

Fox River Watershed planning program prospectus.

[s.l.]: Southeastern Wisconsin Regional Planning Commission,
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WISCONSIN
Regional Planning S.E.
WATER RESOURCES DEVELOPMENT

Jordan

**FOX RIVER
WATERSHED PLANNING
PROGRAM PROSPECTUS**



Graduate Research Center
Dept. of Urban & Regional Planning
The University of Wisconsin-Madison

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**FOX RIVER WATERSHED
PLANNING PROGRAM PROSPECTUS**

SOUTHEASTERN WISCONSIN REGIONAL
PLANNING COMMISSION

Old Courthouse

Waukesha, Wisconsin

October, 1964

Graduate Research Center
Dept. of Urban & Regional Planning
The University of Wisconsin-Madison



SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

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STATEMENT OF THE CHAIRMAN

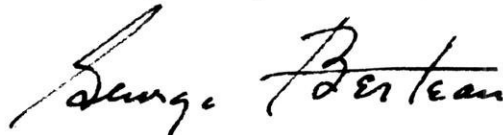
At its regular quarterly meeting held at the Walworth County Courthouse on December 6, 1962, the Southeastern Wisconsin Regional Planning Commission recognized that, with the Land-Use Transportation Study well underway, emphasis should now shift to the inauguration of comprehensive watershed planning programs within the Region. These words were given meaning with the implementation of the Root River Watershed Planning Program Prospectus in May 1963 after the counties concerned had expressed their approval, both as to the substance of the study and to the method of financing thereof.

This--the Fox River Watershed Planning Program Prospectus--is not only an extension of the Commission's expressed policy but is in fulfillment of the expressed concern of Waukesha County.

This Prospectus is the work of the Fox River Watershed Committee, the Staff, and the Technical Advisory Committee on Natural Resources and Environmental Design. The Committees were created by the Commission to assist it in the production of workable plans to guide a managed development of the resource base. No one resource problem within the watershed is singularly overwhelming. Yet the combined effects of the problems within the watershed, such as storm water drainage and flood control, inadequate sewage and industrial waste disposal facilities, deteriorating surface water quality and lake and stream pollution, soil erosion, lake and stream siltation, land use development in relation to streams and their floodways and flood plains, recreation and public open-space reservation, if allowed to bear constantly on the existing resource base, must ultimately destroy the values which are sought and needed by an ever increasing populace.

From the recommended program, broadly outlined in this Prospectus, will evolve a comprehensive watershed plan. The work of the Commission is entirely advisory in nature. Therefore, such a plan to be effective must be cooperatively prepared and adopted; and it must be jointly implemented by the units of government within the watershed.

Respectfully submitted,



George C. Berteau
Chairman

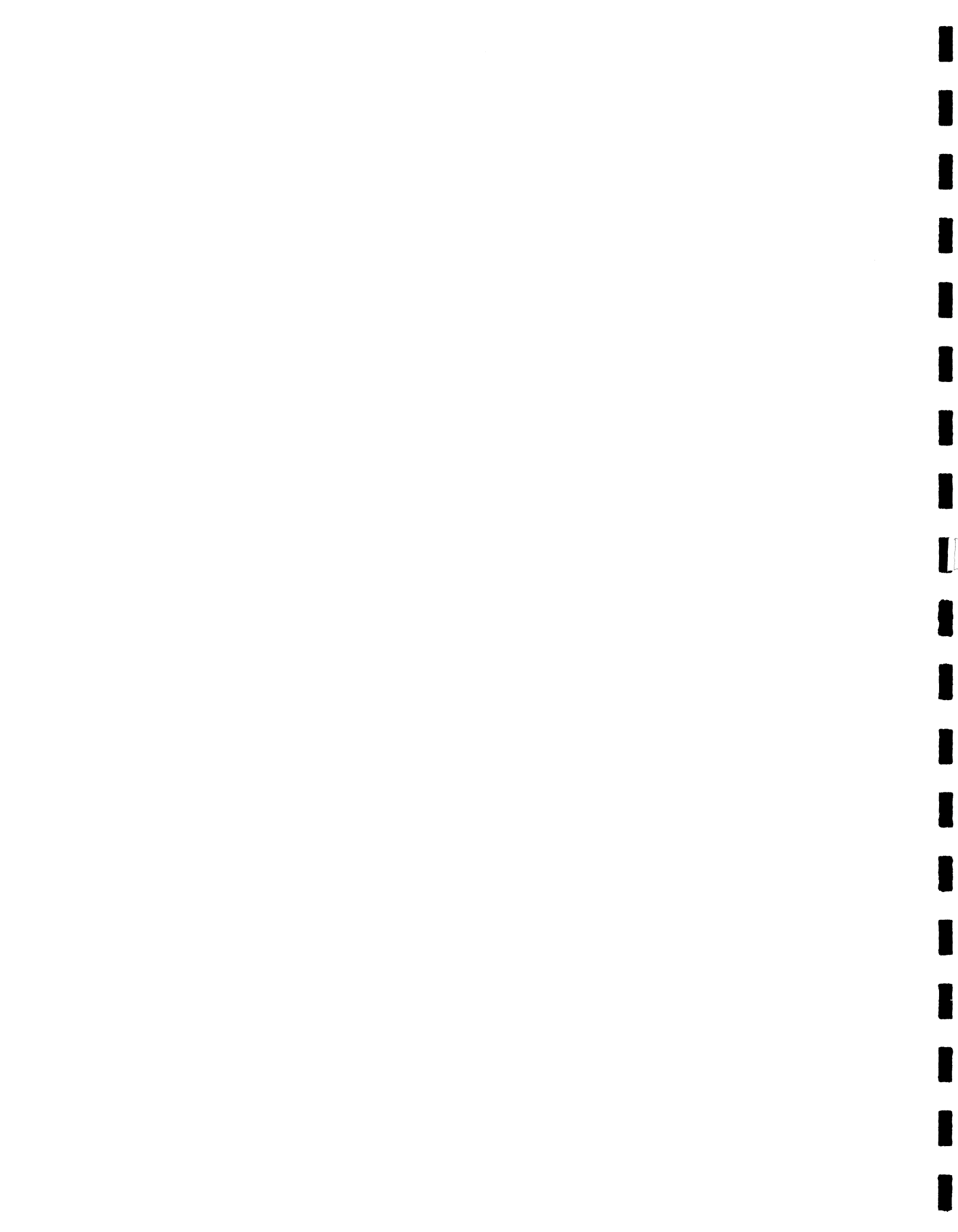


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CHAPTER I

INTRODUCTION

The Southeastern Wisconsin Regional Planning Commission (SEWRPC) was created in August, 1960, under the provisions of Section 66.945 of the Wisconsin Statutes. It exists to serve and assist the local units of government and their citizens in planning for the orderly and economic development of a seven-county region comprised of Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, and Waukesha counties.

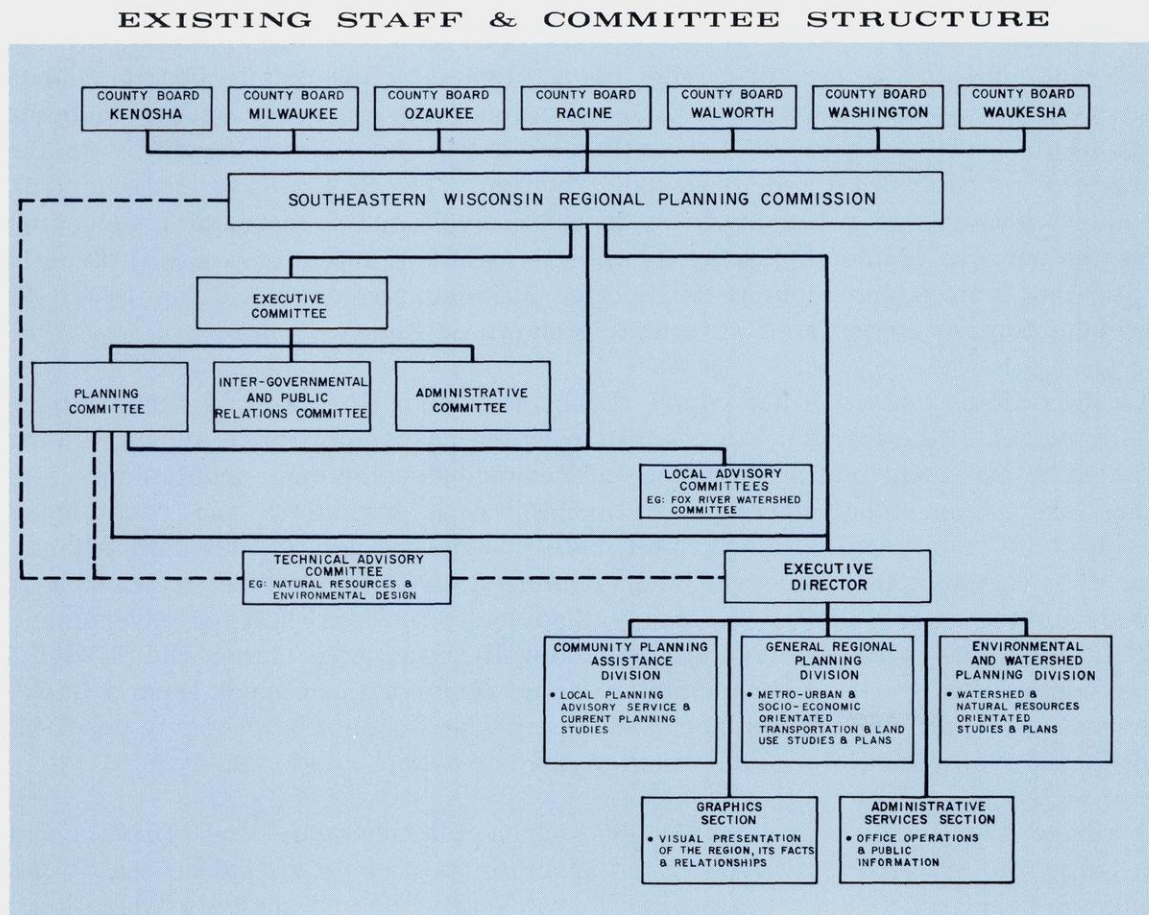
The Commission itself is composed of 21 members, three from each of the member counties, two of the three from each county being appointed by the Governor and one from each county being elected by the county board. Funds necessary to support the SEWRPC operations are provided by the member counties, and the budget is proportioned among the several counties on the basis of relative equalized assessed valuation. The SEWRPC 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 federal government for Section 701 planning grants. The SEWRPC present committee and staff structure is shown on Figure 1, page 2.

As the official research and study agency for one of the nation's large urbanizing regions, the SEWRPC is charged with the responsibility of accomplishing research and coordinating planning on areawide development problems as distinguished from local development problems, to formulate and recommend solutions to such problems, and to ultimately suggest a general development plan for the Region. Such research and planning activity is intended to serve as a basis for the extension of assistance and advice to the local units of government. Thus, equipped with research studies and well-thought-out plans, the SEWRPC can communicate with governmental units as requested and speak from a background of factual information about problems which cannot be properly resolved within the framework of a single municipality or even a single county.

Drainage and flood control is one such areawide problem, and officials and citizens who are daily involved in the problem have come to realize that it can only be resolved within a regional framework of study and analysis where local governments can join hands in cooperative efforts. Drainage and flood control is a problem which is intensified by urbanization and which requires that a planning area smaller than the Region but larger than the individual counties, namely, the watershed or drainage basin, be recognized and considered as a unit. Storm water drainage and flood control facilities must form a single integrated system over an entire watershed, a system capable of carrying both the present runoff loads generated by the existing land use patterns in the watershed and the

future runoff loads that may be generated by changing land use patterns in the watershed. In addition, the drainage and flood control problem is closely related to other watershed problems, such as: water quality and stream pollution; low flow augmentation; soil erosion and stream siltation; land use, not only with respect to the stream channel and its floodways and flood plains, but also with respect to the entire watershed; land and water conservation and management practices; park and open space reservation; fish and wildlife habitat conservation and management; sewerage and sewage disposal; and water supply. Prac-

Figure 1



tical solutions to any one of these basic problems must, therefore, simultaneously consider solutions to the other water-related problems and needs. Thus, any effective water-related planning program must recognize watersheds as integrated land-water resource units which create a complex community of interests among their residents.

Solutions to these and other water-related problems within southeastern Wisconsin require, therefore, the development of specific programs for the comprehensive study of each watershed within the seven-county planning Region. The ultimate purpose of these watershed studies is to develop workable plans to guide the staged development of drainage and flood control, sewerage, water supply, water quality, soil and water conservation, fish and wildlife enhancement, and recreation and open space facilities within each watershed. These facility plans are to be based upon a long-range land use plan for the watershed. If the studies are to assist local officials and citizens in formulating and deciding upon multi-purpose facility plans, factual information must be developed on the overall potential needs for such facilities as well as upon the major determinants of such needs.

Recognizing that any comprehensive watershed study program covers a broad spectrum of resource related interests and governmental programs, the SEWRPC has established two types of advisory committees to assist the Commission in its work.

The first type is represented by a single committee known as the "Technical Advisory Committee on Natural Resources and Environmental Design." This committee was established in January, 1962, and includes representatives from the following agencies with active resource related programs in southeastern Wisconsin:

Federal Government

U. S. Geological Survey

U. S. Corps of Engineers

Soil Conservation Service

State of Wisconsin

Department of Resource Development

Conservation Department

State Committee on Water Pollution

Soil and Water Conservation Committee

Geological and Natural History Survey

Highway Commission

Public Service Commission

Board of Health

Local

Metropolitan Sewerage Commission of the County of Milwaukee

Milwaukee County Park Commission

Waukesha County Park and Planning Commission

Carroll College, Waukesha, Wisconsin

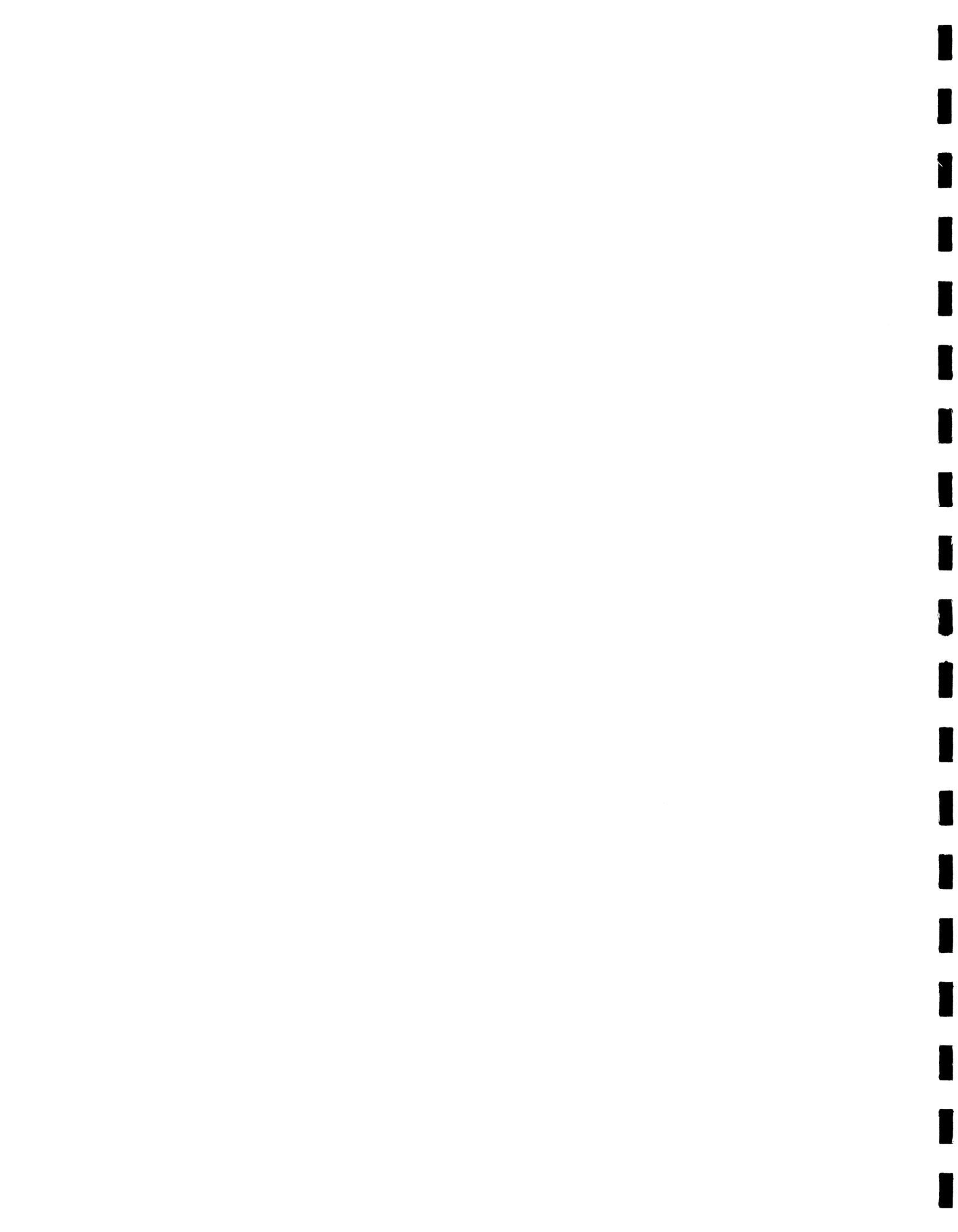
Southeastern Wisconsin Regional Planning Commission

One of the main purposes of the "Technical Advisory Committee on Natural Resources and Environmental Design" is to place the experience, knowledge, and resources of the represented federal, state, and local agencies at the disposal of the second type of committee -- the local watershed committee. To date two such local watershed committees have been formed under the auspices of the SEWRPC: the Root River Watershed Committee and the Fox River Watershed Committee. It is the Commission's hope and intention that in time such watershed committees, representing local interests, can be formed for each major watershed within the seven-county planning Region. The purpose of these watershed committees is to bring the knowledge of local personnel possessing broad experience in the various facets of watershed development and land use planning to bear on the specific problems of each watershed.

The Fox River Watershed Committee is the second such local watershed committee to be formed by the Southeastern Wisconsin Regional Planning Commission. Membership on this committee includes elected and appointed county, city, village, and town officials, property owners, and other citizen groups and agricultural interests. The Fox River Watershed Committee was organized on November 8, 1962, and spent its first 18 months in the following activities: conduct of informational meetings to acquaint the full committee with the problems of the watershed, a field trip in the watershed, the formation of a steering committee, and meetings with county board committees in each of the four counties within the watershed. The informational meetings included presentations by representatives of federal, state, and local water and water-related resource agencies on such subjects as: watershed planning concepts, water quality and pollution, water law, water supply, flooding, and recreation and open space preservation. At its meeting on May 27, 1964, the committee was informed by the U.S. Corps of Engineers that favorable consideration of federal participation in flood control works could only be considered within the frame-

work of multipurpose projects based upon comprehensive watershed planning efforts.

After careful review of its work and findings over the 18-month period, the Committee unanimously recommended that a prospectus for a comprehensive Fox River watershed planning program be prepared under the aegis of the steering committee with additional representation as necessary from such agencies as the U. S. Department of Agriculture, Soil Conservation Service; U. S. Corps of Engineers; Wisconsin Conservation Commission; and the Wisconsin State Board of Health. The steering committee held its first meeting for this purpose on June 29, 1964, and has held bimonthly meetings from that date to the present. This Prospectus and its recommendations are the work of the committee.



CHAPTER II

PURPOSE OF THE PROSPECTUS

The purpose of this Prospectus is to explore and recommend the means by which a feasible comprehensive watershed planning program can be established for the Fox River watershed in southeastern Wisconsin. The Prospectus is intended to provide sufficient information to permit the county boards and other affected governmental agencies to consider the costs and benefits of such a program and determine the desirability of its execution.

To this end the Prospectus is intended to accomplish the following:

1. Establish the need for a comprehensive watershed planning program in the Fox River watershed.
2. Specify the main divisions of the work required to be undertaken, along with the techniques to be applied. Specifically, the Prospectus is intended to recommend desirable scope and dimensions of the necessary watershed planning studies, explore the necessary data requirements and possible data sources, and recommend techniques to be applied.
3. Recommend the most effective method for establishing, organizing, and accomplishing the required studies and suggest possible roles and responsibilities of the various levels and units of government concerned.
4. Recommend a practical time sequence and schedule for a comprehensive watershed planning program.
5. Provide sufficient cost data to permit the development of an initial budget and suggest possible allocation of costs among the various levels and units of government concerned.
6. Determine the extent to which the various levels and units of government might be able to contribute assistance in the form of qualified personnel toward the joint interagency conduct of the necessary studies.



CHAPTER III

THE FOX RIVER BASIN -

NEED FOR A COMPREHENSIVE

WATERSHED PLANNING PROGRAM

The Fox River basin is the largest of 11 major natural watersheds within the southeastern Wisconsin planning region. The general boundaries of the basin together with the locations of the channel of the Fox River and of its principal tributaries within southeastern Wisconsin are shown on Figure 2, page 10.

The Fox River begins near State Trunk Highway 74 and the Chicago, Milwaukee, St. Paul and Pacific Railroad right-of-way in the Village of Menomonee Falls in Waukesha County and flows southerly through the cities and villages of Brookfield, Waukesha, Big Bend, Waterford, Rochester, Burlington, and Silver Lake, crossing into Illinois near Wilmot. The river continues southerly through Illinois, flowing through the cities and villages of McHenry, Elgin, Geneva, Aurora, and discharging to the Illinois River near Ottawa, Illinois. Major tributaries to the Fox River in Wisconsin include Poplar Creek, Pewaukee River, Pebble Creek, Saylesville (Genesee) Creek, Pebble Brook, Mukwonago River, the Wind Lake Drainage Canal, and the White River including Sugar Creek and Honey Creek.

The entire Fox River basin has a drainage area of about 2600 square miles of which 942.37 square miles lie within Wisconsin, and of which 938.72 square miles lie within the southeastern Wisconsin planning region. The Wisconsin portion of the watershed includes 337.85 square miles (35.85 percent) in Walworth County, 338.45 square miles (35.92 percent) in Waukesha County, 165.03 square miles (17.51 percent) in Racine County, 96.61 square miles (10.25 percent) in Kenosha County, 0.29 square miles (0.03 percent) in Washington County, 0.50 square miles (0.05 percent) in Milwaukee County, and 3.64 square miles (0.39 percent) in Jefferson County.

The main stream of the Fox River which traverses Waukesha, Racine, and Kenosha counties has a length of 79.4 miles. In general, the main channel is confined only by low banks and surrounded by relatively wide flood plains. Overall falls and average slopes for major reaches of the main channel and for selected major tributaries are shown in Table 1 and indicate that the slopes of the main channel and of the major tributaries are relatively steep in the head-water reaches and quite flat in the lower reaches.

Figure 2

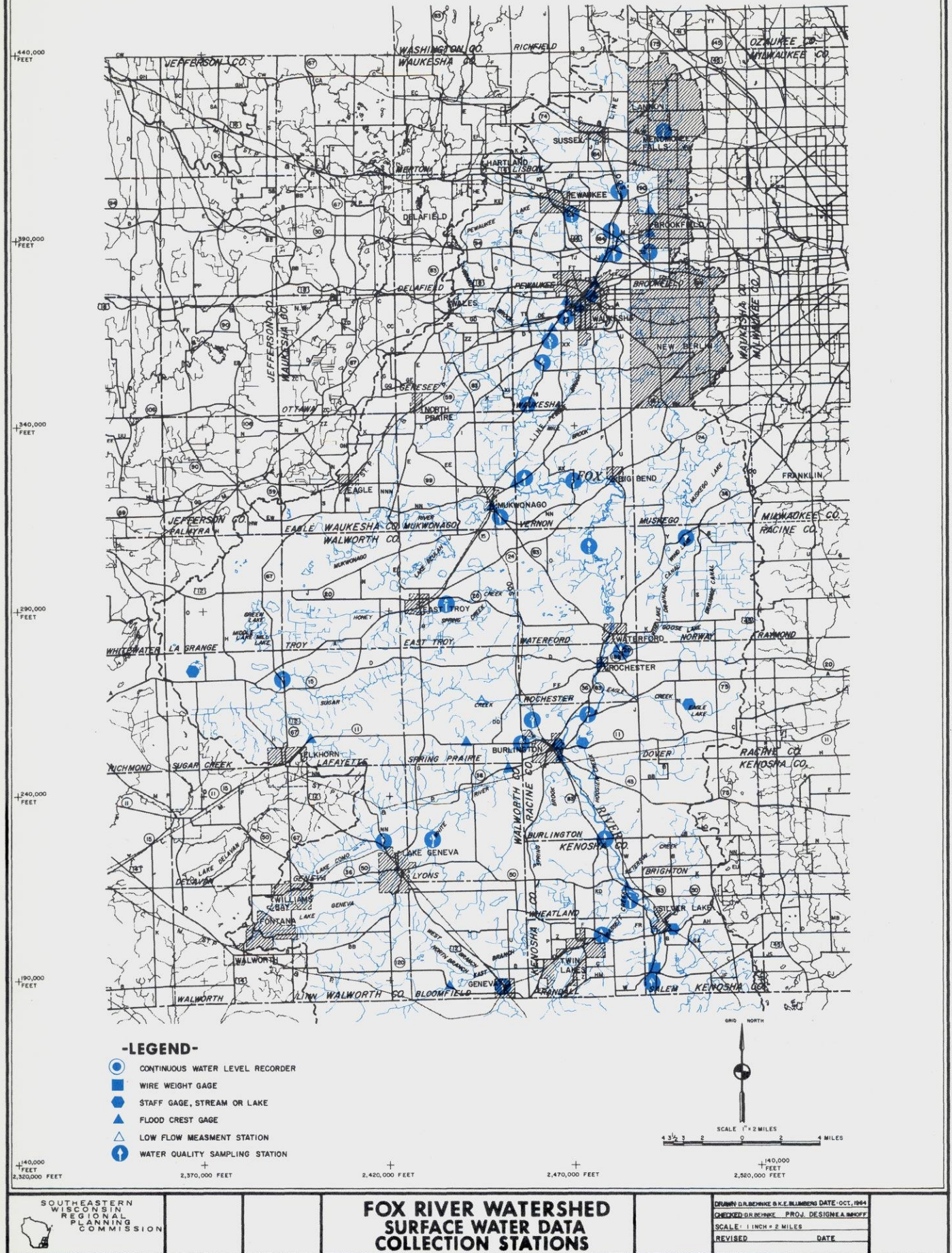


Table 1

SLOPE CHARACTERISTICS OF
THE FOX RIVER AND MAJOR TRIBUTARIES IN WISCONSIN

<u>Stream</u>	<u>Length in Miles</u>	<u>Overall Fall in Feet</u>	<u>Slope in Feet per Foot</u>
Fox River Origin to Waukesha Dam	20.1	138	0.0013
Fox River Waukesha Dam to State Line	59.3	71	0.0002
Fox River Origin to State Line	79.4	209	0.0005
Pewaukee River	4.8	30	0.0012
Mukwonago River	13.0	110	0.0016
Honey Creek	18.5	130	0.0013
Sugar Creek	19.5	125	0.0012
White River	12.3	110	0.0017

The landscape of the Fox River basin is largely the product of glacial action. Large rolling morainal hills mark the northern and western extremities of the basin. In the central and southern parts of the basin, the gently sloping flood plain of the Fox River has been developed on glacial fill materials. Some of the glacial lakes of the hill lands, for example, Lake Geneva in Walworth County, are deep (135 feet) ; but most of the basin's lakes are aging, shallow remnants of once extensive glacial lakes.

Many diverse soil types are present in the basin. Each soil, with its own range of physical characteristics, has certain use suitabilities and distinct treatment and management needs under various uses. Extensive areas of loamy soils, organic soils, and sandy soils present problems in soil and water resources treatment and management.

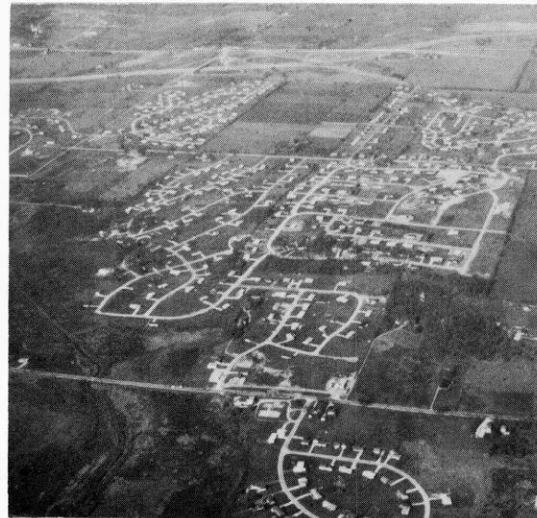
The bedrock underlying the glacial surface materials consists of alternating layers of dolomites, shales, and sandstones, all of which slope gently toward the east. Some of the bedrock layers, especially the sandstones, comprise the primary aquifer of water supply for the industries and municipalities of the basin.

The average annual precipitation in the basin is about 30 inches. Record extremes, however, of only 19.52 inches in 1932 and of 43.57 inches in 1938 illustrate the considerable range in deviation from average rainfall amounts. Too little and too much surface water in a given year are fairly common phenomena in the basin. For example, there is less than a 50 percent probability of receiving an inch of rainfall, the amount considered ideal for many crops, during any given week of the growing season; and the streamflow of the Fox River at Wilmot in Kenosha County has varied, within the same year, from a mere trickle to a flow of about four million gallons per minute. The average daily pumpage of water to supply the City of Waukesha, 1960 population 30,004, is little more than four million gallons per day or approximately equal to one minute's peak discharge of the Fox River. The long-term average flow of the Fox River at Wilmot is 463 cubic feet per second or about 208,000 gallons per minute. No long-term streamflow records of the tributaries to the Fox River exist. Partial flow data collected to date indicate that some tributaries are dry when main stem flows at Wilmot are at seasonal lows.

The opportunities inherent in the physical characteristics of the basin have long been recognized, and population growth along with economic development rose steadily until the end of World War II. A variety of land and water-related problems appeared during a century of such steady but slow development. These historic land and water-related problems, however, tended to be localized geographically.



Important changes in the regional transportation system are encouraging urban expansion into the Fox River basin and thereby are directly and indirectly affecting the demand upon the resources of the Fox River basin. The effects of high standard highway facilities on the runoff characteristics and flow regimen as well as on the land use pattern of a watershed are readily apparent from this view of a new interchange recently completed in the upper reaches of the Fox River Watershed.



Less than a decade ago, this land in the Fox River basin was almost totally agricultural; and watershed problems were minimal. Today, impervious rooftops, driveways, sidewalks, and pavements are replacing permeable cropland, wood lots and wetlands. The soil and surface water resources must carry more and more waste material, and the stream channels, more and more storm water runoff. Urban development in the headwater reaches of a watershed affects all of the downstream areas, creating problems of water pollution, siltation, increased storm water runoff, and deteriorating fish and wildlife habitat.

Since World War II, however, population growth and economic development in the basin have accelerated rapidly. This accelerated growth has been due in part to the radical changes which have occurred in regional development patterns over the last two decades. In 1945 urban development in the Milwaukee, Racine, and Kenosha metropolitan areas was still relatively concentrated around three urban core areas. Changes of tremendous impact on the Fox River basin have occurred since then. Not only has urban development in the Milwaukee area expanded into the upper Fox River valley but the densities and pattern of distribution of the various land uses comprising this urban expansion have changed radically. There has been a substantial migration of people from the older central cities to the suburban and rural-urban fringe areas. Industry and trade as well as residences have followed this trend to low density, decentralized urban development. Urban and suburban growth from the Milwaukee, Racine, Kenosha and, to a lesser extent, the Chicago areas has spilled over into the basin; and concentrated urban development has occurred along certain transportation routes and near water bodies. Population growth has also been widely distributed throughout the basin, however; and in the decade from 1950 to 1960, the growth rate of ten of the townships in the basin, representing about one-third of the basin land area, exceeded 50 percent. In the same period, Waukesha County, situated on the headwater area of the Fox River basin, had the highest rate of population increase in the state: 84 percent. Important changes in the regional transportation system, particularly construction of the Interstate Highway System and the Milwaukee County Expressway System, are encouraging and will continue to further encourage urban expansion into the Fox River basin.

These shifts in regional development have been accompanied by comparable shifts in demand upon the resources of the Fox River basin. The demand for water has accelerated rapidly. The data in Table 2 illustrate the rapid upward trend in municipal water demand which is occurring basin-wide. Accurate data on withdrawals by self-supplied industries are not available, but it may be assumed that substantial increases have also occurred.

Table 2

GROUND WATER WITHDRAWALS BY SELECTED MUNICIPALITIES
IN FOX RIVER BASIN, 1953 AND 1963

<u>Municipality</u>	Annual Pumpage in Million Gallons	
	<u>1953</u>	<u>1963</u>
Burlington	232	278
Elkhorn	123	170
Lake Geneva	189	255
Waukesha	1, 058	1, 665

Recreation surveys indicate that the basin, historically a resort area, is becoming even more of a playground, not only for basin residents, but for out-of-basin visitors as well. More than one-half of the public hunting and fishing areas and licensed shooting preserves in the seven-county Region are in the Fox River basin. Every part of the basin is within the "day-use" area (within 50 miles) of a million or more people and, therefore, comes under intensive use; and every part of the basin is within 100 miles of population concentrations of several million people. Most recreational activities depend upon a certain quality and quantity of water and related resources. In unplanned development, the delicately balanced natural environments which comprise a camping site, a boating stream, a duck marsh, or a fishing lake are easily destroyed by the very people who would use them.

The increasing basin-wide demands upon the resource base, although most evident in the form of urban and recreational development, are also affected by changing agricultural methods and needs. Agriculture is placing a sustained, and in some cases increasing, demand on the land and water resources of the basin. Total agricultural acreage, now high, is decreasing; but intensity of use is increasing. Increasingly larger quantities of water are being used to irrigate field and specialty crops. Agriculturists are discovering that supplemental water: (1) helps prevent frost damage; (2) improves carrying capacity; (3) "insures" against drought; (4) increases yield; and (5) improves the quality of a crop. Basin agriculture is oriented to regional markets and regional manufacturing and can be said to be healthier basin-wide than state-wide. The case for agricultural use of resources is strong. In the absence of planning, it is likely that conflict and competition between agricultural, urban, and recreational activities will be intense and costly.

Because of increasing pressures on the resource base, old resource problems are enlarging and new problems are appearing in the basin. It must be recognized that these resource problems are all interrelated and separate categorization of these problems can be misleading. For convenience of presentation, however, these problems will be arbitrarily presented under the following major categories:

1. Flooding
2. Water pollution
3. Water supply
4. Land use
5. Fish and wildlife and recreation

Flooding

The existing channel capacity of the Fox River is inadequate to carry peak discharges, and inundation of the floodplains adjacent to the main channel and major tributaries is common during severe storms and during the spring snow melt. The water-holding characteristics of the urbanizing headwaters portion of the basin have been altered drastically by the conversion of farm lands, woodlands, and wetlands to urban use. Such changing land use affects the amount and rate at which storm water runoff occurs and intensifies flood problems. The encroachment of urban development upon historic flood plains further intensifies flood problems; and numerous examples exist of the flooding of homes, businesses, streets, and other urban development which has been allowed to encroach on natural floodways and flood plains. Damages to urban properties due to the 1960 flood on the Fox River, as determined by the U. S. Corps of Engineers, are shown in Table 3, page 16. It should be noted that damages to agricultural properties are not included in Table 3 and that the 1960 flood was not the maximum flood of record.



This flood flow of the Fox River, which is shown under-cutting trees and cropland, is the cumulative result of the discharge from a multitude of farm rivulets and from agricultural and urban drains. Intelligent water control measures must, therefore, involve the entire watershed, including the upland areas, and not just the main stream channels.



The streams and watercourses within the Fox River basin have from time immemorial overflowed their banks and taken possession of their natural flood plains. Urban development has in some areas of the watershed been allowed to preempt these natural flood plains, often without due regard to the periodic flood hazard and concomitant damage to property and danger to human life and public health. This unplanned urban development has brought an increasing demand for flood control through expensive protective expensive public works. Here a new store is being protected by emergency measures during the 1960 spring flood of the Fox River.

Table 3

URBAN FLOOD DAMAGES WITHIN THE FOX RIVER BASIN
DURING FLOOD OF APRIL, 1960

<u>Area of Damages</u>	<u>Estimated Damages</u>
Mouth to McHenry Dam, Illinois	\$ 211,000
Chain O'Lakes, Illinois	1,627,000
Silver Lake and nearby communities, Wisconsin	264,000
Burlington to Waukesha, Wisconsin	48,000
Waukesha, Wisconsin	61,000
Waukesha to headwaters, Wisconsin	<u>10,000</u>
Total	\$2,221,000
Within Wisconsin	\$ 383,000

As already noted, storm water drainage and flood control is a problem which is intensified by urban development and which requires that the watershed be recognized and considered as a planning unit. Storm water drainage and flood control facilities must form a single integrated system over the entire watershed, a system capable of carrying both present runoff loads generated by the existing land use patterns in the watershed and future runoff loads that may be generated by changing land use patterns in the watershed.

The storm water drainage and flood control problems of the Fox River watershed are intensified because of the geographic distribution of existing and probable future urban development in relation to the watershed. The upper reaches of the basin lying in eastern Waukesha County are subject to rapid areawide urbanization while the lower reaches of the basin comprise rich and stable agricultural areas interspersed with growing urban settlements, many located along the main channel of the Fox River. Increasing urbanization in the headwater areas of the basin will materially decrease the length of time needed for water to concentrate in the main channel and will, therefore, increase the peak discharge of storm water runoff. Flood conditions in downstream communities will be intensified, adversely affecting not only urban development but farm land and farm drainage systems as well.

Urban storm water drainage systems in existing and newly developing communities in the basin must depend upon the Fox River for the ultimate disposal of storm water. Such systems can only be designed properly within the framework of a cooperatively adopted regional drainage and flood control plan setting forth an agreed upon treatment for the main channel and major tributaries of the Fox River, so that elevations and capacities of urban storm drainage systems can be adjusted to the ultimate design hydraulic grade lines of the receiving channels. Moreover, local land use plans and plan implementation devices can only be applied to adjust development to the drainage pattern, and thereby avoid future flood problems, within the framework of such an agreed upon plan. Finally, it should be noted that the problem of storm water drainage and flood control is closely related to other watershed problems, such as land and water use, stream pollution, recreation and public open space reservation. Practical solutions to any of these related problems must, therefore, simultaneously consider solutions to the other water-related problems and needs.

Although urban storm water drainage and flood control is a problem of considerable magnitude within the basin, it must be recognized that agriculture is still an important land use within the basin and that agricultural water management is also an important problem. Active farm drainage districts tributary to the Fox River exist within the basin, and the special problems of these districts must be considered in any comprehensive watershed planning study. Like urban drainage systems, the elevations and capacities of farm watercourses and drains must be adjusted to the ultimate design hydraulic grade lines of the receiving channels; and such districts will benefit greatly from the adoption of a regional drainage and flood control plan setting forth an agreed upon treatment for the main channel and major tributaries of the Fox River.

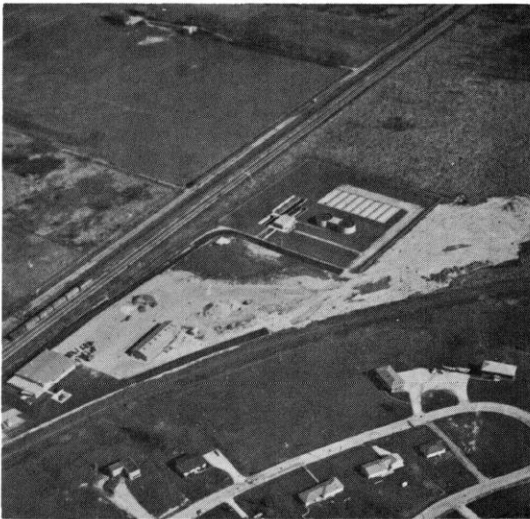
Water Pollution

There are perhaps as many standards for evaluating water quality, both economically and esthetically, as there are uses of water. Thus, there is no unanimity of agreement among water users in the basin regarding exactly what constitutes "bad" water. Technicians who have examined the quality of the basin's waters, however, generally agree that the quality of most surface water is deteriorating; and this deterioration is due to other than natural causes. More detailed analyses will be required to determine exact changes and related causes, but surveys to date generally indicate that the following factors are contributing to the deterioration of water quality within the basin:

1. Increasing quantities of destructive sediments are being contributed to streams and lakes within the basin by silt laden runoff from agricultural lands, urban and suburban construction sites, highway construction, improperly maintained road ditches and streambanks.
2. Extensive suburban areas which are without community sewers and sew-

age treatment plants and are located on generally impervious soils are contributing heavy pollution loads to lakes and streams within the basin.

3. Increasing quantities of refuse, sewage, and sediment are overfertilizing streams and lakes within the basin, causing a deterioration of fish and wildlife habitat and hastening the "death" of the lakes.
4. In three water quality surveys of the Fox River and its tributaries (1954, 1960, and 1962), certain reaches of the streams were found to be so polluted by sewage and wastes that only sludge worms could survive in the area of, and downstream from, some sources of pollution.
5. Some of the sewage treatment facilities within the basin have inadequate capacities to properly treat summer loadings; and others are inoperative or ineffective during periods of flooding, with consequent discharge of pollutants to surface waters.
6. The quantity of streamflow in the basin is often inadequate to assimilate any sizeable pollution load.



Multiple, and often conflicting, demands upon the natural resource base emphasize the need for comprehensive watershed planning. Here new homes and a sewage treatment plant compete for space with the Fox River and its natural flood plain. Treated wastes from sewage treatment plants discharged to the Fox River and its tributaries compete with aquatic life for the dissolved oxygen in the water. When the river is unable to assimilate the increasing municipal and industrial waste loadings, its potential for multi-purpose use will have been destroyed.



During a ten-day period in the summer of 1964, extensive reaches of the normally picturesque Fox River became a foul-smelling, unsightly flowage of dark waters, dead fish, and foam--evidenced by this scene of the Fox River at the Barstow Street Dam in the City of Waukesha. It was no accident that the unprecedented "souring" of the river was triggered by heavy rainfalls on a watershed characterized by a combination of pollution hazards, including: refuse disposal in or adjacent to waterways; unsewered residential development on soils unsuited for such use; overloaded sewage disposal facilities; and extensive natural swampland.

Problems of sewerage and sewage treatment will be intensified as urban development proceeds within the basin. Presently there are six secondary type sewage treatment plants discharging treated effluent to the Fox River and its tributaries in Waukesha County. These plants presently serve a population of approximately

40,000 persons. Difficulties are encountered at several of these plants during the wet seasons of the year when large volumes of clear water discharge through the sewerage systems. During these periods it is necessary to bypass raw sewage directly to the receiving streams.

There are presently two sewage treatment plants in Racine County discharging treated or partially treated effluent to the Fox River. One is a primary treatment plant and the other, a secondary treatment plant which is overloaded on occasions, necessitating the bypassing of raw sewage directly to the receiving stream. These plants presently serve a population of approximately 8,000 persons.

There are presently three secondary type sewage treatment plants discharging treated effluent to tributaries of the Fox River in Walworth County, one of which is overloaded. In addition, two secondary type sewage treatment plants discharge treated effluent to lagoons and depend upon evaporation and soil absorption for final effluent disposal. These five plants presently serve an estimated population of 10,000 persons not including the greatly increased population levels experienced in this growing resort area during summer months.

There is one secondary type sewage treatment plant in Kenosha County discharging treated effluent to a tributary of the Fox River and serving a population of approximately 3,000 persons.

The population of the Fox River basin is rapidly increasing, and the disposal of sanitary sewage is an ever increasing problem. Many of the soils in the basin are unsuitable for application of the soil absorption method of waste disposal. In addition, a number of residential subdivisions located along the Fox River are subject to flooding; and even under normal conditions the shallow water table is high and prevents the proper operation of private on-site sewage disposal systems. Under these conditions private on-site sewage disposal facilities work only for a limited period of time, and ultimately partially treated sewage is discharged upon the surface of the ground or into farm drain tile systems or roadside ditches. Subdivisions around many of the lakes in the drainage basin were laid out many years ago for summer residence use. Many of these areas have now been converted to year-round residential use with consequent aggravation of the sewage disposal problem.

The Fox River, its tributaries, and the many lakes in the basin presently offer recreational enjoyment to a large and increasing number of people. Future water usage will be multiplied many times and, coupled with increasing population pressure, will aggravate the already serious sewage disposal and water pollution problems of the basin.

Water Supply

Although most parts of the basin are located in relatively close proximity to

Lake Michigan, this ample supply of good water is apparently not available to basin water users except, perhaps, conditionally, because the eastern limits of the Fox River watershed also form a subcontinental divide. Existing statutory and case law and current litigation indicate the difficulties of exporting water from the St. Lawrence River Basin (including Lake Michigan), and these difficulties would seem to preclude reliance of the Fox River basin on Lake Michigan for water.

Lacking a good source of surface water, virtually all water users within the Fox River basin rely upon well water from shallow and deep underground aquifers. It is, therefore, important to protect these aquifers and to conserve the quantity and the quality of the water they supply.

The concentration of deep, high-capacity wells in certain localities has created cones of depression which are affecting shallower wells of smaller water supply systems. A steady overall drop in water tables is taking place throughout much of the basin. Water tables and water surfaces in the northern and southern parts of the basin are being lowered by the Milwaukee and Chicago ground water extractors respectively. Artesian (deep well) water levels in the Waukesha area have dropped about forty feet during the last ten years and 100 feet during the last 17 years. Chicago pumpage has caused a decline in water levels in the Kenosha and Walworth County portions of the basin of a maximum of 20 feet during the period 1958 to 1964. In places, the shallow ground water aquifers, which are important as a secondary source of supply, have been contaminated by sewage. Because of the natural interconnection between ground and surface waters, the continued lowering of water tables also threatens many shallow lakes in the basin.

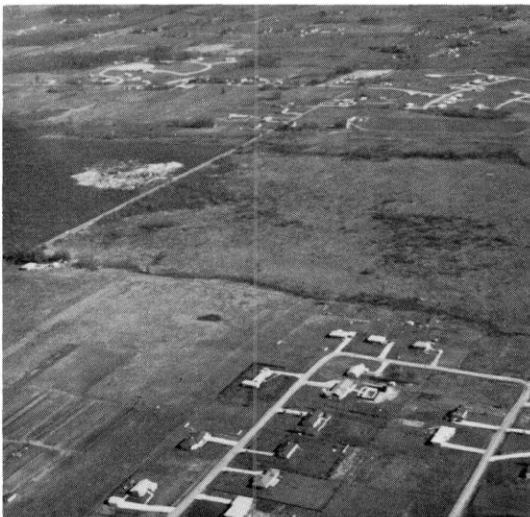
Another significant water problem is developing in the use of ground water for irrigation. Because of the unreliability of surface water supplies, irrigators are turning to ground water; but here they encounter the legal restriction that they must not interfere with municipal wells. Conflicts over the use of a generally abundant but locally and periodically scarce resource are increasing.

Land Use

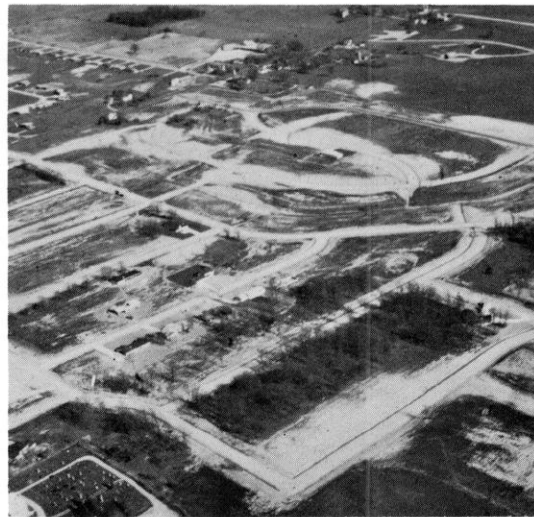
That a close relationship exists between land use and water-related resource problems was implied in the introduction to this chapter. A watershed is a natural land area which receives, stores, and delivers water; and, therefore, good land use and good water go hand in hand. A watershed may through proper land use planning, development, and conservation management be expected to produce a maximum regular flow of clear, clean, high quality water. The fact that every square foot of ground within a watershed performs a vitally important function in receiving and disposing water is a fact that has often been neglected in land use planning and development within the Fox River basin; and as a consequence, the basin soil and water resources have been abused, wasted, and sometimes destroyed.

Land use and water control facilities are particularly closely related since the land use pattern is an important determinant of the loads which the water control facilities must carry. Water control facilities and their effects upon the water resources of the basin are, in turn, an important determinant of how land should be used. Long-range plans for land use and for water control facilities must, therefore, be developed together and must recognize the watershed as a rational planning unit.

It has already been noted that rapid land use changes are taking place within the watershed. Perhaps the principal land use change is from agricultural use to urban use, and much of the prime agricultural land within the basin is subject to conversion to urban use. Improved land management and protection of the good agricultural land remaining are, therefore, problems requiring attention within the basin. Problems associated with areas remaining in agriculture involve



A highway, a refuse dump, and housing developments are beginning to crowd this marshland which has long been a place for the storage of floodwaters and the propagation of wildlife. Because scenes like this are repeated many times over in the Fox River Watershed, a study of the impact of changing land use upon storm water runoff, water supply, water quality, and wildlife habitat is essential if sound long-range solutions are to be found to the water-related problems of the Fox River Watershed.



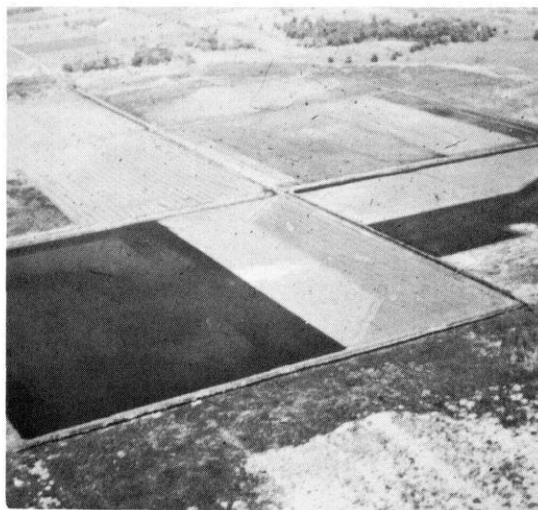
Changes in land use, particularly the conversion of land from agricultural to urban use, have many far reaching impacts on the resources and flow regimen of a watershed. Increasing quantities of destructive sediments are being contributed to streams and lakes within the Fox River basin from agricultural lands, from urban subdivision and highway construction sites, and from improperly maintained road ditches and stream banks. The effects of land scraping operations in new subdivision construction are apparent from this view of new urban development in the Fox River basin. Although siltation from such construction sites may be only temporary, increased runoff and decreased ground water replenishment will be permanent features of the urban development.

planning for sound water conservation, utilization, and disposal as well as for sound soil conservation and utilization. Provision should be made for adequate cover and land treatment measures to retain rainfall and improve the hydrologic and hydraulic characteristics of the entire watershed and to eliminate sheet, gully, and streambank erosion. Provision should also be made for individual and group drainage outlets and water disposal for agricultural as well as for urban development. Rapidly changing land use within the watershed, especially conversion of wetlands, woodlands, and croplands to urban uses, is compounding problems of misuse of the land and soil as well as of the water resources of the basin.

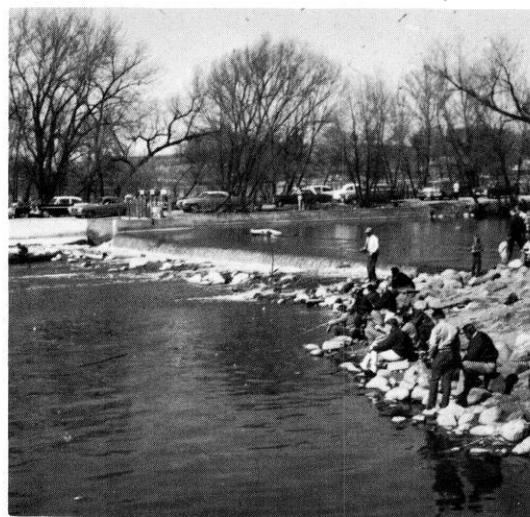
Fish and Wildlife, Parks and Recreation

It has already been noted that the recreational demands on the basin resource base are rapidly increasing. These recreational demands are centered, in part, directly upon such resources as surface water, woodlands, wetlands, and land as open space and, in part, are centered on the fish and wildlife populations sustained by the underlying resource base. Where the recreation demand is centered on the resource base itself, poor land and water development and management practices in the basin, which adversely affect this resource base, also destroy recreational values. Water pollution, soil erosion, stream sedimentation, overuse, and land use conversion are all examples of resource problems affecting recreational values.

Where the recreation demand is centered directly on fish and wildlife, damage to, and loss of, woodlands, wetlands, potential park sites, and other fish and game habitat through new urban development, highway construction, and conversion to intensive agricultural uses are destroying recreational values. Wetlands, vital for spawning and rearing fish and wildlife, are being lost through



Agricultural as well as urban land use changes are affecting the resources of the Fox River Watershed. This Waukesha County scene on the edge of the Vernon Marsh challenges today's citizen with a decision for tomorrow. Less than one-half of the historic wetland in the watershed remains; and continuing conversion will adversely affect water supply, flooding, recreational opportunities, and fish and game habitat within the basin.



The intensive recreational use made of the Fox River by fishermen is illustrated by this scene at one of the several small but important dams on the Fox River. Because of the low gradient of the Fox River and the many competing uses made of the River, a change in a structure such as this dam would affect upstream and downstream farm drains, municipal drainage and sewerage facilities, and the recreational activities of many people. It is, therefore, necessary that any program for solving the accelerating problems of the Fox River be founded upon a consideration of the needs of people throughout the watershed.

dredging and filling operations carried on to create additional water frontage for residential development and through drainage improvements for agricultural development. Surveys indicate that less than one-half of the historic wetland acreage of the basin remains. Pollution of surface waters by sewage and industrial wastes, sedimentation, and excessive enrichment by treated sewage effluent and agricultural fertilizer runoff is destroying the quality of fish and wildlife habitat and is damaging recreational values within the basin. Harassment of fish and game due to overuse by recreation seekers is also adversely affecting fish and game populations. Overuse of park, public hunting and fishing grounds, and

recreational waters is rapidly deteriorating the once excellent recreational resources of the basin. Shortages of fish, game and other wildlife, boat landings, campsites, and developed recreational areas are aggravating problems of over-use. Finally, there is an apparent lack of appreciation for the considerable value which woodlands, wetlands, and other open space and their proper management can contribute to the total quality of the landscape, especially with respect to watershed protection and resource conservation. This is reflected in continuing urban sprawl in many parts of the basin.

Many conservationists believe that these destructive influences on the natural resource base of the watershed have already made significant inroads on the reputation of the basin as one of the foremost agricultural and outdoor recreational areas in the United States. This latter combination of values contributed greatly to the historic development of the basin and may, in light of a changing economy, become very important to the future economic well-being of the Region.

Summary and Conclusion

On the basis of the preceding information, it is apparent that no one resource problem in the Fox River basin is singularly overwhelming. The combined effects of the many interrelated problems, however, if allowed to bear constantly on the existing resource base, must ultimately destroy those values which are sought and needed by an increasing number and variety of water, soil, forest, wetland, and wildlife users. The major resource related problems within the basin may be summarized as:

1. Storm water drainage and flood control.
2. Deteriorating surface water quality and lake and stream pollution.
3. Irregular streamflow.
4. Soil erosion, lake, and stream siltation.
5. Changing land use, not only with respect to the stream channels and their floodways and flood plains, but also with respect to the basin as a whole.
6. Inadequate soil and water conservation and management practices.
7. Park and open space reservation.
8. Inadequate sewage and industrial waste disposal facilities, both private and public.
9. Water availability and use.

10. Deteriorating fish and wildlife habitat.

These problems are closely interrelated and will be intensified as urbanization increases within the watershed. Practical solutions to any of these basic problems must, therefore, simultaneously consider solutions to the other related problems and needs. This can only be accomplished effectively within the framework of a comprehensive planning program which recognizes the watershed as an integrated land-water resource unit having a complex community of interests among its residents.

CHAPTER IV

MAJOR ELEMENTS OF A COMPREHENSIVE WATERSHED PLANNING PROGRAM

The following outline sets forth the major necessary work elements of a proposed comprehensive watershed planning study of the Fox River basin in southeastern Wisconsin. The outline has been prepared for the purpose of establishing a generalized work program appropriate to meet the specific needs of the Fox River basin and to provide fair and practical solutions to the problems of the basin as cited previously in this Prospectus.

The outline is based upon the following assumptions:

1. That the ultimate purpose of a watershed planning study of the Fox River basin is to assist in the abatement of the water-related problems of the basin and in the preservation and enhancement of the resource base by developing a workable plan to guide the staged development of multi-purpose water-related facilities and related resource conservation and management programs for the Fox River basin. In addition, the study shall provide, insofar as possible, planning and engineering data which can contribute to local planning programs and to broader regional resource planning programs.
2. That the study must be comprehensive in both functional scope and in geographic area, fully recognizing the interrelationship of the water and land use problems of the basin as well as the need to consider the watershed as a rational planning unit.
3. That the study will utilize the latest planning and engineering techniques and seek to achieve a comprehensive, coordinated plan for the entire basin.
4. That the task of establishing a comprehensive watershed planning program, the collection and analysis of basic data under such a program, the formulation of improvement plans, and plan implementation all require close and continuing cooperation among the various levels and agencies of government concerned with, and involved in, the land and water use problems of the watershed.

It is intended that the study present and evaluate alternative water-related facility plans and accompanying development patterns. Evaluation of the alternative plans should be based upon a comprehensive assessment of effects on the natural resource base and on the total environment as well as on the overall costs of developing and operating the combined water-related facilities and accompanying development patterns.

While sufficiently detailed to permit the development of initial cost estimates and time schedules, the outline is not intended to be a detailed study design. It is sufficiently general to permit latitude in the selection of specific procedures and techniques as the study proceeds. It is intended that full use be made of all existing and available surveys, reports, and other data pertinent to the study. Additional data collection activities should be conducted only as necessary to develop essential original data currently unavailable or to supplement or update existing data.

A. STUDY ORGANIZATION AND DETAILED STUDY DESIGN

Before beginning actual work, the study must be designed in sufficient detail to assure maximum coordination between participants, the efficient use of funds and personnel, and the ultimate combination of work elements into a sound, comprehensive plan. In order to accomplish this, it is necessary to begin the watershed study with the design of an organizational fabric which sets forth very clearly the detailed work procedures, staff assignments and requirements, and time schedules. Initial effort expended in study design will result in a greatly increased efficiency in the planning program.

B. COLLECTION OF BASIC PLANNING AND ENGINEERING DATA

1. Maps

Essential to any consideration of watershed planning is a knowledge of the topographic and cultural features of the watershed, and such knowledge can only be adequately based upon topographic and cadastral maps of the required scale and accuracy. Information will be required on such natural features as relief, watershed boundaries, areas subject to inundation, and locations of streams, lakes, and wetlands as well as on such man-made features as real property boundary lines, highways, railroads, and principal buildings.

a. General base maps

General base maps of the watershed will be required to provide a medium for recording and presenting in graphic form the results of the planning studies as well as the natural and man-made features of the watershed.

Regional base maps have been prepared by the SEWRPC and are available for the study. These maps portray each county in the Region at four scales: 1:24000, 1:48000, 1:62500, and 1:96000 and can be assembled by mosaic processes to cover the watershed as a unit. These base maps can be expanded or reduced in scale for use in various phases of the study and will show, among

other information: all major lakes, streams, and watercourse lines; all railroads, streets, and highways; all township range and section lines and all civil division lines. These maps are compiled to National Map Accuracy Standards utilizing the Wisconsin State Plane Coordinate System Grid (South Zone) as the map projection.

Large scale topographic and/or planimetric maps and cadastral maps of their respective jurisdiction are available from certain of the municipalities within the basin, and large scale topographic maps of Waukesha are available from the Waukesha County Park and Planning Commission.

b. Aerial Photographs

Current aerial photography at appropriate scales will be required to provide detailed planimetric data, as a basic source for land use data and as a data source for the necessary updating of all base maps.

New aerial photography of the entire planning Region was obtained by the SEWRPC in April of 1963, and these aerial photographs are available for the study at scales of 1:4800 and 1:24000.

c. Flood hazard and land reservation maps

As the study efforts reach a more precise and definitive stage, maps providing detailed information on property boundary lines and topography to a much greater degree of accuracy and precision than furnished by the general base maps will be required. The degree of accuracy which can be attained in such plan implementation activities as flood plain regulation depends upon the accuracy and scale of available detailed planning maps. Therefore, such maps will have to be available at a scale of 1 inch equals 200 feet, with a vertical contour interval of five feet. In order to properly correlate topographic and cadastral (property boundary) map data, such maps should be based upon a monumented control survey network which relates the U. S. Public Land Survey System to the State Plane Coordinate System. These maps will be required only along such reaches of the major stream channels as the ultimate plan may indicate as requiring land use controls for flood plain reservation or as requiring the reservation of land for the ultimate construction of drainage and flood control facilities. These maps will provide a basis for the preparation of local plans and plan implementation devices.



The flooding pictured in these two scenes occurred in the Kenosha County community of Silver Lake in 1961 and 1962, respectively, as the result of a normal spring snow melt in the Fox River basin and do not represent the severe flood conditions possible under unusual weather and runoff conditions. The possible damage to private and public property and the attendant public health hazard from such flooding are apparent. Changing land use in the watershed is generally intensifying flood dangers. Before reasonable plans can be drawn to abate flooding, it is necessary to collect and analyze a great deal of engineering data on land use, soils, rainfall, the physical dimensions and capacities of waterways, and the expected frequencies of flooding. Such analysis must include all upstream tributary areas as well as all downstream areas producing a back-water effect.

2. Surface Water Data Inventory - Hydrologic and Hydraulic Investigations

Essential to effective water use and land use planning, as well as to effective drainage and flood control engineering, is data on water quantity, particularly on the flood potential of streams. Basic data on the hydrologic and hydraulic characteristics of the Fox River will, therefore, have to be gathered. These data should include historic flood data and stream flow measurements, including information on low flows as well as peak discharges from which flood magnitudes, expected frequencies, stage-discharge relationships, flood profiles, velocities, and expected sustained average and low flows can be derived. Rainfall frequency-intensity-duration data should be collected and correlated to historic flood data and streamflow measurements. A physical inventory of the major stream channels will be necessary to determine existing flow capacities and should include data on culverts and bridges, including heights of underclearance, number and width of spans, and deck and guard rail elevations above stream bed; dams and encroachments, including heights and overflow sections; historic high water marks; and stream profiles and cross sections showing the main channel and its relationship to the natural flood plains. Data on damages from past floods will have to be collected including specific information on fatalities and personal injuries, if any, on property damage and the cause and nature of the damage and on areas of particularly high damage.

Streamflow and lake level information within the basin is incomplete and generally represents a short time range. The only long-term record of streamflow has been obtained at Wilmot where water levels have been read twice daily since 1939. A partial record of lake levels has been obtained at Browns Lake and Eagle Lake in Racine County and Silver Lake in Kenosha County. A network of surface water gaging devices, including one water-stage recorder, two staff gages, and eight crest gages, was established along the main stem of the Fox River in 1962 by the SEWRPC in cooperation with local municipalities in the basin. Because of the short period of record of most of the hydrographic stations in the basin, methods of synthesizing streamflow records will probably have to be utilized in the watershed planning study.

3. Ground Water Basic Data Studies

In view of the degree of dependency of the basin water users upon ground water, the geology, hydrology, and use of the ground water supplies must be established as a basis for projecting future water needs and foreseeing future water problems. Because most lake levels and practically all nonflood streamflow is maintained by ground water discharges, it is vitally necessary to determine the quantitative relationships between ground waters and surface waters. In order to accomplish these objectives, a ground water study should include determination of: the location of recharge areas; the hydraulics of aquifers within the basin, including permeability, transmissibility, and specific capacities; trends in ground water pumpage; trends in ground water levels as related to precipitation, pumpage, lake levels, streamflow and wetland existence; and ground water conditions, such as the Milwaukee and Chicago drawdown cones, which are limited, not by the Fox River drainage basin areas, but primarily by the boundaries of the larger artesian water basin comprising parts of southeastern Wisconsin and northeastern Illinois.

The ground water studies will be performed to the degree of intensity necessary in a basin-wide comprehensive approach, and the studies will not involve consideration of extremely localized problems which do not pertain to the surface drainage basin or the ground water reservoirs. Although the study will be based primarily upon existing data, considerable effort will have to be expended in the assembly of data from various sources. Field work will be required to verify and update existing data and to collect additional information. Additional well-drilling or extensive field testing of aquifers will not be required.

4. Water Quality Investigations

The value of water is tied directly to its quality. Because of differing economic and esthetic limitations, the concept of "suitable" water changes considerably from one type of use to another. It is, therefore, necessary to establish a generalized but comprehensive understanding of the quality of water in the Fox River basin in order to determine the suitability for all general kinds of use, including domestic and industrial water supply, agriculture, recreation, and the dilution and assimilation of wastes.

The SEWRPC is presently conducting a regional surface water quality study. This study includes the periodic collection and analysis of surface water from each of 28 stations on the Fox River and its major tributaries. The analyses include determination of standard parameters of physical, chemical, and bacteriological quality; and the results of this study will be available for application in the watershed planning work. In addition, certain state agencies have in the past performed pollution surveys of the Fox River and major tributaries, including physical, chemical, bacteriological, and biological analyses. The existing data should prove adequate for an assessment of the quality of stream water in the Fox River basin for watershed planning purposes.

A data collection program will, however, be required to determine the quality of lake waters. The Wisconsin Conservation Department has sampled and analyzed lake waters for certain selected physical and chemical characteristics, but additional data will be needed to determine the extent of pollution and fertilization of the basin's lakes.

Existing information should prove adequate for a summary appraisal of ground water quality.

5. Water Use Inventory

An investigation will be required of the various kinds of water use and of the intensities of water use, relating both to water quality and land use. Decennial (1950 and 1960) and current consumption rates will be established for ground water and surface water--and to the extent practicable, for precipitation--in terms of land use requirements. It will be necessary to establish not only the withdrawal demand for water, but also to determine, to the extent reasonable, the demand for water as a commodity in recreation, wildlife preservation, and in the dilution of wastes.

6. Soils Capabilities Investigation

Detailed soil capability information, including type and depth of major

horizons, depth to bedrock, depth to water table, permeability and runoff characteristics, susceptibility to erosion, suitability for reservoir sites, terraces and diversion structures, and for sewage disposal systems and foundations, will be required.

An operational soil capabilities study (standard soil survey) of the entire Region is presently being performed by the SEWRPC in cooperation with the S.C.S., and will be available for application in the watershed planning work.

7. Land Use Inventory

Since land use is an important determinant of water use and the time and rate at which storm water runoff occurs, a land use inventory of the watershed will be required as an integral part of the basin study. Such an inventory must determine the existing and proposed amount, type, intensity, and spatial distribution of all land use, including agricultural and recreational, and be adequate to establish historic patterns and trends. Generalized data should be included, in addition to use, on land and improvement values and for currently undeveloped land, physical characteristics of the site, valuation, and availability of utilities and community facilities. The inventory should also include data on existing local land use plans and development policies.

The results of the regional land use and of the local planning inventories being conducted by the SEWRPC will be available for the planning work.

Additional land use data will be available from such organizations as the Wisconsin Conservation Department and the Waukesha County Park and Planning Commission.

8. Economic and Population Base Study

It will be necessary to inventory and analyze the socio-economic factors which underlie the increasing demand for the basin's natural resources and which are accentuating the accompanying problems of flooding, falling ground water levels, and water pollution. Such a study will include the mapping of trends in population and economic activity and a correlation of these trends with the supply and suitability of the basin's resources.

Population and economic basic studies of the Region have been completed by SEWRPC and will be available for application in the watershed planning work.

9. Fish, Game, Park, and Recreation Study

A comprehensive approach to the problems of the watershed will require the collection of data on fish, game, park and other open space resources. Basic water-related surveys should include collection of data on species of fish, food chains, habitat analysis, basin configurations and shore types, and on habitat destruction. Any reservoir sites having recreational potential should be located. Data should be collected on the present use of water-related recreational facilities, such as beaches and launching ramps. Data on existing and potential game and other wildlife values will need to be collected and present habitat consisting of wetlands, waterways, lakes, and uplands inventoried. An inventory of existing and potential park and open space facilities will be required to appraise the recreational values of proposed changes in the flow regimen. A standard forest inventory and forest utilization and development study should also be included in a basic inventory of the resource base.

Results of the regional existing and potential park and open space inventory being conducted by the SEWRPC will be available for the planning work as will additional resource data from the Wisconsin Conservation Department.

10. Inventory of Public Utility Facilities

An inventory of the existing and proposed public utility facilities within the watershed, including sanitary sewerage, water supply, and urban storm water drainage facilities, together with existing and possible future service areas, will be required to determine urban land use capabilities and possible future effects upon the basin's hydrography.

An existing public utilities inventory has been completed by the SEWRPC and will be available for application in the watershed planning work.

11. Survey of Existing Water Law

A survey of the present legal framework of public and private water rights affecting general water management planning and project engineering design will be required. This should include an inventory of the existing powers and responsibilities of the various levels of government involved in resources management and the structure of public and private water rights which must necessarily be considered in the formulation of water management plans. Effort should be concentrated upon those aspects of common, statutory, and case law which apply specifically to the problems and potential developments in the Fox River basin.

C. PLANNING OPERATIONS

1. Technical Analysis of Water Resource Problems, Characteristics and Capabilities

A careful and detailed analysis of the hydrologic and hydraulic data collected will be required and should include identification of the extent of existing and probable future flood hazards by the preparation of overflow maps, an analysis of the character of the flooding-velocities, time of concentration, duration and causative factors. Noteworthy historic floods in the basin and in the Region surrounding the basin should be analyzed and related to the probable flood hazard and to rainfall intensity-duration-frequency data. Data on past flood damages will have to be analyzed and related to probable future flood frequencies and stages. General deterioration of the stream through erosion, sedimentation, debris and rubbish accumulation should be analyzed. Probable average and sustained low flow data should be analyzed and related to both water quality and potential consumption rates by various land use categories. The probable sustained yield of the ground water reservoirs should be established. The quality of the basin's lakes should be analyzed in terms of current and foreseeable impact of urbanization and recreation.

This work, of central importance to the planning operations, will have to be carried out as an integral part of the study program.

2. Analysis of Population Growth Trends and Resource Requirements

A careful and detailed analysis of the human activities within the watershed as these affect the water resources will be required. Such analyses should include an analysis of the economic and population structure and trends within the watershed and preparation of future population and economic growth levels; the establishment of future resource requirements based upon the estimated future population and economic growth levels; and the probable spatial distribution of these future requirements based upon an analysis of existing local development plans and policies and upon an analysis of soil and water capabilities and the capacities of public utility facilities to support such development. This phase of the work will be critical since the effect of future development and changing land uses are particularly important on smaller watersheds. Future development patterns will have to be analyzed to determine their effects upon demands for water recreation facilities; increasing municipal, industrial, and agricultural water supply and waste disposal needs; and continuing encroachment on flood plains, stream channels, and lake sides.

With respect to recreational resources, the fish, game, and other related

wildlife needs should be correlated with other land and water requirements within the basin; and the potential needs for the development or modification of natural units, such as stream habitat development, wetland restoration, scenic wayside units, dam sites for recreational reservoirs, and others, should be analyzed and liability-benefit ratios in the public interest established. A recreational demand analysis of the basin should consider the preservation of scenic areas; historic sites; natural fauna and flora; potential swimming, boating, fishing, hunting, picnicking, and camping areas in relation to the demand generated both within the Region and the Chicago metropolitan area to the south as well as to the resource base itself.

3. Adoption of Design Criteria and Standards

There are certain planning and engineering criteria and guides that are applicable in determining solutions to water resource problems that will have to be agreed upon by all parties concerned within the watershed if any cooperatively adopted plans and plan implementation measures are to be evolved.

The selection of floods--maximum known flood, standard project flood, regional flood, maximum probable flood, or design flood--to be used for regulatory purposes will have to be decided upon. This selection is one of public policy and is dependent on many nonengineering as well as engineering considerations and will require agreement among the various levels and units of government involved. Similarly, common design criteria, methods, and devices for channel improvements and reservoir



Man affects the flow regimen of a natural stream system, not only through changing land use, but also through changing stream channel capacities. Such changes may drastically affect historic flood plains. Basin-wide drainage and flood control measures must take into consideration existing drainage ways, such as this large canal in Racine County which drains the abandoned Bong Air Force Base. Moreover, the elevations and capacities of farm waterways and urban storm drains must be adjusted to the ultimate design hydraulic grade line of the receiving channels if the drainage facilities are to function properly.

construction, as well as for urban storm water drainage systems relating to the main channel, will have to be agreed upon among the various agencies of government involved. Agreement must be reached on exact measures for augmenting low streamflow for the carriage and disposal of wastes. It may become necessary to agree on the most beneficial uses of lake waters or of certain zones within lakes. Pollution will have to be defined; and standards for surface and ground water quality, based upon the existing and potential water and land uses by channel reach, will have to be established and agreed upon. Again, such classification is dependent upon many nonengineering as well as engineering considerations and is, therefore, a matter of public law and policy. Finally, acceptable cost-benefit ratios for any public works improvements necessary to develop the water resources of the basin, such as channel improvements, protective levees and upstream dams and holding reservoirs, will have to be developed and agreed upon.

The adoption of such criteria and standards by all parties concerned is extremely important since these criteria and standards will be used as a basis for the determination of the adequacy of existing water-related facilities, as a basis for plan preparation and as a basis for determining the relative urgency among various needs. The consideration and adoption of any and all of these and other criteria and standards will, therefore, have to be preceded by appropriate studies.

All levels and agencies of government concerned will have to participate in this phase of the planning work, and it will be particularly important that the criteria and standards adopted meet the requirements of such Federal agencies as the Soil Conservation Service and the Corps of Engineers which might be asked to participate in the plan implementation.

4. Preparation, Testing, and Public Evaluation of Alternative Watershed Plans

The ultimate purpose of the proposed work will be the preparation and presentation of a number of feasible alternative watershed plans for public evaluation and choice of a final plan for implementation. Watershed plans may include proposals for erosion and sedimentation control, flood protection, urban and rural drainage facilities, streamflow augmentation, water quality protection, pollution abatement, conservation and recreation facilities, flood plain protection and stream channel stabilization and beautification, ground water recharge and conservation, land use zoning, water management facilities, and the improvement and maintenance of fish and wildlife habitat. Each alternate plan must be quantitatively tested to establish the ability of the flood control-channel and sewerage facilities to carry their respective loadings within adopted standards.

Any single plan for specific water management facilities and engineering structures carries with it far-reaching decisions and effects on general land and water use patterns, allocation of resources, public investment policies, and broad community "benefits" and "costs." Decisions regarding such broad matters should not be made by technical planners or engineers alone. Such decisions properly belong in the realm of public policy-making through officials and citizens utilizing democratic processes.

If, therefore, an adopted watershed plan is to represent and include more than merely technical planning and engineering decisions, then the related physical, economic, social, and legal effects of alternative watershed plans must be analyzed and presented in understandable form to watershed officials and citizens for their study and evaluation. This should be done through a preliminary report describing the correlary effects and broad "benefits" and "costs" of alternative plans.

A preliminary report adequate for plan selection and public policy-making purposes should include, in addition to feasible alternative plans, statements providing information on the following important points:

- a. The purpose of the watershed program and the resultant preliminary report as an instrument for public decision making.
- b. Clear statements of watershed problems revealed by surveys and studies.
- c. The role and effects of public capital investment and resource allocation decisions in watershed development.
- d. Positive and negative general effects of watershed growth on variables, such as resource use rates, resource qualities, public overhead costs, environmental amenities, and required levels of public controls.
- e. Description of the general structure of water law as a design and decision-making framework and consideration of how it relates to the plan.
- f. Description of cost-benefit concepts used in evaluating the watershed plans.
- g. Critical decisions that need to be made in the watershed in the light of the total problem.

5. Selection of Final Plan

One plan should be chosen, after public hearings, as the final plan for the long-range development of the watershed and, through cooperative adoption by all levels and agencies of government involved, become the basic reference for future urban development patterns, soil and water management, public investment in public works, and detailed drainage and sewerage design within the watershed. The published report should include a clear graphic and written description of the general plan and the reasons for its selection.

6. Administrative - Financial Analysis

An administrative and financial study will be required to suggest practical organizational and financial arrangements under which the selected watershed plan and its related water management structures can be constructed and operated. The study should analyze the fiscal capacities of local units of government, identify Federal and State financial and technical assistance for watershed projects, and recommend an organizational structure and financial procedures for implementation of the watershed plan.

7. Preparation of Precise Plans and Plan Effectuation Devices

The primary objective of the planning studies is to motivate specific action toward the solution of the most pressing watershed problems. While a plan setting forth the general location and characteristics of proposed water management facilities is necessary as a statement of mutually agreed upon long-range objectives, it is, however, quite ineffective as a sound basis for plan implementation through land reservation and for extending technical planning assistance and advice to local governments.

With respect to the drainage and flood control problem, the application of such flood abatement devices as flood plain regulation, flood forecasting, temporary and permanent evacuation, open space reservation, flood proofing, urban redevelopment, warning signs, tax adjustments, and development policies as well as the proper design of local storm drainage facilities, all require the preparation of precise and definitive plans. These precise plans should set forth the ultimate development of each major stream channel of regional significance so that both present and possible future floodways and flood plains can be delineated and flood hazard maps prepared. In the case of drainage and flood control facilities, such plans should set forth proposals as to centerline location of channel improvements; location and extent of reservoir sites, floodways and restrictive zones; waterway openings required; channel bottom elevations and elevations of hydraulic gradients at low, average, and peak discharge rates.

If ground water recharge facilities are recommended in the plan, the sites, design features, and methods of operation must be carefully detailed. The proposal of a well-spacing and management program to enable maximum sustained withdrawals of ground water would require also that precise details be spelled out. As pollution generally has a traceable source, suggestions for remedial measures should include plans or devices of sufficient precision to enable cost determinations.

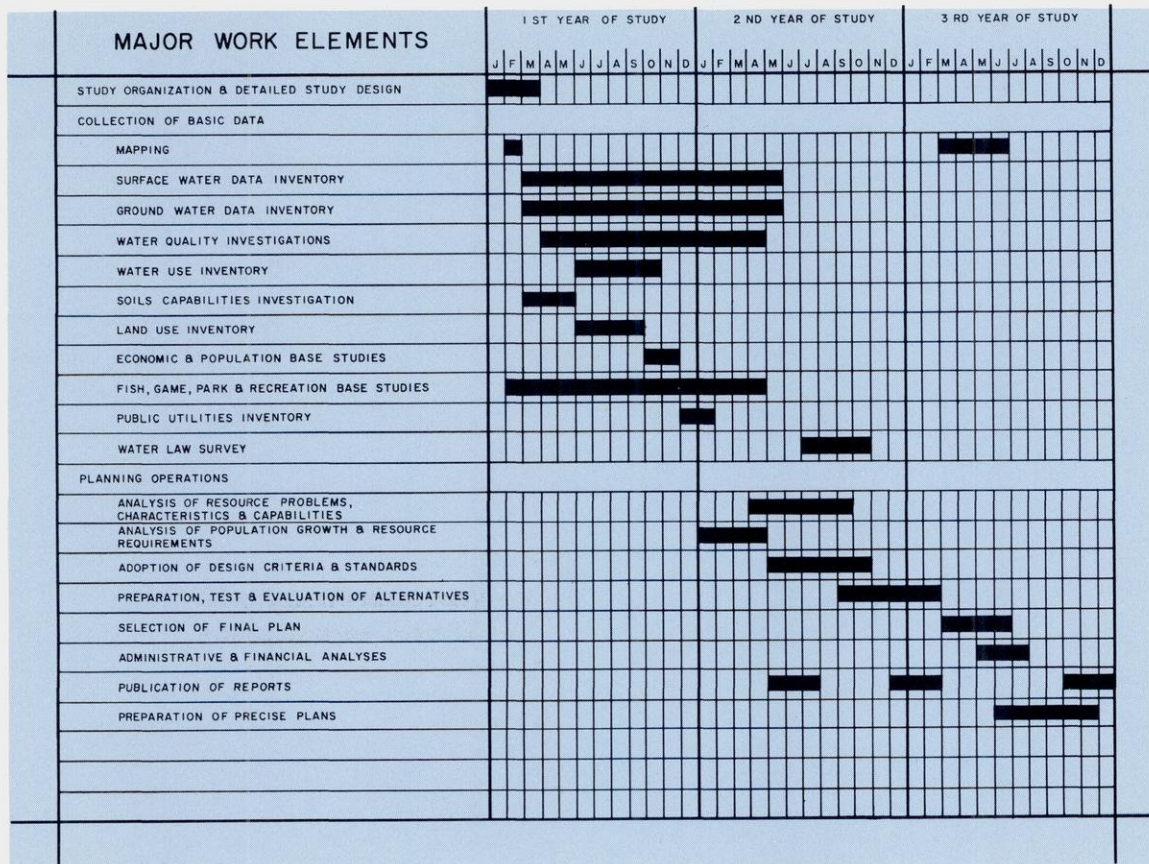
Finally, upland soil and water conservation measures necessary for the protection and efficient management of the land and water resources above any proposed improvement works shall be recommended in sufficient detail to provide a sound basis for conservation action programs; and plans shall be prepared for each water area, recommending the best land and water use in terms of the public interest and the protection of the resource base.

D. TIME SCHEDULE

An estimated time schedule for the accomplishment of the major elements of the study is shown on Figure 3, page 39. This schedule is subject to revision upon detailed study design but represents the best estimate possible in the absence of such a design. Study organization and cost estimates are predicated upon the recommended time schedule, which identifies all of the major work elements.

Figure 3

TIMING OF MAJOR WORK ELEMENTS OF THE PLANNING PROGRAM FOR THE FOX RIVER WATERSHED





CHAPTER V

ORGANIZATION FOR THE STUDY

A. STAFF REQUIREMENTS

The proper execution of the recommended comprehensive watershed planning program for the Fox River basin will require a staff trained and experienced in many different skills and professional disciplines including land use and resource planners; hydrologists; hydraulic, sanitary, and agricultural engineers; foresters; fish and game biologists, and specialists in recreation and in soil and water conservation. The complexity of the problems existing in the Fox River basin and their close interrelationship, coupled with conflicting interests in, and demands on, the resource base, make an interdisciplinary approach to the planning work particularly important.

Alternate approaches to the staff requirement problem were explored by the committee including staffing entirely by consultants and entirely by the SEWRPC itself. After careful consideration, it is recommended that the proposed watershed planning program be carried out under the direction of the staff of the Southeastern Wisconsin Regional Planning Commission and that the Commission assume direct responsibility for all those work elements which might logically be considered of a general regional planning nature.

It is further recommended that the regional planning staff be heavily supplemented by the use of contractual services to provide the other professional skills required to successfully complete the watershed planning program, particularly the required hydrologic, hydraulic, and sanitary engineering and the soil and water conservation skills. Certain governmental agencies having active resource conservation and management programs within the watershed have acquired many years of cumulative experience with, and insight into, certain of the resource problems of the basin. In some instances, the experience and knowledge accumulated by these agencies is not available elsewhere at any price. Moreover, from the standpoint of plan implementation, it would seem wise to involve in the planning process those governmental agencies which may later have an important role in plan implementation, including financial assistance in actual construction of water control facilities. It is recommended, therefore, that some of these skills be drawn from other governmental agencies as well as from private consulting firms.

Several of the key investigative service agencies have expressed a desire to participate in the recommended comprehensive planning program for the Fox River basin, including the Soil Conservation Service, U. S. Department of Agriculture; the Geological Survey, U. S. Department of the Interior; Wisconsin

Conservation Commission; the Wisconsin Geological and Natural History Survey; the State Committee on Water Pollution; and the State Board of Health. In addition, the Corps of Engineers, U. S. Army, has agreed to withhold completion of the single-purpose flood control study on the Fox presently underway pending completion of a comprehensive watershed planning program and has indicated a willingness to complete their work in light of the findings of the comprehensive study and plan recommendations and also to offer their services in coordinating planning work in that part of the basin lying south of the Wisconsin State line. Contractual agreements would have to be drawn during the detailed study design setting forth the exact roles of each of the agencies in the study.

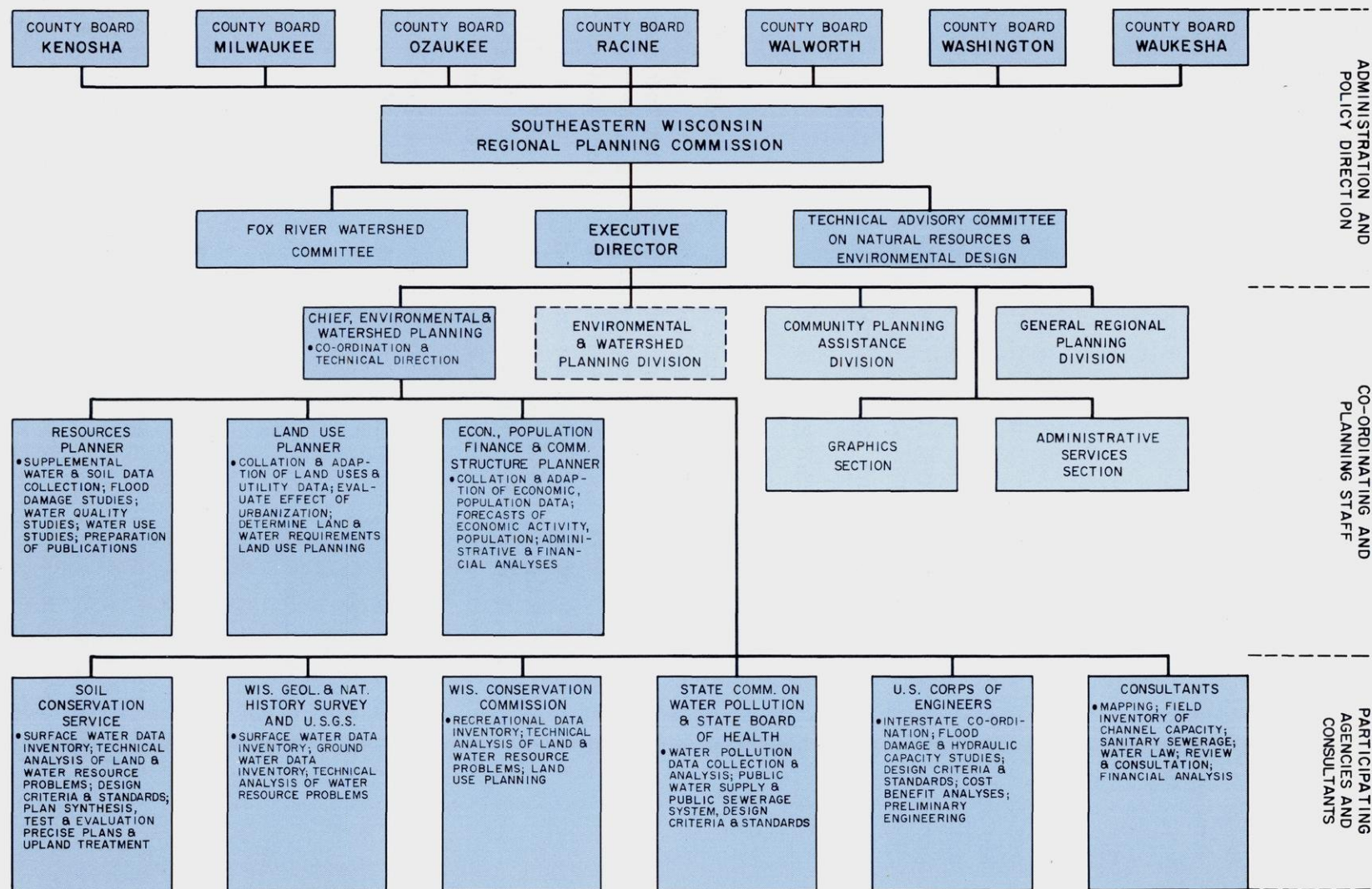
Certain work elements, especially mapping and certain specialized engineering studies, can probably best be accomplished through private consultants; and such private consultants might also be used in an advisory and review capacity. Again, contractual agreements setting forth the exact role of the consultant in the study will have to be drawn during the detailed study design.

The SEWRPC staff should be responsible for the coordination of all work roles and for the accomplishment of all basic data studies which might logically be considered of a general regional planning nature, including land use, economic activity, population, water use, and public utilities inventories. The staff of the Commission should also be able to collate and provide to other participants a great deal of very valuable planning and engineering data which has been developed in other Commission work programs. In addition, the SEWRPC staff should be responsible for coordinating the adoption of design criteria and standards, the evaluation of alternative watershed plans, the selection of the final plan, including the necessary public hearings and publication of reports. It is estimated that these portions of the work program require the services of two full-time planners over the period of the study, together with supporting administrative, technical, clerical, and drafting services. The Regional Planning Commission must, in addition, be responsible for interpreting the planning studies to the local governments and assisting these local units of government in plan implementation through appropriate land use controls, local planning, development, and resource management programs, thus assuring continuity of the planning program after completion of the study proper.

It is extremely important that the proposed study be carried out under the direction of a relatively small permanent staff with experienced professionals responsible for the final plan. The size of the task to be accomplished, coupled with the fact that some important phases of the work will have to be done with little precedent, requires that all participants in the study function as a smoothly operating team geared to tight production schedules. The recommended staff organization is indicated on Figure 4, page 43, as are the recommended lines of authority and responsibility and a possible functional designation of tasks. It must be recognized that actual service agreements negotiated with partici-

Figure 4

FOX RIVER WATERSHED STUDY ORGANIZATION CHART



pating agencies during detail study design could change the personnel requirements, the lines of authority and responsibility, and particularly the functional designation of tasks. Moreover, it must be recognized that certain functions must be shared. Particularly important among the latter are the functions of technical analyses of resource problems, the adoption of design criteria and standards, plan synthesis, test and evaluation, administrative and financial analysis, and report preparation.

B. COMMITTEE STRUCTURE

It is recommended that two advisory committees be made integral parts of the organization for the planning program; i.e., the Fox River Watershed Committee and the Technical Advisory Committee on Natural Resources and Environmental Design. Both these committees are advisory to the SEWRPC and are presently organized and operative, their composition having been described in Chapter I of this Prospectus. The recommended purpose of each committee in relation to the watershed planning study follows:

1. Fox River Watershed Committee

The basic purpose of the Fox River Watershed Committee will be to actively involve the various governmental bodies, technical agencies, and private interest groups within the watershed in the planning process and to assist the SEWRPC in determining and coordinating basic policies involved in the conduct of the necessary studies and in the resultant plans and programs. This committee will have a particularly important role in the selection of the final plan and in assuring its financial and administrative feasibility. The committee will assist in familiarizing the local leadership within the watershed with the study and its findings and in generating understanding of basic objectives and implementation procedures.

It is recommended that the existing membership on this committee be retained but that the possibility of an expanded membership remain open as the study progresses.

2. Technical Advisory Committee on Natural Resources and Environmental Design

The basic purpose of the Technical Advisory Committee on Natural Resources and Environmental Design will be to place the experience, knowledge, and resources of the represented federal, state, and local agencies having active resource planning, development, and management programs within the Fox River watershed at the disposal of the study and to ensure that the planning and design criteria of these agencies are recognized and incorporated in the planning work. If the assistance of any of the

agencies concerned is to be obtained during the subsequent plan implementation stages, the active participation of this committee in the planning work and in the evaluation of the alternative plans will be essential.

It is recommended that the existing membership on this committee be retained for the purposes of the study.

As the Fox River Watershed planning program proceeds, the need for other advisory committees may become evident, especially in relation to plan implementation. In the event such need becomes evident, the Southeastern Wisconsin Regional Planning Commission could create any additional required committees and designate their role in the planning program.



CHAPTER VI BUDGET

COST ESTIMATES

Estimated study costs are set forth in Table 4, below, and are based upon the scope of work, time schedules, and study organization set forth in this Prospectus. The cost estimates presented for each major work element are based upon three independent cost estimates prepared by the staff of the SEWRPC, a private consulting firm, and a state or federal agency having experience and competence in the work element area.

In any consideration of these cost estimates, it must be recognized that precise cost estimates are impossible without a detailed study design. This is particularly true with respect to the analytical phases of the work since the depth and detail of analysis required becomes apparent only as the work progresses. Consequently, the cost estimates presented in Table 4 must be considered tentative with respect to allocation of total fund requirements among the various work elements; and changes in this allocation must be expected upon completion of a detailed study design. Overall study costs, however, should not vary greatly from that estimated.

Table 4

STUDY COST ESTIMATES

A. Study organization and detailed study design	\$ 2,500.00
B. Collection of basic planning and engineering data	
1. Mapping	
a. General base maps	3,900.00*
b. Aerial photography	8,600.00*
c. Flood hazard and land reservation maps	50,000.00
2. Surface water data inventory	35,800.00
3. Ground water basic data studies	40,000.00
4. Water quality investigations	50,000.00*
	24,400.00
5. Water use inventory	7,000.00
6. Soils capabilities investigation	91,000.00*
	1,000.00
7. Land use inventory	56,200.00*
	5,000.00
8. Economic and population base study	21,000.00*
	1,000.00

9. Fish, game, park, and recreation study	10,500.00*
	23,300.00
10. Public utilities inventory	6,500.00*
	1,000.00
11. Water law survey	2,500.00
Subtotal	441,200.00

C. Planning operations

1. Analysis of water resource problems, characteristics and capabilities	33,700.00
2. Analysis of population growth, land and water requirements	35,100.00
3. Adoption of design criteria and standards	4,000.00
4. Preparation, testing and public evaluation of alternative plans	40,200.00
5. Selection of final plan	5,100.00
6. Administration and financial analysis	5,900.00
7. Preparation of precise plans and plan effectuation devices	39,500.00
8. Publication of reports	25,000.00
Subtotal	188,500.00
Gross project costs, all items	629,700.00
Less work items to be furnished by SEWRPC at no direct cost to project	247,700.00
Net project costs, all items	\$382,000.00

*Work items to be accomplished by SEWRPC under other work programs and furnished at no direct cost to project.

COST ALLOCATIONS

In order to take advantage of the availability of federal funds for the planning work, it is recommended that the study be financed in part by an HHFA Section 701 planning grant. Study costs would under the provisions of such a planning grant be shared on a two-thirds - one-third basis by the federal government and local governments, respectively. Therefore, of the total estimated study cost of \$382,000.00, \$254,679.00 could be financed through federal assistance, leaving \$127,321.00 to be provided by the local units of government.

Consideration was given to three alternative methods of allocating the local costs: allocation to the respective counties on the basis of proportionate area within the watershed, allocation to the respective counties on the basis of approximate proportionate population within the watershed, and allocation to the respective counties on the basis of approximate proportionate 1963 state equalized assessed valuation within the watershed.

The third method was followed in the execution of the Root River Watershed Planning Program and is also recommended by the committee as representing the fairest distribution of local cost for the Fox River basin since it implicitly recognizes the extent of existing urban development subject to flood damage as well as the extent of the actual drainage area within the boundaries of each county concerned. This method is, moreover, consistent with the state legislation enabling regional planning to be carried on cooperatively by the local units of government within the state.

It is recommended, therefore, that the necessary matching local funds be provided by the several counties in which the Fox River watershed lies through the SEWRPC approximately proportionate to the relative 1963 state equalized assessed valuation within the watershed. Utilizing this method of local cost allocation in conjunction with an HHFA Section 701 planning grant would result in the total study cost allocations presented in Table 5, below. Local allocations are based upon the 1963 state equalized valuations, and actual contributions might change slightly from year to year as these valuations change.

Table 5

RECOMMENDED COST ALLOCATIONS--FOX RIVER WATERSHED STUDY

Agency	1st Year of Study	2nd Year of Study	3rd Year of Study	Total Amount	Percent
HHFA	\$ 84,893.00	\$ 84,893.00	\$ 84,893.00	\$254,679.00	66.67
Kenosha County	6,086.00	6,086.00	6,087.00	18,259.00	4.78
Milwaukee County	369.00	369.00	369.00	1,107.00	0.29
Racine County	11,715.00	11,715.00	11,715.00	35,145.00	9.20
Walworth County	6,430.00	6,430.00	6,430.00	19,290.00	5.05
Washington County	13.00	13.00	13.00	39.00	0.01
Waukesha County	17,827.00	17,827.00	17,827.00	53,481.00	14.00
Subtotal	\$ 42,440.00	\$ 42,440.00	\$ 42,441.00	\$127,321.00	33.33
Total	\$127,333.00	\$127,333.00	\$127,334.00	\$382,000.00	100.00



CHAPTER VII

CONCLUDING RECOMMENDATIONS

The Fox River Watershed Committee after careful study and consideration wishes to submit the following findings and recommendations to the Southeastern Wisconsin Regional Planning Commission:

A. Ten serious resource related problems presently face the local units of government within the Fox River watershed and require early solution if further deterioration of the environment is to be avoided:

1. Storm water drainage and flood control.
2. Deteriorating surface water quality and lake and stream pollution.
3. Irregular streamflow.
4. Soil erosion, lake, and stream siltation.
5. Changing land use, not only with respect to the stream channels and their floodways and flood plains, but also with respect to the basin as a whole.
6. Inadequate soil and water conservation and management practices.
7. Park and open space reservation.
8. Inadequate sewage and industrial waste disposal facilities, both private and public.
9. Water availability and use.
10. Deteriorating fish and wildlife habitat.

These problems are all closely interrelated and will be intensified as urbanization continues within the watershed. Particularly important is the close interrelationship existing between the water control facilities required within the basin and the land use pattern which these facilities must sustain and support. Storm water drainage and flood control facilities must form a single integrated system over the entire watershed capable of carrying both present and future runoff loadings, and design of these facilities must be properly related to water quality, adjacent land uses, recreation and public open space requirements.



An increasing number of urbanites are becoming year-round residents around the streams and lakes within the watershed, not only because of the varied year-round recreational opportunities offered by these streams and lakes, but also because of the desirable esthetic qualities and feeling of open space which water lends to residential development. Unfortunately, past unplanned development around lakes and streams has greatly aggravated problems of water pollution and flooding within the basin. From the headwaters of the Fox to the Wisconsin state line, on riverbanks and on lake shore, man is destroying the very resource he so eagerly seeks.

- B. Solutions to these resource related problems require the preparation of a comprehensive watershed plan based upon factual information on overall potential needs as well as upon the major determinants of such needs. Such a comprehensive watershed plan to be practical and workable must be cooperatively prepared and adopted and jointly implemented by all of the units of government operating within the watershed.
- C. Preparation of the necessary comprehensive watershed plan is technologically feasible. Although the area recommended to be included in such a comprehensive plan includes only that part of the total Fox River basin lying north of the Illinois-Wisconsin state line, the preparation of a comprehensive plan for this portion of the basin is nevertheless technologically sound since it includes all of the headwater portions of the basin.
- D. The preparation of the necessary comprehensive watershed plan is financially feasible with federal assistance secured under the terms of the Federal Housing Act of 1961.

The committee, therefore, recommends that a comprehensive watershed planning program be established for the Fox River watershed in southeastern Wisconsin at the earliest possible date and that the scope, techniques, time sequence, staff and committee structure, and cost allocations for such a study all be as recommended in this Prospectus.

The committee respectfully urges the Southeastern Wisconsin Regional Planning Commission to give careful consideration to this Prospectus, to act favorably thereon, and to initiate the necessary planning program as quickly as possible.

Respectfully submitted,

Fox River Watershed Committee
25 August 1964

FOX RIVER WATERSHED COMMITTEE

*William D. Rogan, Chairman
*Harold A. McMiller, Vice-Chairman

*Lester Hoganson, Vice-Chairman

*Paul G. Jaeger, Secretary

K. W. Bauer

Jack Beardsley

Henry W. Beyer

*Mervin L. Brandt

Karl Davidson

Walter E. Dick

Robert L. Frank

*Clifford E. Germain

H. Copeland Greene

*Howard C. Hass

McKinley Hodge

Eugene Hollister

V. H. Holtdorf

Stanley W. Ihlenfeldt

John E. Jones

*Fortney Larson

Elwin G. Leet

Paul Lohaus

Charles P. Maier

John H. Mielke

Kenneth Mitchell

Bauer Mohr

*Benjamin F. Richason

Phil Sander

George L. Schlitz

*Al Stivarius

Theodore Vogel

*Franklin Walsh

Franklin Wirth

John Zillmer

Waukesha County Agricultural Agent
Executive Director, Waukesha County
Park and Planning Commission

SEWRPC Commissioner

Kenosha County Agricultural Agent

Executive Director, SEWRPC

Chairman, Town of Waterford

Zoning Administrator, Racine County

SEWRPC Commissioner

Society of American Foresters

Director of Public Works, City of
Waukesha

Lake Geneva, Wisconsin

Wisconsin Conservation Department

Genesee Depot, Wisconsin

Area Conservationist, Soil Conservation
Service

Lake Geneva Property Owners
Association

SEWRPC Commissioner

Supervisor, Village of Silver Lake

Walworth County Agricultural Agent

Chairman, Town of Genesee

Waukesha County

Racine County Agricultural Agent

Chairman, Fox River Flood Control
Committee, Burlington

Mayor, Village of East Troy

Ruekert & Mielke, Inc., Waukesha

Zoning Supervisor, Walworth County

Rochester, Wisconsin

Professor, Department of Geography,
Carroll College

S. E. Wisconsin Sportsmen's Federation

SEWRPC Commissioner

Wisconsin State Board of Health

Chenequa, Wisconsin

Walworth County Board Supervisor

Mayor, City of Brookfield

Ice Age Park & Trail Foundation

*Members of the Fox River Watershed Steering Committee which also included the following:

Louis D'Alba

Cyril Kabat

O. J. Muegge

William Russell

Theodore F. Wisniewski

District Engineer, U. S. Corps of
Engineers, Chicago, Illinois

Wisconsin Conservation Department,
Madison

State Board of Health, Madison

Soil Conservation Service, Madison

Director, State Committee on
Water Pollution

Graduate Research Center
Dept. of Urban & Regional Planning
The University of Wisconsin-Madison



STAFF

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

Old Courthouse
P. O. Box 769

Waukesha, Wisconsin
53187

Kurt W. Bauer Executive Director

Central Office

William J. Kockelman Chief Community Assistance Planner

Edgar A. Imhoff Chief Natural Resources Planner

Dallas R. Behnke Chief Planning Illustrator

Land Use-Transportation Study Office

J. Robert Doughty Study Director

Richard B. Sheridan Chief Transportation Planner

Harlan E. Clinkenbeard Chief Land Use Planner

Kenneth J. Schlager Chief Systems Engineer

Sheldon W. Sullivan Administrative Officer

Wade G. Fox Cartography and Design Supervisor

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Professor Benjamin Richason, Carroll College
Waukesha Freeman



COMMISSION OFFICE
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