any storm sewers owned and operated by a metropolitan sewerage commission.

Joint Sewerage Commissions

Section 144.07 provides authority for the creation of joint sewerage commissions. The Department of Natural Resources may order any town, village, or city to be planned or constructed so that it may be connected with the sewerage or refuse system of another town, village, or city. After the appropriate hearing, the Department may order that proper connections be made. No hearing is required regarding systems of unincorporated areas. Cities, villages, and town sanitary or utility districts may construct and own such sewerage or refuse systems without being required to do so by the Department of Natural Resources. A proper hearing and Department of Natural Resources approval are required.

The joint sewerage systems may be owned and operated by one governmental unit or by the several participating units. Joint ownership would cause each unit to pay its proportionate share of the costs. With sole ownership, various services would be sold to participating areas. In any event, various opportunities to be heard are provided to those participating units of government that feel an incorrect or unreasonable fee is being assessed for services rendered.

In the situation of joint ownership of the sewerage system, a joint sewerage commission must be established to construct and manage the system. Where only two governmental units are participating the commission shall consist of three members. With more than two participating units of government, commission representation shall be determined by a resolution adopted by the participating units of government.

Authority to Plan, Construct, Operate, and Maintain New and Existing Waste Treatment Facilities for the Control of Point Source Pollution: Section 144.07(4)(c) authorizes the joint sewerage commission to plan, construct, and maintain intercepting and main sewers, sewage disposal works, storm water sewers, and solid waste disposal facilities. In addition, the joint sewerage commission may employ personnel as necessary. Finally, any sewage disposal facilities or property constructed or maintained by the joint sewerage commission may be used for the disposal of garbage and refuse.

Authority to Accept Industrial Wastes: Section 144.07 (4)(c) authorizes the joint sewerage commissions to provide intercepting and main sewers for the collection and transmission of industrial wastes. Although treatment of industrial wastes is not specifically authorized, joint sewerage commissions may treat sewage, the statutory definition of which includes wastes from industrial sources.

Authority to Plan, Construct, Operate, and Maintain Facilities or Structures for the Control or Abatement of Nonpoint Source Pollution: Joint sewerage commissions have very limited authority to deal with nonpoint source pollution. Authority is provided to construct and maintain intercepting and main sewers for the collection and disposal of storm water which shall be separate from the sanitary sewerage system. In addition, Section 144.07(4)(c) includes authority to project, plan, construct, and operate solid waste disposal facilities.

Authority to Enact and Enforce Regulations for the Control and Abatement of Nonpoint Source Pollution: Joint sewerage commissions have no authority to enact regulations relating to the abatement of nonpoint source pollution.

Drainage Districts

County drainage districts are special-purpose units of government administered by a single county drainage board consisting of three individuals appointed by the county court. Selection is made from a list of at least nine resident landowners of the county compiled by the county committee on agriculture. At least one of the members shall be an experienced farmer and another shall be someone familiar with drainage engineering if such an individual is available.

A drainage district may be created upon petition submitted by the owners of more than one-half the area of the lands proposed to be within the district or a majority of landowners owning at least one-third of the land area. The petition must contain a description of lands to be included; a statement that the public health will be promoted; and a map of the area to be included and other related data. After notice is mailed to all affected landowners, the county drainage board is to approve or disapprove the petition. In addition, if the district is to include more than 200 acres, feasibility reports must be submitted by the Wisconsin Department of Administration and the College of Agriculture of the University of Wisconsin. If the proposed drainage district contemplates activities involving navigable waters, a permit must be obtained from the Department of Natural Resources pursuant to Section 88.31 of the Wisconsin Statutes. At the conclusion of the DNR hearing, the Department is to issue the permit if it finds that the public health and welfare will be promoted by the proposed activity; that the proposed activity is necessary to the proper operation of the drainage system; and that navigability will not be impaired. Within 30 days of the hearing conducted by the drainage board, the drainage board must submit a preliminary report. Public health and welfare considerations play a major role in this determination. In determining the effect on public health and welfare, the board shall consider the effects on water temperature, water level of surface water and groundwater, and whether the land proposed to be drained is needed to such a degree as to warrant possible harmful effects caused by drainage. In addition, the drainage board's preliminary report may recommend an increase or decrease in the land area to be included within the district.

When the court orders the organization and creation of the drainage district, benefits, special assessments, and annual operation and maintenance costs are to be estimated. The board must file a written report with the court describing planned drains and improvements and the estimates mentioned above.

Once a drainage district has been established, state statutes include provisions for annexation of additional territory, withdrawal of territory, consolidation of two or more districts, suspension or dissolution of district operations, and transfer of jurisdiction to cities, villages, and towns in certain instances. All of the above may be effected through the use of various contracts, petitions, and agreements. Specific requirements are outlined in Chapter 88 of the Wisconsin Statutes.

Authority to Plan, Construct, Operate, and Maintain New and Existing Waste Treatment Facilities for the Control of Point Source Pollution: Drainage districts have no authority to undertake any activity designed to abate or control point source pollution.

Authority to Plan, Construct, Operate, and Maintain Facilities or Structures for the Control or Abatement of Nonpoint Source Pollution: The primary purpose behind the creation of drainage districts is to facilitate the installation and operation of structural devices and practices designed to promote proper drainage of lands included within the drainage district. The activities of a drainage district may, however, have a significant impact upon nonpoint source pollution. The drainage board is authorized to perform the following activities:

1. Purchase lands necessary for the construction, repair, and maintenance of drains and related systems.

2. Purchase, lease, and operate equipment and machinery necessary to construct and repair drains including the equipment and machinery necessary to control weeds and brush using herbicides.

3. Enter into agreements with the federal government to permit drainage of federal lands within the drainage districts.

4. Enter into agreements with the federal government to accept the benefits of any federal law concerning flood prevention or the conservation, development, utilization, and disposal of water.

5. Layout drains of sufficient depth to adequately drain the lands proposed to be drained, and prepare profiles showing the grades of all drains and proposed location of all drains.

No drains may be constructed on state-owned lands without the written permission of the State.

As was mentioned earlier, a drainage district must obtain a permit from the Department of Natural Resources before any improvements or new construction involving navigable water may commence. Once such a permit is obtained, the drainage district may:

(a) Do all acts necessary in and about the surveying, laying out, constructing, repairing, altering the course of, enlarging, clearing, deepening, widening, protecting, and maintaining any drain in, through, or upon such waters both within and beyond the limits of the drainage district; and

(b) Procure, purchase or condemn by proceedings had under Chapter 32, riparian rights, rights of flowage, dams and water powers in such waters, both within and beyond the limits of the drainage district.[66]

Authority to Enact and Enforce Regulations for the Control and Abatement of Nonpoint Source Pollution: Drainage districts do not possess independent authority to enact and enforce regulations relating to the abatement and control of nonpoint source pollution. Any regulations within the drainage district must be enacted by various counties or townships.

PRIVATE STEPS FOR WATER POLLUTION CONTROL

The foregoing discussion deals exclusively with water pollution control machinery available to units and agencies of government. Direct action may also be taken, however, by private individuals or organizations to effectively abate water pollution. In seeking direct action for water pollution control, there are two categories of private individuals: riparians, or owners of land along a natural body of water, and nonriparians.

Riparians

It is not enough for a riparian owner or proprietor seeking an injunction to show simply that an upper riparian is polluting the stream and thus he, the lower riparian, is being damaged. Courts will often inquire as to the nature and the extent of the defendant's activity, its worth to the community, its suitability to the area, and his present attempts, if any, to treat or abate wastes. The utility of the defendant's activity is weighed against the extent of the plaintiff's damage within the framework of reasonable alternatives open to both. On the plaintiff's side, the court may inquire into the size and scope of his operations, the degree of water purity that he actually requires, and the extent of his actual damages. This approach may cause the court to conclude that the plaintiff is entitled to a judicial remedy. Whether this remedy will be an injunction or merely an award of damages depends on the balance which the court strikes after reviewing all the evidence. For example, where a municipal treatment plant or industry is involved, the court, recognizing equities on both sides, might not grant an injunction stopping the defendant's activity but might compensate the plaintiff in damages. In addition, the court may order the defendant to install certain equipment or to take certain measures designed to minimize the future polluting effects of his waste disposal. It is not correct to characterize this balancing as simply a test of economic strengths. If it were simply a weighing of dollars and cents, the rights of small riparians would never receive protection. The balance that is struck is one of reasonable action under the circumstances, and small riparians can be and have been adequately protected by the courts.

Riparians along the water bodies of southeastern Wisconsin are not prevented by the existence of federal, state, or local pollution control efforts from attempting to assert their common law rights in courts. The court may ask the Wisconsin Department of Natural Resources to act as its master in chancery, especially where unbiased technical evidence is necessary to determine the rights of litigants. The important point, however, is that nothing in the Wisconsin Statutes can be found which expressly states that, in an effort to control pollution, all administrative remedies must first be exhausted before an appeal to the courts may be had or that any derogation of common law judicial remedies was intended. Thus, the courts are not prevented from entertaining an original action brought by a riparian owner to abate water pollution.

Nonriparians

The rights of nonriparians to take direct action through the courts are less well-defined than in the case of riparians. The Wisconsin Supreme Court set forth a potentially far-reaching conclusion in Muench v. Public Service Commission when it concluded that:

> The rights of the citizens of the State to enjoy our navigable streams for recreational purposes, including the enjoyment of scenic beauty, is a legal right that is entitled to all the protection which is given financial rights.[67]

This language, however, was somewhat broader than necessary to meet the particular situation at hand, since the case involved an appeal from a state agency ruling. The case has not yet arisen where a private nonriparian citizen is directly suing to enforce his public rights in

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[66] *Sec. 88.31(8).*

[67] *261 Wis. 492, 53 N.W. 2d 514 (1952).*

a stream. Only when such a case does arise can it be determined if the court will stand behind the broad language quoted above or draw back from its implications. The more traditional view would be that a nonriparian citizen must show special damages in a suit to enforce his public rights.

It should be noted that Section 144.537 of the Wisconsin Statutes presently enables six or more citizens, whether riparian or not, to file a complaint leading to a full-scale public hearing by the Department of Natural Resources on alleged or potential acts of pollution. In addition, a review of Department orders may be had pursuant to Section 144.56 of the Wisconsin Statutes by "any owner or other person in interest." This review contemplates eventual court determination under Chapter 227 of the Wisconsin Statutes when necessary. The phrase "or other person" makes it clear that nonriparians may ask such judicial review.

The Federal Water Pollution Control Act also provides for citizen suits. Under this law, any citizen, meaning a person or persons having an interest which is or may be adversely affected, may commence a civil action on his own behalf against any person, including any governmental agency, alleged to be in violation of any effluent standard, limitation, or prohibition or any pollution discharge permit or condition thereof; or against the Environmental Protection Agency Administrator when there is alleged failure by the Administrator to duly carry out any nondiscretionary duty or to act under the Federal Water Pollution Control Act. Prior to bringing such action, however, the citizen commencing the action must give notice of the alleged violation to the Environmental Protection Agency Administrator, to the state in which the alleged violation occurs, and to the alleged violator. The courts, when issuing final orders in any action under this section, may award costs of litigation to any party.

LEGAL ISSUES OF CONCERN TO THE AREAWIDE WATER QUALITY MANAGEMENT PLAN

Three specific legal questions of direct concern to the implementation of areawide water quality plans are addressed below. Of major concern to areawide implementation are any existing authorities for limiting access to sewerage systems and thereby controlling development on adjacent residential lands; the basic legal authority for regulation of sludge management in general and land management of sludges specifically; and the authority of various state and federal agencies to review, approve, or otherwise comment on the reasonableness of intermunicipal contract fees for sanitary sewerage service or a given user charge-industrial cost recovery system.

Limited Access Sewerage Systems

A basic issue relating to the construction of sewerage systems is whether any public body may impose limitations upon access to main and trunk sewers in order to avoid stimulation of unwise land use development that may occur as a result of the availability of centralized sanitary sewer service. Problems related to limited access sewer systems become more numerous and important in connection with areawide sewerage systems serving several perhaps noncontiguous municipalities. There are several considerations which bear on this question.

Section 144.04 provides the Department of Natural Resources with authority to review sanitary sewer extensions. Administrative Code Chapter NR 110.05(6) identifies a Department of Natural Resources policy which may require that an applicant for a sewer extension restrict the number of connections made to said extension as a condition for Department approval under subsections 3, 4, or 5. The above-cited subsections authorize the Department to grant extension approval under several conditions including the submittal of an acceptable program to eliminate dry-weather or wet-weather bypasses or overflows by 1982 and time schedules for completion of the work and proof of financial ability and commitment. The Department, however, does not have specific authority to deny approval of a trunk sewer which would permit the development of land beyond that identified in local or regional plans, if such a trunk sewer meets all conditions set forth in Chapter NR 110.05, none of which are related to local or regional plans. The Department is limited to those criteria cited in Chapter NR 110.05 in approving sewer extensions and the number of allowable connections thereto.

Cities and villages are authorized by Sections 61.39 and 62.18(13) to lay sewers:

> in and through any alleys and streets, and through any breakwater into any lake and also in any highways of the county whether within the limits of said city or not.[68]

In addition, cities and villages possess plat approval and subdivision regulatory authorities. Through utilization of these authorities, cities and villages may restrict development to desired areas and indirectly control access to trunk and main sewers.

Town boards are required to:

> grant to any adjoining city or village permission, in the extension of its water or sewage systems, subject to the rights of abutting property owners, to lay and maintain water mains and sewers in any street or highway in the town . . . .[69]

This requirement is vital in that towns may not exercise approval authority over the construction of sewer lines between two incorporated areas and may not force the provision of sewer service via connections to that system.

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[68] *Sec. 62.18(13).*

[69] *Sec. 60.29(16).*

Cities and villages may construct sewers in county highways through unincorporated lands and need not provide access to such newly constructed sewers.

State Sludge Management Authority

A major element of the areawide water quality planning and management program has been the development of a sludge management plan for the Southeastern Wisconsin Region. During the preparation of this element of the areawide water quality plan, the general public's interest in sludge management has been rapidly increasing. This increased interest is at least partially due to increased regulatory activity of the Wisconsin Department of Natural Resources. Safe disposal of residual waste sludge is a crucial element of any areawide water quality plan. An important concern is the authority of the Department of Natural Resources to regulate the management and disposal of sludge.

The authority to regulate sludge may be examined in terms of authority to regulate the sludge generator and the disposal site. Section 147.02 of the Wisconsin Statutes authorizes the Department of Natural Resources to regulate sludge generators through the issuance or denial of discharge permits. The section states:

> The discharge of any pollutant into any waters of the state or the disposal of sludge from any treatment work by any person shall be unlawful unless such discharge or disposal is done under a permit issued by the Department.[70]

Section 147.015(3) provides the definition of pollutant sewage sludge. Section 147.26 encourages publicly owned treatment works to be designed to provide for the ultimate disposal of sewage sludge in a manner not resulting in environmental hazards. Through the issuance of Chapter 147 discharge permits, the Department of Natural Resources is authorized to closely monitor sludge generation sites.

The authority of the Wisconsin Department of Natural Resources over the disposal of sludge at the disposal site is not as clearly specified. The Department is given authority to regulate solid waste disposal at sanitary landfill sites. In addition, the Department of Natural Resources has published Technical Bulletin No. 88, Guidelines for the Application of Wastewater Sludge to Agricultural Land in Wisconsin, discussed earlier in the chapter. Administrative Code Chapter NR 110.27(6) requires sludge management plans developed by each owner of a waste treatment facility to be evaluated on the basis of recommendations contained in Technical Bulletin No. 88.

Authority over the disposition of sludge at the disposal site is present at the local level. Counties, towns, cities, and villages may protect and promote the public health through regulations and ordinances. Such regulations could limit the time of sludge application, the amounts of sludge applied, and the location of sludge applications. Such local regulations could have significant land resouce protection and water quality impacts.

[70] *Sec. 147.02.*

Sewage Treatment Rate Review Authority

A vital concern to areawide water quality planning and plan implementation is the development of sewage treatment rates and schedules whereby individuals or contracting municipalities will pay a proportionate share of any waste treatment services provided. Of particular concern is the situation where one community uses the leverage of extremely high waste treatment charges or restriction of service to compel certain actions on the part of a dependent community. The prime issue raised here is where the review authority, if any, lies. It should be noted that any new facility utilizing federal construction grant funds must adopt a user charge system whereby recipients of waste treatment services pay a proportionate cost of operation and maintenance.

The Wisconsin Public Service Commission is given statutory authority to supervise and regulate public utilities of the State. With two principal exceptions, the Public Service Commission does not have regulatory authority over sewerage operations, since such operations are not included within the statutory definition of public utility. Towns, villages, and cities of the fourth class that operate a joint utility for the provision of sewer and water services may have their sewer and water rates subject to Public Service Commission approval. In addition, Section 66.076(9) authorizes the Public Service Commission to hear complaints filed by users of the service of sewerage systems of towns, villages, cities, or metropolitan sewerage districts or the holder of debt securities. Such complaints may state that rates, or practices related to rates, are unreasonable or unjustly discriminatory. The Public Service Commission shall investigate the complaint and may hold a public hearing. According to Section 66.076(9), after the public hearing:

> if the public service commission shall determine that the rates, rules or practices complained of are unreasonable or unjustly discriminatory, it shall determine and by order fix reasonable rates, rules and practices and shall make such other order respecting such complaints as may be just and reasonable.

No mention is made of any Public Service Commission jurisdiction over rates of joint sewerage commissions established under Section 144.07 or intergovernmental contracts established under Section 66.30. It appears that Public Service Commission sewer service rate jurisdiction is limited to the two circumstances noted above and does not cover intergovernmental sewerage contracts authorized by Section 66.30, or service provided by Section 144.07 joint sewerage commissions. Wisconsin State Senate Bill 422 enacted in 1977 would provide the Milwaukee Metropolitan Sewerage Commission with authority to initiate a limited user charge and industrial cost recovery system. In addition, Senate Bill 422 would authorize rate hearings before the Public Service Commission upon a complaint of any user. The Public Service Commission, upon a finding that the questioned rates are unreasonable or unjustly discriminatory, would be empowered and obligated to fix reasonable charges, rules, and practices by order. The bill did pass the Legislature and was signed by Acting Governor Martin J. Schreiber on May 11, 1978, and became effective on May 24, 1978.

SUMMARY AND CONCLUSIONS

This chapter has described in summary form the basic existing legal framework for areawide water quality planning and plan implementation in southeastern Wisconsin. This framework consists primarily of water pollution control legislation and administrative machinery at the federal, state, and local levels. In areawide water quality management planning and plan implementation, the law can be as important as the technical feasibility and cost of proposed facilities in determining the ultimate feasibility of the areawide water quality plan. Two companion analyses of existing law in southeastern Wisconsin provide a background against which this chapter is set. These reports are SEWRPC Technical Report No. 2, Revised Edition, Water Law in Southeastern Wisconsin, and SEWRPC Technical Report No. 6, Revised Edition, Planning Law in Southeastern Wisconsin. These two volumes provide background information for analysis of existing laws and regulations as they relate to the areawide water quality planning and management effort. Of critical importance is a determination of those local agencies qualified to be formally designated as management agencies. This determination will be based on information presented here and criteria mandated by Section 208 of the Federal Water Pollution Control Act Amendments of 1972 for management agencies designation. Additional considerations include the administrative, staff, and financial capabilities of specific agencies to execute their specific roles in the physical plan implementation.

With the passage of the Federal Water Pollution Control Act Amendments of 1972, the United States Congress set in motion a series of actions which will have many ramifications for areawide water quality planning and plan implementation within the Region. Water use objectives and supporting water quality standards are now required for all navigable waters of the United States. It is a national goal to eliminate the discharge of pollutants into the navigable waters of the United States by 1985 and to obtain an interim goal of water quality suitable for the maintenance of fish life and for human recreational activities in and on the water by 1983. To meet these goals, the Act requires in addition to water use objectives and water quality standards the enactment of specific effluent limitations for all point sources of water pollution. For certain categories of pollutors, national standards of wastewater treatment are to be formulated and applied to any newly established source within the categories. In addition, the Act established a pollutant discharge permit system under which the State of Wisconsin issues permits under federally delegated authority, limiting the discharge of any pollutants or combination of pollutants.

Each state must have a continuing planning process designed to achieve the overall water quality objectives of the Act. This process is to result in the preparation of comprehensive development plans for natural basins and watersheds and must incorporate metropolitan or regional sanitary sewerage system plans. In order to provide a basis upon which to expend federal monies in metropolitan areas for public waste treatment works construction, the new Act requires the development and *implementation* of areawide water quality management plans. Upon completion of areawide water quality management plans, management agencies must be designated to carry out the plans. The Administrator of the Environmental Protection Agency can issue federal grants for waste treatment works construction only to such management agencies and only for treatment works found to be in accordance with the officially adopted plan. In addition, no permits may be issued for any point source of water pollution found to be in conflict with an adopted areawide waste treatment management plan.

In addition to the Federal Water Pollution Control Act Amendments of 1972, other important pieces of federal legislation relate to development and implementation of this areawide plan. These include the National Environmental Policy Act, the Safe Drinking Water Act, the Coastal Zone Management Act, the Resource Conservation and Recovery Act of 1976, and the Toxic Substances Control Act. Of particular importance is the federal legislation dealing with rural land management and technical and financial aids for purposes of soil conservation on agricultural lands. The Consolidated Farm and Rural Development Act and Food and Agriculture Act of 1962 authorize loans to farm owners, tenants and farm associations for purposes of land and water development and conservation. The Watershed Protection and Flood Prevention Act authorizes river basin surveys, watershed planning, and the installation of works of improvement including floodwater retarding structures, stream channel improvements, and sediment control structures. The Water Bank Act provides grants to conserve, preserve, and improve wetlands. Agreements are signed whereby landowners pledge to preserve the status of certain lands for the duration of the agreement. Another federal act relating to agriculture is the Soil Conservation and Domestic Allotment Act. This Act authorizes the Soil Conservation Service to provide technical and consultive assistance to individuals and local units of government in the planning, developing, and application of local soil and water conservation plans. Finally, the Clean Water Act of 1977 amends earlier federal laws to provide for cost-sharing of agricultural pollution control project costs through Section 208(j) of the Federal Water Pollution Control Act.

Responsibility for water pollution control in Wisconsin is centered in the Wisconsin Department of Natural Resources. The Department is given authority to prepare long-range water resources plans, to establish water use objectives—with supporting water quality standards—applicable to all waters of the State, to issue pollution abatement orders, to certify sewage treatment plant operators, to review and approve plans for sewerage facilities, to order the installation of sanitary sewerage systems, and to administer financial assistance programs for the construction of water pollution abatement facilities. Water use objectives and supporting water quality standards applicable to all of the surface waters of the State were established by the Wisconsin Resource Development Board in 1967-68 and were revised in 1973 by the Department of Natural Resources, the successor agency. Wisconsin Statutes concerning nonpoint source pollution control include Chapter 144, which authorizes the Department of Natural Resources to assume general water pollution control in the State; Chapter 236, which establishes procedures and criteria for plat approvals; Chapter 92, which authorizes the State Board of Soil and Water Conservation Districts to oversee the activities of county soil and water conservation districts; Chapter 25.44, which creates the "Wisconsin Fund" to provide financial assistance for both point and nonpoint pollution control projects; Chapter 33, which authorizes the Department of Natural Resources to establish districts and give grants and project approvals for inland lake protection and rehabilitation; and Chapter 94, which authorizes the State Department of Agriculture to regulate the registration, application, sale, and distribution of pesticides.

Perhaps most important of the legal aspects pertaining to implementation are the legal authorities possessed by local units of government, since the ultimate success or failure of the areawide water quality management plan depends upon local acceptance and implementation. Four general-purpose units of government—towns, villages, cities, and counties—were examined to determine their qualifications as management agencies with regard to their authority to implement the areawide water quality management plan. In addition, eight types of special-purpose units of government were examined for their legal qualification to be designated as management agencies. These special-purpose units include soil and water conservation districts; public inland lake protection and rehabilitation districts; utility districts; drainage districts; town sanitary districts; metropolitan sewerage districts; the Milwaukee Metropolitan Sewerage District; and joint sewerage commissions.

Private citizens may take steps to abate existing water pollution and prevent potential pollution. Riparians have a common law right to enjoin another riparian from polluting a stream, providing significant damages can be shown. Nonriparians also have certain rights to enjoy the navigable waters for recreational and other purposes. The Wisconsin Statutes permit six or more citizens, whether riparian or not, to file a complaint leading to a public hearing by the Department of Natural Resources on alleged or potential acts of water pollution. Private citizens may also file suit in U. S. Courts to enjoin violations of the Federal Water Pollution Act and to force federal officials to properly carry out their nondiscretionary activity under the Act.

Based on the findings of this chapter, several conclusions relative to legal authorities possessed by potential management agencies may be advanced.

1. In the area of point source control, there appears to be adequate authority to implement the various elements of any areawide water quality management plan. The Wisconsin Department of Natural Resources through its authorities found in Chapters 144 and 147 of the Wisconsin Statutes generally possesses adequate statewide implementation authority. Of particular importance is the Chapter 147 discharge permit system currently administered by the Department. The only identified area of inadequacy was the absence of authority to specifically consider land use impacts among the criteria upon which to review sanitary sewer extension applications under Chapter 144.04, a limitation removed by the Wisconsin Legislature in the 1977 session.

2. Traditionally, cities, villages, metropolitan sewerage districts, and joint sewerage commissions have been the major agencies to deal with the management and operation of waste treatment facilities. These units of government possess adequate authority to implement those portions of the areawide water quality plan dealing with point source pollution. In some cases, however, the implementation of the required user charge-industrial cost recovery systems may overreach these existing authorities. Specifically, the Milwaukee-Metropolitan Sewerage Commission established under Wisconsin Statutes is currently seeking legislative authorization powers needed to implement such a system. No specific authorization to utilize a system of user charge-industrial cost recovery was included in Section 59.96 of the Wisconsin Statutes—the section which provides authority for the creation of a metropolitan sewerage district—until amendments were proposed in the Wisconsin Legislature in the 1977 session, since authorization to raise revenues was restricted to ad valorem taxation. Other units of government appeared to have adequate authority to implement this system but may need to overcome administrative difficulties of implementation.[71]

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[71] *Subsequent to the preparation of this text, the Wisconsin State Legislature enacted legislation authorizing the Metropolitan Sewerage Commission of Milwaukee County to develop and apply a user charge and cost recovery system. Such authority did not address the issuance of revenue bonds, another capability which could be considered important to the development of large-scale sewerage facilities for the Metropolitan Sewerage District.*

3. Because nonpoint source pollution was a concern rarely addressed in past planning and enforcement efforts, many deficiencies in implementation authorities are present. A logical list of local agencies to be considered for designation for the implementation of rural nonpoint source plan elements includes counties, towns, and soil and water conservation districts. A basic problem inherent in all three units is that only limited implementation and enforcement authority extends to unincorporated areas. County soil and water conservation districts may enter into voluntary, cooperative programs with incorporated villages and cities, and appear to be suited by tradition and technical expertise to implement aspects of the rural nonpoint element of the areawide plan as it relates to agriculture and construction activities. In addition, Chapter 92 of the Wisconsin Statutes authorizes the establishment of land use regulations for unincorporated areas of the county following a lengthy and difficult procedure which includes county board and local referendum approval. This cumbersome process has effectively precluded utilization of this authority and forced soil and water conservation districts to rely on more traditional voluntary agreements. A strict interpretation of Chapter 92 language regarding the policy behind Chapter 92 might indicate that ordinances enacted for the purposes of water pollution control would not be allowed, since only soil conservation purposes are cited. In summary, soil and water conservation districts have adequate statutory plan implementation authority but in practice they are forced to rely on voluntary cooperation due to procedural difficulties of ordinance passage. In addition, innovative and improved funding programs and incentives must be implemented before the soil and water conservation district can be an effective management agency.

4. Counties have adequate authority to deal with nonpoint source pollution in unincorporated areas but such authority is very limited within cities or villages. Counties have only limited plat review authority within incorporated areas. In addition, counties may enter into various voluntary programs with incorporated areas under Section 66.30. Counties may utilize police powers in their zoning authority to regulate land uses within the unincorporated areas, but to do so effectively, three related hindrances must be overcome. These hindrances are the facts that a county zoning ordinance cannot restrict existing uses; that variances to the zoning regulations are often freely given; and that the county is dependent in most cases upon town acceptance to be in force. Counties have the authority to enact Chapter 92 land use regulations which are enforced by the county soil and water conservation district; however, these regulations are difficult to enact, as noted above. In addition to zoning authorities, counties possess regulatory authority to control nonpoint source pollution by means such as plat approval, building and sanitary codes, shore protection, solid waste management, and shoreland and floodplain zoning ordinances. County health and sanitary authorities may be utilized to deal with various sources of nonpoint pollution.

5. Civil towns may rely on their police powers for zoning to implement portions of the areawide plan, although town zoning, like county zoning, requires joint acceptance by both levels of government except in cases where no county zoning ordinance exists. In addition to zoning powers, towns have regulatory powers to control nonpoint source pollution through ordinances governing subdivision regulation, building and sanitary codes, and garbage disposal regulations.

6. Chapter 33 inland lake protection and rehabilitation districts possess potential for significant involvement in nonpoint source abatement activities within the boundaries of those districts as they affect the inland lakes. A major deficiency with the authorities possessed by the lake district is that such a district may include only the property which will be benefited by the creation of such a district. This restriction would cause many upland areas contributing to lake degradation not to be included within such a district. In addition, Chapter 33 addresses only those lakes, reservoirs, or flowages which have public access via contiguous public lands or easements.

7. Cities, villages, and metropolitan sewerage districts are generally qualified to implement portions of the areawide plan dealing with urban nonpoint source pollution. Cities, villages, and metropolitan sewerage districts have demonstrated sufficient authority to convey and treat storm water by means including construction, operation, and maintenance of urban storm water conveyance, storage, and treatment facilities. Other types of urban nonpoint management activities will not differ from current public works activities of cities and villages including litter and leaf control, pet and animal waste control, and street sweeping/cleaning. These expanded activities are well within the police power and home rule authority of cities and villages to construct, maintain, and plan nonpoint pollution abatement projects and to promote the health, safety, and welfare of the people. In addition, villages and cities have adequate authority to review plats and to enact subdivision control ordinances and floodplain zoning ordinances. Cities and villages also have sufficient police power authority to enact ordinances requiring basic maintenance practices to be performed by the private sector. Cities and villages possess broad authority to regulate the construction of buildings through the issuance or denial of building permits. In addition, cities and villages have

broad zoning authority whereby they may regulate and restrict buildings and other structures. Through this authority and the issuance of conditional use permits, nonpoint abatement structures associated with storm water management may be required. In addition, cities and villages may enact subdivision control ordinances requiring the installation of certain necessary improvements such as storm water management systems.

8. The Wisconsin Department of Natural Resources appears to have sufficient authority to regulate wastewater sludge management practices. The Department may regulate the treatment, storage, transport, and disposition of sludge primarily through the issuance of Chapter 147 discharge permits to sludge generators. In addition, the Department has issued Technical Bulletin No. 88, Guidelines for the Application of Wastewater Sludge to Agricultural Land in Wisconsin, as a guide for agricultural land application, and has incorporated the bulletin by reference in the Wisconsin Administrative Code. Improved record keeping systems must be devised with the capability to quickly determine past sludge application rates. This task could be performed by the Department as part of the permit process. Adequate temporary storage of sludge on or near the site of land application may also be regulated by the Department as well as by towns and counties having the local land use control authority, inclusive of sludge storage and methods and conditions of application of sludge to properly suited lands. This allows for local control over DNR decisions in this matter.

9. From the previous discussion of specific legal issues pertaining to water quality management in southeastern Wisconsin, several conclusions may be stated. The Wisconsin Department of Natural Resources possesses authority to restrict sewer connections. As of 1976, it did not have the authority, however, to limit such connections for reasons solely based on land management criteria. In addition, cities and villages have authority to limit connections to sewerage systems extending through unincorporated areas. Conversely, towns may not demand connection to a proposed system as a condition of approval. The Wisconsin Department of Natural Resources possesses adequate authority to regulate the disposal of sewage sludge through utilization of Chapter 147 discharge permits. Finally, public service commission sewer service rate jurisdiction is limited to two situations. It appears that the public service commission does not have sewerage rate jurisdiction in situations involving joint sewerage commissions or contracts agreed to pursuant to Chapter 66.30 of the Wisconsin Statutes.

Chapter VII

FINANCIAL RESOURCES AFFECTING WATER QUALITY MANAGEMENT

INTRODUCTION

The sound evaluation of any recommended areawide water quality management plan requires a determination that the implementing local units of government and other agents have the financial ability to make the improvements and take the other actions recommended for the attainment of the agreed-upon water quality objectives. It is accordingly the purpose of this chapter to examine the financial ability of the local units of government and of the private interests in the Region that may be affected to carry out the recommended water quality management program. Three major aspects of the financial ability to implement the recommended plan are considered herein: the amount of the public financial resources which may be expected to be available; the probable financial ability of the private agricultural, industrial, and commercial interests which may be affected; and the various potential sources of public revenue.

The public financial resources of a unit of government may be expressed in terms of the revenues obtained and the expenditures made. For the purposes of this study, a five-year time span was selected to typify the historic financial resource patterns of the governmental units within the Region. This relatively short time span was selected because it was believed to be more typical of the current financial condition of the Region and, therefore, a better basis for projecting the probable future condition.

The main sources of funds available to the units of government within the Region, as indicated by Commission inventories, are generally taxes, both direct and state-shared; borrowing; and revenues for public services rendered. Each of these sources was considered at the county, city, village, and town levels of government, based on past experience and future potential so that the relative importance of each source to the total financial base and to water quality plan implementation could be ascertained. Public expenditures were considered in terms of total expenditures by the various levels of government and in terms of the proportion devoted to water quality-related expenditures.

Since the areawide water quality management planning program may also be expected to affect the private sector, it was also necessary to evaluate the probable availability of private financial resources for plan implementation. Due to disclosure laws, any inventory of private financial resources must be limited to an estimate of income earned by the agricultural sector of the area economy and an estimate of the value added by the manufacturing sector. Thus, the private costs of recommended water quality programs may be viewed in relation to the value added in the Region by industrial and commercial enterprises and in relation to agricultural income.

The final purpose of this chapter is to explore possible additional sources of public and private funds to aid in implementing the water quality management recommendations. This exploration involves consideration of the potential funds available as well as of the legal ramifications of using specific potential funding sources.

THE FINANCIAL BASE OF THE REGION

The purpose of the Commission inventory of the financial resources of the Region was to provide an estimate of the amounts of funds historically allocated to water quality management-related programs by both the public and private sector, along with the sources of those funds and the potential sources available for future revenues necessary to implement the recommended areawide water quality management plan. The specific groups which are likely to be charged with responsibility for plan implementation include the individual units of government within the Region which represent the public sector, plus those private sector groups identified herein as either agricultural or industrial-commercial.

Since water quality is only one of the many concerns of government, the proportionate share of total revenues available for the construction, operation, and maintenance of water quality management-related facilities must also be investigated because the availability of funds for these facilities is affected by funding needs of other public facilities and services. Knowledge of the proportionate share of total public revenues and expenditures historically allocated to water quality management is particularly useful in preparing forecasts of the probable future level of funding for the implementation of the water quality management plan.

The primary source of data on the historic and current levels and sources of revenues and expenditures and on the levels of indebtedness by the general units of government operating in the Region was the annual financial report form filed by the local units of government with the Wisconsin Department of Revenue, Bureau of Municipal Audit, at the end of each calendar year or—in the case of towns—at the end of each fiscal year. Data used to analyze tax levy and taxable property valuation trends and to compile historic and current indebtedness were obtained from the Wisconsin Department of Revenue, Bureau of Local Fiscal Information. Additional data were also obtained from the Annual Report of the Milwaukee-Metropolitan Sewerage

Commission and personal communications with the staff of the Commissions regarding their expenditures. The Regional Planning Commission also conducted a survey of the local units of government which operate sanitary sewerage systems in order to obtain more specific data about the expenditures for such systems. This survey included a mail questionnaire and, as needed to supplement that questionnaire, personal interviews with local staffs. The resulting data reflect only the estimated actual 1975 cost—including debt retirement and interest and operations and maintenance costs and excluding state and federal grants-in-aid—as opposed to the financial commitments made in 1975, by issuing bonds or notes. These data provided a basis for interpretating data obtained from other sources—especially from the Wisconsin Department of Revenue audit forms—which frequently include as lump sums the local commitments for the entire amount of indebtedness incurred for capital improvement projects related to water quality management.

In order to provide a more meaningful assessment of trends in the revenue and expenditure levels of local units of government, yearly revenue and expenditure amounts were converted to a constant dollar base, thus offsetting the changes in the purchasing power of the dollar that have taken place over time due to general price inflation. The Consumer Price Index (CPI) as issued by the U. S. Bureau of Labor Statistics was used to "inflate" current year dollar amounts to a 1976 base or real dollar amount. These CPI values are shown in Table 148. The revenues and expenditures contained herein are thus stated in constant 1976 dollars and are directly comparable in terms of general purchasing power.[1]

EXPENDITURES

Expenditure patterns for the City of Milwaukee and Milwaukee County are presented separately from those of other city and county units of government in the Region. This was done because of the sheer magnitude of the Milwaukee expenditures, which would overwhelm any analysis of the expenditures of other local governmental units, and because the expenditure patterns of the City and County of Milwaukee vary significantly from those of the other units of government. It should be noted that school districts, which are largely autonomous in their budgeting process and have little direct affect on water quality-related finances, were excluded from the analysis.

[1] *In order to update the 1976 dollar amounts contained in this report to more current values, a multiplier may be used. A multiplier value of 1.13 times the 1976 values will bring the listed dollar amounts up to May 1978 dollar values.*

Table 148

MILWAUKEE AREA ANNUAL AVERAGE CONSUMER PRICE INDEX VALUES: 1971-1976

Year	Base 1967	Base 1976
1971	120.1	71.9
1972	123.7	74.1
1973	131.5	78.7
1974	144.3	86.4
1975	157.1	94.1
1976	167.0	100.0

Source: U. S. Department of Labor, Bureau of Labor Statistics and SEWRPC.

The combined total expenditures—expressed in 1976 dollars—of local units of government in the Region for all categories of expenditures, including water quality management-related expenditures, increased from more than $1,100 million in 1971 to more than $1,120 million in 1975, an overall real increase of $20 million, or about 2 percent, as shown in Table 149. In contrast, the expenditures for water quality management-related items by all local units of government in the Region decreased in real dollar amounts, as shown in Table 150, from a 1971 total of $119 million to $116 million in 1975, a decrease of $3 million, or 3 percent. This decrease is in part the result of the completion of a heavy capital investment program during the period from 1971 through 1973 by the Metropolitan Sewerage Commission of the City of Milwaukee involving construction of the South Shore sewage treatment plant. The decrease is also attributed in part to the effects of a decrease in the local share of the total cost of projects, as the federal share under the grants-in-aid program for sewage collection and treatment systems rose from 50 percent to 75 percent between 1971 and 1975. If the expenditures of the Metropolitan Sewerage Commission are excluded from the analysis, the expenditures by the other units of government for water quality management-related items would show a real increase from $97 million in 1971 to $102 million in 1975, a $5 million, or 5 percent, increase over the five-year period. In 1971, the water quality-related expenditures comprised about 10.8 percent of the total expenditures of all local units of government in the Region. By 1975, this percentage had decreased to about 10.3 percent, as shown in Table 151. Therefore, because of the expenditures for the South Shore sewage treatment plant during the early part of the period of the inventory data, the relative level of water quality-related expenditures by all units of government has decreased since 1971, as has the absolute level of expenditures expressed in constant dollars. Figure 45 indicates that water quality expenditures parallel total expenditures.

The following discussion details the expenditure patterns of the local units of government based on the data available for the period from 1971 to 1975.

Table 149

TOTAL REPORTED EXPENDITURES FOR ALL PURPOSES BY UNIT OF GOVERNMENT IN THE REGION: 1971-1975 (IN CONSTANT 1976 DOLLARS)

Unit of Government	Expenditures (millions)					Difference 1971-1975	
	1971	1972	1973	1974	1975	Absolute	Percent
Milwaukee County	$ 361.1	$ 383.4	$ 374.1	$ 348.2	$ 374.4	$13.3	3.7
All Counties (excluding Milwaukee County)	119.6	148.5	150.3	128.0	143.6	24.0	20.1
City of Milwaukee	306.5	333.5	294.4	284.5	257.6	- 48.9	- 16.0
All Cities (excluding Milwaukee)	237.0	246.3	217.4	207.4	267.6	30.6	12.9
Villages	57.8	57.1	56.9	61.1	56.4	- 1.4	- 2.4
Towns	19.7	22.5	23.0	18.9	20.5	0.8	4.1
Region	$1,101.7	$1,191.3	$1,116.1	$1,048.1	$1,120.1	18.4	1.7

Source: Wisconsin Department of Revenue, Bureau of Municipal Audit and SEWRPC.

Table 150

TOTAL REPORTED WATER QUALITY-RELATED EXPENDITURES BY UNIT OF GOVERNMENT IN THE REGION: 1971-1975 (IN CONSTANT 1976 DOLLARS)

Unit of Government	Expenditures (millions)					Difference 1971-1975	
	1971	1972	1973	1974	1975	Absolute	Percent
Milwaukee County[a]	$ 31.1	$ 37.3	$ 23.6	$ 14.2	$ 15.4	- 15.7	- 50.5
All Counties (excluding Milwaukee County)	1.1	1.4	2.5	2.7	2.5	1.4	127.3
City of Milwaukee[b]	34.3	31.5	37.8	35.7	28.7	- 5.6	- 16.3
All Cities (excluding Milwaukee)[b]	38.6	45.2	39.0	44.9	52.6	14.0	36.0
Villages	11.4	8.8	15.6	6.8	13.0	1.6	14.0
Towns	2.3	2.2	2.4	3.6	3.3	1.0	43.5
Region	$118.8	$126.4	$120.9	$107.9	$115.5	- 3.3	- 2.8

[a] *Includes the expenditure for capital projects undertaken by the Sewerage Commission of the County of Milwaukee.*

[b] *Includes the expenditures for operation and maintenance of the Sewerage Commission of the City of Milwaukee.*

Source: Wisconsin Department of Revenue, Bureau of Municipal Audit; Sewerage Commission of the County of Milwaukee; and SEWRPC.

Milwaukee County Expenditures

Water quality expenditures by Milwaukee County largely reflect the pattern of capital expenditures by the Metropolitan Sewerage Commission, since the County provides the capital construction monies for the Metropolitan Sewerage Commission except for those monies produced by contractual agreements with communities outside of Milwaukee County. These expenditures reached a maximum of more than $37 million in 1972, as shown in Table 150 and Figure 46, during construction at the South Shore treatment plant. As previously discussed, the annual expenditures have consistently declined since then, to a 1975 level of about $16 million. This pattern of declining expenditure could be significantly altered in the future. The Metropolitan Sewerage District of the County of Milwaukee, in a stipulation with the State of Wisconsin, has agreed to annual expenditure levels which average $38 million per year over the 17-year period covered by the stipulation. The Federal Court order sought by the State of Illinois against the Metropolitan Sewerage District would call for much larger average expenditures over a 13-year time span. The estimated expenditures resulting from these Court actions are shown in Table 152. Accordingly, the future proposed expenditures would greatly exceed the 1972 expenditure level, with the annual cost of the construction program (in terms of debt service costs) estimated to equal or exceed $49 million.

Table 151

REPORTED WATER QUALITY EXPENDITURES AS A PERCENTAGE OF TOTAL EXPENDITURES FOR THE LOCAL UNITS OF GOVERNMENT IN THE REGION: 1971-1975

Unit of Government	1971	1972	1973	1974	1975
Milwaukee County. . . .	8.6	9.7	6.3	4.1	4.1
Remaining Counties. . .	1.0	1.0	1.6	2.1	1.7
City of Milwaukee	11.2	9.5	12.8	12.6	11.1
Remaining Cities.	16.3	18.4	17.9	21.6	19.7
Villages	19.8	15.4	27.4	11.1	23.0
Towns.	11.6	10.0	10.6	19.3	16.1
Average of Total Regional Expenditures	10.8	10.6	10.8	10.3	10.3

Source: SEWRPC.

Table 152

PROPOSED EXPENDITURES BY THE METROPOLITAN SEWERAGE DISTRICT IN COMPLIANCE WITH STIPULATIONS MADE WITH THE STATES OF WISCONSIN AND ILLINOIS (IN CONSTANT 1976 DOLLARS)

Year	Expenditures Agreed to with State of Wisconsin (millions)	Expenditures Agreed to with State of Illinois[a] (millions)
1977	$ 35.2	$ 2.4
1978	40.1	26.1
1979	31.2	46.9
1980	52.5	82.4
1981	60.4	139.8
1982	51.6	187.4
1983	45.6	187.1
1984	40.2	180.5
1985	40.2	155.5
1986	33.2	86.3
1987	33.2	46.6
1988	33.2	22.5
1989	33.2	22.5
1990	33.2	--
1991	33.2	--
1992	33.2	--
1993	22.5	--
Total	$651.9	$1,186.0
Annual Average	$ 38.3 per year	$ 91.2 per year

[a] *These estimates were prepared in November 1977 by consultants to the Metropolitan Sewerage District, and are based on the outcome of the initial trial, the judgment of which was being appealed as of March 1978. Thus, these estimates may be subject to revision.*

Source: Metropolitan Sewerage District and SEWRPC.

Remaining Counties

The remaining six counties in the Region show a $1.4 million, or 127 percent, increase in water quality expenditures between 1971 and 1975, as shown in Table 150 and Figure 47. This sizable increase is largely the result of increases in urban land management practices including snow and ice control and highway cleaning.

The City of Milwaukee

The City of Milwaukee has shown a general decline in water quality expenditures, as reported through the state audit forms, since 1973. This pattern closely matches the overall expenditure pattern for the City, since the overall expenditures made by the City have also declined since 1973, as shown in Table 150 and Figure 48. Accordingly, the percentage of total expenditures comprised of water quality expenditures has remained relatively uniform over time, as shown in Table 151.

Remaining Cities

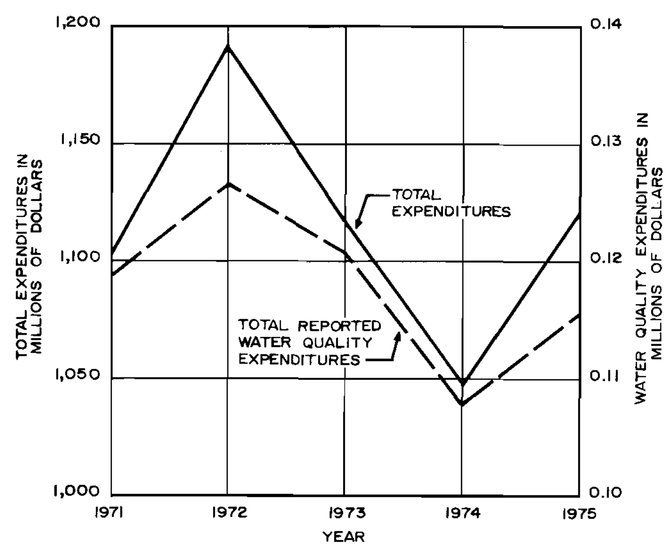
The remaining cities in the Region exhibited overall growth in water quality expenditure patterns, with only 1973 showing a decline, as indicated in Table 150 and Figure 49. The relative importance of water quality expenditures also increased and represented almost 20 percent of total expenditures by 1975, as shown in Table 151.

Villages

The villages in the Region show the highest variability in their water quality expenditure patterns, ranging from a 1973 high level of $15.5 million to a 1974 low of $6.2 million, as shown in Table 150 and Figure 50. This variability is attributed largely to the occurrence of major capital projects, since a single large project may account

Figure 45

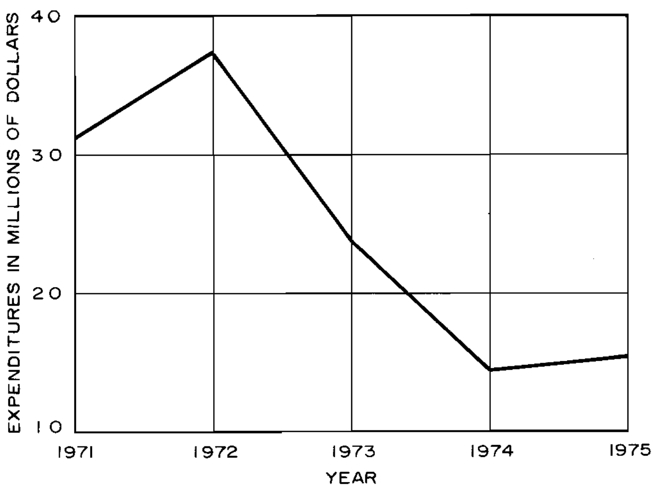
TOTAL REPORTED EXPENDITURES AND REPORTED WATER QUALITY EXPENDITURES BY ALL GOVERNMENTAL UNITS IN THE REGION: 1971-1975 (IN CONSTANT 1976 DOLLARS)



Source: Wisconsin Department of Revenue and SEWRPC.

Figure 46

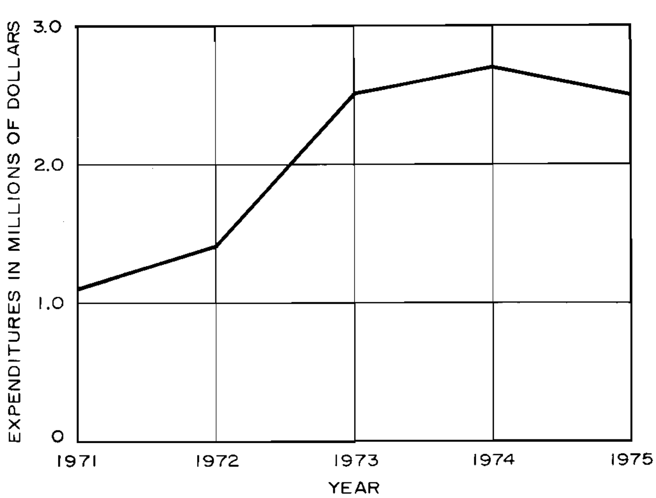
TOTAL REPORTED EXPENDITURES BY MILWAUKEE COUNTY FOR WATER QUALITY-RELATED ITEMS: 1971-1975 (IN CONSTANT 1976 DOLLARS)



Source: Wisconsin Department of Revenue, Bureau of Municipal Audit; Metropolitan Sewerage Commission; and SEWRPC.

Figure 47

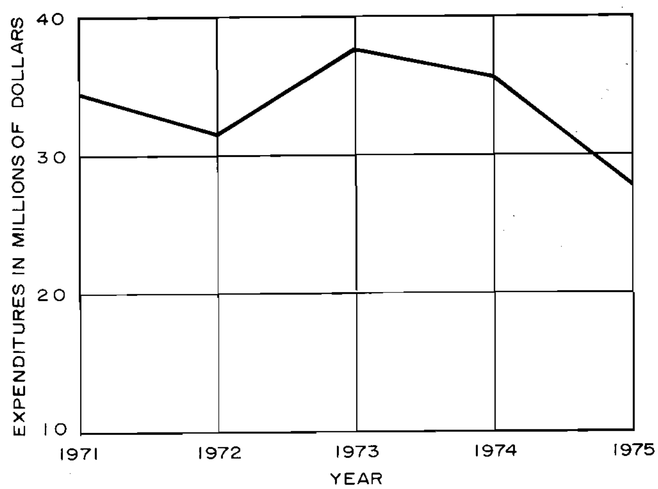
TOTAL REPORTED EXPENDITURES BY COUNTIES (EXCLUDING MILWAUKEE COUNTY) IN THE REGION FOR WATER QUALITY-RELATED ITEMS: 1971-1975 (IN CONSTANT 1976 DOLLARS)



Source: Wisconsin Department of Revenue, Bureau of Audit and SEWRPC.

Figure 48

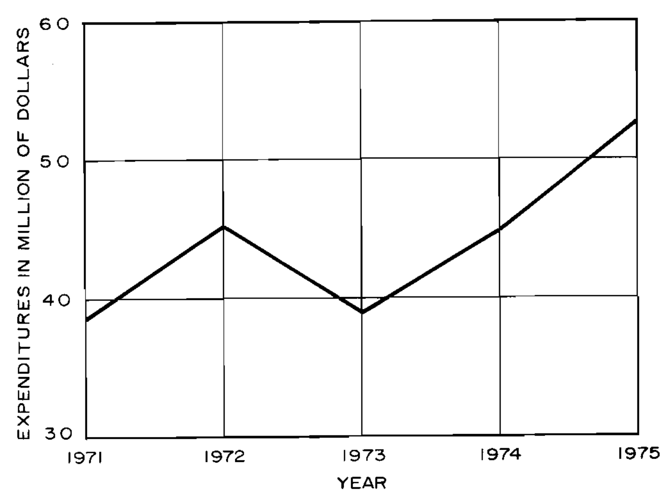
TOTAL REPORTED EXPENDITURES BY MILWAUKEE COUNTY FOR WATER QUALITY-RELATED ITEMS: 1971-1975 (IN CONSTANT 1976 DOLLARS)



Source: Wisconsin Department of Revenue, Bureau of Municipal Audit; Metropolitan Sewerage Commission; and SEWRPC.

Figure 49

TOTAL REPORTED EXPENDITURES BY CITIES (EXCLUDING MILWAUKEE) IN THE REGION FOR WATER QUALITY-RELATED ITEMS: 1971-1975 (IN CONSTANT 1976 DOLLARS)



Source: Wisconsin Department of Revenue, Bureau of Municipal Audit and SEWRPC.

for as much as 30 to 50 percent of the total yearly water quality expenditures made by villages. It should be noted that 1973 was a year of increased activity in the installation of advanced waste treatment for phosphorus removal and auxiliary disinfection facilities, while 1974 was a year of relatively little sanitary sewerage facility construction as state and federal agencies sought to implement the changes in construction grants administration following the 1972 water pollution control act amendments.

Towns

Towns—under which category the town sanitary districts also report—show a sizable increase over time in their level of water quality expenditures, as shown in Table 150 and Figure 51. This increase is due largely to the increasing population in towns and their attendant need for urban services.

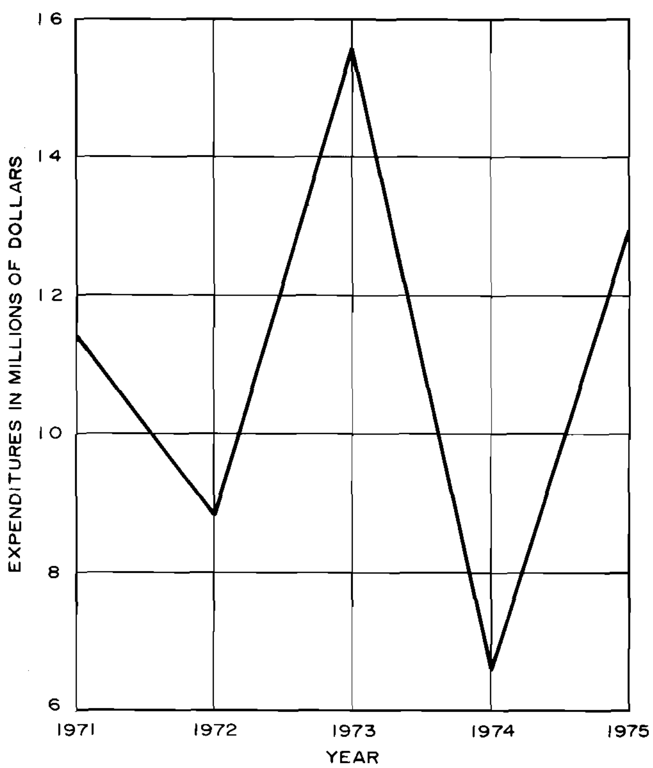
Sanitary Sewerage Expenditures by Local Units of Government

A review of the uniform audit reports required by the Wisconsin Department of Administration, Bureau of Municipal Audit, revealed some nonuniformity of reporting, including, in some cases, nonreporting, particularly with respect to capital versus operating and maintenance expenditures and debt retirement expenditures, as well as a lack of detail regarding specific expenditures. Thus, although the audit form data were believed to produce a relatively accurate assessment of total water quality-related expenditures, they were not considered to be reliable for the purpose of tabulating accurately the specific levels of expenditures made over a period of years in each of the 93 centralized sanitary sewerage systems in the Region. Accordingly, it was determined to pursue an alternate means of obtaining more detailed as well as more uniform data for 1975 directly from the local public officials responsible for management of each sanitary sewerage system. The results of the inventory conducted for this purpose by the Commission are presented in summary form in Table 153.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement for all sanitary sewerage systems in the Region, approximated $64 million or about $41 per capita in 1976 dollar amounts, such per capita cost being based upon the estimated total population within the Region served by sanitary sewers. Of this total, about $19 million, or about $12 per capita, was expended for operation and maintenance and about $45 million, or about $29 per capita, was expended for capital improvements, including debt retirement costs on existing capital structures. Total expenditures during 1975 on a per capita basis ranged from a low of $10 in the Village of Belgium to a high of $905 in the Town of Pleasant Prairie Sanitary District, which is a recently constructed system with a relatively low initial population served.

Figure 50

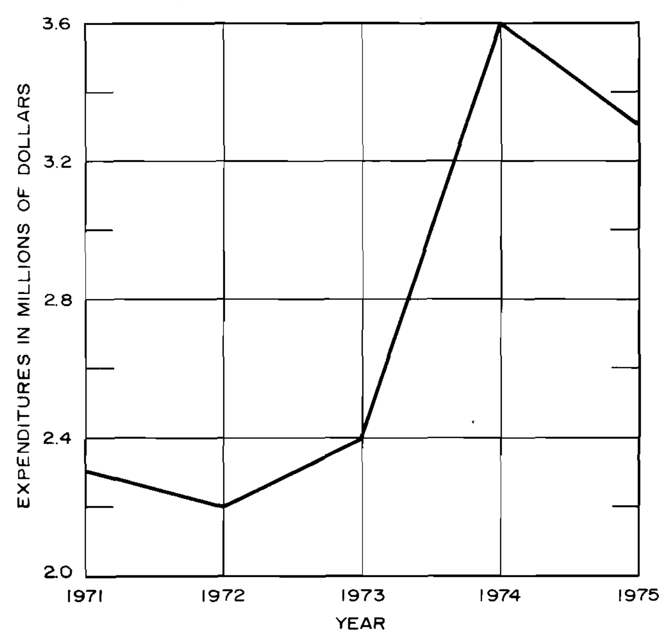
TOTAL REPORTED EXPENDITURES BY VILLAGES IN THE REGION FOR WATER QUALITY-RELATED ITEMS: 1971-1975 (IN CONSTANT 1976 DOLLARS)



Source: Wisconsin Department of Revenue, Bureau of Municipal Audit and SEWRPC.

Figure 51

TOTAL REPORTED EXPENDITURES BY TOWNS IN THE REGION FOR WATER QUALITY-RELATED ITEMS: 1971-1975 (IN CONSTANT 1976 DOLLARS)



Source: Wisconsin Department of Revenue, Bureau of Municipal Audit and SEWRPC.

Table 153

ESTIMATED SANITARY SEWERAGE EXPENDITURES IN THE REGION BY PUBLIC SANITARY SEWERAGE SYSTEM: 1975 (IN CONSTANT 1976 DOLLARS)

		Sanitary Sewerage Expenditures						
		Operation and Maintenance		Capital Improvements Including Debt Retirement		Total		
Public Sanitary Sewerage System	Estimated Population Served	Dollars	Dollars per Capita	Dollars	Dollars per Capita	Dollars	Dollars per Capita	Code Number on Figure 52
Milwaukee Metropolitan Subregional Area[a]								
City of Brookfield	16,300	257,459	16	971,157	60	1,228,616	76	1
City of Cudahy	21,700	355,215	16	390,193	18	745,408	34	2
City of Franklin	8,800	50,743	6	1,968,986	224	2,019,729	230	3
City of Glendale	13,500	198,077	15	611,839	45	809,916	60	4
City of Greenfield	29,900	223,503	7	1,144,489	38	1,367,992	45	5
City of Mequon	9,500	158,423	17	1,487,151	157	1,645,574	174	6
City of Milwaukee	670,100	9,201,264	14	15,110,446	23	24,311,710	37	7
City of Muskego	10,200	101,983	10	170,080	17	272,063	27	8
City of New Berlin	13,600	138,628	11	813,673	60	952,301	71	9
City of Oak Creek	14,400	502,323	35	657,112	46	1,159,435	81	10
City of South Milwaukee	23,400	336,546	15	31,385	1	367,931	16	11
City of St. Francis	9,900	98,354	10	117,727	12	216,081	22	12
City of Wauwatosa	55,700	499,044	9	1,336,140	24	1,835,184	33	13
City of West Allis	69,000	687,558	10	2,022,842	29	2,710,400	39	14
Village of Bayside	4,400	44,132	10	118,556	27	162,688	37	15
Village of Brown Deer	13,600	112,504	8	228,930	17	341,434	25	16
Village of Butler	2,100	29,344	14	52,267	25	81,611	39	17
Village of Elm Grove	7,000	93,103	13	158,053	23	251,156	36	18
Village of Fox Point	7,900	72,820	9	184,130	23	256,950	32	19
Village of Germantown	4,600	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Village of Greendale	16,800	152,149	9	439,535	26	591,684	35	20
Village of Hales Corners	8,800	60,444	7	268,538	31	328,982	38	21
Village of Menomonee Falls	20,400	N/A	N/A	N/A	N/A	N/A	N/A	22
Village of River Hills	1,500	30,949	21	211,469	141	242,418	162	23
Village of Shorewood	14,300	130,475	9	236,178	17	366,653	26	24
Village of Thiensville	4,200	73,193	16	11,640	3	84,833	19	25
Village of West Milwaukee	3,800	281,364	74	347,613	91	628,977	165	26
Village of Whitefish Bay	16,200	105,425	7	301,567	19	406,992	26	27
Caddy Vista Sanitary District	1,000	15,798	16	6,591	7	22,389	23	28
Rawson Homes Sewer and Water Trust	600	N/A	N/A	N/A	N/A	N/A	N/A	29
Subregional Area Subtotal[b]	1,093,200	14,010,820	13	29,398,287	27	43,409,107	40	
Upper Milwaukee River Subregional Area								
City of Cedarburg	10,400	164,468	16	158,954	15	323,422	31	30
City of West Bend	21,000	212,857	10	264,448	13	477,305	23	31
Village of Fredonia	1,500	17,097	11	9,567	6	26,664	17	32
Village of Grafton	8,800	186,482	21	39,687	5	226,169	26	33
Village of Jackson	2,000	9,714	5	28,437	14	38,151	19	34
Village of Kewaskum	2,000	90,314	45	18,880	9	109,194	54	35
Village of Newburg	600	14,186	24	10,380	17	24,566	41	36
Village of Saukville	2,300	55,324	24	23,950	10	79,274	34	37
Subregional Area Subtotal[b]	48,600	750,442	15	555,782	11	1,306,224	26	
Sauk Creek Subregional Area								
City of Port Washington	9,500	141,552	15	122,689	13	264,241	28	38
Village of Belgium	900	5,102	6	3,189	4	8,291	10	39
Subregional Area Subtotal[b]	10,400	146,654	14	125,878	12	272,532	26	
Kenosha-Racine Subregional Area								
City of Kenosha	83,400	795,974	10	1,023,669	12	1,819,643	22	40
City of Racine	96,700	973,541	10	9,779,919	101	10,753,450	111	41
Village of Elmwood Park	400	N/A	N/A	N/A	N/A	N/A	N/A	42
Village of North Bay	1,300	8,329	8	4,678	5	13,007	13	43
Village of Sturtevant	4,400	107,820	25	39,959	9	147,779	34	44
Town of Caledonia Sewer Utility District	4,300	62,717	15	151,584	37	214,301	52	45
Town of Mt. Pleasant	13,800	105,748	9	273,038	23	378,786	32	46
Town of Pleasant Prairie-	4,600	18,483	4	52,355	11	70,838	15	47
Sewer Utility District 1								
Sewer Utility District 2								
Sewer Utility District A								
Sewer Utility District B								
Sewer Utility District C								
Sewer Utility District E								
Town of Somers Sanitary District 1	1,500	34,358	21	51,782	32	86,090	53	52
Town of Somers Utility District 1	700	14,882	21	3,900	6	18,782	27	53
Crestview Sanitary District	2,500	N/A	N/A	N/A	N/A	N/A	N/A	53a
North Park Sewer Utility District	6,800	N/A	N/A	N/A	N/A	N/A	N/A	54
Pleasant Park Utility Company	800	N/A	N/A	N/A	N/A	N/A	N/A	55
Subregional Area Subtotal[b]	221,200	2,121,852	10	11,328,479	55	13,431,848	65	

Table 153 (continued)

Public Sanitary Sewerage System	Estimated Population Served	Sanitary Sewerage Expenditures: Operation and Maintenance		Capital Improvements Including Debt Retirement		Total		Code Number on Figure 52
		Dollars	Dollars per Capita	Dollars	Dollars per Capita	Dollars	Dollars per Capita	
Root River Canal Subregional Area								
Village of Union Grove	3,200	48,931	15	21,657	7	70,588	22	57
Subregional Area Subtotal[b]	3,200	48,931	15	21,657	7	70,588	22	
Des Plaines River Subregional Area								
Village of Paddock Lake	1,900	63,028	33	51,773	27	114,801	60	58
Town of Bristol Utility District 1	800	7,536	9	14,191	18	21,727	27	59
Town of Pleasant Prairie Sanitary District No. 73-1	100	20,019	200	70,557	705	90,576	905	60
Pleasant Prairie Utility District D	1,000	18,505	19	36,295	36	54,800	55	61
Town of Salem Sewer Utility District No. 1	1,000	N/A	N/A	N/A	N/A	N/A	N/A	62
Subregional Area Subtotal	4,800	109,088	29	172,816	45	281,904	74	
Upper Fox River Subregional Area								
City of Brookfield	16,200	255,864	16	932,357	58	1,188,221	74	63
City of Waukesha	51,300	413,720	8	414,979	8	828,699	16	64
Village of Pewaukee	4,800	68,029	14	152,801	32	220,830	46	65
Village of Sussex	4,000	46,631	12	9,443	2	56,074	14	66
Subregional Area Subtotal[b]	76,300	784,244	10	1,509,580	20	2,293,824	30	
Lower Fox River Subregional Area								
City of Burlington	8,900	N/A	N/A	N/A	N/A	N/A	N/A	67
City of Lake Geneva	5,700	74,049	13	322,780	57	396,829	70	68
Village of East Troy	2,200	63,472	29	0	0	63,472	29	69
Village of Genoa City	1,100	18,435	17	7,437	7	25,872	24	70
Village of Mukwonago	3,400	34,083	10	5,379	2	39,462	12	71
Village of Rochester[c]	800							
Village of Silver Lake	1,300	32,275	25	71,986	55	104,261	80	72
Village of Twin Lakes	3,400	73,845	22	254,720	75	328,565	97	73
Village of Waterford	2,300							
Town of Rochester[c]	300	45,047	17	113,561	44	158,608	61	74
Brown's Lake Sanitary District	1,900	37,322	20	78,963	42	116,285	62	75
Subregional Area Subtotal[a]	33,600	378,528	18	854,826	40	1,233,354	58	
Upper Rock River Subregional Area								
City of Hartford	7,600	190,671	25	128,090	17	318,761	42	76
Village of Slinger	1,300	33,750	26	7,013	5	40,763	31	77
Allenton Sanitary District	800	N/A	N/A	N/A	N/A	N/A	N/A	78
Subregional Area Subtotal[b]	9,700	224,421	25	135,103	15	359,524	40	
Middle Rock River Subregional Area								
City of Oconomowoc	11,100	95,114	9	76,867	7	171,981	16	79
Village of Dousman	1,000	16,064	16	15,030	15	31,094	31	80
Village of Hartland	4,400	54,452	12	7,612	2	62,064	14	81
Subregional Area Subtotal[b]	16,500	165,630	10	100,509	6	266,139	16	
Lower Rock River Subregional Area								
City of Delavan	5,800	70,156	12	120,459	21	190,615	33	82
City of Elkhorn	4,400	60,394	14	219,423	50	279,817	64	83
City of Whitewater	11,000	179,454	16	209,540	19	388,994	35	84
Village of Darien	1,000	N/A	N/A	N/A	N/A	N/A	N/A	85
Village of Fontana	1,800	N/A	N/A	N/A	N/A	N/A	N/A	86
Village of Sharon	1,400	22,606	16	14,690	10	37,296	26	87
Village of Walworth	1,700	N/A	N/A	N/A	N/A	N/A	N/A	88
Village of Williams Bay	1,700	N/A	N/A	N/A	N/A	N/A	N/A	89
Subregional Area Subtotal[b]	28,800	332,610	15	564,112	25	896,722	40	
Regional Total[b]	1,549,000	19,073,220	12	44,767,029	29	63,821,766	41	

NOTE: N/A indicates data not available.

[a] *The expenditures noted for each of the communities included in the Metropolitan Sewerage District of the County of Milwaukee, which includes all municipalities in Milwaukee County except the City of South Milwaukee, include expenditures for the Milwaukee-metropolitan sanitary sewerage system apportioned back to the municipalities in the District. Capital improvement costs for the metropolitan system were prorated back to the communities based upon equalized assessed valuation. Operation and maintenance costs for the metropolitan system were prorated back to the communities based upon sewage flow.*

[b] *In calculating the per capita costs on a subregional and regional basis, only that aggregate population in those communities providing expenditure data was included.*

[c] *Includes expenditures related to operation, maintenance, and capital improvements for the Western Racine County Sewerage District.*

Source: SEWRPC.

Capital expenditures during 1975 on a per capita basis ranged from a low of $1.26 in the City of South Milwaukee to a high in the Town of Pleasant Prairie Sanitary District No. 73-1 of $705. Operation and maintenance expenditures during 1975 ranged from a low of $4 per capita in the Town of Pleasant Prairie Sewer Utility Districts 1 and 2 and A, B, C, and E to a high of $200 per capita in the Town of Pleasant Prairie Sanitary District No. 73-1.

In any comparison of the reported data, it must be realized that the data may reflect differing levels of service provided, particularly with respect to the level of treatment. It also should be recognized that those communities currently undergoing rapid development or redevelopment may be experiencing disproportionately high expenditures for capital improvements. For example, the very high per capita improvement costs noted in 1975 in the Cities of Franklin and Mequon include capital expenditures during calendar year 1975 for major sewerage construction projects. Similarly, it should be noted that the distribution of land uses within communities will affect per capita costs. For example, there is a relatively high per capita operation and maintenance cost for the Village of West Milwaukee. This is to be expected since the Village experiences high sewage flows due to the large amount of industrial and commercial land use development within the community, but has a relatively low resident population.

Table 154 presents the 1975 budgeted operations and capital expenditures apportioned to the local units of government served by the Metropolitan Sewerage District. These expenditures reflect apportioned county tax levies for those governmental units within Milwaukee County and contract payments for those units outside of the County.

While the data presented in Table 153 relate only to one year and, therefore, with respect to data for any given individual sanitary sewerage system are subject to qualification in any comparisons of sewerage costs between communities, it is reasonable to assume that because the data include both average and extreme local situations, the county and regional averages represent valid per capita costs for a typical year. This would be particularly true with respect to the operation and maintenance costs. As noted above, the average per capita cost for operation and maintenance of sanitary sewerage systems during 1975 was $12. On a subregional basis such per capita costs ranged from $10 in the Middle Rock River subregional area to $29 in the Des Plaines River subregional area. The per capita operation and maintenance costs for each reporting system in the Region during 1975 (in 1976 dollars) are depicted in Figure 52. From this figure it may be concluded that, in general, per capita operation and maintenance costs for sanitary sewerage systems decrease with increasing system size.

The foregoing per capita costs developed for the Region as a whole may be compared with the national average per capita costs developed for the U. S. Environmental Protection Agency (EPA). In a report published by the EPA, the 1968 average annual per capita cost for operation and maintenance of centralized sanitary sewerage systems was estimated in 1976 dollars at $7.30. Given the precision with which the data were collected at the national and regional level, this figure is comparable to the regional average of $9.10 per capita for operation and maintenance of centralized sanitary sewerage systems for the year 1970. Similarly, the regional average of $32.60 per capita for capital improvements during 1970 may be compared with a national average of about $25 per capita for the year 1968 when expressed in 1976 dollars.

Table 154

OPERATING EXPENDITURES APPORTIONED WITHIN THE AREA SERVED BY THE METROPOLITAN SEWERAGE DISTRICT: 1975 (IN CONSTANT 1976 DOLLARS)

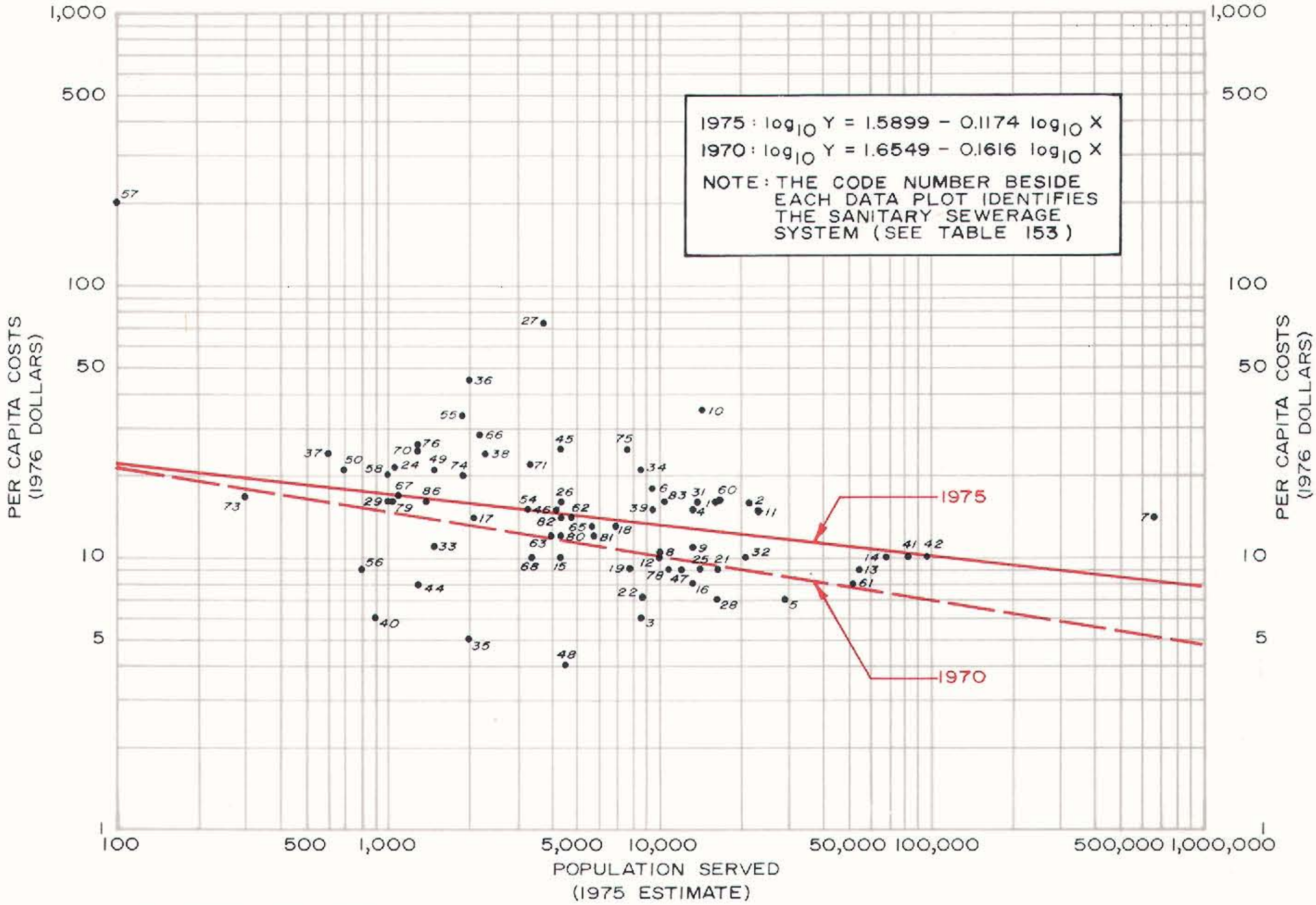
Unit of Government	Local Share of Operating Budget of the Metropolitan Sewerage District Funded through County Tax Levy and Contract Payments
City of Brookfield[a]	$ 147,487
City of Cudahy	240,162
City of Franklin	26,359
City of Glendale	118,973
City of Greenfield	123,327
City of Mequon[a]	95,462
City of Milwaukee	5,777,425
City of Muskego[a]	0
City of New Berlin[a] (including population of 1,100 in Regal Manors Subdivision)	105,722
City of Oak Creek	191,117
City of South Milwaukee	0
City of St. Francis	72,508
City of Wauwatosa	315,440
City of West Allis	446,682
City Total	$7,660,665
Village of Bayside	$ 24,064
Village of Brown Deer	56,359
Village of Butler[a]	28,322
Village of Elm Grove[a]	86,003
Village of Fox Point	47,811
Village of Germantown[a]	0
Village of Greendale	69,104
Village of Hales Corners	31,662
Village of Menomonee Falls[a]	5,677
Village of River Hills	19,789
Village of Shorewood	84,461
Village of Thiensville[a]	0
Village of West Milwaukee	192,588
Village of Whitefish Bay	77,257
Village Total	723,097
Caddy Vista Sanitary District	0
Rawson Homes Sewer and Water Trust	0
Area Total	$8,383,762

[a] *Communities that have contractual agreements with the Metropolitan Sewerage District. These contract payments are applied to operating expenditures as well as to capital expenditures made within the District.*

Source: Metropolitan Sewerage District and SEWRPC.

Figure 52

RELATIONSHIP OF PER CAPITA OPERATION AND MAINTENANCE COSTS OF SANITARY SEWAGE TREATMENT TO POPULATION SERVED: 1970 AND 1975 (IN CONSTANT 1976 DOLLARS)



NOTE: ONLY 1975 DATA POINTS ARE PLOTTED

Source: SEWRPC.

Comparable regional data relating to sanitary sewerage system expenditures for the year 1970—the data base year for the regional sanitary sewerage system plan—are presented in Table 155. The table indicates that the regional average annual cost for operation, maintenance, and capital improvements decreased from \$41.70 per capita in 1970 to \$41.20 per capita in 1975 when expressed in constant 1976 dollars, representing a decrease of about 1.2 percent over the five-year period. The annual costs expended for operation and maintenance increased from \$9.10 per capita in 1970 to \$12.30 per capita in 1975, representing an increase of 35 percent, while the annual expenditure capital improvements decreased from \$32.60 per capita in 1970 to \$28.90 per capita in 1975, representing a decrease of over 11 percent. The increase in expenditures for operation and maintenance can be expected due to the increased capacity and higher levels of treatment required. In particular, the high percentage increase in operation and maintenance can be attributed to the large increase in the number of people served by treatment plants providing advanced waste treatment for phosphorus removal—from less than one million people in 1970 to nearly 1.5 million in 1975. Chemical treatment utilized for conventional methods of phosphorus removal can be expected to cost about \$40 per million gallons, or about \$3 per capital per year at a per capita contribution of 210 gallons per day.

Expenditures for Urban Land Management Practices

The local expenditures included in the category "urban land management practices" and as reported in the available data support the provision of urban land management practices which affect nonpoint sources of pollution and which—as line items in local budgets—will be the expenditure categories to which future urban nonpoint source control expenditures must be added. These land management activities include refuse collec-

Table 155

ESTIMATED SANITARY SEWERAGE SYSTEM EXPENDITURES IN THE REGION: 1970 AND 1975
(IN CONSTANT 1976 DOLLARS)

		Sanitary Sewerage Expenditures					
		Operation and Maintenance		Capital Improvements Including Debt Retirement		Total	
Year	Estimated Population Served	Dollars	Dollars per Capita	Dollars	Dollars per Capita	Dollars	Dollars per Capita
1970	1,488,700	13,542,897	9.10	48,561,156	32.60	62,104,054	41.70
1975	1,549,000	19,073,220	12.30	44,819,384	28.90	63,892,604	41.20
Percent Increase 1970-1975	4	40.8	35.2	- 7.7	- 11.4	2.9	- 1.2

Source: SEWRPC.

tion and disposal, street sweeping, leaf and rubbish pickup and disposal, storm sewer cleaning and maintenance, snow removal, sanding and salting, and local water quality sampling and enforcement programs. Not included in the listing of water quality-related urban land management expenditures are such items as park maintenance and operation, outdoor and water recreation expenditures, and other park and recreation expenditures related to open space. Recent estimates of total expenditures made by local units of government for park and outdoor recreational activities in the Region approximated $42 million in 1974 when expressed in 1976 dollars. Both water quality-related urban land management expenditures estimates and sanitary sewerage system expenditure estimates for 1975 are presented in Table 156. It should be stressed that the Commission quantified by means of a special-purpose inventory the subset of expenditures for the more readily definable and more precisely identifiable category of sanitary sewerage system expenditures.

The detail presented by the survey of local government units which operate sanitary sewerage systems does allow an estimate to be made of the relative importance of sanitary sewerage costs to total water quality expenditures for 1975. By subtracting the debt retirement costs from the Commission survey results, and by subtracting the sanitary sewerage expenditures from the total reported water quality expenditures for 1975, expenditures by local units of government for other water quality-related items can be estimated. These then, are the estimated expenditures for urban land management practices.

Thus, the majority of the water quality-related expenditures in the Region—54 percent—are for land management practices. It should be noted that these costs may include activities which contribute rather than reduce pollutants to the lakes and streams. Examples include snow and ice removal and dumping along river banks and sanding and salting of streets. This qualification also applies to a limited degree to sanitary sewerage expenditures, which support the cost of constructing flow relief devices. Such devices protect homes against the health hazards of sewer surcharging but result in raw sewage discharges to streams and lakes. Villages and towns spend the largest percentage of their water quality-related expenditures on land management practices—79 percent and 67 percent, respectively. Counties, except for Milwaukee County, report no sanitary sewerage expenditures, leaving the provision of these services to the individual municipalities within the counties.

PRIVATE DISBURSEMENTS

While the public sector does provide a large portion of expenditures for water quality management-related items, the private sector also expends funds in this regard. Specifically, the agricultural sector expends significant amounts for soil and water conservation practices—inclusive of vegetative cover, water retention, flow control, and crop production practices, and animal waste management facilities. A part of these efforts are supported with public financial and technical assistance through the U. S. Department of Agriculture (USDA).

Data concerning federal cost-sharing in the Region for soil and water conservation by the agricultural sector were obtained from records of the Soil Conservation Service (SCS) and the Agricultural Stabilization and Conservation Service (ASCS) of the U. S. Department of Agriculture, and are based on practices carried out during calendar year 1975. These expenditures have been adjusted to constant 1976 dollars to aid interpretation and are shown in Table 157. The total value of the soil and water conservation practices undertaken with technical or financial assistance from the USDA in the Region from 1965 through 1975 is estimated at $12.5 million in constant 1976 dollars as shown in Table 158. This represents an annual average expenditure of $1.14 million. The federal share of soil and water conservation practice expenditures in the Region in 1975 was $188,000, or approximately 40 percent of

Table 156

TOTAL ESTIMATED WATER QUALITY MANAGEMENT EXPENDITURES BY UNIT OF GOVERNMENT IN THE REGION: 1975

Unit of Government	In Millions of 1976 Dollars: Urban Land Management Expenditures	In Millions of 1976 Dollars: Sanitary Sewerage Expenditures[a]
Milwaukee County. . .	$ 1.1	$15.0[b]
Other Counties	2.5	0.0
City of Milwaukee . . .	14.8	13.9
Other Cities	31.3	21.3
Villages	10.3	2.7
Towns.	2.2	1.1
Total	$62.2	$54.0

[a] *Does not include debt retirement expenditures.*

[b] *It should be noted that this figure could increase to as high as 400 percent of the 1975 estimated expenditure in complying with the judgment order issued on July 29, 1977, in the initial trial of the State of Illinois v. The Sewerage Commission of the City of Milwaukee and the Metropolitan Sewerage Commission of the County of Milwaukee.*

Source: SEWRPC.

Table 157

FEDERAL FUNDING OF FARM CONSERVATION PRACTICES AND PROPORTION OF FARMS BY COUNTY IN THE REGION: 1975

County	(In constant 1976 dollars) Funds Expended	(In constant 1976 dollars) Percent of Total Funds Expended	Percent of Total Farms in Region
Kenosha	$ 30,745	16.3	10.5
Milwaukee . . .	2,004	1.1	2.0
Ozaukee	22,194	11.8	11.0
Racine.	35,471	18.8	12.5
Walworth. . . .	32,882	17.4	22.1
Washington . .	29,926	15.9	22.8
Waukesha. . . .	35,237	18.7	19.1
Total	$188,459	100.0	100.0

[a] *Includes Agricultural Stabilization and Conservation Service long-term agreements (LTA) requiring conservation practices, as well as Agricultural Conservation Program (ACP) payments. Does not include Cropland Adjustment Programs (CAP) payments reflected in Table 159.*

Source: U. S. Department of Agriculture and SEWRPC.

the total 1975 agricultural conservation expenditures shown in Table 159. Although the federal share of individual projects over the period ranged between 50 and 75 percent, the 1975 federal assistance is a relatively smaller share of the total because the 1975 expenditures were lower than the average for the decade, and because the purchasing power of the federal allocations to the counties of the Region was eroded by inflation. While it is not possible to compare the total replacement costs presented in Table 158 with the expenditures reported by the Agricultural Stabilization and Conservation Service in Table 159, the grants awarded by the ASCS normally cover 50 to 90 percent of the estimated costs of conservation practices. The amount of reported expenditures by the ASCS has consistently declined since 1967, with the 1975 expenditure level representing only 36 percent of the 1967 level, as shown in Figure 53. This decline may be due to the decrease in the number of farms in the Region as well as to reduced funding by the U. S. Department of Agriculture. Table 158 shows that Ozaukee and Washington Counties received more than 50 percent of all monies spent on soil and water conservation practices in the Region between 1965 and 1975, whereas the federal cost-sharing funds applied are spread relatively uniformly throughout the rural areas of the Region, with the obvious exception being Milwaukee County, which received only 2 percent of the funds in 1975, as shown in Table 157.

One measure of the ability of the Region to fund future soil and water conservation practices is net farm income. Table 160 sets forth the estimated net farm income per capita, per farm, and per acre for farms in the Region in 1975. The net income per farm of $12, 674 exceeds the state average of $8,500 by 49 percent, with the highest income reported for Milwaukee and Racine Counties—both of which have a high proportion of sales in high-value products. Thus, the annual average expenditure for soil and water conservation practices has historically amounted to about 2 percent of the current farm net income.

Other portions of the private sector, specifically industrial and commercial establishments of the Region, also probably expend considerable sums on water quality control-related practices. Frequently, the related costs are considered part of the indirect production costs of an industry, and are accordingly held in relative confidence. Therefore, in lieu of a detailed local inventory, an analysis of data prepared by the U. S. Bureau of Census was conducted, and adjusted for regional conditions. As noted in Table 161, the estimated total expenditure for water pollution control by industry in 1975, adjusted to 1976 dollars, was more than $32 million, or only about 0.5 percent of the value added by manufacturing in the Region. This total also represents about 27 percent of the water quality-related expenditures made by local governments, while the water pollution abatement capital expenditures represent only 4 percent of the $400 million total industry capital expenditure in the Region for 1975. However, this

Table 158

ESTIMATED REPLACEMENT COSTS OF SOIL AND WATER CONSERVATION PRACTICES CARRIED OUT IN THE REGION BY COUNTY: 1965-1975 (IN CONSTANT 1976 DOLLARS)

County	Practice Category (thousands)					County Total
	Vegetative Cover Practices	Water Retention Practices	Flow Control Practices	Crop Protective Practices	Animal Waste Facilities	
Kenosha	$ 79.3	$ 260.0	$ 310.6	$ 613.9	$ 48.0	$ 1,311.8
Milwaukee	11.7	52.0	17.6	12.9	0.0	94.2
Ozaukee	2,455.2	396.6	418.1	566.0	0.0	3,835.9
Racine.	85.6	116.7	344.6	299.4	48.0	894.3
Walworth.	93.8	373.9	570.3	692.4	48.0	1,778.4
Washington	262.9	753.5	1,031.2	628.8	48.0	2,724.4
Waukesha.	360.3	784.0	465.3	255.1	96.0	1,960.7
Total	$3,348.8	$2,736.7	$3,157.7	$3,068.5	$288.0	$12,599.7

Source: U. S. Department of Agriculture and SEWRPC.

Table 159

REPORTED EXPENDITURES FOR AGRICULTURAL CONSERVATION PRACTICES IN THE REGION BY THE AGRICULTURAL STABILIZATION AND CONSERVATION SERVICE: 1967-1975[a] (IN CONSTANT 1976 DOLLARS)

County	Year									Total	Percent of Total
	1967	1968	1969	1970	1971	1972	1973	1974	1975		
Kenosha	$ 104,869	$ 86,808	$ 84,793	$ 81,534	$ 65,884	$ 63,211	$ 31,890	$ 38,036	$ 49,086	$ 606,111	7.8
Milwaukee . . .	35,429	32,758	31,239	27,903	27,948	25,534	19,082	15,787	15,217	230,897	3.0
Ozaukee	73,829	61,450	21,051	57,801	63,206	43,414	21,389	24,903	33,987	401,030	5.1
Racine	234,488	221,460	207,283	215,483	148,055	122,642	110,542	76,067	81,157	1,417,177	10.1
Walworth. . . .	182,523	179,886	170,947	174,633	152,204	97,921	58,643	60,787	57,999	1,135,543	14.5
Washington . .	121,334	119,459	101,159	97,820	106,361	65,927	28,795	43,595	45,035	729,485	9.3
Waukesha . . .	535,632	524,233	478,207	425,021	345,285	329,745	238,119	227,620	185,324	3,289,186	42.2
Total	$1,288,104	$1,226,054	$1,094,679	$1,080,195	$908,943	$748,394	$508,460	$486,795	$467,805	$7,809,429	100.0

[a] *Includes Agricultural Stabilization and Conservation Service long-term agreements (LTA) requiring conservation practices, Agricultural Conservation Program (ACP) payments to undertake soil and water conservation practices, and Cropland Adjustment Program (CAP) lands payments for land removed from production and therefore subject to reduced soil losses.*

Source: SEWRPC.

amount is only a generalized estimate, since Census Bureau disclosure laws and the inherent variance of the sample data may cause the number to be underestimated.

The Region thus received 34 percent of the estimated $93.4 million water pollution abatement expenditures made by industry in the State during 1975. This amount expended within the Region is consistent when compared to the relative importance of the Region to the State in terms of overall employment; however, the bulk of water pollution expenditures within the State was made by the pulp and paper industry, an industry having relatively low employment in the Region.

PUBLIC REVENUE SOURCES

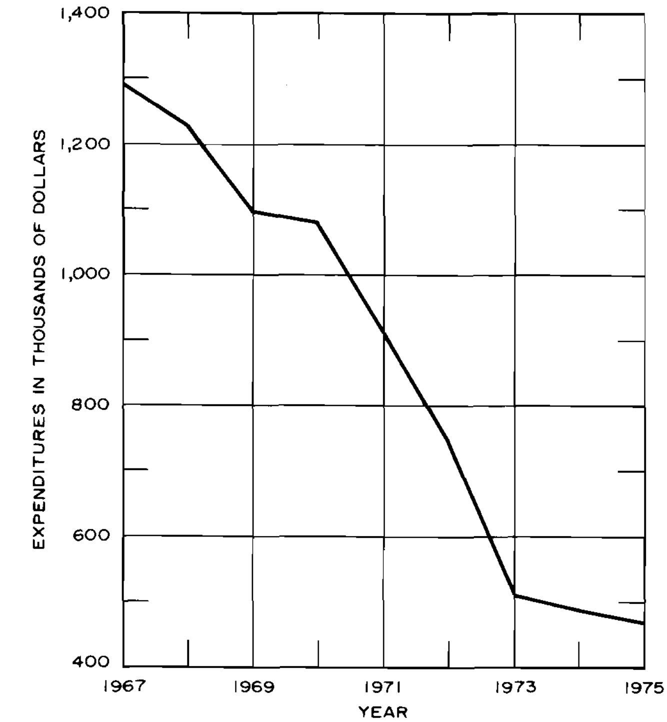
The monies raised each year by local governments come from five primary sources: tax revenues, including both returned state and local property taxes; borrowing revenues; state and federal grants-in-aid; the State of Wisconsin Outdoor Resources Action Plan (ORAP) program; and general revenues, including receipts from public industries.

Tax Revenues

The property tax levy has consistently been the largest source of revenue for local governments in the Region,

Figure 53

REPORTED EXPENDITURES FOR AGRICULTURAL CONSERVATION PRACTICES IN THE REGION BY THE AGRICULTURAL STABILIZATION CONSERVATION SERVICE: 1967-1975 (IN CONSTANT 1976 DOLLARS)



Source: U. S. Department of Agriculture and SEWRPC.

comprising more than 26 percent of the 1975 governmental revenues. Monies needed for the operation of local governments that are not received from other sources are principally supplied by the property tax levy. As such, the property tax is a residual source of government revenue, and may be expected to vary significantly by year and type of government as total local government revenues and expenditures change. Overall, the present tax levies for all general-purpose government types are at or below the tax levy ceilings imposed on each unit by the Wisconsin legislature. Table 162 reflects the fiscal position of the counties in this respect. These levy limits allow property taxes for a unit of government to increase by the statewide percentage increase of equalized property valuation; however, levies for debt service and pollution abatement orders are not subject to these constraints. The availability of future governmental revenues from property tax levies remains strong as long as the value of property in the Region continues to increase.

The full, or equalized, value of all taxable real and personal property in the Region expressed in 1976 dollars has increased from more than $21.3 billion in 1971 to about $25.2 billion in 1975, a real increase of $4 billion, or 18 percent, as shown in Table 163. However, this rate of increase has not been equally distributed among the seven counties. The largest relative increases in the full value of property occurred in Waukesha, Ozaukee, and Washington Counties, which are experiencing rapid urbanization, while the equalized values within the urban counties of Kenosha, Milwaukee, and Racine are increasing at lower rates.

Table 160

ESTIMATED CASH RECEIPTS AND NET INCOME FOR FARMS IN THE REGION: 1975 (IN CONSTANT 1976 DOLLARS)

County	Gross Cash Receipts[a] (thousands)	Realized Net Income (thousands)	Net Income per Capita (farm population)	Net Income per Farm	Net Income per Acre
Kenosha	$ 20,551	$ 5,960	$2,732	$12,290	$ 63.46
Milwaukee	8,031	2,330	7,689	24,783	217.94
Ozaukee	18,804	5,453	3,105	10,755	64.56
Racine.	45,488	13,191	5,583	22,782	115.23
Walworth.	47,769	13,853	3,183	13,567	61.07
Washington . . .	38,178	11,072	2,450	10,472	66.70
Waukesha.	23,312	6,760	2,214	7,665	49.27
Total	$202,133	$58,619	$3,165	$12,674	$ 70.32

[a]*Excludes government payments.*

Source: Wisconsin Statistical Reporting Service and SEWRPC.

Table 161

ESTIMATED VALUE ADDED BY INDUSTRY, ESTIMATED CAPITAL EXPENDITURES BY INDUSTRY, AND ESTIMATED WATER QUALITY-RELATED EXPENDITURES BY INDUSTRY IN SOUTHEASTERN WISCONSIN BY COUNTY: 1975 (IN CONSTANT 1976 DOLLARS)

County	Value Added by Industry[a]		Capital Expenditures for All Plant and Equipment[a]		Water Quality-Related Expenditures (millions)			Water Quality Capital Expenditures as a Percentage of All Industry Capital Expenditures (millions)
	Amount (millions)	Percent of Region Total	Amount (millions)	Percent of Region Total	Operation and Maintenance[b]	Capital[c]	Total	
Kenosha	$ 618.5	8.8	$ 28.9	7.2	$ 1.3	$ 1.2	$ 2.5	0.3
Milwaukee . . .	4,326.2	61.7	258.9	64.7	10.5	10.0	20.5	2.5
Ozaukee	202.5	2.9	12.2	3.1	0.5	0.5	1.0	0.1
Racine	798.1	11.4	44.6	11.1	1.7	2.4	4.1	0.6
Walworth. . . .	115.2	1.6	11.5	2.9	0.3	0.4	0.7	0.1
Washington . .	282.3	4.0	8.5	2.1	0.3	0.4	0.7	0.1
Waukesha . . .	673.9	9.6	35.8	8.9	1.5	1.4	2.9	0.3
Total	$7,016.7	100.0	$400.4	100.0	$16.1	$16.3	$32.4	4.1

[a] *Based on annual survey conducted by the Bureau of the Census for all counties.*

[b] *Based on annual survey conducted by the Bureau of the Census for Standard Metropolitan Survey Areas (SMSA). Data allocated to respective counties within the Milwaukee SMSA are based on ratio of operation and maintenance expenditures to water quality capital costs within the SMSA. Walworth County estimates are based on a similar ratio for the Region.*

[c] *Based on annual survey conducted by the Bureau of the Census for SMSA's. Data allocated to respective counties within the Milwaukee SMSA based on ratio of water quality capital expenditures to all capital expenditures for the SMSA. Data for Walworth County based on information supplied by Wisconsin Department of Revenue.*

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

Table 162

PERCENT OF ALLOWABLE TAX LEVY INCREASE UTILIZED BY COUNTY GOVERNMENT IN THE REGION: 1975-1977

County	Percent of Allowable Tax Levy Increase[a]
Kenosha	97
Milwaukee	0
Ozaukee	95
Racine.	5
Walworth.	20
Washington	97
Waukesha.	8

[a] *Based on state-imposed limits on tax levies which restrict the percentage increases to no more than the percentage increase in statewide equalized assessed values.*

Source: Wisconsin Department of Revenue and SEWRPC.

It is helpful to relate the data presented in this chapter to the average property tax rates in the Region. The means of the reported 1975 property tax rates were $25.11, $22.93, and $18.72 per $1,000 of equalized assessed values for the cities, villages, and towns in the Region, respectively. The total water quality-related public expenditures within the Region for 1975 would be equal to about $4.60 per $1,000 of equalized assessed value in the Region in 1975. Of these expenditures, only a portion is supported by local property tax revenues, with the balance coming from operating revenues, such as "user charges" and "industrial cost recovery charges," and from state and federal grants-in-aid. In addition, it should be noted that of the $4.60, only about $2.50 per $1,000, or about 54 percent, would be associated with sanitary sewerage system expenditures, again only paid in part through local property taxes. The remaining 46 percent would be associated with urban land management practices such as street and highway maintenance and collection and transport of solid wastes.

Borrowing Revenues

Borrowing has been another major source of revenue for the local units of government. Revenues from borrowing are often used to finance needed public facilities, such as wastewater treatment plants, which can be amortized over a considerable period of time. The length of time a municipality or special-purpose district may amortize a borrowed debt is generally limited to 20 years by state law. In the Region, notable exceptions to this law are Racine, Milwaukee, and Waukesha Counties, which meet statutory population requirements enabling them to amortize bond issues for land acquisition purposes within their county over a period of up to 50 years. The following listing briefly defines the various forms of borrowing available to the local units of government in the Region.

Table 163

STATE EQUALIZED PROPERTY VALUES FOR THE REGION BY COUNTY: 1971-1975
(IN CONSTANT 1976 DOLLARS)

County	Value (millions)					Percent Increase 1971-1975
	1971	1972	1973	1974	1975	
Kenosha	1,270.9	1,335.5	1,425.8	1,482.3	1,612.1	26.7
Milwaukee	12,254.0	12,555.1	12,796.2	12,928.8	13,421.6	9.5
Ozaukee	829.8	891.0	956.1	1,033.9	1,110.5	33.8
Racine.	1,869.1	1,929.0	2,005.5	2,128.6	2,215.4	18.5
Walworth.	1,018.9	1,155.1	1,176.3	1,230.1	1,305.4	28.1
Washington	874.9	966.6	1,035.9	1,106.0	1,168.2	33.5
Waukesha.	3,191.0	3,512.7	3,791.9	4,093.3	4,360.2	36.6
Total	21,308.6	22,345.0	23,187.7	24,002.0	25,193.4	18.2

Source: Wisconsin Department of Revenue, Bureau of Local Fiscal Information and SEWRPC.

Municipal Bonds: Municipal bonds are issued by a jurisdiction having the power to levy a general property tax. These bonds are backed by the taxing power and require the approval of the electors via a referendum if sufficient signatures are presented in a petition. Such debts are limited by a statutory requirement that the total amount of indebtedness, including existing indebtedness, of any municipality shall not exceed 5 percent of the state equalized property value for that municipality. Further, taxes levied to pay off the debt are exempt from any legislative limit of rates and amount.

Mortgage or Revenue Bonds: Mortgage or revenue bonds are issued by municipalities to acquire, construct, lease, operate, or manage a public utility and use the public facility as collateral, with the revenues produced by the facility being used to repay the bonds. Indebtedness incurred via mortgage bonds is not restricted by the 5 percent debt limit of a municipality, and such bonds do not require the approval of the electorate for issuance unless a petition is filed. Public Law 94-305, which became effective in June 1976, allows a state or municipality to issue tax exempt revenue bonds to finance pollution control facilities for small- and moderate-sized businesses. The Federal government, through the Small Business Administration, guarantees these loans which are to be paid back from the private business revenues generated. The actual effectiveness of this newly established program could not be assessed as of this writing.

Public Improvement Bonds: Public improvement bonds are issued by municipalities to finance construction or acquisition of any revenue-producing public improvement. The bondholders have first call on the revenues produced. If revenues are insufficient to cover debt service and operations, the municipality is to make up the difference from its general tax levy. Public improvement bonds are a general obligation of the municipality and, as such, come under the 5 percent debt limit of a municipality.

Special Improvement Bonds and Certificates: When payment for all or part of a public improvement is to be made by special assessment, municipalities are authorized to use contractors' certificates, general obligation-local improvement bonds, or special assessment bonds to provide financing. Contractors' certificates shift financing costs onto the contractor who does the work. Should the special assessment levied not be paid off, the contractor would exchange his certificates for tax sale certificates of the property involved. The municipality collects the special assessment and pays it over to the contractor. The contractor is protected against nonpayment by liens established at the date of assessment against the property involved. General obligation-local improvement bonds are issued by the municipality. Collections of special assessments and the interest on them is placed into a "sinking fund" which is used to pay off the local improvement bonds. An irrepealable tax is levied at the time of issuance, and the tax rate is adjusted annually so that it brings in only enough money to pay off the difference between what is in the sinking fund and the payment coming due. Special assessment bonds are issued by the municipality and used to finance work projects where the bonds relate to individual properties and are secured and paid from assessments against those particular properties. Thus each bond has its own sinking fund. In the event of nonpayment of the special assessment, the proceeds from the tax sale are used to pay off the bond; however, if these proceeds are insufficient, no additional payment from other sources is guaranteed. Special assessment bonds do not come under the 5 percent debt limit since they are not supported by tax levies.

Other Notes and Bonds: Promissory notes may be issued by municipalities to meet short-term financing requirements. Such notes are backed by an irrepealable tax, which makes the note a general obligation and thus subject to the 5 percent debt limit. These notes must be paid off by August 30th of the year following the levy. Thus the maximum effective length of such notes would be about 21 months.

Bond anticipation notes may be issued by municipalities where contracts are to be let but where the bonds authorized to be sold for the project have not as yet been sold. The proceeds from the sale of the bonds constitute a trust fund to pay off the notes.

Delinquent tax bonds with terms of up to five years may be issued by municipalities as a form of temporary borrowing. The total amount is limited to the amount of delinquent taxes at the time of issue. Proceeds from delinquent taxes are used to establish a sinking fund which is used to pay off the bonds. The municipality has the option to levy a direct tax to make up any deficiency if tax collections fall short.

Table 164 presents in summary form the typical means of borrowing which are available to the various units of government in the Region. These various forms of borrowing may be grouped into two general categories: general obligations and revenue or special assessment debt, with the major difference between the categories being that general obligation borrowing is fully backed by the tax base of the local government and is subject to a state-imposed debt limit, while revenue or special assessment-based borrowing uses as collateral the asset for which the bond was issued and is not subject to the debt limit, since revenues—rather than tax levies—produced by the asset, or by assessment, are used to retire the bond. Table 165 summarizes the amounts of debt outstanding in the Region by general group for the units of government.

Federal Grants-in-Aid: Of special importance to the local units of government are state and federal grants-in-aid for construction of elements of sanitary sewerage systems. The federal grants program, conducted under the provisions of Title II of the 1972 Federal Water Pollution Control Act Amendments, provides for financial assistance in the amount of 75 percent of the cost of planning, designing, and constructing sanitary sewage collection and treatment facilities. This program, authorized for appropriations in the amount of $18 billion for federal fiscal years 1973, 1974, and 1975—$5 billion, $6 billion, and $7 billion, respectively—represents the largest public works program in American history. Although no monies were appropriated through the federal water pollution control laws in fiscal year 1976, the program was the vehicle for approximately $900 million in the 1976 Public Works Act appropriation, and $1 billion in the 1977 water pollution control grants appropriation. The total amount available to Wisconsin from these appropriations was $317,401,800. As of August 5, 1977, $307,901,800 had been committed to local projects in the State. Over the intervening 58-month period, this averaged $63.7 million per year. Of this amount, $61.1 million, or about 96 percent, was in routine appropriations under the Federal Water Pollution Control Act Amendments of 1972. The Wisconsin Department of Natural Resources anticipates, based on recent federal legislation, 2.013 percent of the national appropriation of $4.5 billion. Thus, Wisconsin's share of the appropriations through federal fiscal year 1988 is forecast at an average of $90.6 million per year, a 42 percent increase over the amounts available from October 1, 1972 to September 1977.

Of the $307.9 million committed to date, approximately $104.2 million, or 33.9 percent, went to the support of projects in the Region. Table 166 sets forth the amounts of federal grants-in-aid appropriated to the Region by county and by year, along with the number of projects by county.

In addition, the State of Wisconsin, through its Outdoor Resources Action Plan (ORAP) program has—between 1969 and 1977—provided important local assistance in the amount of $144 million, or $18 million per year, for 5 percent grants supplemental to the federal grant support, 25 percent grants for projects not immediately eligible or not fundable by the federal program, and 15 percent grants for construction of advanced waste treatment facilities. In addition, $5 million of the ORAP funds was allocated by the legislature to support 50 percent of the total cost of building or upgrading sewage collection and treatment systems in communities with under 10,000 population, in the legislative creation of Section 144.23 of the Wisconsin Statutes. Table 167 indicates the number and amounts of grants awarded within the counties of southeastern Wisconsin over this eight-year period, during which a total of 198 projects were awarded grants totaling $57 million, or about $7.1 million per year. Thus, in-Region project grants constitute about 39 percent of the statewide total.

General Revenues: User Charges

Additional sources of water quality-related revenue are user charges and industrial cost recovery charges (UC/ICR). User charges are associated with mortgage revenue bonds, because these bonds are required to be paid off from revenues generated by the facility instead of by property taxes and user charges perform this function. Federal law also requires repayment of the industrial share of federal grants-in-aid to municipalities for construction of sewage treatment facilities in the form of industrial cost recovery charges. The industrial share of the grant is that portion of the project cost necessitated by industrial discharge to the treatment works. This share of the project cost may be paid back over a period of up to 30 years with no interest charged to the municipality receiving the grant. Of the money recovered, federal law requires that 50 percent be retained at the local level. Of that portion, 80 percent must be invested for future capital improvements to the treatment works. The remaining 20 percent may be used to reduce overall costs. Of the 95 centralized sanitary sewerage systems in the Region, 72, or about 76 percent, were reported to have a system of user charges functioning, as shown in Table 168. Of the 72 public sanitary sewerage systems financed utilizing user charges, 49 reported using other methods of financing such as general property taxes or special assessment in addition to the user charge system.

Table 164

AVAILABILITY OF DIFFERENT FORMS OF BORROWING FOR CATEGORIES OF UNIT OF GOVERNMENT IN THE REGION

Unit of Government	Municipal Bonds	Mortgage Bonds	Mortgage Certificates	Public Improvement Bonds	Special Improvement Bonds and Certificates	Promissory Notes	Bond Anticipation Notes	Delinquent Tax Bonds
City	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Village	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Town	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Town Utility District	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Town Sanitary District	Yes	Yes	No	Yes	Yes	Yes	No	No
Joint Sewerage Commission[a]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Metropolitan Sewerage District Organized under Chapter 66 of the Wisconsin Statutes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Metropolitan Sewerage District Organized under Chapter 59 of the Wisconsin Statutes	Yes	Yes	Yes	Yes	Yes	No	Yes	No
Inland Lake Protection and Rehabilitation Districts	Yes	Yes	No	No	Yes	Yes	No	Yes
County	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[a] *Approval requirements of participating communities place severe restrictions on the exercise of any financing authority.*

Source: Wisconsin State Statutes and SEWRPC.

Table 165

EXISTING LONG-TERM INDEBTEDNESS, STATUTORY DEBT LIMITS, MORTGAGE REVENUE BONDS, AND NOTES OUTSTANDING FOR THE REGION BY UNIT OF GOVERNMENT: 1975

Unit of Government	Total Indebtedness (millions)	Debt[b] Limit (millions)	Margin Under Limit (millions)	Total as Percent of Limit	Mortgage Revenue Bonds Outstanding
County[a]	$134.8	$1,184.2	$1,049.4	11.4	$ 0.0
City	240.1	815.0	574.9	29.5	55.7
Village	43.7	173.1	129.4	25.2	6.8
Town	5.0	168.7	163.7	3.0	2.5
Total	$423.6	$2,341.0	$1,917.4	18.1	$65.0

[a] *Includes Metropolitan Sewerage Districts which had a total of about $64 million in long-term debt outstanding.*

[b] *Determined by the State, based on 5 percent of the total equalized property value for the local unit of government.*

Source: Wisconsin Department of Revenue, Bureau of Local Fiscal Information and SEWRPC.

If the current bonding statutes of the State of Wisconsin, as they pertain to the Metropolitan Sewerage Commission, remain unchanged, it is estimated—as demonstrated in Figure 54—that the state-imposed bonding limit for Milwaukee County will be reached in 1984 due to the estimated capital expenditures needed to comply with the Federal Court order brought by the State of Illinois. Currently, legislation is being sought to allow the Metropolitan Sewerage Commission to institute user charges and industrial cost recovery fees to meet federal requirements of cost recovery. If the Metropolitan Sewerage Commission can generate revenue in this manner, it may then be possible to initiate revenue bonding to finance new construction. Revenue bonding has no state-imposed limit, and local tax monies are not needed in order to retire the bonds.

SUMMARY

Evaluation of recommended water quality plans requires a determination that the units of government and other agents responsible for implementation have the financial ability to act as specified by the plan. Accordingly, an evaluation of financial resources affecting water quality management was conducted to reflect generally the financial resources expended during the year 1975 or during the preceding years where historical data are available. Utilizing information obtained by the Commission from a special-purpose sanitary sewerage system expenditures inventory, the Wisconsin Department of Revenue, Bureau of Municipal Audit Reporting Forms, the annual reports of selected sanitary sewerage operating

Table 166

FEDERAL SANITARY SEWAGE COLLECTION AND TREATMENT GRANTS-IN-AID: 1974-1977[a]

County	Number of Projects	Total Project Federal Share (millions)	1974 Federal Share[b]	1975 Federal Share[b]	1976 Federal Share[b]	1977 Federal Share[b,c]
Kenosha	5	1.08	0.00	0.00	0.04	1.04
Milwaukee	13	25.47	11.44	0.34	1.39	12.30
Ozaukee	5	0.21	0.00	0.00	0.07	0.14
Racine.	13	23.53	11.17	0.12	0.22	12.02
Walworth.	10	1.76	0.00	0.00	0.43	1.33
Washington	6	15.89	0.00	0.05	0.67	15.17
Waukesha.	22	10.27	0.00	5.70	0.30	4.27
Total	74	78.21	22.61	6.21	3.12	46.27

[a] *Average monthly grant amounts over the 43-month period equal $1.82 million or about $21.83 million per year.*

[b] *75 percent.*

[c] *Includes only the first seven months of 1977, to August 5, 1977.*

Source: *Wisconsin Department of Natural Resources and SEWRPC.*

Table 167

STATE GRANTS-IN-AID FOR SANITARY SEWERAGE FACILITIES UNDER ORAP PROGRAM: 1969-1977[a]

County	Number of Grants	Amount
Kenosha	20	$ 3,320,273
Milwaukee	92	36,613,021
Ozaukee	14	1,947,780
Racine.	21	5,362,028
Walworth.	6	519,982
Washington	9	1,224,380
Waukesha.	36	8,032,267
Total	198	$57,019,731

[a] *Data are current as of September 20, 1977. The amounts shown may change slightly as final audits are conducted on some of the projects.*

Source: *Wisconsin Department of Natural Resources and SEWRPC.*

agencies, the U. S. Bureau of Labor Statistics, the records of the U. S. Department of Agriculture, the Wisconsin Department of Natural Resources Construction Grants Management Section, and the U. S. Bureau of Census, the Commission identified the total expenditures by all local units of government, the subset of those expenditures which is related to water quality management-related activities, and the even more specialized subset related to sanitary sewerage system operation, maintenance, and construction. Also identified were the available data on farm income and expenditures for agricultural nonpoint pollution control practices, and the estimated pollution control expenditures of industrial and commercial activities. Table 169 summarizes these estimated 1975 expenditures by source of funds. From this table, it is apparent that both the public and private sectors expend only a small portion of their total expenditures on water quality-related uses. It is also apparent that state and federal grants constitute only a small portion of the overall water quality-related expenditure total.

The inventory of public financial resources indicates that water quality-related expenditures by all units of local government in the Region are not increasing as rapidly as total expenditures and, in fact, are remaining relatively stable when adjusted to reflect the effects of general price inflation. Revenue sources apparently remained strong with an increasing tax base and a variety of funding resources and mechanisms available. The limited experience to date indicates that user charges and industrial cost recovery charges may provide significant potential additional revenues to support water quality management activities.

The expenditures of cities and counties as well as the expenditures of all governmental units in the Region were significantly affected by the final stages of construction of the South Shore sewage treatment plant by the Milwaukee Metropolitan Sewerage District from 1971 to 1973, as reflected in heavy capital expenditures during that period. Excluding the Metropolitan Sewerage Commissions of the City and County of Milwaukee, a real increase in the water quality-related expenditures of $5 million, or 5 percent over the five-year period, is indicated. Concurrently, a reduction from 10.8 percent—represented by $119—to 10.3 percent—represented by $116 million—of the total expenditures for water quality-related items by all units of government was reflected in the expenditures. Increases in total water quality management-related activities over the decade, not including construction at the South Shore sewerage treatment plant, are attributed largely to increases in demand for urban services, including refuse pickup and

Table 168

REPORTED METHODS UTILIZED FOR FINANCING PUBLIC SANITARY SEWERAGE SYSTEMS IN SOUTHEASTERN WISCONSIN: 1975

Public Sanitary Sewerage System	Methods Utilized to Finance Public Sanitary Sewerage Systems: General Property Tax	User Charge	Other
Milwaukee Metropolitan Subregional Area			
City of Brookfield	X	X	
City of Cudahy	X		
City of Franklin		X	Special Assessment, Sewer Connection Fee
City of Glendale	X		
City of Greenfield	X	X	
City of Mequon	X	X	Special Assessment
City of Milwaukee	X		
City of Muskego	X	X	
City of New Berlin			
Area Connected to Milwaukee Metropolitan System		X	
Regal Manors Subdivision		X	
City of Oak Creek	X	X	Special Assessment
City of South Milwaukee	X		
City of St. Francis	X		
City of Wauwatosa	X		Federal Revenue Sharing Funds
City of West Allis	X		
Village of Bayside	X		
Village of Brown Deer	X		
Village of Butler		X	
Village of Elm Grove			
Sanitary District No. 1	X	X	
Sanitary District No. 2	X	X	
Village of Fox Point	X		
Village of Germantown	X	X	
Village of Greendale	X	X	
Village of Hales Corners	X	X	
Village of Menomonee Falls	X	X	
Village of River Hills	X	X	Special Assessment
Village of Shorewood	X		
Village of Thiensville	X	X	
Village of West Milwaukee	X		
Village of Whitefish Bay	X		
Caddy Vista Sanitary District	X	X	
Rawson Homes Sewer and Water Trust		X	
Upper Milwaukee River Subregional Area			
City of Cedarburg	X	X	
City of West Bend	X	X	
Village of Fredonia	X	X	
Village of Grafton		X	
Village of Jackson	X		
Village of Kewaskum		X	
Village of Newburg	X		
Village of Saukville		X	
Sauk Creek Subregional Area			
City of Port Washington	X	X	
Village of Belgium		X	
Kenosha-Racine Subregional Area			
City of Kenosha	X	X	
City of Racine	X		
Village of Elmwood Park	X		
Village of North Bay	X		
Village of Sturtevant		X	
Town of Caledonia Sewer Utility District No. 1	X	X	Special Assessment Sewer Connection Fee

Table 168 (continued)

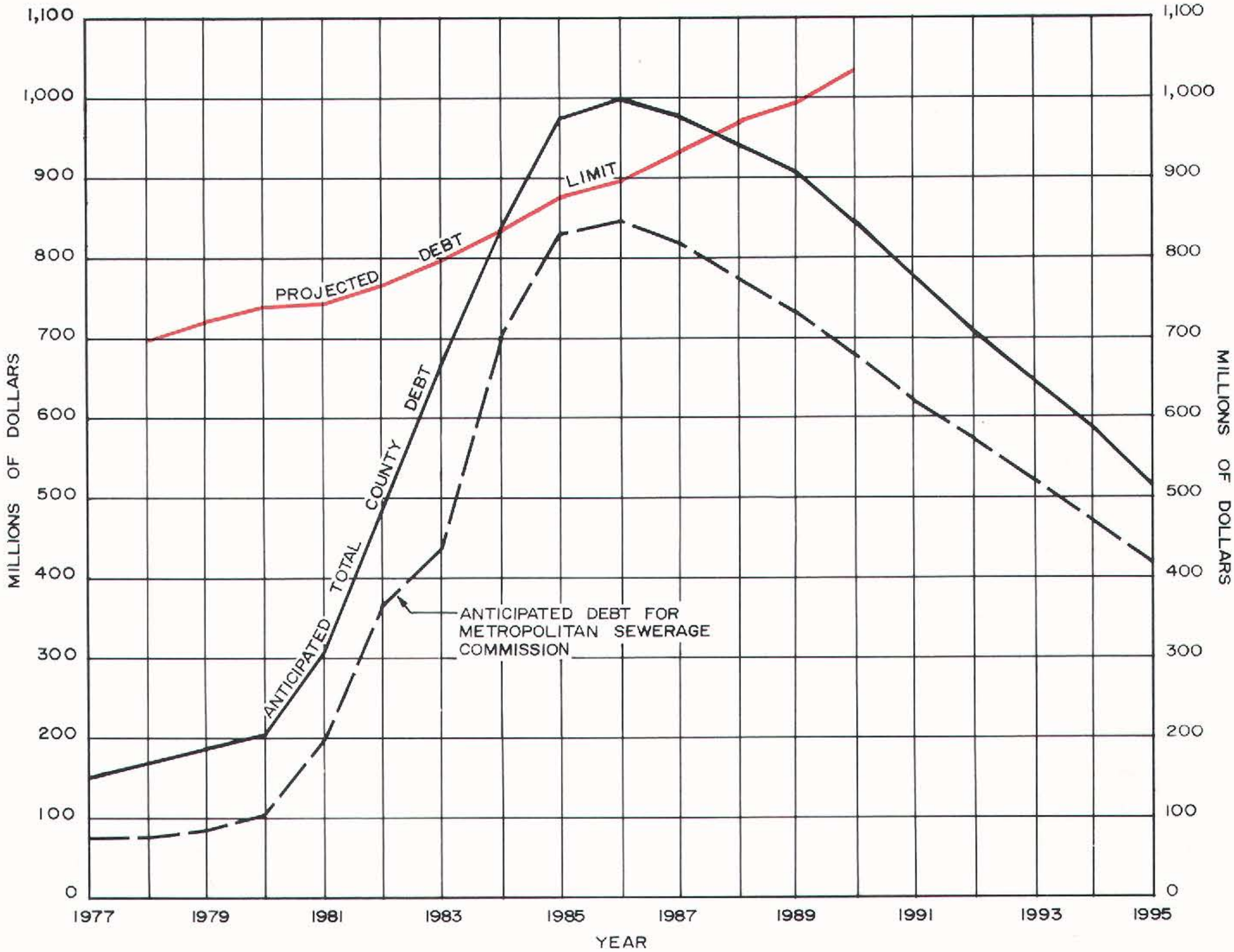
Public Sanitary Sewerage System	Methods Utilized to Finance Public Sanitary Sewerage Systems: General Property Tax	User Charge	Other
Kenosha-Racine Subregional Area (continued)			
Town of Mt. Pleasant			
Sewer Utility District No. 1		X	
Town of Pleasant Prairie			
Sewer Utility District No. 1		X	Special Assessment
Sewer Utility District No. 2		X	Special Assessment
Sewer Utility District A		X	Special Assessment
Sewer Utility District B		X	Special Assessment
Sewer Utility District C		X	Special Assessment
Sewer Utility District E		X	Special Assessment
Town of Somers Sanitary District No. 1	X	X	
Town of Somers Utility District No. 1	X	X	
Crestview Sanitary District		X	
North Park Sanitary District	X	X	
Pleasant Park Utility District		X	
Root River Canal Subregional Area			
Village of Union Grove	X	X	
Des Plaines River Subregional Area			
Village of Paddock Lake		X	
Town of Bristol Utility District No. 1		X	
Town of Pleasant Prairie			
Sewer Utility District D		X	Special Assessment
Sanitary District No. 73-1		X	Special Assessment
Town of Salem Sewer Utility District No. 1		X	
Upper Fox River Subregional Area			
City of Brookfield	X	X	
City of Waukesha	X		
Village of Pewaukee		X	
Village of Sussex	X	X	
Lower Fox River Subregional Area			
City of Burlington	X		
City of Lake Geneva		X	
Village of East Troy	X		
Village of Genoa City	X	X	
Village of Mukwonago	X		
Village of Rochester		X	
Village of Silver Lake	X	X	Special Assessment
Village of Twin Lakes	X	X	
Village of Waterford	X	X	Special Assessment
Town of Rochester Sanitary District		X	
Browns Lake Sanitary District	X		
Upper Rock River Subregional Area			
City of Hartford	X	X	
Village of Slinger	X	X	
Allenton Sanitary District	X	X	
Middle Rock River Subregional Area			
City of Oconomowoc	X	X	
Village of Dousman	X	X	
Village of Hartland	X	X	
Lower Rock River Subregional Area			
City of Delavan		X	
City of Elkhorn	X	X	
City of Whitewater	X	X	
Village of Darien	X	X	
Village of Fontana		X	
Village of Sharon		X	
Village of Walworth		X	
Village of Williams Bay		X	

NOTE: N/A indicates data not available.

Source: SEWRPC.

Figure 54

TOTAL ANTICIPATED DEBT FOR MILWAUKEE COUNTY AND ANTICIPATED DEBT FOR THE METROPOLITAN SEWERAGE COMMISSION OF MILWAUKEE COUNTY IN RELATION TO THE DEBT LIMIT FOR MILWAUKEE COUNTY: 1977-1995



Source: CH_2M-Hill estimates as of November 1977.

disposal, in urbanizing—but unincorporated—areas. Total expenditures and water quality-related expenditures were found to be declining between 1971 and 1975 for the City of Milwaukee, while the total reported expenditures by other cities increased over the same period. Water quality-related items also reflected general increases over the analysis period for expenditures by towns and villages.

Sanitary sewerage system expenditures of about $64 million, or about $41 per capita, were reported for 1975. Of this total, about $19 million, or about $12 per capita, was expended for operation and maintenance, and about $45 million, or about $29 per capita, was expended for capital improvements. On a per capita basis, these expenditures represent an increase of about 35 percent for operation and maintenance and a decrease of about 11 percent for capital improvements over the expenditures in 1970. The unit costs of sanitary sewerage services were found to be lower for the larger facilities and sanitary sewerage systems within the Region. General urban land management practices including refuse collection and disposal, street sweeping, leaf and rubbish pickup and disposal, storm sewer cleaning and maintenance, street and highway maintenance, snow and ice removal and sand and salting, and local water quality sampling and enforcement programs were found to comprise approximately 54 percent of the total water quality management-related expenditures by all local units of government.

Table 169

SUMMARY OF PUBLIC AND PRIVATE EXPENDITURES FOR WATER QUALITY MANAGEMENT IN SOUTHEASTERN WISCONSIN: 1975 (IN CONSTANT 1976 DOLLARS)

Revenue Source	Expenditures (millions)						
	Water Quality—Point Source			Water Quality—Nonpoint Source	Water Quality-Related[d]	All Nonwater Quality-Related	Total
	Operation and Maintenance	Capital (includes debt retirement)	total				
Public							
Local Tax Base.	$19.00	$31.50	$50.50	$62.20	$112.70	$ 994.10	$1,106.80
State Water Pollution Control Grants	0	7.10	7.10	0	7.10	0	7.10
Federal Water Pollution Control Grants (point source)	0	6.20	6.20	0	6.20	0	6.20
Federal Water Pollution Control Grants (nonpoint source)	0	0	0	0.19	0.19	0	0.19
Subtotal	$19.00	$44.80[c]	$63.80	$62.39	$126.19	$ 994.10	$1,120.29
Private							
Agriculture	$ 0	$ 0	$ 0	$ 0.28	$ 0.28	$ 143.03	$ 143.31
Industry	16.10[b]	16.30	32.40	--[a]	32.40	7,617.10	7,649.50
Subtotal	$16.10	$16.30	$32.40	$ 0.28	$ 32.68	$7,760.13	$7,792.81
Total	$35.10	$61.10	$96.20	$62.67	$158.87	$8,754.23	$8,913.10

[a] *Not categorized or reported as such in the U. S. Bureau of the Census survey forms. These costs are also an integral element of both production costs and of overhead.*

[b] *Includes user charges paid to local units of government.*

[c] *Includes $10.5 million in debt retirement.*

[d] *Includes point source- and nonpoint source-related expenditures.*

Source: SEWRPC'

A total of approximately $12.5 million was expended on soil and water conservation practices with the technical and financial assistance of the U. S. Department of Agriculture from 1965 through 1975. This represents an annual average expenditure of $1,140,000. The federal share of soil and water conservation practice expenditures in the Region in 1975 was $188,000 or approximately 40 percent of the 1975 total for such expenditures in the Region. The net farm income in the Region was found to equal $58,619,000. Accordingly, the average annual expenditures for soil and water conservation practices have been approximately 2.0 percent of the current farm net income.

Industrial and commercial establishments of the Region are estimated to have expended approximately $32 million, or 0.5 percent of the value added by industry during 1975, for purposes of water pollution control.

Equalized property values, which provide the basis for the tax revenues of local units of government, have increased by 18.2 percent from 1971 to 1975, ranging from a low of 9.5 percent in Milwaukee County to a high of 36.6 percent in Waukesha County. The result of this increase in assessed value has been a steady decrease in effective tax rates in the Region. It is estimated that capital improvements and operation and maintenance costs of sanitary sewerage systems in the Region are equivalent to $2.50 per $1,000 of equalized assessed value in 1975. At the same time, the local units of government, as of 1975, were found to be at about 18.1 percent of their maximum allowable bonded indebtedness as established by the State, and were found to have about $65 million outstanding in mortgage revenue bonds from other units of government and about $63.6 million in long-term debts outstanding from the Milwaukee Metropolitan Sewerage District.

Over the period from 1972 to 1977, an average of about $21.8 million per year was granted in the form of sewerage system construction grants-in-aid from the federal construction grants program to the seven-county Region, constituting about 34 percent of the total such grants-in-aid committed in the State. In addition, an annual average of approximately $7.1 million per year, or about 39 percent of the state total, was provided to the Region through the Wisconsin Outdoor Resources Action Plan (ORAP) program in the form of sanitary sewerage system grants-in-aid.

Different forms of bonds and notes are available to local units of government for the construction and financing of public works projects. At the end of calendar year 1975, the units of government in the Region were found to be at approximately an average of 18.1 percent of their potential bonded indebtedness with a total of $424 million in municipal bonds outstanding, including the Metropolitan Sewerage Districts, which were found to have a total of $63.6 million in long-term debt outstanding at the end of the year.

Although under pressure by the demand for additional urban services, and generally restrained by the levy limits on local expenditures, the local units of government were found to have a growing tax base and—with the 1977 legislative authorization of user charges and mortgage revenue bonds by the Metropolitan Sewerage Commission of the County of Milwaukee—sufficient legal mechanisms by which to produce revenues for the purposes of public works financing. Similarly, taken as gross proportions of total expenditures, pollution control expenditures by the private sector including agricultural, industrial, and commercial activities are estimated to be a modest proportion, about 27 percent, of the total of water quality-related expenditures by governmental units. The forms, period, and timing of major debts incurred for pollution control by the private sector will play a major part in the relative importance of such expenditures to the short-term profits of private individuals or firms, and therefore must be considered in plan implementation.

Chapter VIII

SUMMARY AND CONCLUSIONS

INTRODUCTION

Water resources constitute one of the most important elements affecting the overall quality of the environment, as well as the growth and development of an area. Water resources not only condition, but are conditioned by regional growth and development. Any meaningful comprehensive regional planning effort must, therefore, recognize water resources as an important element of a limited natural resource base to which both rural and urban development must be adjusted if serious developmental and environmental problems are to be avoided. This is particularly true in the highly urbanized seven-county Southeastern Wisconsin Region, a Region richly endowed with water resources. Properly husbanded, these water resources can constitute a renewable resource which can serve the Region for all time to come. Misused and mismanaged, however, this resource will become the focus of serious and costly developmental and environmental problems and a severe constraint on the sound social and economic physical development of the Region. Water pollution is one manifestation of the misuse of water resources, and the public has become increasingly aware of, and concerned over, such pollution which has seriously interfered with desired water uses.

Recognizing the importance of water resources to the sound development of the Region, the Southeastern Wisconsin Regional Planning Commission in 1975, pursuant to the requirements of Section 208 of the Federal Water Pollution Control Act, undertook an areawide water quality management planning program for the seven-county Southeastern Wisconsin Region. The findings and recommendations of that planning program are presented in a three-volume report. This, the first of the three volumes, sets forth the basic concepts underlying the planning program and the factual findings of the extensive inventories and analyses conducted under the program. It describes the man-made and natural features of the Region pertinent to water quality management planning, describes the existing and historic water quality conditions within the Region, identifies the existing sources of water pollution, and identifies the legal and financial structures affecting water quality.

The information presented in this volume is intended to provide the basis for the forecasts of probable future population and economic activity and of attendant land and water use requirements presented in the second volume, together with recommended water use and related objectives and standards, and alternative proposals for abating water pollution and attaining these objectives and standards over time. The recommended plan for the prevention and abatement of water pollution in the Region and the attainment of the agreed-upon water use objectives and supporting standards is presented in the third volume of this report, together with recommendations concerning the best means for implementing the recommended plan. Together, the three-volume report is intended to provide a sound basis for decisions concerning water pollution abatement and control by the local, state, and federal units and agencies of government operating within the Region. To this end, the report considers the economic and financial, as well as the technical and environmental, factors involved in such abatement and control, together with the social and political considerations involved in plan adoption and implementation.

STUDY PURPOSE AND ORGANIZATION

The Southeastern Wisconsin Regional Planning Commission is the official planning and research agency for the seven-county Southeastern Wisconsin Region. The Commission is charged by law with the function and duty of preparing and adopting a comprehensive plan for the physical development of the Region, as well as of conducting such studies as may be necessary to the implementation, as well as the preparation, of such a plan. The areawide water quality management planning program is the eighth major planning program to be undertaken by the Commission for the purpose of preparing an element of the comprehensive plan for the physical development of the Region.

On September 27, 1974, the Governor of the State of Wisconsin designated the seven-county Southeastern Wisconsin Region as a water quality management planning area under the provisions of Section 208 of the Federal Water Pollution Control Act, and designated the Commission as the official areawide water quality management planning agency for this Region. Pursuant to these designations, the Commission early in 1975 established a Technical Advisory Committee on Areawide Water Quality Management Planning to assist it in the conduct of the federally mandated areawide water quality management planning program. An Intergovernmental Coordinating Committee on Water Quality Management Planning was also established for the purpose of assisting the Commission with those aspects of the planning program having important intergovernmental and interagency policy implications of a statewide, as well as regionwide, nature. Finally, a Citizens Advisory Panel was created to provide increased opportunity for representatives of citizen interest groups and for knowledgeable citizens to become familiar with and influence the planning program, the resulting plan, and the implementation measures proposed. Further opportunity for participation in the planning program was provided through other standing advisory committees to the Commission, particularly the Technical Coordinating and Advisory Committee on Regional Land Use-Transportation Planning and the Technical and Citizen Advisory Committee on Regional Park and Open Space Planning.

The technical work was carried out by the Commission staff with the assistance of cooperating governmental agencies—including the U. S. Department of the Interior, Geological Survey; the Wisconsin Department of Natural Resources; the University of Wisconsin-Extension Service; the soil and water conservation districts of the seven constituent counties; the Geneva Lake Watershed Environmental Agency—and private consultants engaged by the Commission, including Hydrocomp, Inc.; Stanley Consultants, Inc.; Camp, Dresser and McKee, Inc.; Alster & Associates, Inc.; and Sommer-Frey Laboratories, Inc. Each of these organizations was selected by the Commission for participation in the areawide water quality management planning program because of its skill and experience in specialized phases of water resources planning, engineering, and management. The disciplines provided through such assistance included photogrammetric mapping and control surveys; stream flow measurement and surface water and groundwater quality sampling and analyses; sludge quality sampling and analyses; hydrologic-hydraulic water quality simulation modeling; assessment of the costs and effectiveness of various pollution control measures, wastewater sludge management, soil erosion control, and other nonpoint source pollution abatement measures; agronomy; and public information, education, and participation.

The primary objective of the areawide water quality management planning program for southeastern Wisconsin, as set forth in the approved study design,[1] was to prepare and adopt an areawide water quality management plan providing for the abatement and prevention of water pollution in the lakes and streams of the Region and the attainment of water use objectives and supporting water quality standards to the year 2000. In addition, the plan was intended to include specific recommendations for the designation of water quality management agencies in order to assure its effective implementation. Other ancillary objectives of the planning program included:

1. Providing for full integration of regional water quality management planning with comprehensive regional planning, particularly regional land use planning;

2. Providing for the conduct of a refined areawide water quality and quantity monitoring and modeling program;

3. Preparing an areawide point source pollution abatement plan element through revision and refinement, as may be found necessary, of the previously prepared and adopted comprehensive watershed and regional sanitary sewerage system plans;

4. Preparing an areawide nonpoint source pollution abatement plan element, extending previous Commission watershed planning efforts;

5. Preparing a practical areawide sludge management systems plan element;

6. Assisting in the conduct of subarea facilities planning for municipal wastewater conveyance and treatment facilities; and

7. Providing for the establishment of a continuing areawide water quality planning and management program for southeastern Wisconsin.

This three-volume report can only present in brief summary form the large quantity of information assembled in the extensive data collection, analysis, forecasting design, and evaluation phases of the areawide water quality management planning program for southeastern Wisconsin. Although the reproduction of all of this information in report form is impractical, all of the basic data developed under the program and presented in summary form in this volume have also been assembled in "Areawide Water Quality Plan Development Study Volumes." These study volumes are maintained in the Commission offices and are available for use to member units and agencies of government and to the general public upon specific request. This report, therefore, serves the additional purpose of indicating the types of water quality and related data which are available from the Commission and which may be of value to federal, state, or local units of government or to private interests within the Region.

INVENTORY FINDINGS[2]

Geography

The seven counties which comprise the Southeastern Wisconsin Planning Region have a combined area of about 2,689 square miles, or about 5 percent of the total area of the State of Wisconsin. Geographically, the Region is located in a relatively good position with regard to continued growth and development. It is bounded on the east by Lake Michigan, which provides an ample supply of fresh water for both domestic and industrial use, as well as being an integral part of a major interregional and international transportation network. It is bounded on the south by the densely populated northeastern Illinois metropolitan region, and on the west and north by the fertile agricultural lands and desirable recreational areas of the rest of the State of Wisconsin. Many of the most important industrial and heaviest population concentrations in the Midwest are located within 250 miles of the Region; and slightly more than 35 million people reside within this radius, an increase of approximately 5 million persons over the 1960 level.

[1] *See Study Design for the Areawide Water Quality Planning and Management Program for Southeastern Wisconsin: 1975-1977, SEWRPC, July 1975.*

[2] *The base year for conducting the inventories for the areawide water quality management planning program was 1975. This year was chosen to coincide with the SEWRPC 1975 land use inventory and thereby provide a common data base for use in the calibration, validation, and application of the hydrologic-hydraulic water quality simulation model. This model was the principal analytic tool used in the program.*

A complex of 154 general-purpose local units of government and an even greater number of special-purpose units of government operates within the Southeastern Wisconsin Region. The 154 general-purpose local units of government include the seven counties comprising the Region—Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, and Waukesha—and 28 cities, 54 villages, and 65 towns. In addition, certain other special-purpose districts have important responsibilities for water resource management within the Region, including the Metropolitan Sewerage District of the County of Milwaukee, the Western Racine County Metropolitan Sewerage District, and the Walworth County Metropolitan Sewerage District, 44 legally established town sanitary and utility districts, seven soil and water conservation districts, six drainage districts—composed of five agricultural drainage districts and one urban storm water drainage district—and 19 inland lake protection and rehabilitation districts.

Superimposed upon this multiplicity of local, general, and special-purpose units of government are the state and federal governments, certain agencies of which also have important responsibilities for water resources management. These include the Wisconsin Department of Natural Resources; the Wisconsin Department of Health and Social Services; the Wisconsin Board of Soil and Water Conservation Districts; the U. S. Department of the Interior, Geological Survey; the U. S. Environmental Protection Agency; the U. S. Department of Agriculture, Soil Conservation Service; and the U. S. Army Corps of Engineers.

Population and Economic Activity

Inventories of population and economic activity are complementary basic studies essential to sound water quality management planning as well as to comprehensive land use planning. Population and economic activity levels are the most basic determinants of pollution loadings and of the need for pollution abatement and water quality management actions. The size, composition, and spatial distribution of the population is greatly influenced by growth and change in regional economic activity levels; therefore, these two aspects of regional development are often considered together.

The resident population of the Region, which as of 1975 stood at 1,789,871 persons, increased at the rate of over 33,000 persons per year from 1950 to 1960, at a rate of over 18,000 persons per year from 1960 to 1970, and at the rate of only 2,900 persons per year from 1970 through 1975. Regional population growth rates have thus apparently declined from the very high rates of the recent past to rates which approximate those that prevailed within the Region in the pre-1950 periods of this century. Moreover, it presently appears unlikely that the very large absolute population increases of the 1950's and 1960's will reoccur within the Region in the foreseeable future. Consequently, the internal redistribution of population may be expected to be a more important consideration in the areawide water quality management planning program than the accommodation of regional population growth. During the first three decades of the 1900's, the highest rates of population increase occurred in the now urban counties of Kenosha, Milwaukee, and Racine. Since 1930, however, the highest rates of such increase have occurred in the suburban-rural areas of Ozaukee, Waukesha, and Washington Counties. This continuing trend of population decentralization has important implications for land use development and for related water quality control facilities since the decentralization of population and attendant land use development will affect both the older urban centers and the newer suburban and rural-urban fringe areas of the Region.

With respect to pertinent characteristics of the resident population, household sizes have been declining within the Region so that the total number of households may be expected to increase faster than the resident population. In this respect, household sizes within the Region declined from 3.36 persons per household in 1950, to 3.30 in 1960, to 3.20 in 1970. Personal income levels have been increasing within the Region but at a decreasing rate. The areas of highest average household income are located in the most rapidly growing newer suburban and rural-urban fringe areas of the Region.

Increases in the resident population of the Region are closely related to increases in the level of economic activity within the Region. The number of jobs within the Region increased from 552,700 in 1950 to 779,000 in 1975, an increase of about 41 percent, with the largest increases occurring during the last decade of this period. Over this same period, the resident population increased by about 44 percent, with the smallest increases occurring during the last decade of this period. Historically, employment in the Region has been heavily concentrated in manufacturing, although this concentration is changing, with the economy becoming more oriented toward public and private services and trade. The economic factors which promote population growth and urbanization in the Region are largely centered in and around the major urban centers of Milwaukee, Racine, and Kenosha, although diffusion of economic activity paralleling the diffusion of population into the outlying areas of the Region is occurring.

Land Use

One of the central concepts underlying the areawide water quality management planning program for southeastern Wisconsin is that land use, water quality, and the need for water quality management facilities are closely interrelated. The type, intensity, and spatial distribution of land use is an important determinant of water quality which, in turn, influences land use development patterns. An inventory of existing land use and of historic trends in such land use is, therefore, important to any water quality management planning effort.

Although urban development within the Region has been continuous since 1850, the character of this development has changed dramatically since 1950. The earlier form of compact concentric urban development has been supplanted by the highly diffused pattern of areawide urbanization. Between 1950 and 1970, a 47 percent increase in urban population was accompanied by a 188 percent increase in the amount of land committed to urban use. The spread of urban development within the Region has been accompanied by a marked reduction in the urban population density of the developed portions of the Region, which dropped from more than 11,300 persons per square mile in 1920 to about 4,800 persons per square mile in 1970. Urban land uses within the Region increased from a total of about 340 square miles, or about 13 percent of the total area of the Region in 1963, to 387 square miles, or about 15 percent of the total area of the Region in 1970. The greatest proportion of the urban lands is devoted to residential use, which occupies about 9 percent of the total area of the Region. Nonurban land uses occupy about 85 percent of the total area of the Region. The greatest proportion of the nonurban lands is devoted to agricultural use, which occupies about 60 percent of the total area of the Region.

Of the 12 watersheds within the Region, the most highly urbanized watershed is the Kinnickinnic River watershed, with about 89 percent of its total area being devoted to urban land uses. The Menomonee River watershed ranks second, with about 53 percent of its total area being devoted to urban land uses. The least urbanized watershed within the Region is the Sheboygan River watershed, with about 3 percent of its total area being devoted to urban land uses.

The highly diffuse nature of the urban development occurring within the Region, along with a sharp decline in urban population density, has intensified many longstanding developmental and environmental problems, including problems of water pollution abatement and water quality management. The concentration of urban development around the shorelines of many of the inland lakes within the Region has intensified the need for water quality management in order to protect these particularly valuable recreational resources.

Public Utility Service and Transportation Facilities

Public utility and transportation facilities are among the most important and permanent elements influencing regional growth and development. Moreover, certain utility facilities are closely linked to the surface and groundwater resources of an area and, therefore, affect the overall quality of the environment in the Region. This is particularly true of sanitary sewerage, water supply, and storm water drainage facilities which are, in a sense, modifications of, or extensions to, the natural watercourse system of an area and of the underlying groundwater reservoirs. Knowledge of the location and capacities of these utilities is, therefore, essential to intelligent water quality management planning, as well as to comprehensive land use planning.

The public utility base of the Region is composed of its sanitary sewerage, storm water drainage, water supply, electric power service and gas service systems. There are a total of 95 centralized public sanitary sewerage systems presently operated by utilities within the Region serving about 350 square miles, or 13 percent, of the total area of the Region, and approximately 1.54 million people, or about 86 percent of the total regional population. These sewerage systems include a total of 128 sewage treatment plants of which 67 are privately owned. The remaining 14 percent of the total regional population, or approximately 246,000 persons, rely on the use of onsite systems for the treatment and disposal of liquid wastes.

Of a total of 55 urban storm water management systems, 48 systems having known defined service areas serve a total composite area of about 180 square miles, or about 7 percent of the total area of the Region, and a resident population of about 1.5 million people, or about 84 percent of the total regional population. Approximately 330 square miles, or about 12 percent of the total area of the Region, and about 1.6 million people, or about 90 percent of the total population of the Region, are served by the 72 publicly owned water utilities existing in the Region. Urban development located east of the subcontinental divide, which traverses the Region, can utilize both Lake Michigan and the two underlying ground aquifers as a source of supply. Urban development west of that divide must depend primarily upon the two groundwater aquifers. Gas and electric power services can be considered readily available throughout the Region, and therefore do not constitute a major constraint on the location or intensity of urban development within the Region.

Transportation facilities provide a relatively high level of service throughout the Region, with the extensively developed high-speed, all-weather highway system having had an important influence on the spatial location of urban development within the Region in the recent past. This influence has, however, been significantly modified by the location within the Region of such natural resources as lakes, streams, woodlands, and fertile farmlands. Intercity bus service is provided between the various communities within the Region, and urban mass transit service is provided in the Milwaukee, Racine, and Kenosha urbanized areas. The only remaining scheduled rail passenger services in the Region consist of the National AMTRAK service operated over the lines of the Chicago, Milwaukee, St. Paul & Pacific (Milwaukee Road) Railroad Company between Chicago, Sturtevant, Milwaukee, and points west; and Chicago-oriented commuter service operated by the Chicago & Northwestern Railway from the City of Kenosha and the Village of Walworth.

Climate

Climate, especially the extreme variations in the principal elements of climate—temperature, precipitation, and snow cover—directly affects water quality management, as well as the growth and development of an area. Climate determines to a large extent the recreational interests and pursuits that can be followed by residents of an area; has important economic implications affecting the kinds of agricultural crops which can be produced, as well as the yields; and affects the design of buildings and structures of various kinds and the cost of operating and maintaining both private and public facilities and services.

The Region has a continental-type climate characterized primarily by a continuous progression of markedly different seasons and a large range of annual temperature, and by frequent distinct changes in weather conditions which, particularly in the winter and spring, normally occur once every two or three days. Air temperatures within the Region are subject to great seasonal change and yearly variation as well as diurnal variations and influence many of the chemical processes which occur in the lakes and streams of the Region. The annual temperature range, which is based on monthly means for six geographically representative weather observation stations, extends from a monthly average daily minimum of about 21°F in January to a monthly average daily maximum of about 71°F in July. The growing season averages about 165 days, with the last frost of spring occurring in late April or early May and the first frost of fall occurring in mid-October.

Based on precipitation and snowfall data for eight geographically representative observation stations in and near the Region, the average annual total precipitation is 31.3 inches expressed as water equivalent, with monthly averages ranging from a February low of 1.19 inches to a high of 3.77 inches in June. Snow cover is most likely in southeastern Wisconsin during the months of December, January, and February and averages about 44.5 inches annually.

Air Quality

Air quality is not only a particularly important determinant of the overall quality of the environment for life in an area but has important direct and indirect affects on water quality. Air always contains foreign matter in the form of smoke, soot, dust, fly ash, fumes, mists, odors, pollens, and spores, which through the atmospheric fallout and washout may directly affect surface water quality. Although some of the foreign particulate and gaseous matter in air is contributed by natural sources, much is contributed by man from such activities as land cultivation, heat and power generation, industrial processes, transportation movements, and waste burning, including incineration of wastes produced by wastewater treatment facilities. Urbanization tends to intensify the contribution of air pollutants from human activities because it tends to concentrate pollutant sources. When the level of pollutants in the ambient air becomes so severe as to seriously and adversely affect health and property, an air pollution problem exists. Because of the direct and indirect linkages involved, air and water quality management programs must be conducted in a coordinated, if not integrated manner.

Five major pollutants have been identified as having significant adverse effects on human health and property: particulate matter, sulfur dioxide, carbon dioxide, nitrogen dioxide, and ozone. A sixth pollutant, hydrocarbons, may under certain atmospheric conditions contribute to the formation of ozone, which has an adverse effect on human health and property, is considered a pollutant. Commission studies indicate that national ambient air quality standards, as established by the U. S. Environmental Protection Agency for particulate matter, carbon monoxide, sulfur dioxide, nitrogen dioxide, and photochemical oxidants, are presently exceeded or have a potential for being exceeded in the most highly urbanized areas of the Region—the central portions of the Milwaukee, Racine, and Kenosha urbanized areas. The major sources of pollutants contributing to air pollution in the Region are transportation movement, industrial processes, and power generation, with the concentration of the air pollutants in the atmospheric being directly related to the intensity of urban development. The abatement of air pollution within the Region through planning and implementation programs currently underway, especially with respect to particulate matter, should assist in improving surface water quality. The fallout and washout of particulate matter may contribute significant amounts of nutrients, particularly phosphorus, to surface waters, together with other potentially hazardous materials, such as heavy metals and exotic chemicals.

Physiography and Geology

The land forms and physical features of a planning area, including the topography and drainage pattern, are important determinants of regional growth and development. The physiography of an area must, therefore, be considered in any water quality management planning, as well as in comprehensive land use planning. Certain physiographic features are particularly important to water quality management planning, including the topography, subsurface geology, surface drainage pattern, and soils.

The Southeastern Wisconsin Planning Region is located in the upper Midwest between Lake Michigan on the east, the Green Bay-Lake Winnebago lowlands on the north, the Rock River basin on the west, and the low dunes and swampland at the headwaters of the Illinois River on the south. The seven-county Region extends for approximately 52 miles from east to west at its widest point, and approximately 72 miles from north to south. The Region encompasses approximately 2,621 square miles of land area and 68 square miles of inland water area exclusive of Lake Michigan, for a total gross land and water area of approximately 2,689 square miles, or 1,720,000 acres. Topographic elevations range from approximately 580 feet above sea level at the Lake Michigan shore to about 1,320 feet above mean sea level at Holy Hill in southwestern Washington County. The Region lies astride a major subcontinental divide between the upper Mississippi River and the Great Lakes-St. Lawrence River drainage basins. Glaciation has largely determined the physiography and topography as well as the soils of the Region. There is evidence of four major stages of glaciation in the Region, the last of which, the Wisconsin stage, terminated about 11,000 years ago, and was the most influential in terms of present physiography and topography.

The dominant physiographic and topographic feature is the Kettle Moraine, an interlobate glacial deposit, or moraine, formed between the Green Bay and Lake Michigan tongues, or lobes, of the continental glacier which moved in a generally southerly direction from its point of origin in what is now Canada. Topographically high points in the Kettle Moraine include areas around Lake Geneva in Walworth County, areas in southwestern Waukesha County north of Eagle, areas in central Waukesha County around Lapham Peak, and areas around Holy Hill and Hartford in southwestern and western Washington County. The Kettle Moraine, which is oriented in a general northeast-southwest direction across western Washington, Waukesha, and Walworth Counties, is a complex system of kames, or crudely stratified conical hills; kettle holes marking the site of glacial ice blocks that became separated from the ice mass and melted to form depressions; and eskers, consisting of long, narrow ridges of drift deposited in abandoned drainageways. It forms some of the most attractive and interesting landscapes within the Region, as well as being the area of the highest elevation and the area of greatest local elevation difference, or relief, within southeastern Wisconsin. The Kettle Moraine of Wisconsin, much of which lies within the Region, is considered one of the finest examples of glacial interlobate moraine in the world. Because of its still predominantly rural character and its exceptional natural beauty, the Kettle Moraine and the surrounding area is and may be expected to continue to be subjected to increasing pressure or urban development.

The remainder of the Region is covered by a variety of glacial land forms and features, including kames, ground moraine or heterogeneous material deposited beneath the ice; recessional moraines consisting of material deposited at the forward margins of the ice sheet; lacustrine basins, or former lake sites; outwash plains formed by the action of flowing glacial meltwater; eskers, or elongated meandering ridges of crudely stratified waterlain sand and gravel deposits; and drumlins, or elongated mounds of drift molded by and parallel to the advancing glacier. Glacial land forms are of economic significance because some are prime sources of sand and gravel for highway and other construction purposes. Many of the larger topographic depressions of the Region, including the kettle holes, have developed into the numerous lakes which dot large areas of western Washington, Waukesha, and Walworth Counties, and which are becoming increasingly popular both as recreational areas and as centers for residential development.

Regional surface drainage is characterized by a disordered dendritic pattern, primarily because of the heterogeneous nature of the glacial drift. There is a preponderance of ponds and lakes, and much of the Region is covered by wetlands, with many streams being mere threads of water through those wetlands. A major subcontinental divide, which bisects the planning region such that 1,685 square miles, or 63 percent of the Region, drain toward the Mississippi River while 1,004 square miles, or 37 percent of the Region, are tributary to the Great Lakes-St. Lawrence River drainage basin, determines the gross surface water drainage pattern and also creates certain legal and water use problems.

The surface water drainage pattern of southeastern Wisconsin may be further subdivided so as to identify 11 individual watersheds, five of which—the Root River, Menomonee River, Kinnickinnic River, Oak Creek, and Pike River watersheds—are wholly contained within the Region. In addition to the 11 watersheds there are numerous small catchment areas contiguous to Lake Michigan that are drained directly to the lake by small natural streams and artificial drainways. These areas may be considered as comprising a twelfth watershed. The surface drainage pattern and location of watershed boundaries are particularly pertinent to the areawide water quality management plan since emphasis on in-watershed solutions is one of the five basic principles formulated under the areawide water quality management planning program.

The glacial drift of southeastern Wisconsin is underlain by bedrock formations of the Cambrian through Devonian periods that dip gently down toward the east at a slope on the order of 20 feet per mile, and attain a thickness in excess of 1,500 feet beneath the eastern boundary of the Region. The bedrock of the Region is, for the most part, covered by deep, unconsolidated glacial deposits, attaining a thickness in excess of 500 feet in some buried preglacial valleys. Bedrock lies within 20 feet of the ground surface within areas of the Region which together total only about 150 square miles in extent, and a few localized areas exist where the bedrock is actually exposed at the surface. These shallow drift areas and rock outcrops tend to occur in Washington and Waukesha Counties along a northeasterly-southwesterly alignment generally paralleling the interlobate Kettle Moraine, and reflect the presence of a preglacial ridge. Sand and gravel, dolomite building stone, and organic material are the three principal mineral and organic resources in the Region that have significant commercial value as a result of their quantity, quality, and location.

Soils

A wide variety of soil types have developed in southeastern Wisconsin as a result of the interaction of parent glacial deposits covering the Region; the resulting topography; the climate; the plants and animals; and time. Under a soil survey conducted for the Commission by the U. S. Soil Conservation Service, all the diverse soil types of southeastern Wisconsin have been mapped; their physical, chemical, and biological properties identified; and interpretations of these properties made for planning purposes. The soil survey data and interpretations indicate that approximately 716 square miles, or about 27 percent of the total area of the Region, are covered by soils that are poorly suited for residential development with public sanitary sewer service; approximately 1,637 square miles, or about 61 percent of the total area of the Region, are covered by soils that are poorly suited for residential development without sanitary sewer service on lots smaller than one acre in size; and about 1,181 square miles, or approximately 44 percent of the total area of the Region, are covered by soils that are poorly suited for residential development without public sanitary sewer service on lots one acre or larger in size.

Woodlands and Wetlands

Historically, vegetational patterns in southeastern Wisconsin were determined by natural factors such as climate, soil types, fire, topography, and drainage characteristics. Since his settlement of the Region, however, man has increasingly influenced the quantity and quality of woodland, wetland, and aquatic vegetation. Woodlands in the Region in 1970 covered a total area of about 125,300 acres, or approximately 7 percent of the total area of the Region, with more than 91,700 acres, or 73 percent, being located in Walworth, Washington, and Waukesha Counties. Milwaukee County, with about 3,200 acres of woodlands, had the smallest amount of any county in the Region. In addition to commercial value, woodlands have significant environmental value, limiting runoff and promoting infiltration and attendant groundwater recharge, contributing oxygen to the atmosphere, and otherwise assisting in limiting air and water pollution. In addition, woodlands have significant wildlife habitat and aesthetic value when viewed in conjunction with the beauty of the Region's lakes, streams, and glacial land forms.

Water and wetland areas in the Region in 1970 covered about 181,000 acres, or about 11 percent of the total area of the Region, with more than 124,500 acres, or 69 percent, being located in Walworth, Washington, and Waukesha Counties. Of the total water and wetland category only 48,000 acres, or 27 percent, actually consisted of surface water. The remaining 132,800 acres consisted of swamps, marshes, and other wetland areas. Large amounts of surface water areas are located in northwestern Waukesha County, southern Walworth County, and southwestern Kenosha County, while concentrations of wetland areas occur in the Cedarburg Bog in Ozaukee County, the Jackson and Theresa marshes in Washington County, and the Menomonee Falls and Vernon marshes in Waukesha County. Wetlands attenuate peak flood flows, help to protect stream and lake water quality by serving as nutrient and sediment traps, and provide important wildlife habitat and aesthetic value.

Fish and Wildlife Resources

Most of the major lakes in southeastern Wisconsin and many of the perennial streams are capable of supporting significant fish populations under existing conditions. However, a regional decline in lake and stream water quality may be expected to continue in the absence of the adoption and implementation of a sound areawide water quality management plan. Dominant fish species of importance to the fisheries of the Region include, among others, bluegills, largemouth bass, northern pike, walleye, bullhead, black crappie, yellow perch, and carp.

Inventories of the lands and inland waters of the Region known to be inhabited by various forms of wildlife were carried out by the Wisconsin Department of Natural Resources in the Southeastern Wisconsin Regional Planning Commission in 1963 and again in 1970. Based on these inventories, wildlife habitat areas in 1970 covered about 259,800 acres, or about 15 percent of the total area of the Region. The overwhelming majority of this area, more than 192,500 acres, or 74 percent, was located in Walworth, Washington, and Waukesha Counties. From 1963 to 1970 about 1,300 acres of wildlife habitat areas were lost primarily to urban development. If the remaining wildlife habitat areas in the Region are to be preserved, the woodlands, wetlands, and related surface waters together with the contiguous crop and pasture lands must be protected from mismanagement and continued urban encroachment.

Surface Water Resources

Surface water resources, consisting of lakes, streams, and associated floodlands, form the singularly most important element of the natural resource base of the Region. The water resources perform multifaceted functions including the support of numerous, popular water-oriented recreational activities; provision of habitat for fish and wildlife; provision of desirable sites for vacation homes and permanent residential development; and provision of water for domestic, municipal, and industrial water use. The Region contains 1,118 linear miles of perennial streams and 100 major lakes having a surface area of 50 acres or more. The latter have a total surface area of 57 square miles, or about 2 percent of the total area of the Region, and a total shoreline length of 448 miles. There are an additional 228 lakes and ponds in the Region having a surface area of less than 50 acres. These minor lakes have a combined surface water area of four square miles, or about 0.15 percent of the total area of the Region, and a total shoreline length of 141 miles. These surface water resources in general, and many of the streams in the Region in particular, are vulnerable to pollution because the low flows are small relative to existing and probable future municipal treatment plant discharges and other waste loadings.

Commission studies indicate that many of the major lakes and many miles of the major streams in the Region are being degraded as the result of man's activities to the point where they now have, or will in the future have, little or no value for recreational purposes, as desirable locations for controlled water-oriented residential development, or as aesthetic assets of southeastern Wisconsin. In general, the surface waters of the Region may be characterized as being highly polluted.

For planning and regulatory purposes, floodlands are defined as those areas of the Region, excluding the stream channels and lake beds, that are subject to inundation by a 100-year recurrence interval flood event. Approximately 7 to 10 percent, or 188 to 269 square miles of southeastern Wisconsin, is estimated to lie within the inundation limits of a 100-year recurrence interval flood event. The 100-year recurrence interval flood hazard area has been delineated by the Commission along approximately 540 linear miles of major stream channel in the Root, Fox, Menomonee, Milwaukee, and Des Plaines River watersheds within the Region. This delineation serves to identify those portions of the Region poorly suited to urban development because of flood hazard, high water tables, inadequate soils, and high costs for public utilities and services such as sanitary sewerage systems, while at the same time identifying areas well suited for much needed open space uses. Recommended regional land use development policies in general, and areawide water quality management planning and development policies in particular, should direct urban development to more suitable locations outside of the flood hazard areas, reserving those areas for park and open space uses consistent with the preservation and protection of the underlying natural resource base.

Groundwater Resources

Groundwater resources constitute another valuable element of the natural resource base of the Region. The groundwater reservoir not only sustains lake levels and provides the base flow of the streams within the Region, but comprises a major source of water supply for domestic, municipal, and industrial purposes. The Region is richly endowed with groundwater. Forty-six of the 67 public water utilities operating within the Region utilize groundwater as their source of supply. Together, these 46 utilities serve a resident population of about 190,000 persons, or about 11 percent of the total resident population of the Region and 14 percent of the resident population served by public water utilities. In addition, many major industries in the Region utilize groundwater as a source of supply. The aquifers which underlie the Region attain a combined thickness in excess of 1,500 feet in the eastern portions of the Region, and may be divided into three distinct groundwater sources. In order from the land surface downward, these are: 1) the sand and gravel deposits of the glacial drift, 2) the shallow dolomitic strata of the underlying bedrock, and 3) the deeper sandstone and dolomitic strata.

Because of their relative nearness to the land surface and their hydraulic interconnection, the first two aquifers are commonly referred to collectively as the "shallow" aquifer, while the latter is referred to as the "deep" aquifer. The shallow and deep aquifers are separated by a layer of shale which forms a relatively impermeable barrier between the two aquifers. While some water is recharged to the deep aquifer by vertical movement through wells open to both the shallow and deep aquifers and by some vertical leakage through the relatively impermeable shale barrier, the principal source of recharge to the deep aquifer is precipitation percolating downward through glacial deposits into the deep aquifer strata, which are in contact with the glacial deposits within the Region only in the westerly portions of Walworth and Waukesha Counties. This recharge area for the deep aquifer within the Region is a long narrow area oriented in a generally north-south direction along the western edges of Waukesha and Walworth Counties. Groundwater in the deep aquifer moves in a generally easterly direction from this primary recharge area toward Lake Michigan and the major deep well pumping centers of the Region. Protection of the quality and quantity of recharge water entering the deep aquifer is important to the protection, preservation, and wise use of this economically important resource.

The shallow aquifer is recharged locally by downward percolation of precipitation and surface water. In contrast to the deep aquifer, the direction of water movement in the shallow aquifer is much more variable and complex. Movement occurs from local recharge areas toward multiple points of discharge, such as streams, lakes, wetlands, springs, and wells. In comparison to the deep aquifer, the shallow aquifer is more susceptible to pollution by wastewater because it is nearer both in distance and in time to potential pollution sources, thus minimizing the potential for dilution, filtration, and other natural processes that tend to reduce the detrimental effects of pollutants. The potential for groundwater pollution is dependent upon such natural factors as the depth to groundwater, the type of soils through which the precipitation and surface water must percolate, the location of the recharge areas, and the subsurface geology. Based on analyses of these factors, it is estimated that a potential for severe groundwater pollution exists over about 18 percent of the total area of the Region, whereas a slight potential exists over about 37 percent of the Region. The current quality of groundwater in both the shallow and deep aquifers is good. If this groundwater is to remain a valuable asset, however, the resource will have to be carefully managed to protect its quality as well as quantity.

Environmental Corridors

One of the most important tasks completed under the Commission's initial regional land use planning effort was the identification and delineation of what the Commission termed "environmental corridors." Such corridors are defined by the Commission as elongated areas in the landscape encompassing concentrations of the best remaining elements of the natural resource base, areas which should, therefore, be preserved in essentially natural open uses in order to maintain a sound ecological balance, protect the overall quality of the environment, and preserve the unique natural beauty and cultural heritage of the Region. Such corridors by definition encompass lakes and streams and associated undeveloped shorelands and floodlands; woodlands, wetlands, and wildlife habitat areas and areas covered by organic soils; areas of rugged terrain and high relief topography, significant geological formations, and physiographic features; areas of groundwater recharge and discharge; sites of historic scientific and cultural value; potential park and open space sites; and significant scenic areas and vistas.

Primary environmental corridors by definition contain three or more of the above-listed elements. Such corridors occupy approximately 19 percent of the total area of the Region including all of the surface waters, undeveloped floodlands, and shorelands, most of the best remaining wildlife habitat areas, and the best remaining potential park and open space sites. The primary corridors generally lie along major stream valleys, around major lakes, and through the Kettle Moraine area of the Region.

Prime Agricultural Lands

Agriculture is still the singularly largest land use in the Region, occupying more than one million acres of land, or about 60 percent of the total area of the Region. The agricultural land use base of the Region declined by almost 44,000 acres from 1963 to 1970, or by more than 4 percent, with the decline being due primarily to the conversion of agricultural land uses to urban land uses as a result of the highly diffused pattern of urban development taking place within the Region. Prime agricultural lands total about 491,500 acres, or about 39 percent of all agricultural lands in the Region. Between 1963 and 1970 the prime agricultural acreage decreased by 8,400 acres, or by about 2 percent.

A major objective of the Commission's regional land use planning efforts has been the preservation in agricultural use of the remaining prime agricultural areas of the Region. Such areas have been delineated by the Commission on the basis of soils; the size of the individual farm units and of the aggregate area being farmed; the capital invested in irrigation, drainage, and good soil and water conservation practices; and the demonstrated ability of the areas to consistently produce higher than average crop yields. The preservation of these prime agricultural lands is important for economic reasons, as well as to ensure the overall wholesomeness of the regional environment. The preservation of these areas has particularly important implications for water quality management planning. The application of good soil and water conservation practices and the abatement of nonpoint pollution from agricultural runoff is dependent in part on the stability of the agricultural communities involved.

EXISTING AND HISTORIC WATER QUALITY

The term "water quality" refers to the physical, chemical, and biological characteristics of surface water and groundwater. Water quality is determined both by the natural environment and by the activities of man. The development of areawide water quality management plans requires the collection of definitive data on the existing levels of water quality in the streams and lakes of the planning area and an evaluation of the ability of those levels to support existing and proposed water uses. The water quality conditions and long-term trends in such conditions were analyzed by the Commission from data obtained at 87 sampling stations located at strategic points on the stream networks of the 12 major watersheds of the Region and available for the period from 1964 through 1975. (A benchmark stream water quality study was conducted by the Commission in 1964 and 1965, and a continued monitoring effort took place over the 1965-1975 decade.) The analyses also sought to determine the extent to which past pollution abatement programs have been successful in improving water quality conditions.

Des Plaines River Watershed

In the Des Plaines River watershed, surface water quality conditions were found to be essentially unchanged over the 1965-1975 decade. The water quality of the Des Plaines River and Brighton Creek, both intended for recreational use and the maintenance of a warmwater fishery and other aquatic life, did not meet the water quality standards set by the Wisconsin Department of Natural Resources (DNR) for dissolved oxygen and fecal coliform bacteria in 1975. In addition, total phosphorus concentrations were found to be higher than the recommended level adopted by the Commission.

Two of the four lakes in the watershed experienced less than 1.0 milligram per liter (mg/l) dissolved oxygen concentrations in the hypolimnion (lower layer) during summer stratification. With regard to their trophic status, Paddock Lake was classified as mesotrophic and Benet/Shangrila Lakes were classified as very eutrophic. For Lakes George and Paddock, for which complete chemical water quality data were available, the recommended levels of water quality with respect to dissolved oxygen were not achieved based on sample data collected by the DNR and the Commission.

Fox River Watershed

In the Fox River watershed, surface water quality conditions as measured at 12 sampling stations along the Fox River main stem were found to be somewhat improved over the 1965-1975 decade. However, streamwater quality conditions as a whole did not meet the established water use objectives for recreational use and the maintenance of a warmwater fishery and other aquatic life in 1975. Supporting standards for dissolved oxygen, ammonia-nitrogen, and fecal coliform, and the recommended level for total phosphorus, were generally not met.

Of the 31 major lakes in the watershed for which water quality data were available, 19 exhibited potentially anaerobic conditions in the hypolimnion (lower layer) in summer sampling. Thirty-five of the major lakes in the watershed were classified as to trophic status: 8 were classified as very eutrophic and 2 lakes in the watershed were considered to be oligotrophic, with the remaining 25 being classified as mesotrophic. Of the 22 lakes for which complete chemical water quality data were available, 13 lakes, or 59 percent, did not meet the recommended water quality level with respect to dissolved oxygen, phosphorus, or ammonia-nitrogen based on sample data collected by the DNR and the Commission.

Kinnickinnic River Watershed

In the Kinnickinnic River watershed, surface water quality as measured at the single Commission sampling station was found to be essentially unchanged over the decade and met the applicable water quality standards for restricted use and minimum standards as established by the DNR for temperature, dissolved oxygen, pH (hydrogen ion concentration), and fecal coliform counts. However, the water quality did exhibit degradation as measured by dissolved oxygen, chlorides, and fecal coliform over the period since 1964.

Menomonee River Watershed

Although remaining generally constant over the decade, the water quality of the Menomonee River upstream from the confluence with Honey Creek, intended for recreational use and the maintenance of a warmwater fishery and other aquatic life, did not meet the established water quality standards for fecal coliform, dissolved oxygen, and ammonia-nitrogen, nor the recommended level for total phosphorus in 1975. The water quality of Honey Creek and Underwood Creek tributaries also showed no significant change over the decade. Both reaches, which are designated for restricted use and minimum standards, exhibited violations of fecal coliform counts, with Honey Creek recording excessive levels during the 1975 sampling period despite the industrial use standards applicable to these stream reaches which drain generally urban, commercial, and industrial land uses.

Milwaukee River Watershed

The water quality of the Milwaukee River and its major tributaries fluctuated as measured by different indicators between slightly improved, no change, or slightly degraded. The overall trend since 1964 indicates a slightly degraded water quality condition. In comparing the 1975 water quality data to the water quality standards as adopted by the DNR, dissolved oxygen and fecal coliform counts were found not to satisfy the minimum standards for recreational use and the maintenance of a warmwater fishery and other aquatic life set for the reaches of the Milwaukee River and its tributaries upstream from the North Avenue dam, nor the standards for fecal coliform for restricted use set for the reaches of the main stem of the Milwaukee River downstream from the North Avenue dam and for Lincoln Creek. In addition, total phosphorus levels were generally found to be significantly higher than the recommended level adopted by the Commission.

Of the 12 major lakes located within the Milwaukee River watershed within the Region, dissolved oxygen profiles were available on seven. All of these exhibit potentially anaerobic conditions in the hypolimnion (lower layer) during summer. Four of the major lakes were classified according to their trophic status: Silver Lake as oligotrophic, Big Cedar and Little Cedar Lakes as mesotrophic, and Mud Lake as very eutrophic. Of the four major lakes within the watershed for which complete chemical water quality data were available, only Mud Lake exhibited conditions which conformed to the recommended water quality standards, set forth in Volume Two, Chapter II of this report, used in the areawide water quality management planning program. Excessive levels of phosphorus, inorganic nitrogen, or ammonia-nitrogen were noted in the other three lakes.

Minor Streams Directly Tributary to Lake Michigan

The largest of the minor streams draining directly to Lake Michigan include Barnes Creek, Pike Creek, and Sucker Creek. In the Barnes Creek subwatershed, water quality conditions were found to be essentially unchanged over the past decade. The 1975 water quality conditions in the creek, which is intended for restrictive use and minimum standards, met the water quality standards for temperature, pH, dissolved oxygen, ammonia-nitrogen, and fecal coliform.

In the Pike Creek subwatershed, the observed dissolved oxygen levels at the single sampling station indicate essentially unchanged water quality conditions over the past decade; however, fecal coliform counts and chloride levels showed slight decreases. Although the water quality did not change significantly over the decade, the applicable standards for recreational use and the maintenance of a warmwater fishery and aquatic life were not met with respect to fecal coliform counts and dissolved oxygen in 1975. In addition, total phosphorus concentrations were in violation of the Commission's recommended standard of 0.1 milligram per liter (mg/l).

Improvements were noted at the sampling station in the Sucker Creek subwatershed for dissolved oxygen and chloride levels, indicating improvements in water quality conditions over the decade. Fecal coliform counts, on the other hand, were found to have increased, and phosphorus levels remained in excess of the recommended levels. Sucker Creek exhibited substandard conditions for recreational use and the maintenance of a warmwater fishery and aquatic life with respect to fecal coliform, dissolved oxygen, and total phosphorus.

Oak Creek Watershed

In the Oak Creek watershed, surface water quality conditions were measured at two sampling stations on the Oak Creek main stem and were found to have slightly degraded over the decade for all parameters except fecal coliform levels, which were somewhat improved. The total phosphorus levels observed during the 1975 sampling period were found to be in excess of the level recommended to avoid the stimulation of undesirable growth of aquatic plants; and the dissolved oxygen, ammonia-nitrogen, and fecal coliform levels did not meet the applicable water quality standards for recreation and the maintenance of a warmwater fishery and other aquatic life. The downstream station generally exhibited better water quality than that of the upstream sampling station.

Pike River Watershed

Two sampling stations on the Pike River and two sampling stations on Pike Creek of the Pike River watershed were monitored as part of the Commission's continuing water quality monitoring program. The sampling on Pike Creek indicated that fecal coliform, pH, temperature, and dissolved oxygen standards designated for restricted use and minimum standards were being met in 1975, with dissolved oxygen levels indicating that the water quality of the Pike River had improved slightly over the decade. The chloride and fecal coliform levels showed general improvement over the decade at both sampling stations on the main stem except during sampling periods which followed significant precipitation events. The main stem of the Pike River, which is designated for recreational use and the maintenance of a warmwater fishery and aquatic life, exceeded the standards for dissolved oxygen, ammonia-nitrogen, fecal coliform bacteria, and total phosphorus. High levels of total phosphorus were recorded at all stations in 1975.

Rock River Watershed

Water quality conditions in the major tributaries of the Rock River within the Region were monitored under the Commission's continuing water quality monitoring effort at 13 sampling stations—8 in the Upper Rock River subwatershed and 5 in the Lower Rock River subwatershed within the Region. The Bark and Ashippun Rivers showed no significant change in water quality conditions over the decade. No significant change was observed in the water quality of the Rubicon River except at the sampling station located downstream from the City of Hartford sewage treatment plant, where sewage treatment plant improvements completed in the summer of 1973 were reflected in improved dissolved oxygen levels. Water quality conditions in the Oconomowoc River showed no change except at the sampling station located downstream from the City of Oconomowoc's old sewage treatment plant, where increased loadings from the plant were reflected in decreased water quality conditions. Whitewater Creek showed a slight improvement in fecal coliform counts over the decade. The water quality of Jackson Creek and Turtle Creek exhibited some degradation over the decade as measured at the sampling stations located downstream from the City of Elkhorn and the City of Delavan sewage treatment plants. In general, the water quality of the Rock River tributaries lying within the Region, which are designated for recreational use and for the maintenance of a warmwater fishery and other aquatic life, with the exception of portions of Jackson Creek, did not meet the water quality standards for dissolved oxygen, ammonia-nitrogen, and fecal coliform counts, and frequently exhibited concentrations of total phosphorus significantly exceeding the level recommended for the avoidance of nuisance aquatic growth. That reach of Jackson Creek, located one mile upstream from sampling station Rk-11, which is designated for marginal aquatic life, recreational use, and minimum standards, was not in compliance with the prescribed dissolved oxygen and fecal coliform standards. In addition, high concentrations of ammonia-nitrogen at stations on Jackson Creek and at the Delavan Lake outlet were observed.

Of the 38 major lakes in the Rock River watershed, all exhibited the potential for anaerobic conditions in the hypolimnion (lower layer) during the summer, with attendant adverse effects on fish and other aquatic life.

Twenty-four of the lakes were rated for their trophic status: 5 were rated as oligotrophic, 13 as mesotrophic, 3 as eutrophic, and 3 as very eutrophic. Of the 21 major lakes for which complete chemical water quality data were available, all 21 failed to meet the recommended levels of water quality with respect to phosphorus and nitrogen.

Root River Watershed

In the Root River watershed, the Commission's continuing water quality monitoring program included sampling at six stations. Water quality conditions as measured by fecal coliform within the middle reaches of the watershed exhibited improvement as the result of abandonment of four sewage treatment facilities previously discharging to the streams of the watershed. Water quality conditions as measured by chloride loadings and dissolved oxygen levels in the upper reaches of the Root River, however, exhibited some decline, attributed to the increased urbanization of the tributary drainage area. The improved wastewater management practices instituted at the Cooper-Dixon Duck Farms were reflected in improved water quality conditions in the Root River Canal. Despite these improvements, the water quality conditions of the streams of the Root River watershed did not meet the applicable water quality standards for recreational use and the maintenance of a warmwater fishery and other aquatic life for dissolved oxygen, ammonia-nitrogen, and fecal coliform, while the total phosphorus levels in all the streams were also found to be higher than the recommended level.

Sauk Creek Watershed

In the Sauk Creek watershed, the continuing water quality monitoring program of the Commission included the collection of samples at two stations. A slight decline in dissolved oxygen levels over the decade, and generally stable levels of chloride and fecal coliform concentrations, as well as total phosphorus concentrations, indicated generally stable water quality conditions within the watershed. However, the water quality standards for dissolved oxygen, ammonia-nitrogen, fecal coliform counts, and total phosphorus concentrations applicable for recreational use and the maintenance of warmwater fishery and other aquatic life were not met within the watershed.

Sheboygan River Watershed

Water quality conditions in Belgium Creek in the Sheboygan River watershed remained essentially unchanged over the decade. Those conditions did not meet the initial recommended water use objectives and supporting water quality standards for marginal use, recreational use, and minimum standards for fecal coliform counts.

General Water Quality in the Region

In addition to a detailed analysis of specific water quality parameters, it is useful in water quality planning to reduce the technical data on water quality to summary form. Accordingly, a water quality index, ranging in value from 0 to 100 was prepared, based on sample results for dissolved oxygen, fecal coliform, pH (hydrogen ion concentration), chloride, nitrate-nitrogen, and total phosphorus. When assessing the average of the water quality index ratings for all samples within the Region, no major shift in water quality conditions over the decade is indicated. However, a subtle decline was noted overall in spite of observed improvements at 26 stations below points of improved or reduced effluent discharge from wastewater treatment plants. This conclusion is readily observed in the comparison of sample results to the state-adopted water quality standards. Of the total 459 miles of perennial streams in the Region for which water quality data are available, only 88 miles, or 19 percent, met the adopted DNR water quality standards in 1975, compared to 164 miles, or 36 percent, in 1964. When the Commission's recommended levels for total phosphorus are applied to the 1975 sample results, only about 9 miles, or 2 percent of the streams within the Region, met existing water quality standards and recommended criteria. In addition, when the entire data availability for the period 1964 through 1975 are considered for the total 459 miles of perennial streams monitored, only 52.1 miles, or 11.4 percent, met the water quality standards adopted by the Wisconsin Department of Natural Resources in 1976. When the Commission-recommended levels for total phosphorus are applied, only 2.5 miles, or 0.5 percent, met the adopted 1976 standards over the period of sampling.

When evaluating the 65 major lakes for which trophic status ratings were available, 8 lakes, or 12 percent of the rated lakes and 1 percent of the rated acreage, are rated as oligotrophic; 38 lakes, or 58 percent of the rated lakes and 52 percent of the rated acreage, are rated as mesotrophic; 6 lakes, or 9 percent of the rated lakes and 12 percent of the rated acreage, are rated as eutrophic; and 13 lakes, or 20 percent of the rated lakes and 29 percent of the rated acreage, are rated as very eutrophic.

Only 1 lake for which complete water quality data were available, or about 2 percent of the total of 49 such lakes and less than 1 percent of the lake acreage, met the initial recommended water use objectives, primarily because inorganic nitrogen and inorganic phosphorus usually exceeded the levels recommended to avoid unnaturally high rates of eutrophication in the other 48 lakes. Water quality in some of these lakes did not meet the recommended levels for dissolved oxygen or ammonia-nitrogen, further indicating the effects of human activities on the lakes. The major lakes also show visual scars of degraded water quality. Although natural eutrophication is a contributing factor, the increased nutrient loadings placed on the lakes in the Region due to urbanization and increased recreational pressures threaten to limit the recreational and aesthetic values of the lakes.

Based on water quality data collected from the period 1964 through 1975, as presented above, degradation of southeastern Wisconsin's lakes and streams continues. Unfortunately, improved techniques of wastewater treatment coupled with more stringent regulations governing the discharge of effluents into the surface waters over the past several years have resulted in only localized or marginal improvements on certain reaches of the streams. The majority of streams do not meet the applicable standards and have declined in quality because of diffuse as well as point source pollution, and violations of the established streamwater quality standards have become more extensive since 1964, when the Commission's benchmark survey of streamwater quality was conducted.

SOURCES OF WATER POLLUTION

A complete analysis of water pollution problems must include the identification of not only the location of the pollution sources, but of the type, quantity, and characteristics of pollutants contributed and of the probable effects of those pollutants on the quality of the receiving waters. Accordingly, the Commission undertook in 1975 an inventory by watershed of the known sources of water pollution within the seven-county Planning Region. The inventory addressed as urban pollution sources: municipal wastewater treatment plant outfalls; sanitary sewerage system flow relief devices; combined sewer outfalls; private wastewater treatment plant outfalls; other point sources including industrial wastewater outfalls; privately owned, onsite sewage disposal systems; and storm water runoff from residential, commercial, industrial, extractive, transportation, recreation, and construction lands. The inventory addressed as rural pollution sources: domestic livestock operations; storm water runoff from croplands, pasture lands, and unused rural lands; storm water runoff from woodlands; and direct atmospheric fallout and washout to surface waters.

Five pollutants were selected for use in the analyses of the kind and amount of pollutants contributed to the surface waters of the Region by the above-listed 19 categories of pollution sources. These five pollutants have been historically identified and studied both as important pollutants in themselves and as principal indicators of the presence of other polluting substances. The five specific indicators utilized were: total nitrogen, total phosphorus, biochemical oxygen demand (BOD), sediment, and fecal coliform organisms.

As of 1975, there were 61 municipally owned sewage treatment plants in operation in the Region. Eight of these plants discharged an estimated total of 254 million gallons per day of treated effluent directly to Lake Michigan. The remaining 53 plants discharged a total of about 39 million gallons per day of treated effluent to the streams and watercourses or to soil absorption systems of the inland portions of the Region. In addition, 67 private wastewater treatment facilities were in operation within the Region. Five of these plants together discharged an estimated 1.3 million gallons per day of treated effluent directly to Lake Michigan. The remaining 63 plants discharged a total of about 4.1 million gallons per day of treated effluent to the streams and watercourses or to soil absorption systems of the inland portion of the Region.

In 1975, there were 619 known sanitary and combined sewer flow relief devices in the Region which discharged an average of about 5.04 billion gallons of wastewater per year directly to the surface waters of the Region, including Lake Michigan. Of this total, about 95 sanitary and combined sewer flow relief devices discharged about 880 million gallons per year directly to Lake Michigan, with the remaining 524 flow relief devices discharging the remaining 4.16 billion gallons to the inland streams and watercourses.

Of the total 619 flow relief devices in operation within the Region, 126 were combined sewer overflow outfalls discharging an estimated 3.89 billion gallons of raw sewage per year in an average of about 52 events per year. One hundred and ten of the 619 devices were separate sewer bypasses, 40 were relief pumping stations, 72 were portable pumping stations, and 271 were sanitary and storm sewer crossovers. Of the 353 square miles of urban development within the Region served by sanitary sewers, about 27 square miles, or 8 percent, were served by combined storm and sanitary sewerage systems. An estimated total of about 365,200 persons, or about 20 percent of the total resident population of the Region, resided in this combined sewer service area.

In 1975, there were a total of 261 industrial establishments discharging cooling, process, rinse, and wash waters directly to the surface waters of the Region and to Lake Michigan through 435 outfalls. Of these, 248 outfalls, or about 57 percent, were identified as discharging only cooling water. Of the 435 outfalls, 67, or about 15 percent, discharged to Lake Michigan. The remaining 368 discharged to the inland streams and watercourses of the Region. In addition to the 435 outfalls, 16 industrial facilities discharged effluent through 17 discharge points to soil absorption systems.

Sanitary wastewater treatment and disposal was also provided through an estimated 68,600 privately owned onsite sewage disposal systems, including 351 known holding tanks and about 44 known mound systems as of 1975, with the balance being conventional septic tank soil absorption systems. These systems serve a total resident population of 246,000 persons, or about 14 percent of the total resident population of the Region, and a total area of about 2,336 square miles, or about 87 percent of the total area of the Region.

Diffuse or nonpoint source pollution consists of discharges that cannot be readily traced to specific discrete sources. Such pollution is carried from urban and rural areas of the Region to the surface waters by means of storm water runoff and snowmelt. As previously noted, urban land uses as of 1970 comprised about 387 square miles, or about 15 percent of the total area of the Region. Of this total, residential land uses comprised about 60 percent of the area in urban use.

There were 55 known urban storm water drainage systems in the Region in 1975. The 48 urban storm water drainage systems for which the service areas could be delineated encompassed a total tributary drainage area of about 180 square miles, or about 7 percent of the total area of the Region, and about 37 percent of the developed urban area of the Region. These 48 mapped systems discharged through a total of 1,358 known storm water outfalls. The combined annual average discharge from these outfalls was estimated to total about 22.9 billion gallons in an average of about 70 events per year.

The rural areas of the Region total about 2,200 square miles, or about 85 percent of the total area of the Region. Based on the Commission 1975 land cover inventory, it is estimated that of the total rural land area, about 45 percent is devoted to clean-tilled row crops, about 14 percent to hay production, about 5 percent to small grain production, and about 36 percent to woodlands, wetlands, and other open space. In 1975, there were an estimated 2,350 domestic livestock raising operations located within the Region—operations with 25 or more equivalent animal units. Each equivalent unit represents the amount of waste contributed by a 1,000 pound dairy cow. Of the total operations, 1,050, or about 45 percent, were found to be located within 500 feet of a stream, lake, or other surface waterbody.

Based on an analysis of the type, magnitude, and location of the known pollution sources, estimates were made of the annual contribution of total nitrogen, total phosphorus, biochemical oxygen demand, fecal coliform organisms, and sediment to the waterbodies of the Region. These estimates helped to define the nature and scope of the water pollution loadings in the Region and, when interpreted in light of the current water quality conditions and the assimilative capacity of the receiving waters, helped to identify alternative pollution control measures. Because the loading estimates were expressed in terms of total annual loadings, the point sources tend to appear to be understated in terms of the importance of their impact on surface water quality. The nonpoint sources contribute pollution primarily during wet weather when streamflows are high, while the point sources are active and affect the ambient concentrations in receiving waters during both high- and low-flow conditions.

Because of the geography of the Region, the estimates must be considered with regard to three principal areas: the Region as a whole, that portion of the Region which drains to the inland lakes and streams and thereby indirectly to Lake Michigan or to the Mississippi River, and that portion of the Region which drains directly to Lake Michigan. The direct Lake Michigan contributions, as noted above, include pollution from major point sources such as the large sewage treatment plants located on the Lake Michigan shoreline, which discharge their treated effluent directly to the lake and serve large tributary drainage areas—areas which may even cross major watershed divides, although they do not in any major way cross the subcontinental divide. Table 170 summarizes the significant sources of the annual pollutant loads in the major watersheds of the Region, presenting those sources which contribute in excess of at least 10 percent of the total annual load of each pollutant within a watershed. Based on these analyses, the following conclusions can be drawn with regard to the sources of pollution in each of the major watersheds. These findings should be considered together with the findings of the hydrologic-hydraulic-water quality simulation analyses set forth in Volume Two, Chapter IV of this report.

<u>Des Plaines River Watershed</u>

Rural storm water runoff was estimated to be a significant source of nitrogen, phosphorus, oxygen-demanding organic matter, and sediment loads in the watershed. Livestock were estimated to be a significant source of nitrogen, phosphorus, organic matter, and fecal coliform. While construction contributed significant proportions of phosphorus and sediment, septic tanks were estimated to contribute significant loads of organic matter and fecal coliform organisms.

<u>Fox River Watershed</u>

Rural land runoff was estimated to be a significant source of nitrogen, phosphorus, oxygen-demanding organic matter, and sediment. Livestock were estimated to be a significant source of nitrogen, phosphorus, organic matter, and fecal coliform organisms. In addition, the quarrying and aggregate mining operations in the watershed were estimated to be significant sources of phosphorus and sediment. Municipal sewage treatment plants were found to contribute a major proportion of the phosphorus load. Septic tanks were estimated to be an important source of biochemical oxygen demand.

<u>Kinnickinnic River Watershed</u>

Combined sewer overflows were estimated to be a major source of nitrogen, phosphorus, biochemical oxygen demand, and fecal coliform organisms within this highly urbanized watershed. Residential land runoff was estimated to contribute significantly to the nitrogen and biochemical oxygen demand loadings. The estimated nitrogen and sediment loads from transportation land uses were also found to be significant, as were the phosphorus and sediment loads from construction activities. In addition, industrial discharges were estimated to be a significant source of phosphorus.

Table 170

SIGNIFICANT SOURCES OF ANNUAL POLLUTANT LOADS IN THE MAJOR WATERSHEDS OF THE REGION[a]

	Pollutant									
	Nitrogen		Phosphorus		BOD_5		Fecal Coliform		Sediment	
Watershed	Source	Estimated Contribution as Percent of Total Estimated Load	Source	Estimated Contribution as Percent of Total Estimated Load	Source	Estimated Contribution as Percent of Total Estimated Load	Source	Estimated Contribution as Percent of Total Estimated Load	Source	Estimated Contribution as Percent of Total Estimated Load
Des Plaines River	Cropland, Pasture and Unused Rural Land Livestock	67 21	Livestock Construction Cropland, Pasture and Unused Rural Land	44 21 18	Livestock Cropland, Pasture and Unused Rural Land Septic Systems	35 30 20	Livestock Septic Systems	88 11	Cropland, Pasture and Unused Rural Land Construction	65 22
Fox River	Cropland, Pasture and Unused Rural Land Livestock	54 20	Livestock Construction Municipal Sew. Treat. Plants Extractive Cropland, Pasture and Unused Rural Land	30 30 12 11 11	Livestock Cropland, Pasture and Unused Rural Land Septic Systems Atmospheric Contributions to Surface Waters	31 22 14 15	Livestock	89	Cropland, Pasture and Unused Rural Land Construction Extractive	41 38 14
Kinnickinnic River	Combined Sewer Overflow Residential Transportation	25 18 17	Combined Sewer Overflow Industrial Discharges Construction	38 24 21	Industrial Discharges Combined Sewer Overflow Residential	43 24 10	Combined Sewer Overflow	97	Construction Transportation	46 31
Menomonee River	Cropland, Pasture and Unused Rural Land Transportation Construction	23 20 11	Construction Combined Sewer Overflow	35 18	Transportation Septic Systems Combined Sewer Overflow	26 16 16	Combined Sewer Overflow	84	Transportation Construction Cropland, Pasture and Unused Land	47 35 10
Milwaukee River	Cropland, Pasture and Unused Rural Land Livestock	50 27	Livestock Construction Cropland, Pasture and Unused Rural Land	43 23 11	Livestock Cropland, Pasture and Unused Rural Land	41 23	Livestock Combined Sewer Overflow Municipal Sew. Treat. Plants	38 33 26	Cropland, Pasture and Unused Rural Land Construction	51 35
Minor Streams Tributary to Lake Michigan Barnes Creek	Cropland, Pasture and Unused Rural Land Construction Septic Systems	40 31 17	Construction Extractive Septic Systems	71 12 12	Septic Systems Construction Cropland, Pasture and Unused Rural Land	62 16 10	Septic Systems	91	Construction Extractive Cropland, Pasture and Unused Rural Land	76 13 11
Pike Creek	Cropland, Pasture and Unused Rural Land Construction Residential	32 28 14	Construction	78	Residential Septic Systems Commercial Construction Industrial Discharges	22 16 15 14 10	Septic Systems Sew. Flow Relief Devices Industrial	27 24 21	Construction Cropland, Pasture and Unused Rural Land	81 11
Minor Streams Tributary to Lake Michigan (cont) Sucker Creek	Livestock Cropland, Pasture and Unused Rural Land	47 42	Livestock Construction[b]	59 32	Livestock Cropland, Pasture and Unused Rural Land	65 19	Livestock	98	Construction[b] Cropland, Pasture and Unused Rural Land	49 43
Oak Creek	Cropland, Pasture and Unused Rural Land Construction	47 20	Construction	69	Cropland, Pasture and Unused Rural Land Transportation Septic Systems Residential	18 18 15 14	Septic Systems Livestock Residential Industrial	35 21 17 12	Construction Cropland, Pasture and Unused Rural Land Transportation	61 18 14
Pike River	Cropland, Pasture and Unused Rural Land	72	Construction Cropland, Pasture and Unused Rural Land	49 17	Cropland, Pasture and Unused Rural Land Septic Systems	34 27	Municipal Sew. Treat. Plants Livestock Septic Systems	51 25 17	Cropland, Pasture and Unused Rural Land Construction	49 42
Rock River	Cropland, Pasture and Unused Rural Land Livestock	61 24	Livestock Construction Municipal Sew. Treat. Plants Cropland, Pasture and Unused Rural Land	41 23 13 13	Livestock Cropland, Pasture and Unused Rural Land Atmospheric Contributions to Surface Water	41 27 13	Livestock	96	Cropland, Pasture and Unused Rural Land Construction	56 31
Root River	Cropland, Pasture and Unused Rural Land Livestock Septic Systems	60 12 10	Construction Livestock Septic Systems Cropland, Pasture and Unused Rural Land	34 19 11 13	Septic Systems Cropland, Pasture and Unused Rural Land Livestock	35 22 16	Livestock Combined Sewer Overflow Septic Systems	42 30 19	Cropland, Pasture and Unused Rural Land Construction	46 38
Sauk Creek	Livestock Cropland, Pasture and Unused Rural Land	50 46	Livestock Cropland, Pasture and Unused Rural Land	83 10	Livestock Cropland, Pasture and Unused Rural Land	70 19	Livestock	98	Cropland, Pasture and Unused Rural Land	81
Sheboygan River	Cropland, Pasture and Unused Rural Land Livestock	65 28	Livestock Cropland, Pasture and Unused Rural Land	70 21	Livestock Cropland, Pasture and Unused Rural Land	50 34	Livestock	97	Cropland, Pasture and Unused Rural Land	85
Region	Cropland, Pasture and Unused Rural Land Livestock	54 22	Livestock Construction Cropland, Pasture and Unused Rural Land	33 28 11	Livestock Cropland, Pasture and Unused Rural Land Septic Systems	32 22 13	Livestock Combined Sewer Overflow Municipal Sew. Treat. Plants	53 29 10	Cropland, Pasture and Unused Rural Land Construction	45 36

[a] Defined as those sources contributing 10 percent or more of the potential load of the pollutant.

[b] Construction activities are identified as a significant pollution source in the Sucker Creek Watershed because of the construction of Hwy I-43.

Source: SEWRPC.

Menomonee River Watershed

Despite the mixed urban and rural land uses in the watershed, rural land runoff was estimated to be a significant source of nitrogen and sediment. Transportation land uses were estimated to be significant sources of nitrogen, organic matter, and sediment. In addition, construction was found to be a significant source of nitrogen, phosphorus, and sediment. Combined sewer overflows were estimated to be significant contributors of phosphorus, biochemical oxygen demand, and fecal coliform. Improperly located or malfunctioning septic systems were identified as significant sources of oxygen-demanding substances in some suburban and rural urban areas of the watershed.

Milwaukee River Watershed

For the watershed as a whole, rural land runoff and livestock were estimated to be significant sources of nitrogen, oxygen-demanding organic matter, phosphorus, fecal coliform, and sediment. Combined sewer overflows and municipal sewage treatment plants were significant sources of fecal coliform organisms. In addition, for that portion of the watershed within Milwaukee County, virtually all of the total annual load of each pollutant can be associated with urban sources, including sanitary sewerage system flow relief devices, combined sewer overflows, and urban storm water runoff.

Minor Streams Tributary to Lake Michigan

Rural land runoff was estimated to be a significant source of nitrogen and sediment in the drainage areas of all three of the perennial minor streams directly tributary to Lake Michigan—Barnes, Pike, and Sucker Creeks. Similarly, construction was found to be an important source of phosphorus and sediment in all three drainage areas. In Barnes Creek and Pike Creek, both having significant urban land uses, septic tanks were estimated to be significant sources of nitrogen, phosphorus, biochemical oxygen demand, and fecal coliform in the former and of biochemical oxygen demand and fecal coliform in the latter. Residential land runoff was estimated to be a significant source of pollution only in the Pike Creek drainage area, where organic matter and nitrogen were estimated to be contributed in significant amounts from residential land runoff. Livestock operations were estimated to contribute significantly to every pollutant except sediment in the predominantly rural Sucker Creek drainage area.

Oak Creek Watershed

The pollutant loadings in the urbanizing Oak Creek watershed reflect the importance of cropland and other rural storm water runoff as significant sources of nitrogen, oxygen-demanding organic matter, and sediment. Construction was found to be a significant source of nitrogen, phosphorus, and sediment. Septic tanks were identified as major sources of both organic matter and fecal coliform organisms. Transportation and residential lands were found to be important sources of organic matter. fecal coliform organisms, and sediment. The few remaining livestock operations were also estimated to contribute a significant proportion of the fecal coliform organisms in the watershed.

Pike River Watershed

Rural storm water runoff was estimated to be a significant source of nitrogen, phosphorus, oxygen-demanding organic matter, and sediment, while livestock operations were estimated to be significant sources of fecal coliform organisms. Construction was indicated as an important source of phosphorus and sediment, and septic tanks were estimated to be important contributors of organic matter, and fecal coliform loads in the watershed. Municipal sewage treatment plants contributed most of the fecal coliform organisms in the watershed.

Rock River Watershed

Cropland and livestock were estimated to be significant sources of nitrogen, phosphorus, and organic matter in the Rock River watershed, while livestock operations contributed the majority of the fecal coliform organisms. Storm water runoff from rural lands was estimated to contribute the majority of the total sediment loads in the watershed. Municipal sewage treatment plants were identified as significant sources of phosphorus and construction was an important source of phosphorus and sediment in the watershed.

Root River Watershed

Rural storm water runoff was estimated to be a major source of all pollutants in the watershed but fecal coliform organisms. Livestock operations were estimated to be significant sources of nitrogen, phosphorus, organic matter, and fecal coliform organisms. Septic tanks were found to be significant sources of nitrogen, phosphorus, biochemical oxygen demand, and fecal coliform organisms. In addition, construction was estimated to contribute significantly to the phosphorus and sediment loads. Combined sewer overflows were found to be important sources of fecal coliform organisms in the lower reaches of the watershed.

Sauk Creek Watershed

In this watershed, livestock operations and rural storm water runoff were found to be the only significant sources of each of the five pollutants.

Sheboygan River Watershed

Because it adjoins the Sauk Creek watershed and has a very similar mix of land uses, the Sheboygan River watershed within the Region was also found to be affected predominantly by livestock operations and rural storm water runoff.

For the Region as a whole in an average year, about 46 million pounds of nitrogen, 6.7 million pounds of phosphorus, 113 million pounds of biochemical oxygen demand, 6.7 million tons of sediment, and 3.2×10^{17} fecal coliform organisms are estimated to be discharged to the inland lakes and streams and to Lake Michigan from all sources of pollution within the seven-county Region. Of these total estimated amounts, urban sources are estimated to contribute about 43 percent of the nitrogen, 66 percent of the phosphorus, 50 percent of the biochemical oxygen demand, and 55 percent of the sediment loads as well as about 50 percent of the fecal coliform pollutant loads. Rural sources are thus estimated to contribute about 57 percent of the nitrogen, 34 percent of the phosphorus, 50 percent of the biochemical oxygen demand, 45 percent of the sediment, and about half of the fecal coliform pollutant loads.

The most significant urban point sources of pollution in the Region include municipal sewage treatment plants with respect to nitrogen, phosphorus, and biochemical oxygen demand, and combined sewer overflows with respect to fecal coliform organisms. Contrary to popular belief, industrial discharges do not constitute a major source of urban point source pollution within the Southeastern Wisconsin Region as a whole. The largest urban nonpoint sources of pollution include transportation and construction, the latter particularly with respect to sediment and the attendant nutrients. Onsite sewage disposal systems also constitute an important source of urban pollution loads, particularly with respect to biochemical oxygen demand and fecal coliform organisms.

The largest rural sources of pollution are all nonpoint sources and include livestock raising operations and runoff from cropland. Both are major sources of nutrients and biochemical oxygen demand. While livestock raising operations constitute the major source of fecal coliform and biochemical oxygen demand pollution and the largest phosphorus source, cropland constitutes the major source of sediment and nitrogen pollution.

Although urban point sources contribute a significant proportion of the nitrogen, phosphorus, and biochemical oxygen demand within the Region as a whole because of the diversion of large amounts of treated municipal sewage directly to Lake Michigan, urban point sources are relatively minor sources of pollution with respect to the inland lakes and streams of the Region. For example, while urban point sources are estimated to contribute 32 percent of the nitrogen, 34 percent of the phosphorus, and 25 percent of the biochemical oxygen demand within the Region as a whole, these same sources contribute only 7, 14, and 8 percent of the respective pollutant loads to the inland lakes and streams of the Region. Conversely, these urban point sources are major contributors of annual pollution loads to Lake Michigan, with 95, 93, and 87 percent of the pollutant loadings, respectively.

With respect to the annual pollutant loads to inland lakes and streams of the Region, nonpoint sources contribute the preponderance of the total annual loads, contributing 93 percent of the nitrogen, 86 percent of the phosphorus, 92 percent of the biochemical oxygen demand, 60 percent of the fecal coliform organisms, and almost all of the sediment. Rural nonpoint sources of pollution are particularly important with respect to the inland lakes and streams, contributing almost 78 percent of the nitrogen, 45 percent of the phosphorus, 63 percent of the biochemical oxygen demand, 53 percent of the fecal coliform organisms, and 47 percent of the sediment loadings to these streams, with cropland and pasture lands contributing the predominant loads of nitrogen and sediment, and livestock operations constituting the singularly most important source of phosphorus, biochemical oxygen demand, and fecal coliform organisms.

Based upon the Commission's inventories of total annual pollutant loads, the following conclusions may be drawn about the existing sources of water pollution in southeastern Wisconsin:

1. Of the total estimated annual pollutant loading on the surface waters of southeastern Wisconsin, about 28 percent of the nitrogen, 26 percent of the phosphorus, 22 percent of the biochemical oxygen demand, 7 percent of the fecal coliform organisms, and 5 percent of the sediment are contributed directly to Lake Michigan. The remaining 72 percent of the nitrogen, 74 percent of the phosphorus, 78 percent of the biochemical oxygen demand, 93 percent of the fecal coliform organisms, and 95 percent of the sediment are contributed to the inland lakes and streams. Of this total to inland lakes and streams, the waters of the Mississippi River drainage basin received an estimated 62 percent of the nitrogen, 61 percent of the phosphorus, 57 percent of the biochemical oxygen demand, 37 percent of the fecal coliform organisms, and 60 percent of the sediment. The remaining inland waters pollutant load—38 percent of the nitrogen, 39 percent of the phosphorus, 43 percent of the biochemical oxygen demand, 63 percent of the fecal coliform organisms, and 40 percent of the sediment—was contributed to the inland waters of the Great Lakes drainage basin. The majority of the pollutant loading to the inland waters is from nonpoint sources, while the majority of the pollutant loading directly to Lake Michigan is from point sources.

2. Based on the estimated annual pollutant loads, point sources of pollution do not comprise the dominant pollution source for the inland lakes and streams of the Region. Point source contributions can be expected in the future to be further reduced in their magnitude as a result of local, state, and federal requirements; increased expenditures; and improved wastewater treatment technologies. The inventory findings thus indicate the importance of the diffuse sources of pollution in the Region and support the need to develop and implement diffuse source abatement plans for both the rural and urban areas of the Region. This finding is assessed in more detail for each watershed in Volume Two, Chapter IV of this report, in which important factors beyond the total pollutant load are considered. These factors include the spatial distribution of sources within the watersheds, the assimilation capacity of the watercourses, and the seasonal timing and period of the pollutant loading events.

3. Of the point sources of pollution, the sanitary wastewaters discharged from municipal and private sewage treatment plants and from sanitary and combined sewage flow relief devices together constitute the most important sources of pollution in terms of the annual contributions of all pollutants considered. On a regional basis, industrial wastewater discharges are only minor sources of water pollution contributing from less than 0.1 percent to about 1.4 percent of the total for the five pollutants discussed. These sources can, however, constitute important sources of such "exotic" substances as poisonous metals and dangerous chemicals. For the major watersheds, industrial sources are of minor significance, except with regard to biochemical oxygen demand and phosphorus in the Kinnickinnic River watershed. For more localized stream reaches, selected industrial and municipal waste discharges can be expected to be important, and thus the discharges are identified individually in Volume Two, Chapter IV of this report.

4. Storm water runoff from croplands, pasture, and unused rural lands is the largest single contributor of nitrogen and sediment to the inland lakes and streams of the Region, and is a significant source of phosphorus and biochemical oxygen demand. Livestock operations are the largest single source of annual phosphorus, biochemical oxygen demand, and fecal coliform loads.

5. Runoff to inland lakes and streams from urban and suburban construction activities is the second largest single contributor of phosphorus—the most recognized direct cause of eutrophic waters—and is the largest urban source of sediment on an annual load basis.

6. Livestock operations and septic systems are important diffuse source contributors of fecal coliform, and together account for an estimated 58 percent of the fecal coliform organisms potentially reaching the surface waters. Improperly installed or malfunctioning septic systems are important urban sources of surface water pollution, especially those in the poorly suited soils which predominate the eastern half of the Southeastern Wisconsin Region. In addition, flow relief devices, which contribute 30 percent of the total fecal coliform load to inland lakes and streams, and municipal sewage treatment plants, which contribute 10 percent of the total fecal coliform load, account for nearly all of the remaining nonagriculture-related fecal coliform loads in the Region.

7. The estimated annual loads from the inventoried pollution sources indicate that urban sources of pollution are predominant in the Kinnickinnic River watershed, Menomonee River watershed, Barnes Creek subwatershed, Pike Creek subwatershed, and Oak Creek watershed; whereas rural sources are predominant in the Des Plaines River watershed, Fox River watershed, Milwaukee River watershed, Sucker Creek subwatershed, Rock River watershed, Sauk Creek watershed, and Sheboygan River watershed. The pollution sources in the Pike River and Root River watersheds are about equally divided between rural and urban sources.

These conclusions about total annual pollutant loads are further evaluated on the basis of the water quality simulation modeling analyses in Volume Two, Chapter IV of this report. Such evaluation is particularly important with regard to the seasonal distribution of these loads and their recurrence in relation to storm events and related streamflow conditions and with respect to their spatial distribution over the watersheds of the Region.

LEGAL STRUCTURES AFFECTING WATER QUALITY MANAGEMENT

The legal as well as the physical and economic factors affecting water pollution abatement and water quality management must be considered in any sound water quality planning and engineering effort. An assessment of the legal factors involved can serve to identify potential impediments to plan implementation as well as opportunities for enhancing such implementation. A major objective of the Commission's work programs has always been to develop realistic plans which can be implemented within the existing institutional structures whenever possible. Accordingly, an evaluation and inventory of those structures and the legal considerations involved was conducted.

The Federal Water Pollution Control Act Amendments of 1972 established the basic framework for the federal approach to water pollution control. The act establishes broad national water use objectives; provides for the issuance of pollutant discharge elimination permits; provides for the preparation and implementation of water quality plans; and provides federal financial assistance to local units of government and other selective plan implementation agents, including agricultural land managers. In addition, the 1972 Amendments provide for the enactment of specific effluent limitations applicable to all similar point sources of water pollution falling within given categories of pollutants. Finally, the Clean Water Act of 1977 provides for technical adjustments to schedules and effluent criteria of the Federal Water Pollution Control Act. The 1977 Act, however, leaves unchanged the national goal set forth in the Federal Water Pollution Control Act Amendments of 1972 of eliminating the discharge of pollutants into the navigable waters of the United States by 1985, and of achieving water quality which is suitable for the maintenance of fish and other aquatic life and for use for human recreational activities in and on the water by 1983.

Other federal acts which bear on water quality management include the National Environmental Policy Act, the Safe Drinking Water Act, the Coastal Zone Management Act, the Resource Conservation and Recovery Act, and the Toxic Substances Control Act. In addition, the Consolidated Farm and Rural Development Act, the Food and Agriculture Act of 1962, the Watershed Protection and Flood Prevention Act, the Water Bank Act, and the Soil Conservation and Domestic Allotment Act provide for technical and financial assistance to farm land owners and operators in activities related to water resources management.

At the state level, the responsibility for water pollution control is centered in the Wisconsin Department of Natural Resources. The establishment of water use objectives and supporting standards, issuance of pollution abatement orders, certification of treatment plant operators and sewerage works, review and approval of engineering plans, and administration of financial assistance programs are all delegated to the Department. Other activities vested in various state units of government include the establishment of plat approval procedures and criteria; creation and support of soil and water conservation district programs; creation of the "Wisconsin Fund" to provide financial assistance for both point and nonpoint pollution control projects; establishment of inland lake protection and rehabilitation districts and provision of grants and technical assistance thereto; regulation of pesticide use; and general provision of educational and technical assistance.

Four general-purpose local units of government have important responsibilities and authorities for water quality management in Wisconsin. These include the counties, cities, villages, and towns. Eight special-purpose units of government also have potential as important water quality management agencies. These include soil and water conservation districts, public inland lake protection and rehabilitation districts, utility districts, drainage districts, town sanitary districts, metropolitan sewerage districts, and, within the Region, the Milwaukee Metropolitan Sewerage District as governed by the joint sewerage commissions.

With regard to point source control, the legal analyses indicate that there exists adequate authority to implement various elements of any areawide water quality management plan. In addition to general point source regulatory authority, the cities, villages, and metropolitan sewerage districts have sufficient authority to convey and treat storm water, manage urban waste materials, and review plats and enact subdivision control ordinances and floodplain ordinances. The issuance of building permits and the exercise of broad zoning authority and subdivision control ordinances are other important authorities in this respect.

For nonpoint source control, existing agencies have only limited implementation and enforcement authority within unincorporated areas. However, the cities and villages do have sufficient authority to assure that a sound nonpoint source pollution abatement program can be implemented. The limitations of Chapter 92 of the Wisconsin Statutes, and the cumbersome process by which local soil and water conservation districts have to proceed in order to establish land management regulations for unincorporated areas, were identified as important potential impediments to extensive application of pollution abatement measures, and to the implementation of a nonpoint pollution control program in rural areas other than voluntary in nature. Counties were found to have important authority for control of nonpoint source pollution by means of plat approval, building and sanitary codes, shore protection, solid waste management, and shoreland and floodplain zoning ordinance and sanitary ordinance. Civil towns were found to have important authority with regard to zoning, subdivision regulation, building and sanitary codes, and garbage disposal regulation. Inland lake protection and rehabilitation districts were found to have extensive and necessary authority for watershed management, protection, and rehabilitation, but must be considered limited with regard to zoning authority and other land use regulation capability.

In addition to their normal legal rights, private citizens have explicitly identified roles in water pollution control. Riparian rights provide for direct court relief, and nonriparians have certain rights to enjoy the variable waters for recreational and other purposes. The statutes in Wisconsin provide for citizen action petitions by enabling six or more citizens to file complaints leading to public hearings by the Department of Natural Resources on alleged or potential acts of water pollution. Private citizens may also file suit in United States courts to enjoin violation of the Federal Water Pollution Control Act and to force federal officials to properly carry out any nondiscretionary activity under this Act.

Basic legal issues of direct concern to areawide water quality planning and plan implementation are the abilities of any public body to impose limitations upon access to main and trunk sewers in order to avoid stimulation of unwise land use development that may occur as a result of the availability of centralized sanitary sewer service, the authority of the State to regulate sludge management, and the availability of mechanisms for review of rates and fees charged for intergovernmental sewage service contracts. Regarding limitations on sewer connections, the Wisconsin Department of Natural Resources has long possessed certain authorities to restrict sewer connections. However, the Department did not have the authority to limit such connections for reasons solely based on land management criteria until the 1977 Budget Review Bill was passed, expanding the criteria of Chapter 144 of the Wisconsin Statutes to allow for consideration of the land use recommendations within an adopted and approved areawide water quality management plan. In addition, cities and villages have authority to limit connections to sewerage systems extending through unincorporated areas. Conversely, towns may not demand connections to a proposed system as a condition of approval for sewer construction.

The authority of the Department of Natural Resources to regulate the management and disposal of sludge was also explored as a pertinent legal issue. Through the utilization of Wisconsin Statutes Chapter 147 discharge permits, the Department was found to possess adequate authority to regulate the disposal of sewage sludge. A third vital issue analyzed was the development of sewage treatment rates and schedules to assure that individuals or contracting municipalities will pay a proportionate share of any waste treatment services provided. The Wisconsin Public Service Commission's statutory authority to supervise and regulate public utilities within the State is limited. The Public Service Commission does not have regulatory authority over sewerage operations, since such operations are not included within the statutory definition of public utilities. The sewer and water rates of towns, villages, and cities of the fourth class operating a joint utility for the provision of sewer and water services may be subjected to the Commission's approval. The Public Service Commission may investigate complaints and hold a public hearing about unreasonable or unjustly discriminatory rates or practices related to rates. In the case of rates, rules, or practices which are determined to be unreasonable or unjustly discriminatory, the Commission may determine reasonable rates, rules, and practices. It appears that the Public Service Commission does not have sewerage rate jurisdiction in situations involving joint sewage commissions, or intergovernmental sewerage service contracts pursuant to Chapter 66.30 of the Wisconsin Statutes.

FINANCIAL RESOURCES AFFECTING WATER QUALITY MANAGEMENT

The financial ability of implementing agents—including both local units of government and private sector parties—to carry out water pollution abatement measures is an important consideration in any water quality management planning effort. The financial feasibility of recommended areawide water quality management plans depends upon the amounts of public financial resources available—including state and federal grants-in-aid—for the abatement of water pollution from point sources; the private sector financial resources available for the abatement of industrial wastewater pollution; and both the public and private sector financial resources available for agricultural water quality management. In addition, for the abatement of urban nonpoint source water pollution, financial resources must be available in the public sector for local units of government to construct the necessary pollution abatement facilities or to carry out the necessary pollution abatement practices. Moreover, the financial resources required for pollution abatement must be compared to the total financial obligations of the implementing agent to assure that the proposed actions are realistic in light of other financial expenditures necessary for the public good.

Total Local Government Expenditures

In southeastern Wisconsin the Commission inventories indicate that, in 1975, total public expenditures for all purposes except schools by local units of government including counties, cities, villages, and towns totaled about $1,120 million. Of this total, approximately $994 million, or about 89 percent, was for public expenditures other than those related to water quality management. The remaining $126 million, or about 11 percent, was estimated to have been expended for the development and operation of sanitary sewerage systems including debt retirement; urban land management expenditures for activities such as refuse collection and disposal, street sweeping, leaf and rubbish pickup and disposal, storm sewer cleaning and maintenance, snow and ice removal, and street and highway sanding and salting; and local water quality sampling and enforcement programs, all of which would be related to any comprehensive local water quality management program. Of the public sector local governmental expenditures related to water quality management, about $62.2 million, or about 49 percent, was related to urban land management activities—not including debt retirement expenditures. The balance of about $63.8 million, or about 51 percent of the local governmental water quality-related expenditures, including debt retirement, was devoted to sanitary sewerage system expenditures.

As noted, total sanitary sewerage system expenditures in the Region were based on a special Commission inventory, and were estimated at about $63.8 million in 1975. In the same year, $7.1 million in state grants was awarded for sewerage systems development and construction and $6.2 million in federal grants was awarded for sewerage system construction in the Region. Of the reported sanitary sewerage system expenditure cost of $63.8 million, $19 million, or about 30 percent, was reported as being devoted to operation and maintenance expenditures, with new capital improvements reported to be about $34.3 million, or about 54 percent, and debt retirement costs on existing capital structures reported as $10.5 million, or the remaining 16 percent.

In addition to these public sector point source pollution abatement expenditures, significant amounts of pollution abatement expenditures had been incurred by the industrial sector of the private economy in southeastern Wisconsin. Specifically, the U. S. Census data indicate that an estimated $32.4 million was expended in 1975 for such purposes, with $16.1 million, or about 50 percent, devoted to operation and maintenance costs, including user charges paid to local units of government, and $16.3 million, or about 50 percent, devoted to capital improvements. Industrial cost recovery revenue estimates were considered negligible in 1975. Total capital and operating expenditures for all purposes by the industrial sector was estimated at $7.65 billion, indicating that the $32.4 million expenditure in plant improvements and operation and maintenance related to water pollution control comprised about 0.4 percent of the total industrial cash outlay in 1975.

For agricultural pollution control, it was estimated from a special Commission inventory that approximately $0.28 million was expended for capital improvements in the private sector in 1975, with federal financial assistance totaling $0.19 million. Compared to the total agricultural expenditures for all purposes in the Region, estimated at $143.5 million, this results in estimated water quality-related capital expenditures of about 0.3 percent of the total cash outlay.

Water Quality-Related Expenditures

For the period 1971 to 1975, the water quality-related expenditures by all units of government in the Region remained relatively stable when adjusted to reflect the effects of general price inflation, ranging from a total of $119 million in 1971 to $116 million in 1975, not including debt retirement as discussed above. Expenditures by cities and counties as well as expenditures by other units of government reflected the reduced sanitary sewerage system construction grants-in-aid, while major federal grant-in-aid programs were being revised in the period following the passage of the 1972 Federal Water Pollution Control Act Amendments. In addition, the final payments for construction of the South Shore sewage treatment plant by the Milwaukee Metropolitan Sewerage District through 1973 increased the capital expenditures in the first two years of the five-year period evaluated.

By contrast, excluding the Metropolitan Sewerage Commissions of the City and County of Milwaukee, the expenditures by the other units of government for water quality management-related items indicate an expenditure trend which shows a real increase of about $5 million, or about 5 percent over the period 1971 through 1975, and is largely attributed to increases in the provision of general urban services. For the City of Milwaukee, total expenditures and water quality-related expenditures were found to be declining from 1971 through 1975, while increases were indicated for the other cities in the Region over the time period. Similarly, increases were reflected in water quality-related expenditures over the analysis period for towns and villages.

Sanitary Sewerage System Expenditures

Total expenditures in the Region during 1975 for operation, maintenance, and capital improvements, including debt retirement, for sanitary sewerage systems were estimated at $64 million, or about $41 per capita based upon the population served by sanitary sewers. Of this total about $19 million, or about $12 per capita, was expended for operation and maintenance and about $45 million, or $29 per capita, was expended for capital improvements. Total expenditures ranged from $10 to $905 per capita for 1975, while expenditures for operation and maintenance ranged from $4 to $200 per capita and for capital expenditures from $1 to $705.

By comparison, the total expenditures for 1970, expressed in 1976 dollars for operation, maintenance, and capital improvements, including debt retirement, were approximately $62 million, or about $42 per capita, with about $13 million, or about $9 per capita, expended for operation and maintenance and about $49 million, or about $33 per capita, expended for capital improvements. Total expenditures ranged from $6 to $668 per capita, while expenditures for operation and maintenance ranged from $2 to $65 per capita and for capital expenditures from $2 to $666.

Local Government Indebtedness

The potential for local government bonded indebtedness within the Region remains sufficient for implementation of major public works projects. The local units of government in the Region, including the Metropolitan Sewerage District of Milwaukee County, were found to be at an average of approximately 18 percent of their potential bonded indebtedness, with a total of $424 million in municipal bonds outstanding as of 1975. Of this, an estimated $63.6 million, or 15 percent, was represented by the long-term outstanding debt of the Metropolitan Sewerage District, and all of this was committed on the basis of general obligation bonds, with no revenue bank issues outstanding.

CONCLUSION

The development of necessary and practical recommendations for the achievement of water use objectives and supporting water quality standards for the inland lakes and streams of southeastern Wisconsin requires major data collection and analyses efforts. Accordingly, such efforts were undertaken as a part of the areawide water quality management planning program undertaken by the Commission in July 1975 pursuant to federal and state mandates and guidelines. This, the first volume of the planning report documenting the findings and recommendations of that planning effort, has set forth the basic concepts underlying the study and the factual findings of the extensive inventories conducted. More specifically, the formulation of sound plans for water quality management requires the collection and analyses of data on population, economic activity, land use, public utilities, and transportation facilities; on public financial resources; on climate, air quality, topography, and soils; on groundwater and associated discharge and recharge areas; on lakes and stream hydrology and hydraulics; on existing water quality conditions; on existing sources of water pollution, including all point sources, such as sewage treatment plants, industrial wastewater outfalls, and combined and separate sanitary sewer overflows, and all nonpoint sources, such as storm water runoff and runoff from the various rural and urban land uses; on the location and capacity of existing pollution control facilities; on the state-of-the-art of water pollution control; on legal constraints; and on the institutional structures and practices relating to land and water management.

The inventory findings depict a Region experiencing very modest rates of population growth, but a major internal redistribution of population. The relatively modest rates of population growth are accompanied by relatively high rates of employment growth, increasing labor force participation rates, smaller household sizes, and growing household incomes. The pattern of urbanization within the Region is one of continued diffusion and decentralization, with new urban development being attached to the remaining undeveloped stream and lake shorelines and associated floodlands and environmental corridors. This diffusion of population, economic activity, and urban land uses has been accompanied by declines in the population levels of the older central cities and first-ring suburbs. The resulting reduction in use of existing utility systems and the growing demand for the development of new systems have important implications for the abatement of both point and nonpoint sources of water pollution and for the feasibility and use of centralized sanitary sewerage and water supply facilities. Notwithstanding this diffusion of urban development, the total encroachment of urban uses upon the primary environmental corridors and prime agricultural lands of the Region has been relatively small, with these elements of the resource base still largely intact. These lands do enhance the overall quality of the environment in the Region and the environmental corridor lands particularly serve to protect the water resources from the undesirable impacts of human use and urban development. The inventories indicate that local units of government are exhibiting an increasing willingness to utilize zoning powers to preserve and protect environmental corridors and prime agricultural lands. As reported in SEWRPC Planning Report No. 25, A Regional Land Use Plan and a Regional Transportation Plan for Southeastern Wisconsin: 2000, Volume One, Inventory Findings, significant progress toward implementation of the regional land use plan has been made in the development patterns in the Region. However, particularly with regard to residential land development, there is no indication of firm adherence to the recommended regional land use pattern. In light of this, the Commission considered a "controlled sprawl" plan alternative for a low-density regional development pattern. After public hearings and discussion, the Commission rejected that plan in favor of a controlled centralization plan for urban development in the Region through the year 2000.

Two of the most important inventories and analyses conducted by the Commission in support of the areawide water quality management plan effort are reported in summary form in this volume. The first is the analysis of the existing condition and of long-term trends in the condition of water quality in the inland streams and lakes of the Region, including a comparison of such conditions to the adopted water use objectives and supporting standards. The analysis identified both improvements and degradation of surface water quality in various portions of the Region over the period from 1964 through 1975; documented the extent to which water use objectives and supporting standards were being met; documented the benefits of point source pollution abatement measures taken to date; and indicated the need for further point and nonpoint source water pollution abatement efforts. A more detailed presentation of these findings is set forth in SEWRPC Technical Report No. 17, Water Quality of Lakes and Streams in Southeastern Wisconsin: 1964-1975.

The second fundamental inventory and analysis conducted involved the identification of all known sources—both point and nonpoint—of water pollution within the Region, and the quantification of the amount and characteristics of the pollutants contributed by each of these sources. The data were used to estimate by watershed the absolute and relative annual contributions of five critical major pollutants—total nitrogen, total phosphorus, biochemical oxygen demand, sediment, and fecal coliform organisms—from each of the sources identified. The inventory indicated the importance of nonpoint sources of water pollution, as well as the continued need to abate pollution from sewage treatment plants, separate sewer flow relief devices, and combined sewer overflows, all of which were more routinely considered in past water quality management planning efforts. Notably, industrial wastewaters were not identified as a major source of any of the five pollutants for any of the 12 major watersheds of the Region. Only for localized stream reaches or for toxic or hazardous pollutants for which only limited data exist are industrial sources of water pollution of critical importance in southeastern Wisconsin. A more detailed presentation of these findings is set forth in SEWRPC Planning Report No. 21, Sources of Water Pollution in Southeastern Wisconsin: 1975.

The inventory data presented in this volume are used in Volume Two of this report as a basis for the forecasting of future water quality conditions and for the development of alternative plans to meet established water use objectives, and in Volume Three as a basis for the recommendation of selected measures of water pollution control in the Region and for the preparation of the Environmental Impact Assessment of the recommended water quality plan.

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APPENDICES

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Appendix A

ROSTERS OF SEWRPC WATER QUALITY MANAGEMENT ADVISORY COMMITTEES

TECHNICAL ADVISORY COMMITTEE ON AREAWIDE WATER QUALITY MANAGEMENT PLANNING

Joel Wesselman* Chairman	Executive Director, Milwaukee-Metropolitan Sewerage Commissions
Raymond J. Kipp Vice-Chairman	Dean, College of Engineering, Marquette University
Lyman F. Wible Secretary	Chief Environmental Planner, Southeastern Wisconsin Regional Planning Commission
Vinton W. Bacon*	Professor, College of Applied Science and Engineering, University of Wisconsin-Milwaukee
Anthony S. Bareta	Director, Milwaukee County Planning Commission
Kurt W. Bauer*	Executive Director, Southeastern Wisconsin Regional Planning Commission
Frank R. Boucher	Director, Environmental Department, Wisconsin Electric Power Company
J. R. Castner*	Executive Director, Wisconsin Solid Waste Recycling Authority
Frederick H. Chlupp	Land Use and Park Administrator, Washington County
Arnold L. Clement*	Planning Director and Zoning Administrator, Racine County
Norbert H. Dettmann	Washington County Board Supervisor
Alvin A. Erdman	District Conservationist, U. S. Soil Conservation Service, Milwaukee and Waukesha Counties
Kent B. Fuller	Chief, Planning Branch, Region V, U. S. Environmental Protection Agency
Herbert A. Goetsch	Commissioner of Public Works, City of Milwaukee
Thomas N. Hentges	Former Racine County Board Supervisor; Former Chairman, Town of Burlington
Lester O. Hoganson	General Manager, Racine Water and Wastewater Utility
Helen M. Jacobs*	League of Women Voters
Myron E. Johansen*	Former District Conservationist, U. S. Soil Conservation Service, Ozaukee and Washington Counties
Leonard C. Johnson	Research and Development Director, Wisconsin Board of Soil and Water Conservation Districts
Melvin J. Johnson	Chairman, Town of Norway, Racine County Board Supervisor
Elwin G. Leet*	Racine County Agricultural Agent
William G. Murphy	Professor, College of Engineering, Marquette University; Chairman, SEWRPC Citizens Advisory Panel for Public Participation on Areawide Wastewater Treatment and Water Quality Management Planning
O. Fred Nelson*	Manager, Kenosha Water Utility
Wayne A. Pirsig	District Director, Farmers Home Administration, U. S. Department of Agriculture
Herbert E. Ripley*	Health Officer, Waukesha County Department of Health
Donald A. Roensch	Director of Public Works, City of Mequon
Harold F. Ryan	Washington County Board Supervisor
Marvin E. Schroeter	Associated Public Works Contractors of Greater Milwaukee, Inc.; Wisconsin Underground Related Material Suppliers
Bernard G. Schultz*	Assistant District Director, Southeast District, Wisconsin Department of Natural Resources
Walter J. Tarmann*	Executive Director, Park and Planning Commission, Waukesha County
Rodney M. Vanden Noven	Director of Public Works, City of Waukesha
Emmerich P. Wantschik*	Walworth County Planner
Frank A. Wellstein	City Engineer, City of Oak Creek

*Regional Sludge Management Planning Subcommittee.

INTERGOVERNMENTAL COORDINATING COMMITTEE ON AREAWIDE WATER QUALITY MANAGEMENT PLANNING

Joel Wesselman	Executive Director, Milwaukee-Metropolitan Sewerage Commissions
Stephen M. Born	Director, Office of State Planning and Energy, Wisconsin Department of Administration
Richard E. Carlson	Chief, Planning Division, Department of the Army, Chicago District, Corps of Engineers
Richard E. Cohen	Research Analyst, Statistics Division, Wisconsin Department of Agriculture
Kent B. Fuller	Chief, Planning Branch, Region V, U. S. Environmental Protection Agency
Herbert A. Goetsch	Commissioner of Public Works, City of Milwaukee
Lester O. Hoganson	General Manager, Racine Water and Wastewater Utility
George A. James	Director, Bureau of Local and Regional Planning, Wisconsin Department of Local Affairs and Development
Leonard C. Johnson	Research and Development Director, Board of Soil and Water Conservation Districts
Thomas A. Kroehn	Administrator, Division of Environmental Standards, Wisconsin Department of Natural Resources
O. Fred Nelson	Manager, Kenosha Water Utility
Gerald W. Root	State Conservationist, U. S. Soil Conservation Service
Harvey E. Wirth	State Sanitary Engineer, Division of Health, Wisconsin Department of Health and Social Services

CITIZENS ADVISORY PANEL FOR PUBLIC PARTICIPATION ON AREAWIDE WASTEWATER TREATMENT AND WATER QUALITY MANAGEMENT PLANNING

William G. Murphy, Chairman	Professor, Marquette University; Engineers and Scientists of Milwaukee
Miriam G. Dahl, Vice-Chairman	Representative, Izaak Walton League of America, Wisconsin State Division
Francis A. Martin, Secretary	Representative, Racine-Kenosha Citizens for the Environment
Alice G. Altemeier	Designee, League of Women Voters of Wisconsin, Inc.
Richard F. Ashley	Designee, Schlitz Audubon Center
Cari C. Backes	Chairperson, Equality and Quality of Life (EAQQL)
Ralph C. Blum	Representative, American Society of Civil Engineers
Lucile S. Bonerz	Designee, Milwaukee Board of Realtors
Roger Caron	Executive Director, Kenosha Area Chamber of Commerce
Catherine G. Collins	Designee, Wisconsin Academy of Sciences, Arts, and Letters
Delbert J. Cook	Representative, Cedar Creek Restoration Council
John Drake	Executive Director, Associated Public Works Contractors
Tom Eisele	Designee, Lake Michigan Federation
Philip J. Fogle	Director, Geneva Lake Watershed Environmental Agency
Richard M. Franz	Representative, Ecology Association of New Berlin
Norman N. Gill	Executive Director, Citizens Governmental Research Bureau of Milwaukee
Allen Goldmann	Supervisor, Ozaukee County; Ozaukee County Air and Water Pollution Study Committee
James Gramling	Student, Arrowhead Ecology Club
Carroll W. Halsted	Professional Engineer, District 2, Division of Highways, Wisconsin Department of Transportation
Kenneth Holtje	Citizen Member, Village of Dousman
Robert O. Hussa	President, Citizens for Menomonee River
Helen M. Jacobs	President, Southeast Wisconsin Coalition for Clean Air
Mrs. Richard J. Jensen	Secretary, Root River Restoration Council, Inc.
Marlin Johnson	Field Station Manager, University of Wisconsin-Waukesha Center
Paul B. Juhnke	Manager, Metropolitan Milwaukee Association of Commerce, Urban Research and Development
Anthony Kau	President, Waukesha County Farm Bureau
Richard Lansing	Staff Representative, Plumbers and Gasfitters Local 75, Wisconsin State AFL-CIO
Alfred G. Lustig	Designee, Milwaukee River Restoration Council
Lawrence R. Olsen	Representative, Kenosha County Farm Bureau
Charles Opitz	Representative, Ozaukee County Farm Bureau
Wayne M. Paulus	First Wisconsin Mortgage Company
Lynn Peterson	President, Racine County Farm Bureau
Lanis P. Pfolsgrof	Representative, Sierra Club
John R. Rampetsreiter	Designee, District 9, Division of Highways, Wisconsin Department of Transportation
Allen E. Reininger	Plumbing and Health Inspector, City of Glendale
Annabelle Reuter	Designee, Izaak Walton League
Karen Rutz	Representative, Wisconsin Friends of Animals, Inc.
Phil Sander	Executive Secretary, Southeastern Wisconsin Sportsman's Federation
Dr. Abraham Scherr	Representative, Citizens Regional Environmental Coalition
Peter J. Schultz	Representative, Racine Chamber of Commerce
William B. N. Schultz	Professional Engineer, Wisconsin Society of Professional Engineers
David Sharpe	Community Development Agent, University of Wisconsin-Extension
Arthur C. Swanson	Representative, Arrowhead Ecology Club
Robert J. Thill	Representative, Ozaukee County Farm Bureau
Bruce R. Thompson	Representative, Sierra Club
Merv Thompson	Construction Supervisor, Washington County Sedimentation and Erosion Control Project
Howard R. Tietz	Representative, Friends of Havenswood
Joseph C. Waters	President, Wisconsin Association of Campground Owners
Ray Watz	Representative, Ozaukee County Farm Bureau
Kenneth Weddig	Representative, Washington County Recreation and Resource Council
John A. White	Maintenance Engineer, District 2, Division of Highways, Wisconsin Department of Transportation
Steven Woll	Executive Director, Metropolitan Builders Association of Greater Milwaukee

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Appendix B

ROSTERS OF SELECTED SEWRPC ADVISORY COMMITTEES

TECHNICAL COORDINATING AND ADVISORY COMMITTEE ON REGIONAL LAND USE-TRANSPORTATION PLANNING

The Technical Coordinating and Advisory Committee on Regional Land Use-Transportation Planning is divided into several functional subcommittees. Members of the Committee often serve on more than one subcommittee. The following key identifies the various functional subcommittees: 1) Land Use Subcommittee; 2) Highway Subcommittee; 3) Socioeconomic Subcommittee; 4) Natural and Recreation-Related Resources Subcommittee; 5) Transit Subcommittee; 6) Utilities Subcommittee; and 7) Traffic Studies, Models, and Operations Subcommittee.

Stanley E. Altenbern (5) . . . . . President, Wisconsin Coach Lines, Inc., City of Waukesha
Anthony S. Bareta (3) . . . . . Director, Milwaukee County Planning Commission
John M. Bennett (1,4) . . . . . City Engineer, City of Franklin
Robert P. Birchler (2) . . . . . City Engineer, City of Burlington
Stephen M. Born (1) . . . . . Director, State Planning Office, Wisconsin Department of Administration
Richard Brandt (1) . . . . . Manager, Energy Requirements, Wisconsin Gas Company, City of Milwaukee
Robert W. Brannan (2,5,7) . . . . . Deputy Director, Department of Public Works, Milwaukee County
Donald M. Cammack (7) . . . . . Chief Planning Engineer, Division of Aeronautics, Wisconsin Department of Transportation
Frederick H. Chlupp (1,4) . . . . . Land Use and Park Administrator, Washington County
Thomas R. Clark (2,5,7) . . . . . Chief Planning Engineer, District 2, Division of Highways, Wisconsin Department of Transportation
Arnold L. Clement (1,2) . . . . . Planning Director and Zoning Administrator, Racine County
Lucien M. Darin (2) . . . . . Director of Public Works, City of Hartford
Vencil F. Demshar (2) . . . . . County Highway Commissioner, Waukesha County
Russell A. Dimick (2) . . . . . City Engineer, City of Cedarburg
Arthur D. Doll (1) . . . . . Director, Bureau of Planning, Wisconsin Department of Natural Resources
William E. Dow . . . . . District Manager, Network Planning, Wisconsin Telephone Company
William R. Drew (1,2,3,4,5,6,7) . . . . . Commissioner, Department of City Development, City of Milwaukee
Raymond T. Dwyer (6) . . . . . City Engineer, City of Greenfield
James E. Foley (7) . . . . . Airport Engineer, Department of Public Works, Milwaukee County
John M. Fredrickson (1) . . . . . Village Manager, Village of River Hills
Thomas J. Gaffney (2) . . . . . Traffic Engineer, City of Kenosha
Arne L. Gausmann (1,2) . . . . . Director, Bureau of Systems Planning, Division of Planning, Wisconsin Department of Transportation
Norman N. Gill (1,3) . . . . . Executive Director, Citizens Governmental Research Bureau, City of Milwaukee
Herbert A. Goetsch (2,4,6) . . . . . Commissioner of Public Works, City of Milwaukee
George Gundersen (2,4) . . . . . Chief of Statewide Planning Section, Division of Planning, Wisconsin Department of Transportation
Douglas F. Haist (3,5) . . . . . Deputy Administrator, Division of Planning, Wisconsin Department of Transportation
Chester J. Harrison (5) . . . . . Town Engineer, Town of Caledonia
John M. Hartz (5) . . . . . Chief, Urban Transit Assistance Section, Division of Planning, Wisconsin Department of Transportation
Frank M. Hedgcock (7) . . . . . City Planner, City of Waukesha
Sebastian J. Helfer (3) . . . . . Director, Campus Planning and Construction, Marquette University, Milwaukee
Fred J. Hempel (2,5,7) . . . . . Planning and Research Engineer, Federal Highway Administration, City of Madison
John O. Hibbs (2,5,7) . . . . . Division Engineer, U. S. Department of Transportation, Federal Highway Administration, City of Madison
G. F. Hill (3) . . . . . City Manager, City of Whitewater
Bill R. Hippenmeyer (1,2,3,5) . . . . . Director of Planning, City of Oak Creek
Lester O. Hoganson (2,6) . . . . . City Engineer, City of Racine
Donald K. Holland (2,6) . . . . . Director of Public Works, City of Kenosha
Karl B. Holzwarth (2,4) . . . . . Park Director, Racine County
Ronald Hustedde (1,4) . . . . . Resource Agent, Walworth County

TECHNICAL COORDINATING AND ADVISORY COMMITTEE ON REGIONAL LAND USE-TRANSPORTATION PLANNING (Continued)

Robert F. Hutter (2) . . . . . Director of Public Works, Village of Sussex
Paul G. Jaeger (1,2,4) . . . . . County Agricultural Agent, Kenosha County
Edward A. Jenkins (5) . . . . . Transportation Director, City of Kenosha
Dr. Leonard C. Johnson (4) . . . . . Soil and Water Conservation Specialist, Board of Soil and Water Conservation, State of Wisconsin
Roger A. Johnson (1) . . . . . City Planner, City of New Berlin
Paul Juhnke (3) . . . . . Manager, Urban Research and Development, Metropolitan Milwaukee Association of Commerce
Russell E. Julian (3) . . . . . Executive Director, Southeastern Wisconsin Health Systems Agency, Inc., City of Milwaukee
John E. Kane (1,3) . . . . . Director, Milwaukee Area Office, U. S. Department of Housing and Urban Development
William J. Katz . . . . . Director of Technical Services, Milwaukee-Metropolitan Sewerage Commissions
Richard A. Keyes (2) . . . . . Environmental Engineer, Milwaukee County Department of Public Works
Thomas R. Kinsey (2) . . . . . District Director, District 2, Wisconsin Department of Transportation
David L. Kluge (6) . . . . . Director of Public Works, Village of Pewaukee
Douglas C. Knox (4) . . . . . Soil Conservationist, U. S. Conservation Service
Robert F. Kolstad (1,2,4,5) . . . . . Director of Community Development, City of Kenosha
Edwin J. Laszewski, Jr. (2) . . . . . City Engineer, City of Milwaukee
Wilmer F. Lean (2,7) . . . . . County Highway Commissioner, Walworth County
Gerald P. Lee (1) . . . . . Building Inspector, City of Muskego
Elwin G. Leet (1,3,4) . . . . . County Agricultural Agent, Racine County
Russell H. Leitch (3) . . . . . Trade Specialist, Field Services, U. S. Department of Commerce, City of Milwaukee
Edward G. Lemmen (6) . . . . . Water Utility Manager, City of Lake Geneva
James H. Lenz (6) . . . . . Village Engineer, Village of Hartland
J. William Little (2,6) . . . . . City Administrator, City of Wauwatosa
Gilbert R. Loshek (2) . . . . . Area General Manager, Greyhound Lines-West, City of Milwaukee
James J. Lynch (1) . . . . . Village Planner, Village of Shorewood
John Margis, Jr. (2,4,7) . . . . . County Highway Commissioner, Racine County
William L. Marvin (2,7) . . . . . Director, Traffic Engineering Department, American Automobile Association, City of Madison
Antoinette Matthews (3,5) . . . . . Assistant Director, Southeastern Wisconsin Area Agency on Aging
Henry M. Mayer (5) . . . . . Managing Director, Milwaukee Transport Services, Inc.
Norman H. McKegney (5) . . . . . Terminal Superintendent, The Milwaukee Road, City of Milwaukee
George Mead (3) . . . . . Marketing Research Manager, The Milwaukee Journal
Raymond F. Michaud (2) . . . . . City Engineer, City of Delavan
Robert J. Mikula (2,4) . . . . . General Manager, Milwaukee County Park Commission
William A. Muth (6) . . . . . Director of Public Works, Village of Germantown
Thomas J. Muth (1) . . . . . Director of Public Works, City of Brookfield
Melvin J. Noth (2,6) . . . . . Director of Public Works, Village of Menomonee Falls
George J. Novenski (7) . . . . . Chief, Travel Statistics and Data Coordination Section, Division of Planning, Wisconsin Department of Transportation
William F. O'Donnell . . . . . County Executive, Milwaukee County
Dwayne Partain (1,5) . . . . . Librarian, MATC, City of Milwaukee
Nick T. Paulos (1,2) . . . . . Village Engineer, Village of Greendale
Allan P. Pleyte (5,7) . . . . . Traffic Engineer and Superintendent, Bureau of Traffic Engineering and Electrical Services, City of Milwaukee
James F. Popp (5,7) . . . . . Chief of Planning, U. S. Department of Transportation, Federal Aviation Administration, Great Lakes Region, City of Chicago
John B. Prince (1,3,6) . . . . . Director of Corporate Planning, Wisconsin Electric Power Company, City of Milwaukee
Richard A. Rechlicz (5) . . . . . Executive Secretary, Wisconsin School Bus Contractors Association
Richard Repert (3) . . . . . Associate for United Community Services Planning, United Community Services of Greater Milwaukee
Albert P. Rettler (2,7) . . . . . County Highway Commissioner, Washington County
Donald V. Revello (5,7) . . . . . Chief, Planning Methods and Forecasts Section, Division of Planning, Wisconsin Department of Transportation
Donald A. Roensch (1,6) . . . . . Director of Public Works, City of Mequon

TECHNICAL COORDINATING AND ADVISORY COMMITTEE ON REGIONAL LAND USE-TRANSPORTATION PLANNING (Continued)

William D. Rogan (1,4) . . . . . County Agri-Business Agent, Waukesha County
Gordon Rozmus (1,3) . . . . . City Planner, City of Wauwatosa
Dr. Eric Schenker (3,5,7) . . . . . Chairman, Department of Business Administration, University of Wisconsin-Milwaukee
John E. Schumacher (2,7) . . . . . City Engineer, City of West Allis
Gerald Schwerm (2) . . . . . Village Manager, Village of Brown Deer
Harvey Shebesta (2,3,5,7) . . . . . District Director, District 9, Wisconsin Department of Transportation
Leland C. Smith (4) . . . . . County Horticultural Agent, Kenosha County
Philip A. Sundal (3) . . . . . Deputy Administrator, Division of State Economic Development, Wisconsin Department of Local Affairs and Development
George A. Swier (1,2) . . . . . County Highway Commissioner, Kenosha County
G. D. Tang (1,3) . . . . . District Business Research Manager, Wisconsin Telephone Company, City of Milwaukee
Walter J. Tarmann (1,4) . . . . . Executive Director, Waukesha County Park and Planning Commission
Jack Taylor (5) . . . . . President, Flash City Cab, Racine
Norbert S. Theine (1) . . . . . Administrator, City of South Milwaukee
Donald J. Tripp (1,4) . . . . . Agricultural Agent, Ozaukee County
Floyd W. Usher (2) . . . . . City Engineer, City of Oconomowoc
Rodney M. VandenNoven (6) . . . . . Director of Public Works, City of Waukesha
John P. Varda (7) . . . . . General Manager, Wisconsin Motor Carriers Association, City of Madison
Lloyd O. Wadleigh (3) . . . . . Chairman, Department of Economics, Carroll College, Waukesha
Emmerich P. Wantschik (1) . . . . . County Planner, Walworth County
Theodore G. Weigle . . . . . Regional Director, Urban Mass Transportation Administration, U. S. Department of Transportation
Frank A. Wellstein (1,2,4,5,6,7) . . . . . City Engineer, City of Oak Creek
Sylvester N. Weyker (2) . . . . . County Highway Commissioner, Ozaukee County
Henry B. Wildschut (2,7) . . . . . County Highway Commissioner and Director of Public Works, Milwaukee County
Elgar C. Williams (1,3) . . . . . City Planner, City of West Allis
Bruce B. Wilson (1) . . . . . Chief, Urban and Regional Planning Assistance, Wisconsin Department of Transportation
Dan Wilson (4) . . . . . Resource Development Agent, UW Extension, Washington County
Thomas N. Wright (1,3,5) . . . . . Director of Planning, City of Racine

ROOT RIVER WATERSHED COMMITTEE

Robert J. Mikula . . . . General Manager, Milwaukee County Park Commission
Chairman
Thomas N. Wright . . . . Planning Director, City of Racine
Vice-Chairman
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Secretary — Wisconsin Regional Planning Commission
Anthony A. Alberte . . . . President, Village of Hales Corners
John M. Bennett . . . . City Engineer, City of Franklin
Raymond T. Dwyer . . . . City Engineer, City of Greenfield
Alvin A. Erdman . . . . District Conservationist, U. S. Soil Conservation Service, Waukesha and Milwaukee Counties
Jerome J. Gottfried . . . . Mayor, City of Muskego
Donald W. Hermann. . . . . Mayor, City of Oak Creek
Lester O. Hoganson . . . . City Engineer, City of Racine
Elwin G. Leet. . . . . County Agricultural Agent, Racine County
John Margis, Jr. . . . . Chairman, Racine County Board of Supervisors; Commissioner, Southeastern Wisconsin Regional Planning Commission
Stephen F. Olsen. . . . . Mayor, City of Racine
Nick T. Paulos . . . . Village Engineer, Village of Greendale
Anthony A. Pitrof. . . . . Manager of Engineering Services, Milwaukee-Metropolitan Sewerage Commissions
John Schultz . . . . District Engineer, Southeast District, Wisconsin Department of Natural Resources
John E. Schumacher . . . . City Engineer, City of West Allis
Frank A. Wellstein. . . . . City Engineer, City of Oak Creek

FOX RIVER WATERSHED COMMITTEE

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Paul G. Jaeger. . . . . County Agri-Business Agent, Kenosha County
Secretary
Kurt W. Bauer. . . . . Executive Director, Southeastern Wisconsin Regional Planning Commission
Edmund M. Brick . . . . *Chief, Water Regulation Section, Bureau of Water and* Shoreland Management, Wisconsin Department of Natural Resources
Dorothy Bucholtz . . . . Citizen Member, Town of Burlington
Robert Bucholtz . . . . Chairman, Town of Waterford
Arnold L. Clement. . . . . Planning Director and Zoning Administrator, Racine County
Alvin A. Erdman . . . . District Conservationist, Milwaukee and Waukesha Counties, U. S. Soil Conservation Service
Willard R. Evans . . . . Supervisor, Waukesha County; Member, County Health Board
Jerome T. Gottfried. . . . . Mayor, City of Muskego
Thomas Grady . . . . Chairman, Town of Wheatland
Robert Graf . . . . President, Village of Waterford
H. Copeland Greene. . . . . Citizen Member, Genesee Depot
Henry F. Halter. . . . . Commissioner, Norway-Dover Drainage District
Franklin E. Hazelo. . . . . Supervisor, Town of Rochester
Karl B. Holzworth . . . . Park Director, Racine County
Ronald Hustedde. . . . . County Agent, Walworth County
Dr. Leonard C. Johnson . . . . Soil and Water Conservation Specialist, Board of Soil and Water Conservation Districts, University of Wisconsin-Extension
Melvin J. Johnson . . . . Chairman, Town of Norway
Elwin G. Leet. . . . . County Agri-Business Agent, Racine County
Walter Mass . . . . Member, Town of Rochester Plan Commission
John H. Mielke . . . . Consulting Engineer, City of Waukesha

FOX RIVER WATERSHED COMMITTEE
(Continued)

William A. Mitchell	Mayor, City of Brookfield
Raymond J. Moyer, Jr.	Supervisor, Racine County
Eistein Pedersen	Citizen Member, Village of Rochester
Clarence O. Peterson	Chairman, Town of Vernon
Lloyd A. Porter	Chairman, Town of Burlington
Herbert E. Ripley	Health Officer, Waukesha County Health Department
Phil Sander	Executive Secretary, Southeastern Wisconsin Sportsmen's Federation
Dr. Bruno E. Schiffleger	Citizen Member, City of Elkhorn
John Schneider	President, Village of Rochester
Bernard G. Schultz	Assistant District Director, Southeast District, Wisconsin Department of Natural Resources
Art Stratton	Commissioner, Hoosier Creek Drainage District
Walter J. Tarmann	Director, Waukesha County Park and Planning Commission
Rodney M. VandenNoven	Director of Public Works, City of Waukesha
Frank Walsh	Supervisor, Walworth County; Chairman, Town of Linn
Emmerich P. Wantschik	County Planner, Walworth County
Stan Wilson	Citizen Member, City of Burlington
John R. Zillmer	Secretary, Ice Age Park and Trail Foundation, City of Milwaukee

MILWAUKEE RIVER WATERSHED COMMITTEE

Richard W. Cutler Chairman	Attorney, Quarles and Brady, City of Milwaukee; Member, Village of Fox Point Plan Commission; Commissioner, Southeastern Wisconsin Regional Planning Commission
Kurt W. Bauer Secretary	Executive Director, Southeastern Wisconsin Regional Planning Commission
Donald R. Benzella	Director, Department of Environmental Health, Ozaukee County
Vaughn H. Brown	Vice-President, Tri-County Civic Association
Frederick H. Chlupp	Land Use and Park Administrator, Washington County
Delbert J. Cook	Chairman, Cedar Creek Restoration Council
Arthur G. Degnitz	Supervisor, Washington County
Arthur D. Doll	Director, Bureau of Planning, Wisconsin Department of Natural Resources
Edward Frauenheim	Supervisor, Sheboygan County
Herbert A. Goetsch	Commissioner of Public Works, City of Milwaukee
Mrs. Robert H. Jaskulski	Treasurer, Milwaukee River Restoration Council, Inc.
Ben E. Johnson	Alderman, City of Milwaukee
John T. Justen	President, Pfister & Vogel Tanning Company, Milwaukee
Dorothy Klein	Former President, Village of Saukville
Robert L. Konik	County Planner, Fond du Lac County
Adolph Laubenstein	President, Laubenstein Roofing Company, Village of Saukville
Thomas P. Leisle	Supervisor, Ozaukee County
Robert J. Mikula	General Manager, Milwaukee County Park Commission
Rudolph Mikulich	Business Administrator, Clerk-Treasurer, City of Glendale
Dennis E. Nulph	District Engineer, Wisconsin Department of Natural Resources
Anthony A. Pitrof	Manager of Engineering Services, Milwaukee-Metropolitan Sewerage Commissions
Albert Schroeder	Former Chairman, Town of Trenton
George Watts	President, George Watts & Son, Inc., City of Milwaukee
Donald W. Webster	Supervisor, Town of Fredonia; Consulting Civil Engineer, City of Milwaukee
Richard E. Zarling	Director of Elementary Education, Kewaskum Community Schools

MENOMONEE RIVER WATERSHED COMMITTEE

Herbert A. Goetsch Chairman	Commissioner of Public Works, City of Milwaukee
J. William Little Vice-Chairman	City Administrator, City of Wauwatosa
Kurt W. Bauer Secretary	Executive Director, Southeastern Wisconsin Regional Planning Commission
Arthur D. Doll	Director, Bureau of Planning, Wisconsin Department of Natural Resources
Glenn H. Evans	Member, Citizens for Menomonee River Restoration, Inc.
Frederick E. Gottlieb	Village Manager, Village of Menomonee Falls
Frank S. Hartay	Plant Engineer, The Falk Corporation, City of Milwaukee
George C. Keller	President, Wauwatosa State Bank
Raymond J. Kipp	Dean, College of Engineering, Marquette University
Thomas M. Lee	Chief, Flood Plain-Shoreland Management Section, Wisconsin Department of Natural Resources
Thomas P. Leisle	Supervisor, Ozaukee County
Robert J. Mikula	General Manager, Milwaukee County Park Commission
Thomas J. Muth	Director of Public Works, Village of Germantown
Dennis E. Nulph	District Engineer, Wisconsin Department of Natural Resources
Anthony A. Pitrof	Manager of Engineering Services, Milwaukee-Metropolitan Sewerage Commissions
Richard G. Reinders	Trustee, Village of Elm Grove
John E. Schumacher	City Engineer, City of West Allis
Walter J. Tarmann	Executive Director, Waukesha County Park and Planning Commission
Clark E. Wangerin	City Engineer, City of Brookfield

KINNICKINNIC RIVER WATERSHED COMMITTEE

Robert J. Mikula Chairman	General Manager, Milwaukee County Park Commission
Edwin J. Laszewski, Jr. Vice-Chairman	City Engineer, City of Milwaukee
Kurt W. Bauer Secretary	Executive Director, Southeastern Wisconsin Regional Planning Commission
Raymond T. Dwyer	City Engineer, City of Greenfield
Anthony A. Pitrof	Manager of Engineering Services, Milwaukee-Metropolitan Sewerage Commissions
Stanley Polewski	Proprietor, Polewski Pharmacy, City of Milwaukee
Ronald J. Rutkowski	Director of Public Works, City of Cudahy
Rodolfo N. Salcedo	Environmental Scientist, Department of City Development, City of Milwaukee
Frank Schultz	District Engineer, Southeast District, Wisconsin Department of Natural Resources
John E. Schumacher	City Engineer, City of West Allis
Frank J. Wabiszewski	Vice-President, Maynard Electric Steel Casting Company
Henry B. Wildschut	County Highway Commissioner and Director of Public Works, Milwaukee County

TECHNICAL COORDINATING AND ADVISORY COMMITTEE ON REGIONAL AIR QUALITY MAINTENANCE PLANNING

Richard A. Keyes, Chairman	Environmental Engineer, City of Milwaukee County Department of Public Works
Barbara J. Becker, Vice-Chairman	President, Southeastern Wisconsin Coalition for Clean Air
Alice Altemeier	League of Women Voters, Ozaukee County
Norman N. Amrhein	President, Federal Malleable Company, City of West Allis
Kurt W. Bauer	Executive Director, Southeastern Wisconsin Regional Planning Commission
Gerald D. Bevington	Coordinator of Air Programs, Wisconsin Department of Natural Resources, City of Milwaukee
Dr. Roy Elmore	Northeastern Illinois Planning Commission
Edwin J. Hammer	Developmental Engineer, Division of Highways, Wisconsin Department of Transportation
John C. Hanson	Director, Racine County Department of Air Pollution Control
John O. Hibbs	Division Engineer, Federal Highway Administration, U. S. Department of Transportation, City of Madison
Elroy C. Jagler	Meteorologist in Charge, National Weather Service Forecast Office, City of Milwaukee
Thomas R. Kinsey	District Director, District 2, Wisconsin Department of Transportation
Paul Koziar	Meteorologist, Division of Environmental Protection, Wisconsin Department of Natural Resources
Dr. Kenneth W. Ragland	Associate Professor, Department of Mechanical Engineering, University of Wisconsin-Madison
Fred R. Rehm	Director, Milwaukee County Division of Environmental Service
Herbert E. Ripley	Health Officer, Waukesha County Health Department
Rodolfo N. Salcedo	Environmental Scientist, Department of City Development, City of Milwaukee
Harvey Shebesta	District Director, District 9, Wisconsin Department of Transportation
James Sinapoli	Planning Analyst, Office of State Planning and Energy, Wisconsin Department of Administration
Mark Steinberg	Senior Meteorologist, Environmental Planning and Policy Division, Wisconsin Electric Power Company
Michael S. Treitman	Environmental Protection Agency, Region V, City of Chicago
Emmerich P. Wantschik	County Planner, Walworth County
George A. Zimmer	Supervisor, Environmental Health, Kenosha Health Department

TECHNICAL AND CITIZEN ADVISORY COMMITTEE ON COASTAL MANAGEMENT IN SOUTHEASTERN WISCONSIN

George C. Berteau, Acting Chairman	Chairman, Southeastern Wisconsin Regional Planning Commission
Hubert J. Albert	Port Washington Yacht Club
W. J. Blong	Former Village Engineer, Village of Fox Point
Josephine H. Boucher	North Shore League of Women Voters
Thomas H. Buestrin	Commissioner, Southeastern Wisconsin Regional Planning Commission, Ozaukee County
Sol Burstein	Executive Vice-President, Wisconsin Electric Power Company
Col. Benjamin C. Chapla	Health Officer, Town of Caledonia
H. A. Goetsch	Commissioner of Public Works, City of Milwaukee
James L. Haskell	Port Director, City of Milwaukee Harbor Commission
Wayne E. Koessl	Supervisor, Kenosha County Board; Member, Town of Pleasant Prairie Planning Commission
George O. Lampert	Mayor, City of Port Washington
Dr. Norman P. Lasca	Associate Professor, Department of Geological Sciences, University of Wisconsin-Milwaukee

TECHNICAL AND CITIZEN ADVISORY COMMITTEE ON COASTAL MANAGEMENT IN SOUTHEASTERN WISCONSIN
(Continued)

Elwin G. Leet . . . . County Agricultural Agent, Racine County
Thomas P. Leisle . . . . Supervisor, Ozaukee County
Thomas W. Lisota . . . . Alderman, City of Cudahy
Anthony L. Luljak . . . . Alderman, City of Cudahy
R. Richard Mett . . . . Supervisor, Milwaukee County
Dr. Harold M. Meyer . . . . Professor, Department of Geography, University of Wisconsin-Milwaukee
Robert J. Mikula . . . . General Manager, Milwaukee County Park Commission
Dr. William G. Murphy . . . . Professor, Soil Mechanics, College of Engineering, Marquette University
Mary C. Nelson . . . . Alderman, City of South Milwaukee
Dr. William T. Painter . . . . President, Foundation Engineering, Inc., Milwaukee
Anthony A. Pitrof . . . . Manager of Engineering Services, Milwaukee-Metropolitan Sewerage Commissions
Francis J. Pitts . . . . Commissioner, Southeastern Wisconsin Regional Planning Commission, Kenosha County
Fred R. Rehm . . . . Director, Environmental Services Division, Department of Public Works, Milwaukee County
Ronald J. Rutkowski . . . . Director of Public Works, City of Cudahy
Phil Sander . . . . Executive Secretary, Southeastern Wisconsin Sportsmen's Federation
Norbert S. Theine . . . . Administrator, City of South Milwaukee

TECHNICAL AND CITIZEN ADVISORY COMMITTEE ON REGIONAL PARK AND OPEN SPACE PLANNING

Robert J. Mikula . . . . General Manager, Milwaukee County Park Commission
Chairman
Loren R. Anderson . . . . President, Geneva Lake Development Corporation, Village of Williams Bay
Anthony S. Bareta . . . . County Planning Director, Milwaukee County Planning Commission
Donald B. Brick . . . . Recreation Agent, Walworth County
Frederick H. Chlupp . . . . Land Use and Park Administrator, Washington County
Delbert J. Cook . . . . Chairman, Cedar Creek Restoration Council
Norbert Dettmann . . . . County Board Supervisor, Washington County
Arthur D. Doll . . . . Director, Bureau of Planning, Wisconsin Department of Natural Resources
David F. Egelhoff . . . . Supervisor, Ozaukee County
Booker T. Hamilton . . . . Production Supervisor, Rexnord Corporation
Karl B. Holzwarth . . . . Park Director, Racine County
Charles O. Kamps . . . . Attorney, Quarles and Brady, City of Milwaukee
Philip H. Lewis, Jr. . . . . Professor, Department of Landscape Architecture, University of Wisconsin-Madison; Director, Environmental Awareness Center, Madison
Richard J. Lindl . . . . Director of Parks, Kenosha County Park Commission
John Margis, Jr. . . . . Supervisor, Racine County; Commissioner, Southeastern Wisconsin Regional Planning Commission
Kathleen Pfister . . . . Cultural Specialist, Department of City Development, City of Milwaukee
Robert D. Ross . . . . General Manager, The Journal Times, City of Racine
Phil Sander . . . . Executive Secretary, Southeastern Wisconsin Sportsmen's Federation
George L. Schiltz . . . . Chairman, Kenosha County Park Commission
Frederick G. Schmidt . . . . Member, Sierra Club
Mrs. John D. Squier . . . . Member, Riveredge Nature Center, Inc.
Walter J. Tarmann . . . . Executive Director, Waukesha County Park and Planning Commission
Edgar W. Trecker . . . . Supervisor of Forestry, Wildlife, and Recreation, Southeast District, Wisconsin Department of Natural Resources
Elwood R. Voigt . . . . Park Manager, Ozaukee County
Joseph Waters . . . . Proprietor, Lazy Day Campground, Town of Farmington
Dr. Harry J. Wilkins . . . . Outdoor Sportsman, Wauwatosa
Dr. George T. Wilson . . . . Visiting Lecturer, Department of Continuing and Vocational Education, University of Wisconsin-Madison
Thomas N. Wright . . . . Director of Planning, City of Racine