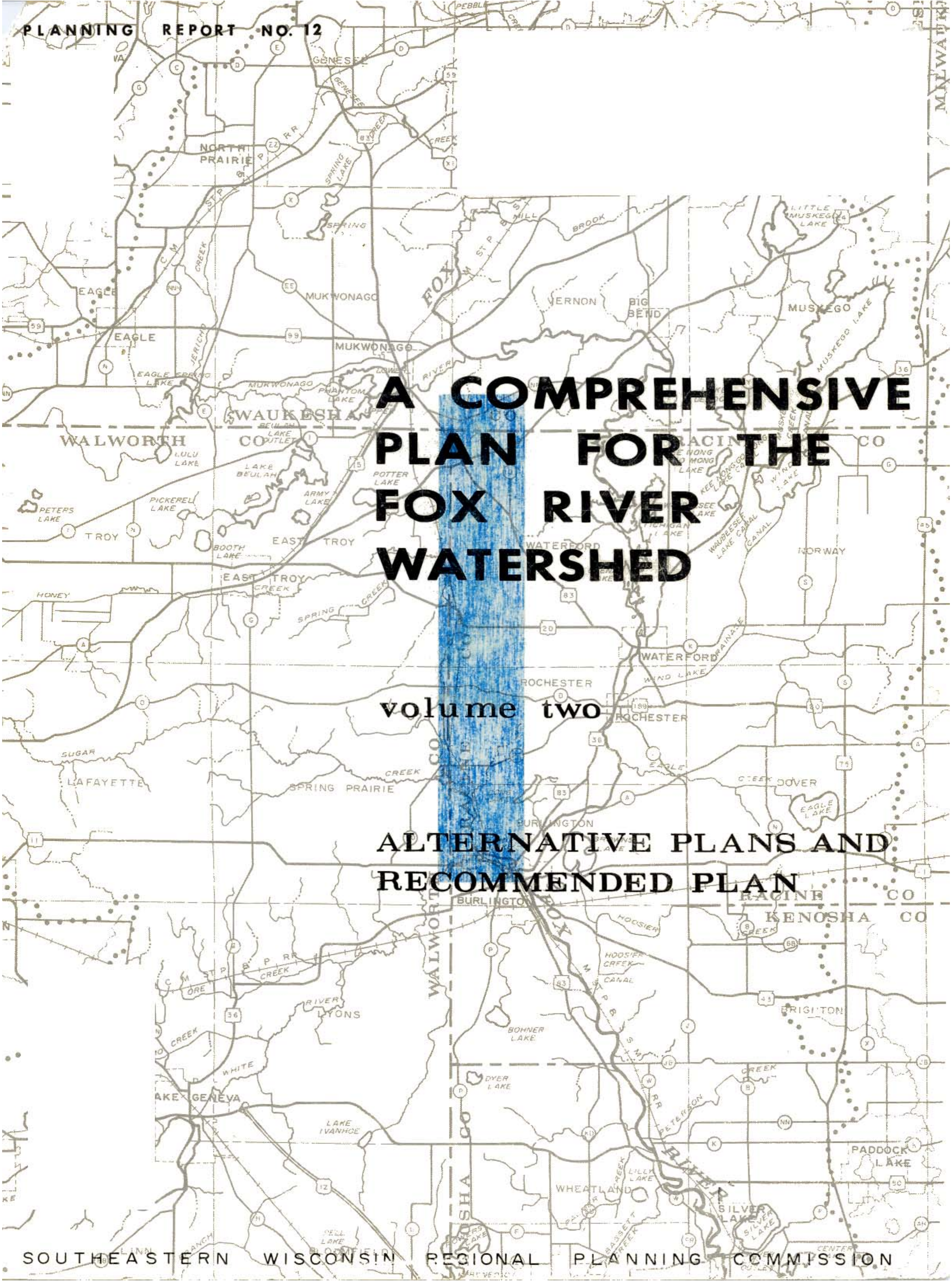
PLANNING REPORT NO. 12



A COMPREHENSIVE PLAN FOR THE FOX RIVER WATERSHED

volume two

ALTERNATIVE PLANS AND RECOMMENDED PLAN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

PLANNING REPORT

NUMBER 12

volume two

A COMPREHENSIVE PLAN FOR THE FOX RIVER WATERSHED

ALTERNATIVE PLANS AND RECOMMENDED PLAN

Southeastern Wisconsin Regional Planning Commission
Fox River Watershed Study
Old Courthouse
Waukesha, Wisconsin
53186

The preparation of this report was financed in part through an urban planning grant from the Department of Housing and Urban Development, under the provisions of Section 701 of the Housing Act of 1954, as amended.

February 1970

Inside Region	$10.00
Outside Region	$15.00

(This page intentionally left blank)

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

916 NO. EAST AVENUE • WAUKESHA, WISCONSIN 53186 • TELEPHONE (414) 547-6721

Serving the Counties of: KENOSHA
MILWAUKEE
OZAUKEE
RACINE
WALWORTH
WASHINGTON
WAUKESHA

February 22, 1970

STATEMENT OF THE CHAIRMAN

In January of 1966 the Commission began a four-year comprehensive study of the Fox River watershed in southeastern Wisconsin. Its purpose, as set forth in the Fox River Watershed Prospectus, was to prepare a comprehensive plan for the physical development of the watershed designed to assist the federal, state, and local units of government concerned in solving the serious problems of flooding, water pollution, and changing land use which exist within the watershed.

In April of 1969 the Commission published the first volume of the two-volume final planning report on the watershed study. That first volume presented a summary of the factual findings of the planning and engineering inventories conducted under the study; identified and, to the extent possible, quantified the land and water resource-related problems of the watershed; and presented pertinent forecasts of anticipated growth and change within the watershed. The inventories and forecasts set forth in the first volume provided the basis for the preparation of alternative watershed plan elements and for the selection of a recommended comprehensive watershed plan from among these alternative elements.

This, the second and final volume of the planning report, presents the alternative land use, resource conservation, park and outdoor recreation, flood control, stream and lake water pollution abatement, and water supply plan elements considered; describes the recommended comprehensive plan for the watershed; and sets forth detailed recommendations on the means for carrying out the plan.

The recommended comprehensive Fox River watershed plan, as set forth herein was, after careful review and approval by the Fox River Watershed Committee, presented for public review and reaction at a series of seven informational meetings and four public hearings held throughout the watershed. These informational meetings and public hearings were well attended by over 600 state, county, and local public officials and by concerned citizens from throughout the watershed; and the reaction was largely favorable.

The recommended watershed plan set forth in this volume represents another element in the evolving framework of plans prepared by the Commission, pursuant to its statutory charge to prepare a comprehensive plan for the physical development of the Southeastern Wisconsin Region. As true of all of the Commission's work, the Fox River watershed plan is entirely advisory to the local, state, and federal units of government concerned. The recommended plan elements and implementation devices set forth in this report are, therefore, intended to provide an advisory point of departure against which watershed development proposals can be evaluated as they arise on a day-to-day basis.

Upon formal adoption of the final watershed plan by this Commission, an official copy thereof will be transmitted to all affected local, state, and federal units and agencies of government concerned, with a request for their consideration and formal adoption and appropriate implementing action. Plan implementation must necessarily be through the cooperative action of all of the governmental units and agencies operating within the watershed, with heavy emphasis, however, upon the role of the county and state levels of government.

In its continuing role of acting as a center for the coordination of planning and plan implementation activities within the Region, the Commission stands ready to provide such assistance as may be requested of it to the various units and agencies of government concerned in implementation of the Fox River watershed plan.

Respectfully submitted,

George Berteau

George C. Berteau
Chairman

(This page intentionally left blank)

TABLE OF CONTENTS

LIST OF APPENDICES

Page

Page

Page

Page

Page

LIST OF TABLES

Chapter VI

Chapter VII

Chapter VIII

LIST OF FIGURES

LIST OF MAPS

Chapter I

INTRODUCTION

This report is the second in a series of two volumes, which together present the major findings and recommendations of the Southeastern Wisconsin Regional Planning Commission Fox River watershed planning program. The first volume, published in August 1969, sets forth the basic principles and concepts underlying the study and presents in summary form the basic facts pertinent to the preparation of a comprehensive plan for the physical development of the Fox River watershed, with particular emphasis upon the existing state of the land and water resources of the basin and the developmental and environmental problems associated with these resources. The first volume also contains forecasts of anticipated future growth and change within the watershed and an analysis of water law as such law relates to watershed plan preparation and implementation, with particular emphasis upon flood control and pollution abatement.

This, the second and final volume of the series, sets forth watershed development objectives, principles, and standards; presents alternative plans for land use and water control facility development and for resource preservation and enhancement within the watershed; and recommends a comprehensive watershed development plan designed to meet the watershed development objectives under existing and probable future conditions. It proposes staging for water control facility development and recommends means for plan implementation. In addition, this volume also presents a comparative analysis of the changes which may be expected to occur within the watershed by 1990 if present development trends continue without redirection in the public interest. This alternative is presented not as a plan to be used to guide development within the watershed but, rather, as a forecast of unplanned development and is intended to be used as a standard of comparison for the evaluation of the recommended watershed development plan.

The recommended watershed development plan presented in this volume is the end result of a seven-step planning process developed by the Commission by which the principal functional relationships existing within the watershed can be accurately described, both graphically and numerically; the hydrologic and hydraulic characteristics of the watershed simulated; and the effect of different courses of action, with respect to land use and water control facility development, evaluated. The seven steps involved in this planning process are: 1) study design, 2) formulation of objectives and standards, 3) inventory, 4) analysis and forecast, 5) plan design, 6) plan test and evaluation, and 7) plan selection and adoption. Volume 1 of this report dealt with the first, third, and fourth steps in this planning process. This volume deals with the remaining four steps: formulation of objectives and standards, plan design, plan test and evaluation, and plan selection and adoption. Plan implementation, although beyond the initial planning process, has been considered throughout the process; and this volume contains specific recommendations for plan implementation.

A brief description of each of the seven steps comprising the planning process is contained in Chapter II, Volume 1, of this report, together with the basic principles and concepts underlying the watershed planning process and the watershed as a rational planning unit. Reconsideration of, and elaboration on, the four steps in the planning process with which this volume are concerned is warranted here.

FORMULATION OF OBJECTIVES AND STANDARDS

It was noted in Volume 1 of this report that planning is a rational process for formulating and meeting objectives; and, therefore, the formulation of objectives is an essential task which must be undertaken before plans can be prepared. The objectives chosen guide the preparation of alternative plans and, when converted to standards, provide the criteria for evaluating and selecting from among the alternatives. Since objectives provide the logical basis for plan synthesis, the formulation of sound objectives is a crucial step in the planning process. Yet, the process of formulating objectives has received relatively little attention in most planning operations. The lack of a comprehensive and tested approach to the problem of formulating objectives, however, provides no valid excuse for neglecting this fundamental task.

It is important to recognize that, because the formulation of objectives involves a formal definition of a desirable physical system by listing, in effect, the broad needs which the system aims to satisfy, the objectives implicitly reflect an underlying value system. Thus, every physical development plan is accompanied by its own unique value system. The diverse nature of value systems in a complex urban society complicates the process of goal formulation and makes it one of the most difficult tasks of the planning process. This difficulty relates, in part, to the lack of a clear-cut basis for a choice between value systems and, in part, to the reluctance of public officials to make an explicit choice of ultimate goals. Yet, it is even more important to choose the "right" objectives than to choose the "right" plan. To choose the wrong objectives is to solve the wrong problem; to choose the wrong plan is merely to choose a less efficient physical system. While, because of differing value systems, there may be no single argument to support a given choice of objectives, it is possible to state certain planning principles which provide at least some support for the choice; and this has been done herein.

Objectives cannot be intelligently chosen without knowledge of the crucial relationships existing between objectives and means. This suggests that the formulation of objectives is best done by people with prior knowledge of the social, economic, and technical means of achieving the objectives, as well as of the underlying value systems. Even so, it must be recognized that the objectives may change as a selection is attempted from among alternative means or plans. In the process of evaluating alternative plans, the various alternative plan proposals are ranked according to ability to meet objectives. If the best plan so identified nevertheless falls short of the chosen objectives, either a better plan must be synthesized or the objectives must be compromised. The plan evaluation provides the basis for deciding which objectives to compromise. The compromises may take three forms: certain objectives may be dropped because their satisfaction has been proven unrealistic; new objectives may be suggested; or conflicts between inconsistent objectives may be balanced out. Thus, formulation of objectives must proceed hand in hand with plan design and plan implementation as a part of a continuing planning process.

Concern for objectives cannot end with a mere listing of desired goals. The goals must be related in a demonstrable and, wherever possible, quantifiable manner to physical development proposals. Only through such a relationship can alternative development proposals be properly evaluated. This relationship is accomplished through a set of supporting standards for each chosen objective.

Because of the value judgments inherent in any set of development objectives and their supporting standards, soundly conceived watershed development objectives, like regional development objectives, should incorporate the combined knowledge of many people who are informed about the watershed and should be established by duly elected or appointed representatives legally assigned this responsibility rather than by planning and engineering technicians. Active participation by duly elected or appointed public officials and by citizen leaders in the regional planning program is implicit in the structure and organization of the Regional Planning Commission itself. Moreover, the Commission has provided for the establishment of advisory committees to assist it in the conduct of the regional planning program, including the necessary watershed planning studies, and to broaden the opportunities for active participation in the regional planning effort.

The use of these advisory committees appears to be the most practical and effective procedure available for involving officials, technicians, and citizens in the regional planning process and of openly arriving at decisions and action programs which can shape the future physical development of the Region and its component watersheds. Only by combining the accumulated knowledge and experience which the various advisory committee members possess can a meaningful expression of desired direction, magnitude, and quality of future regional and watershed development be attained. One of the major tasks of these advisory committees, therefore, is to assist the Commission in the formulation of development objectives, supporting principles, and standards. This chapter sets forth the watershed planning objectives, principles, and standards which have been adopted by the Commission after careful review and recommendation by the advisory committees concerned.

PLAN DESIGN

It was noted in Volume 1 of this report that plan synthesis, or design, forms the heart of the planning process and that the watershed plan design problem consists essentially of determining the allocation of scarce resources—land and water—between competing and often conflicting demands. This allocation must be accomplished so as to satisfy the aggregate needs for each use and comply with the design standards derived from the plan objectives, all at a feasible cost.

The task of designing two of the major components of an environment for life—the land use pattern and the water control facility system of a watershed—is a most complex and difficult problem. Not only does each component constitute in itself a major problem in terms of the sheer size of the system to be designed but the pattern of interaction between the components is also exceedingly complex and constantly changing. The land use pattern must enable people to live in close cooperation and yet freely pursue an enormous variety of interests. It must minimize conflicts between population growth and limited land and water resources; maintain an ecological balance of human, animal, and plant life; and avoid gross public health and welfare problems. The water control facilities must be able to carry the flood and pollution loadings generated by the land use pattern, meeting agreed-upon water use objectives, while recognizing the use of existing facilities and minimizing overall costs.

The magnitude of such a design problem nearly reaches an almost insoluble level of complexity; yet, no substitute for intuition in plan design has so far been found, much less developed to a practical level. Means do exist, however, for reducing the gap between the necessary intuitive and integrative grasp of the problem and its growing magnitude; and these have been fully applied in the Fox River watershed study. These means center primarily on the application of systems engineering techniques to the quantitative test of both the land use and water facility plans, as described below under the plan test and evaluation phase. Yet, the quantitative tests involved in these techniques, while powerful aids to the determination of the adequacy of the plan design, are of strictly limited usefulness in actual plan synthesis. Consequently, it is still necessary to develop both the land use and water facility plans by traditional graphic and analytical "cut-and-try" methods, then to quantitatively test the resulting design by application of simulation model techniques where applicable, and then make necessary adjustments in the design until a workable plan has been evolved.

Finally, and most importantly, it should be noted that, in both land use and water facility plan synthesis, the Commission had at its disposal far more definitive information bearing on the problem than has ever before been available; and this fact alone has made the traditional plan synthesis techniques applied far more powerful and useful.

PLAN TEST AND EVALUATION

It was noted in Volume 1 of this report that, if the plans developed in the design stage of the planning process are to be practical and workable and thereby realized in terms of actual land use and water control facility system development, some measures must be applied to quantitatively test the feasibility of alternative plans in advance of their adoption and implementation. Several levels of review and evaluation may be involved, including engineering performance, technical feasibility, economic feasibility, legality, and political reaction. Devices used to test and evaluate alternative plans range from mathematical models used to simulate river performance through interagency meetings and public hearings. To assist in a quantitative analysis of the engineering performance and the technical and economic feasibility of alternative plan elements, flood flow and water quality simulation models were developed and applied in the study. Test and evaluation, beyond the quantitative analyses permitted by the model application, involved qualitative evaluation of the degree to which each alternative land use or water control facility plan element met development objectives and standards and of the legal feasibility of the alternatives.

PLAN SELECTION AND ADOPTION

It was also noted in Volume 1 of this report that the general approach contemplated for the selection of one plan from among the alternatives considered was to proceed through the use of the Fox River Watershed Committee structure, interagency meetings, and hearings to a final decision and plan adoption by the Commission, in accordance with the provisions of the state enabling legislation. Because plan selection and adoption necessarily involve both technical and nontechnical policy determinations, they must be founded in the active involvement throughout the entire planning process of the various governmental bodies, technical agencies, and private interest groups concerned with watershed development. Such involvement is particularly important in light of the advisory role of the Commission in shaping regional development. The use of advisory committees and both formal and informal hearings appears to be the most practical and effective procedure available for involving public officials, technicians, and citizens in the planning process and of openly arriving at agreement among the affected governmental bodies and agencies on objectives and on plans which can be jointly implemented.

The preparation of a recommended comprehensive plan for the Fox River watershed required that a selection be made from among the alternative elements which together should comprise the comprehensive plan, including a land use base and necessary supporting water control and pollution abatement facilities. Such a selection must be based upon consideration of many tangible and intangible factors but should be focused primarily upon the degree to which the agreed-upon watershed development objectives are satisfied and upon the accompanying costs. The selection of the plan elements to be included in the final plan must ultimately be made by the responsible elected and appointed public officials concerned and not by the planning technicians, although the latter may properly make recommendations based upon evaluation of technical considerations.

In order to facilitate the necessary involvement of the responsible public officials, a series of both informal informational meetings and formal public hearings was held within the watershed before the governing bodies and interested elected and appointed governmental officials and citizen groups for the specific purpose of obtaining the reaction of the governing bodies concerned to the alternative plan elements and preliminary comprehensive plan recommendations. A summary of the inventory, analysis, and forecast findings; of the watershed development objectives; of the alternative land use and water control facilities considered; and of the recommended comprehensive watershed plan was presented at each of the meetings and hearings, together with data on the costs and means for implementation of the recommended plan. The public hearings were held as set forth below, and complete minutes of the hearings are on file in the Commission Offices.

Informational Meetings

Presiding Agency	Place of Meeting	Date of Meeting
Waukesha County Extension Service	City Hall Brookfield, Wisconsin	January 19, 1970 7:30 p.m. - 10:30 p.m.
Racine County Extension Service	Burlington Junior High School Burlington, Wisconsin	January 20, 1970 7:30 p.m. - 10:00 p.m.
Kenosha County Extension Service	Village Hall Silver Lake, Wisconsin	January 21, 1970 7:30 p.m. - 10:00 p.m.
Waukesha County Extension Service	Waukesha County Courthouse Waukesha, Wisconsin	January 22, 1970 7:30 p.m. - 10:00 p.m.
Racine County Extension Service	Waterford High School Waterford, Wisconsin	January 26, 1970 7:30 p.m. - 10:30 p.m.
Walworth County Extension Service	East Troy High School East Troy, Wisconsin	January 27, 1970 7:30 p.m. - 10:00 p.m.
Walworth County Extension Service	Badger High School Lake Geneva, Wisconsin	January 28, 1970 7:30 p.m. - 10:30 p.m.

Public Hearings

Presiding Agency	Place of Meeting	Date of Meeting
SEWRPC Fox River Watershed Committee	Walworth County Courthouse Elkhorn, Wisconsin	February 16, 1970 7:30 p.m. - 10:30 p.m.
SEWRPC Fox River Watershed Committee	Burlington Junior High School Burlington, Wisconsin	February 17, 1970 7:30 p.m. - 10:30 p.m.
SEWRPC Fox River Watershed Committee	Waukesha County Courthouse Waukesha, Wisconsin	February 18, 1970 7:30 p.m. - 10:00 p.m.
SEWRPC Fox River Watershed Committee	Riverview Elementary School Silver Lake, Wisconsin	February 19, 1970 7:30 p.m. - 10:30 p.m.

It is important to note here that the reaction to the recommended plan, as herein set forth at the hearings, was generally favorable. The final plan recommended herein, therefore, does not depart in any significant way from the preliminary plan presented at the hearings and approved by the Advisory Committees after careful review and deliberation.

(This page intentionally left blank)

Chapter II

WATERSHED DEVELOPMENT OBJECTIVES, PRINCIPLES, AND STANDARDS

BASIC CONCEPTS AND DEFINITIONS

The term "objective" is subject to a wide range of interpretation and application and is closely linked to other terms often used in planning work which are equally subject to a wide range of interpretation and application. The following definitions have, therefore, been adopted by the Commission in order to provide a common frame of reference:

1. Objective; a goal or end toward the attainment of which plans and policies are directed.

2. Principle; a fundamental, primary, or generally accepted tenet used to support objectives and prepare standards and plans.

3. Standard; a criterion used as a basis of comparison to determine the adequacy of plan proposals to attain objectives.

4. Plan; a design which seeks to achieve agreed-upon objectives.

5. Policy; a rule or course of action used to ensure plan implementation.

6. Program; a coordinated series of policies and actions to carry out a plan.

Although this chapter deals only with the first three of these terms, an understanding of the interrelationship between the foregoing definitions and the basic concepts which they represent is essential to any consideration of watershed development objectives, principles, and standards.

WATERSHED DEVELOPMENT OBJECTIVES

Objectives, in order to be useful in the watershed planning process, must not only be sound logically and related in a demonstrable and measurable way to alternative physical development proposals but must also be consistent with, and grow out of, region-wide development objectives. This is essential if the watershed plans are to comprise integral elements of a comprehensive plan for the physical development of the Region and if sound coordination of regional and watershed development is to be achieved.

The Southeastern Wisconsin Regional Planning Commission has, in its planning efforts to date, adopted, after careful review and recommendation by various advisory and coordinating committees, nine general regional development objectives, eight specific regional land use development objectives, and seven specific regional transportation system development objectives. These, together with their supporting principles and standards, are set forth in SEWRPC Planning Report No. 7, Volume 2. Certain of these specific regional development objectives relating to land use are directly applicable to the watershed planning effort and are hereby recommended for adoption as development objectives for the Fox River watershed. These are:

1. A balanced allocation of space to the various land use categories which meets the social, physical, and economic needs of the regional population.

2. A spatial distribution of the various land uses which will result in the protection, wise use, and development of the natural resources of the Region—soils, inland lakes and streams, wetlands, woodlands, and wildlife.

3. A spatial distribution of the various land uses which is properly related to the supporting transportation, utility, and public facility systems in order to assure the economical provision of transportation, utility, and public facility services.

4. The preservation and provision of open space to enhance the total quality of the regional environment, maximize essential natural resource availability, give form and structure to urban development, and facilitate the ultimate attainment of a balanced year-round outdoor recreational program providing a full range of facilities for all age groups.

5. The preservation of land areas for agricultural uses in order to provide for certain special types of agriculture, provide a

reserve for future needs, and ensure the preservation of those rural areas which provide wildlife habitat and are essential to shape and order urban development.

In addition to the foregoing specific regional land use development objectives, the following specific land use development objective is recommended for adoption as an additional development objective for the Fox River watershed:

6. Good soil and water conservation practices to reduce storm water runoff, soil erosion, and stream sedimentation and pollution.

The following specific water control facility development objectives are also recommended:

1. An integrated system of drainage and flood control facilities which will effectively reduce flood damage to existing land uses and promote the implementation of the watershed land use plan, meeting the anticipated runoff loadings generated by the proposed, as well as by existing, land uses.

2. An integrated system of land management and water quality control facilities and pollution abatement devices adequate to ensure the quality of stream and lake water necessary to permit the water uses set forth in Table 1.

Complementing each of the foregoing specific land use and water control facility development objectives is a planning principle and a set of planning standards. These, as they apply to watershed planning and development, are set forth in Tables 1 and 2 and serve to facilitate quantitative application of the objectives in plan design, test, and evaluation.

It should be noted that the planning standards herein adopted fall into two groups: comparative and absolute. The comparative standards by their very nature can be applied only through a comparison of alternative plan proposals. Absolute standards can be applied individually to each alternative plan proposal since they are expressed in terms of maximum, minimum, or desirable values. The standards set forth herein should serve not only as aids in the development, test, and evaluation of watershed land use and water control facility plans but also in the development, test, and evaluation of local land use and community facility plans and in the development of plan implementation policies and programs as well.

The foregoing watershed development objectives and their supporting principles and standards necessarily reflect certain value judgments by experienced public officials and technicians within the Region and the watershed. In addition, certain engineering design criteria were utilized in the preparation of the watershed plans; and while these are firmly based in present engineering practice, it was, nevertheless, felt important to document these herein. It should be noted that, while these criteria were used in the preparation of the watershed plans, they do not comprise standards as defined herein in that they relate to the methods used in inventory, analysis, and plan synthesis and test, rather than to specific development objectives.

Table I

WATER CONTROL FACILITY DEVELOPEMENT OBJECTIVES, PRINCIPLES, AND STANDARDS FOR THE FOX RIVER WATERSHED

OBJECTIVE NO. 1

An integrated system of drainage and flood control facilities which will effectively reduce flood damage under the existing land use pattern of the watershed and promote the implementation of the watershed land use plan, meeting the anticipated runoff loadings generated by the existing and proposed land uses.

PRINCIPLE

Reliable local municipal storm water drainage facilities cannot be properly planned, designed, or constructed except as integral parts of an areawide system of floodwater conveyance and storage facilities centered on major drainageways and perennial waterways designed so that the hydraulic capacity of each waterway opening and channel reach abets the common aim of providing for the storage, as well as the movement, of floodwaters. Not only does the land use pattern of the tributary drainage area affect the required hydraulic capacity but the effectiveness of the floodwater conveyance and storage facilities also affects the uses to which land within the tributary watershed, and particularly within the riverine areas of the watershed, may properly be put.

STANDARDS

1. The waterway opening on all existing bridges and culverts over major drainageways and perennial waterways shall be adequate to accommodate the following hydraulic loadings without causing overtopping of the directly related road surface and resultant disruption of traffic by floodwaters:

a. Minor streets used or intended to be used primarily for access to abutting properties: a 10-year recurrence interval flood flow.

b. Arterial streets and highways, other than freeways and expressways, used or intended to be used primarily for fast or heavy through traffic: a 50-year recurrence interval flood flow.

c. Freeways and expressways: a 100-year recurrence interval flood flow.

d. Railroads: a 100-year recurrence interval flood flow.

2. The waterway openings on all new bridges and culverts over major drainageways and perennial waterways shall meet the applicable foregoing standards, providing, however, a minimum freeboard between the specified recurrence interval peak floodwater surface elevation and the high point of the waterway opening of the bridge or culvert. The maximum headloss for new structures only shall not exceed 0.5 foot.

The replacement of any existing structure shall be designed in such a manner that the water surface elevation through the replacement structure will not exceed the water surface elevation of the existing structure while passing the 100-year recurrence interval flood flow.

3. The structural type of waterway opening for all bridges over major drainageways and perennial waterways shall be such as to maximize the passage of ice floes and other floating debris often associated with significant backwater effects and flood damage; and in selection of the structural bridge type, it should be recognized that clear spans and rectangular openings are more efficient than interrupted spans and curvilinear openings in allowing passage of ice floes and debris.

4. Channel improvements, levees, and floodwalls should be restricted to the minimum number and extent absolutely necessary for the protection of existing and proposed land use development, which development is consistent with the land use element of the comprehensive watershed plan, and any such improvements which may significantly increase upstream or downstream peak flood discharges should be used only in conjunction with complementary facilities for the storage and movement of the incremental floodwaters through downstream reaches. The height of levees and floodwalls shall be based on the high water surface profiles for the 100-year recurrence interval flood prepared under the comprehensive watershed study and shall be capable of passing the 100-year recurrence interval flood with a freeboard of two feet. Channel improvements, levees, or floodwalls shall not increase the height of the 100-year recurrence interval flood by more than one-half foot in any unprotected upstream or downstream stream reaches. Increases in flood stages in excess of one-half foot resulting from any channel, levee, or floodwall improvement shall be contained within the upstream or downstream extent of the channel, levee, or floodwall improvement.

The construction of channel improvements, levees, or floodwalls shall be deemed to change the limits and extent of the associated floodways and floodplains. However, no such change in the extent of the associated floodways and floodplains shall become effective for the purposes of land use regulation until such time as the channel improvements, levees, or floodwalls are actually constructed and operative. Any development in a former floodway or floodplain located to the landward side of any levee or floodwall shall be provided with adequate drainage so as to avoid ponding and associated damages.

5. All water control facilities on major drainageways and perennial waterways other than bridges and culverts, such as dams and diversion channels, shall be adequate to accommodate the hydraulic loadings resulting from a 100-year recurrence interval flood. Any reduced regulatory flood protection elevations and accompanying reduced floodway or floodplain areas resulting from any proposed dams or diversion channels shall not become effective for the purposes of land use regulation until the reservoir or channels are actually constructed and operative. For dams in which the product of the height in feet and the storage in acre-feet at the flood pool elevation exceeds 3,000, the following modifications to the hydraulic design loadings are recommended:

a. For structures located in rural or agricultural areas, where failure will damage only farm buildings, agricultural land, and rural roads, the structure shall be adequate to accommodate the hydraulic loadings resulting from a design rainfall equal to the 100-year recurrence rainfall plus 0.1 (probable maximum rainfall[a] minus the 100-year recurrence rainfall).

b. For structures located in predominantly rural or agricultural areas, where failure will damage isolated homes, main highways, or minor railroads or cause interruption of use or service of relatively important public utilities, the structure shall be adequate to accommodate the hydraulic loadings resulting from a design rainfall equal to the 100-year rainfall plus 0.4 (probable maximum rainfall minus the 100-year recurrence rainfall).

c. For structures located where failure will cause loss of life, serious damage to homes, industrial and commercial buildings, important public utilities, main highways, or railroads, the structure shall be adequate to accommodate the hydraulic loadings resulting from a design rainfall equal to the probable maximum rainfall.

6. All public land acquisitions intended to eliminate the need for water control facilities shall encompass at least all of the riverine areas lying within the 100-year recurrence interval flood inundation line.

OBJECTIVE NO. 2

An integrated system of land management and water quality control facilities and pollution abatement devices adequate to ensure a quality of stream water permitting the following beneficial water uses in each of the following reaches of the stream system:

The Fox River from a point five miles downstream from the Waukesha Sewage Treatment Plant outfall line to the Illinois State line shall have a level of water quality suitable for the following uses:[b]

a. Minimum standards

b. Fish and other aquatic life

c. Recreational use

d. Industrial and cooling water use

The Fox River from a point five miles downstream from the Waukesha Sewage Treatment Plant outfall line to the Barstow Street Dam in the City of Waukesha:

a. Minimum standards

b. Industrial and cooling water use

The Fox River upstream from the Barstow Street Dam in the City of Waukesha:

a. Minimum standards

b. Fish and other aquatic life

c. Recreational use--partial-body-contact recreational uses only

The following major tributaries of the Fox River shall have a level of water quality suitable for the following water uses:

Bassett Creek
Beulah Lake Outlet
Brandy Brook
Como Creek
Deer Creek
Eagle Creek
Genesee Creek
Hoosier Creek
Jericho Creek
Kee Nong Go Mong Lake Canal
Mill Creek
Mukwonago River
Ore Creek
Pebble Brook
Pebble Creek
Peterson Creek
Poplar Creek
Silver Lake Outlet
Spring Lake Outlet
Sugar Creek
Waubeesee Drainage Canal
White River
Wind Lake Canal

a. Minimum standards

b. Recreational use

c. Fish and other aquatic life

The following major tributaries of the Fox River: Nippersink Creek, Muskego Canal, and Pewaukee River, shall have a level of water quality suitable for the following water uses:

a. Minimum standards

b. Recreational use--partial-body-contact recreational uses

c. Fish and other aquatic life

The remaining two streams tributary to the Fox River shall have a level of water quality suitable for the following water uses:

1. Honey Creek

    a. Minimum standards

    b. Fish and other aquatic life

    c. Recreational use

    d. Industrial and cooling use

2. Sussex Creek

    a. Minimum standards

    b. Recreational use--partial-body-contact only

PRINCIPLE

Surface water is one of the most valuable resources of southeastern Wisconsin; and even under the effects of increasing population and economic activity levels, the potential of natural stream waters to serve a reasonable variety of beneficial uses, in addition to the single-purpose function of waste transport and assimilation, should be protected and preserved.

STANDARDS

1. Water quality levels in a stream reach shall be adequate to meet the State of Wisconsin water quality standards[c] for all water uses designated for that reach.

2. Regardless of the water uses designated for a stream reach, all reaches of all streams shall meet at least the minimum stream water quality standards set forth in the State of Wisconsin water quality standards.

3. All urban residential development, except single-family residences on lots of five acres or more in area and located on soils rated in the regional detailed operational soil survey as suitable for use of soil absorption sewage disposal systems, shall be served by public sanitary sewerage facilities conveying liquid wastes to a sewage treatment plant that provides a degree of treatment before discharge adequate to meet the stated water use objectives for the stream reach involved.

OBJECTIVE NO. 3

An integrated system of land management and water control facilities and pollution abatement devices adequate to ensure a quality of lake water necessary to permit the following beneficial water uses in each of the following lakes:

For Echo, Long, North, Silver (Walworth County), and Peters Lakes:[d]

a. Minimum standards

b. Recreational use--partial-body-contact recreational uses only

c. Fish and aquatic life

d. Wildlife watering

For Eagle, Tichigan, Wind, Eagle Spring, and Big Muskego Lakes:

a. Minimum standards

b. Recreational use--full- or partial-body-contact recreational uses

c. Fish and aquatic life

d. Wildlife watering

The use of these lakes for full-body-contact recreation is subject to the financial feasibility of attaining the higher level of water quality required.

For all 35 other lakes within the watershed having a surface area of 50 acres or more:

a. Minimum standards

b. Recreational use--full-body-contact recreational uses

c. Fish and aquatic life

d. Wildlife watering

PRINCIPLE

Lakes are an invaluable and irreplaceable surface water resource of southeastern Wisconsin. The recreational opportunities and aesthetic value that the lakes offer the population of the Region far outweigh the value to the Region of any other potential use of the lakes and should be protected and preserved.

STANDARDS

1. Any lake water use other than recreation, fishing, and aesthetic enjoyment shall be considered an accessory use which is permissible only if it is compatible with recreation, fishing, and aesthetic enjoyment uses and is necessary or desirable from the standpoint of meeting watershed development objectives.

2. Lake water uses which shall not be permitted under any circumstances include industrial and cooling water use, direct livestock watering, irrigation, and waste assimilation.

3. Water quality levels in a lake shall be adequate to meet the State of Wisconsin equivalent stream water quality standards for all equivalent, designated water uses.

4. Algae and aquatic weeds shall not be present in numbers sufficient to create an aesthetic nuisance or to interfere with recreational use.

---

[a] The probable maximum rainfall used for design purposes for watersheds throughout southeastern Wisconsin is 24.5 inches for a 6-hour duration and 30 inches for a 24-hour duration.

[b] See Chapter IX, Volume 1, ''Surface Water Quality and Pollution.''

[c] Ibid., footnote b.

[d] The highest water quality objective for these lakes is limited partial-body-contact recreational use because the physical characteristics of these lakes other than water quality, particularly their shallow depths and small size, limit their practical utility for swimming (see Table 72, Volume 1).

Table 2

LAND USE DEVELOPMENT OBJECTIVES, PRINCIPLES, AND STANDARDS FOR THE FOX RIVER WATERSHED

OBJECTIVE NO. 1

A balanced allocation of space to the various land use categories which meets the social, physical, and economic needs of the residents of the watershed, as well as the needs of short-term visitors to the watershed.

PRINCIPLE

The planned supply of land set aside for any given use should approximate the known and anticipated demand for that use.

STANDARDS

1. For each additional 1,000 persons expected to reside within the watershed at each density, the following minimum amounts of land should be set aside:

Residential Land	Net Area[a]	Gross Area[b]
Low Density	250 acres/1,000 persons	312 acres/1,000 persons
Medium Density	70 acres/1,000 persons	98 acres/1,000 persons
High Density	25 acres/1,000 persons	38 acres/1,000 persons

Governmental and Institutional Land	Gross Area[c]
Regional[d]	3 acres/1,000 persons
Local[e]	6 acres/1,000 persons

Park and Recreation Land[f]	Gross Area[g]
Regional[h]	4 acres/1,000 persons
Local[i]	10 acres/1,000 persons

2. For the daily use of short-term visitors to the watershed, the following amounts of land should be acquired and developed for each anticipated 100 participants[j] in each of the five major outdoor recreation activities which require intensive land development within the watershed:

Major Activity	Total Acres	Principal Development Acres	Backup Land or Secondary Development Acres
Swimming[k]	0.45	0.09	0.36
Picnicking[l]	12.50	1.25	11.25
Golfing[m]	32.79	32.79	--
Camping[n]	133.33	6.67	126.66
Skiing[o]	3.70	3.33	0.37

3. For each additional 100 commercial and industrial employees to be accommodated within the watershed, the following minimum amounts of land should be set aside:

	Gross Area[p]
Commercial Land[q]	5 acres/100 employees
Industrial Land[r]	7 acres/100 employees

OBJECTIVE NO. 2

A spatial distribution of the various land uses which will result in the protection, wise use, and development of the natural resources.

PRINCIPLE

The proper allocation of uses to land can assist in maintaining an ecological balance between the activities of man and the natural environment which supports him.

A. Soils

Principle

The proper relation of urban and rural land use development to soils can serve to avoid many environmental problems, aid in the establishment of better regional settlement patterns, and promote the wise use of an irreplaceable resource.

STANDARDS

1. Urban development, particularly for residential use, shall be located only in those areas which do not contain significant concentrations of soils rated in the regional detailed operational soil survey as poor, questionable, or very poor for such development.[s] Significant concentrations are defined as follows:

   a. In areas[t] to be developed for low-density residential use, no more than 2.5 percent of the gross area should be covered by soils rated in the regional detailed operational soil survey as poor, questionable, or very poor for such development.

   b. In areas to be developed for medium-density residential use, no more than 3.5 percent of the gross area should be covered by soils rated in the regional detailed operational soil survey as poor, questionable, or very poor for such development.

   c. In areas to be developed for high-density residential use, no more than 5.0 percent of the gross area should be covered by soils rated in the regional detailed operational soil survey as poor, questionable, or very poor for such development.

2. Rural development, principally agricultural land uses, shall be allocated primarily to those areas covered by soils rated in the regional detailed operational soil survey as very good, good, or fair for such uses.

3. Land developed or proposed to be developed for urban use without public sanitary sewer service should be located only on areas covered by soils rated in the regional detailed operational soil survey as very good, good, or fair for such development.

B. Inland Lakes and Streams

Principle

Inland lakes and streams contribute to the atmospheric water supply through evaporation; provide a suitable environment for desirable and sometimes unique plant and animal life; provide the population with opportunities for certain scientific, cultural, and educational pursuits; constitute prime recreational areas; provide a desirable aesthetic setting for certain types of land use development; serve to store and convey floodwaters; and provide certain water withdrawal requirements.

STANDARDS

1. Urban development, except for park and outdoor recreational use, should not be allocated to more than 50 percent of the length of the shoreline of inland lakes having a surface area in excess of 50 acres and of all perennial streams.

2. In addition, it is desirable that 25 percent of the shoreline of each inland lake having a surface area less than 50 acres be maintained in either a natural state or some low-intensity public use, such as park land.

3. Floodplain lands[u] should not be allocated to any urban development[v] which would cause or be subject to flood damage.

4. No unauthorized structure or fill should be allowed to encroach upon, and obstruct the flow of, water in the perennial stream channels[w] and floodways.[x]

C. Wetlands

Principle

Wetlands support a wide variety of desirable and sometimes unique plant and animal life; assist in the stabilization of lake levels and streamflows; trap, store, and release plant nutrients in runoff with a net improvement in the quality of runoff, thus reducing enrichment of surface waters and obnoxious weed and algae growth; contribute to the atmospheric oxygen supply; reduce storm water runoff by providing area for floodwater impoundment and storage; reduce stream sedimentation; and provide the population with opportunities for certain scientific, educational, and recreational pursuits.

STANDARD

All wetland areas[y] adjacent to streams or lakes, all within areas having special wildlife values, and all wetlands having an area in excess of 50 acres should not be allocated to any urban development except limited recreation and should not be drained or filled. Adjacent surrounding areas should be kept in open-space use, such as agriculture or limited recreation.

D. Woodlands[z]

Principle

Woodlands assist in maintaining unique natural relationships between plants and animals; reduce storm water runoff; contribute to the atmospheric oxygen supply; contribute to the atmospheric water supply through transpiration; aid in reducing soil erosion and stream sedimentation; provide the resource base for the forest product industries; provide the population with opportunities for certain scientific, educational, and recreational pursuits; and provide a desirable aesthetic setting for certain types of land use development.

STANDARDS

1. A minimum of 10 percent of the land area of each watershed[aa] within the Region should be devoted to woodlands.

2. For demonstration and educational purposes, the woodland cover within each county should include a minimum of 40 acres devoted to each major forest type: oak-hickory, northern hardwood, pine species, and lowland forest.

3. A minimum regional aggregate of five acres of woodland per 1,000 population should be maintained for recreational pursuits.

E. Wildlife[bb]

Principle

Wildlife, when provided with a suitable habitat, will provide the population with opportunities for certain scientific, educational, and recreational pursuits; provide a food source; aid significantly in controlling harmful insects and other noxious pests; and provide an economic resource for the fur and fishing industries.

STANDARD

The most suitable habitat for wildlife, that is, the area wherein fish and game can best be fed, sheltered, and reproduced, is a natural habitat. Since the natural habitat for fish and game can best be obtained by preserving or maintaining other resources, such as soil, air, water, wetlands, and woodlands, in a wholesome state, the standards for each of these other resources, if met, would ensure the preservation of a suitable wildlife habitat and population.

OBJECTIVE NO. 3

A spatial distribution of the various land uses which is properly related to the supporting transportation and public utility systems to assure the economical provision of utility and municipal services.

PRINCIPLE

The transportation and public utility facilities and the land use pattern which these facilities serve and support are mutually interdependent in that the land use pattern determines the demand for, and loadings upon, transportation and utility facilities; and these facilities, in turn, are essential to, and form a basic framework for, land use development.

STANDARDS

1. The transportation system should be located and designed to avoid the penetration of prime natural resource areas by through traffic.

2. The transportation system should be located and designed to provide access not only to all land presently devoted to urban development but also to all land well suited for urban development.

3. Land developed or proposed to be developed for medium- and high-density residential use should be located in a gravity drainage area tributary to an existing or proposed public sanitary sewerage system.

4. Land developed or proposed to be developed for medium- and high-density residential use should be located in areas serviceable by an existing or proposed public water supply system.

5. Urban development should be located so as to maximize the use of existing transportation and utility systems.

OBJECTIVE NO. 4

The preservation and provision of open space[cc] to enhance the total quality of the regional environment, maximize essential natural resource availability, give form and structure to urban development, and provide the basis for the ultimate attainment of a balanced year-round outdoor recreational program providing a full range of facilities for all age groups.

PRINCIPLE

Open space is the fundamental element required for the preservation, wise use, and development of such natural resources as soil, water, woodlands, wetlands, and wildlife; it provides the opportunity to add to the physical, intellectual, and spiritual growth of the population; it enhances the economic and aesthetic value of certain types of development; and it is essential to outdoor recreational pursuits.

STANDARDS[dd]

1. Local park and recreation open spaces should be provided within a maximum service radius of one-half mile of every dwelling unit in an urban area, and each site should be of sufficient size to accommodate the maximum tributary service area population at a use intensity of 675 persons per acre.

2. Regional park and recreation open spaces should be provided within an approximately one hour travel time of every dwelling unit in the Region and should have a minimum site area of 250 acres.

3. Areas having unique scientific, cultural, scenic, or educational value should not be allocated to any urban or agricultural land uses; and adjacent surrounding areas should be retained in open-space use, such as agriculture or limited recreation.

OBJECTIVE NO. 5

The preservation of land areas for agricultural uses in order to provide for certain special types of agriculture, provide a reserve for future needs, and ensure the preservation of those unique rural areas which provide wildlife habitat and which are essential to shape and order urban development.

PRINCIPLE

Agricultural areas, in addition to providing food and fibre, contribute significantly to maintaining the ecological balance between plants and animals; provide locations proximal to urban centers for the production of certain food commodities which may require nearby population concentrations for an efficient production-distribution relationship; and provide open spaces which give form and structure to urban development.

STANDARDS

1. All prime agricultural areas[ee] should be preserved.

2. All agricultural lands surrounding adjacent high-value scientific, educational, or recreational resources and covered by soils rated in the regional detailed operational soil survey as very good, good, or fair for agricultural use should be preserved.

In addition to the above, attempts should be made to preserve agricultural areas which are covered by soils rated in the regional detailed operational soil survey as fair if these soils: a) occur in concentrations greater than five square miles and surround or lie adjacent to areas which qualify under either of the above standards, or b) occur in areas which may be designated as desirable open spaces for shaping urban development.

OBJECTIVE NO. 6

Good soil and water conservation facilities and practices to reduce storm water runoff, soil erosion, and stream sedimentation and pollution.

PRINCIPLE

Good soil and water conservation practices, including contour stripcropping, terracing, suitable crop rotation, and grassed waterways in rural areas; seeding; sodding; erosion control structures for drainageways; erosion control structures at storm sewer outlets; and proper land development and construction methods and practices in urban areas can assist in reducing storm water runoff, soil erosion, and stream siltation and pollution.

STANDARDS

1. A minimum of 50 percent of the area of the watershed in agricultural use should be under district cooperative soil and water conservation agreements and planned conservation treatment.

2. A minimum of 25 percent of the area of the watershed in agricultural use should be under adequate conservation treatment.

---

[a]Net land use area is defined as the actual site area devoted to a given use and consists of the ground floor site area occupied by any buildings plus the required yards and open spaces.

[b]Gross residential land use area is defined as the net area devoted to this use plus the area devoted to all supporting land uses, including streets, neighborhood parks and playgrounds, elementary schools, and neighborhood institutional and commercial uses, but not including freeways and expressways.

[c]Gross governmental and institutional area is defined as the net area devoted to this use plus the area devoted to supporting land uses, including streets and off-street parking.

[d]Includes federal, state, and county governmental uses; hospitals; cemeteries; colleges and universities; and large region-serving, semipublic institutional uses, such as central YMCA facilities. Presently approximates 3 acres per 1,000 persons.

[e]Includes schools and churches. Approximately one-half of this standard is met implicitly if the gross acreage standard for residential use is met. Presently approximates 6 acres per 1,000 persons.

[f]This category does not include regional or local open spaces other than those actively used for public park or outdoor recreational purposes; that is, such uses as boulevards, parkways, stadia, environmental corridors, arboreta, zoological gardens, and botanical gardens are not included unless they are a part of, or adjacent to, an active recreation area.

[g]Gross park and recreation area is defined as equal to net area.

[h]Presently (1967) includes 23 existing parks (developed and undeveloped) within the Region classified as being of regional significance, which combined contain 6,741 acres or 3.7 acres per 1,000 persons. These are: the Brighton Dale Park, Fox River Park, Petrifying Springs Park in Kenosha County; seven of the Milwaukee County Park Commission Metropolitan Parks--Brown Deer Park, Grant Park, Greenfield Park, Lake-Juneau Park, Lincoln Park, Oakwood Park, and Whitnall Park; Hawthorne Hills Park and Harrington Beach Park in Ozaukee County; Cliffside Park and Johnson Park in Racine County; Big Foot Park and Whitewater Lake Recreation Area in Walworth County; Pike Lake Recreation Area and Ridge Run Park in Washington County; and Menomonee Park, Minooka Park, Mukwonago Park, Nagawaukee Park, and Ottawa Lake Recreation Area in Waukesha County.

[i] Presently (1963) includes 379 neighborhood and community parks, which combined contain 5,698 acres or 3.4 acres per 1,000 persons. A portion of this standard is met implicitly if the gross acreage standard for residential use is met. This implicit portion totals: 1.3 acres per 1,000 persons in a one-half mile square high-density neighborhood; 2.5 acres per 1,000 persons in a one mile square medium-density neighborhood; and 4.5 acres per 1,000 persons in a two mile square low-density neighborhood.

[j] A participant is defined as a person 12 years of age or older who actively participates in a particular recreational activity on a given day.

[k] Swimming--One acre of developed beach area can accommodate approximately 370 people at any one time. With a daily turnover rate of 3.0, the maximum capacity of one acre of developed beach is 1,110 people per acre per day. In addition, for every one acre of developed beach area, four (4) acres of backup lands are required to provide necessary parking area (approximately 1 1/2 acres), concession services, dressing room area (approximately 1 acre), and other activity area, such as picnic area (approximately 1 1/2 acres).

[l] Picnicking--One acre of developed picnic area with a maximum of 16 tables can accommodate approximately 50 people at any one time. With a daily turnover rate of 1.6, the maximum capacity of one acre of developed picnic area is 80 people per acre per day. In addition, for every one acre of developed picnic area, nine acres of backup land are required to provide necessary parking area and additional secondary facilities.

[m] Golfing--A minimum of 10 acres of land per hole is required to develop a regulation nine or 18 hole golf course, including area for clubhouse and parking and will accommodate approximately one golfer per acre at any one time. With a daily turnover rate of 3.0, the maximum capacity of each golf course is 3.0 golfers per acre per day or 30 golfers per acre per day.

[n] Camping--One acre of developed camp area with a maximum of five camp units can accommodate approximately 14 people per day. There is no daily turnover rate for camping. In addition, for every one acre of developed camp area, 19 acres of backup land is required to provide necessary supporting activities or facilities, such as central convenience facilities, hiking and nature trails, picnic areas, boat and canoe launching sites, and horseback trails.

[o] Skiing--One acre of developed ski slope can accommodate approximately 10 people at any one time. With a daily turnover rate of 3.0, the maximum capacity of one acre of developed ski slope is 30 people per acre per day. In addition, for every 10 acres of developed ski slope, one acre of backup land is required to provide parking and concession facilities. The recommended minimum site area is 100 acres.

[p] Gross commercial and industrial area is defined as the net area devoted to this use plus the area devoted to supporting land uses, including streets and off-street parking.

[q] Includes all regional, local, and highway-oriented commercial activities plus adjacent streets and on-site parking. Presently approximates 3.4 acres per 100 employees.

[r] Includes all manufacturing and wholesaling activities plus adjacent streets and on-site parking. Presently approximates 4.1 acres per 100 employees.

[s] See SEWRPC Planning Report No. 8, Soils of Southeastern Wisconsin, June 1966.

[t] Areas, as used in this context, refer to any land unit, 160 acres or more in areal extent, which is subject to development.

[u] Floodplain lands are herein defined as those floodlands, excluding the floodway, subject to inundation by the 100-year recurrence interval flood or, where such data is not available, by the maximum flood of record.

[v] Urban development, as used herein, refers to all land uses except agriculture, water, woodlands, wetlands, and open lands.

[w] A stream channel is herein defined as that portion of the floodlands lying either within legally established bulkhead lines or within sharp and pronounced banks marked by an identifiable change in flora and normally occupied by the stream under average annual high-flow conditions.

[x] Floodway lands are herein defined as those floodlands, including the channel, required to carry and discharge the 100-year recurrence interval flood. If development and fill are to be prohibited in the floodplain, the floodway may be delineated as that area subject to inundation by the 10-year recurrence interval flood.

[y] Wetland areas are defined as those lands which are partially covered by marshland flora and generally covered with shallow standing water, open lands intermittently covered with water, or lands which are wet and spongy due to a high water table or character of the soil.

[z] The term woodlands, as used herein, is defined as a dense, concentrated stand of trees and underbrush covering a minimum area of 20 acres.

[aa] A watershed, as used herein, is defined as a portion of the surface of the earth occupied by a surface drainage system discharging all surface water runoff to a common outlet and which is 25 square miles or larger in areal extent.

[bb] Includes all fish and game.

[cc] Open space is defined as land or water areas which are generally undeveloped for residential, commercial, or industrial uses and are or can be considered relatively permanent in character; it includes areas devoted to park and recreation uses and to large land-consuming institutional uses, as well as areas devoted to agricultural use and to resource conservation whether publicly or privately owned.

[dd] It was thought impractical to establish spatial distribution standards for open space per se; therefore, only the park and recreation component of the open-space land use category is listed in the standards according to its local or regional orientation. These local park and recreation spaces may include playlots, playgrounds, playfields, and neighborhood parks. Regional park and recreation spaces include large county or state parks. Other open spaces which are not included in this spatial distribution standard are: forest preserves and arboreta; major river valleys; lakes; zoological and botanical gardens; stadia; woodland, wetland, and wildlife areas; scientific areas; and agricultural lands whose location must be related to, and determined by, the natural resource base.

[ee] Prime agricultural areas are defined as those areas which a) contain soils rated in the regional detailed operational soil survey as very good or good for agriculture, and b) occur in concentrated areas over five square miles in extent which have been designated as exceptionally good for agricultural production by agricultural specialists.

ENGINEERING DESIGN CRITERIA FOR THE FOX RIVER WATERSHED

Rainfall-Frequency Relationships

If local storm water drainage and main river flood-control measures are to be compatible and function in a coordinated manner, plans for both must be based on consistent engineering design criteria. A fundamental criterion for both local and watershed drainage planning is the rainfall intensity-duration-frequency relationship representative of the watershed area. Intensity-duration-frequency curves based on a 64-year record at Milwaukee Weather Bureau Station are shown in Appendix C. The curves in Figures C-1 and C-2 are directly applicable to urban storm water drainage system design using the rational formula, while the equivalent curves in Figure C-3 are expressed in a form more convenient for use in hydrologic simulation. These curves are applicable to the Southeastern Wisconsin Region and to the Fox River watershed. The variation of rainfall depth with area of consideration and the seasonal variation of rainfall probability are described in Figures C-4 and C-5, respectively.

Storm Sewer Design Criteria

Revised rainfall criteria and newly available soil survey data made possible more detailed consideration of rainfall-runoff relationships in the design of storm sewers for urban areas in the Southeastern Wisconsin Region and in the watershed. Recommended values for the coefficient of runoff, C, which are based on land use, land slope, and soil type, are presented in Appendix C, Table C-1. Soils which occur in the watershed are categorized in hydrologic groups according to their infiltration capability in Appendix I of Volume 1 of this report.

Rainfall-Runoff Relationships

The rainfall-runoff criteria adopted for storm sewer design are not adequate for hydrologic simulation of basin-wide floods. For this purpose

U. S. Soil Conservation Service rainfall-runoff relationships were adopted. These relationships, and adjustments made to them for the specific conditions existing in the Fox River watershed, are described in Chapter VIII, "River Performance Simulation," Volume 1, of this report.

Channel Capacity

Channel capacities were calculated using the Manning formula and a standard step method of backwater computation for open-channel flow. The Manning formula is used almost universally and has the advantage that values for the empirical coefficient used to represent the hydraulic friction are based on extensive field tests. The methods used in applying the Manning formula and the procedure for determining appropriate values for the friction factor, "n," are described in detail in Chapter VIII, "River Performance," Volume 1, of this report.

Water Surface Elevation-Discharge Relationships and Flood Routing

Water surface elevation-discharge relationships were established using a standard step method of backwater computations for open-channel flow. The method used combines the relationships established in the Manning formula with the conservation of energy principle in order to determine the depth of flow at a given point. Backwater at bridges and culverts was calculated using a procedure developed by the U. S. Geological Survey. This procedure is described and referenced in Chapter VIII, Volume 1, of this report. Water surface elevation-discharge relationships were established at water control structures by the application of standard weir, orifice, and pipe flow formulas. Descriptions of these formulas may be found in standard engineering references, such as: Handbook of Hydraulics, by Horace W. King and Ernest F. Brater, McGraw-Hill Book Company, New York, N. Y., 1963.

The convex method of flood routing was selected as the most suitable for application in the Fox River watershed study. This method, which is based upon inflow-outflow hydrograph relationships, was used on all channel routings performed in the analysis of the watershed. The determination of the effects of water control structures on flood crests was made using the storage-indication method of reservoir routing. Explanations of both routing procedures and appropriate references are given in Chapter VIII, "River Performance Simulation," Volume 1, of this report.

Flood Frequency

Flood frequency relationships were developed at various locations in the watershed using two methods of analysis. At the Wilmot gaging station, records of discharge have been obtained since 1940. These actual, measured discharges were analyzed statistically to establish a flood frequency relationship at this location. The flood frequency line developed for the Wilmot gage was used to establish flood frequency relationships on the main stem of the Fox River between Wilmot and Burlington.

In the remainder of the watershed, flood frequency lines were established synthetically by assigning the frequency of the rainfall amount or the snowmelt volume used as an input to the flood simulation model to the flood event itself. This method was judged to be the best procedure for use in the Fox River watershed study, considering the limited number of stream gaging stations in the watershed and the relatively short period of record at these stations. As streamflow data collection continues within the watershed, flood frequency relationships should be reviewed and revised if necessary. On the basis of the analyses made, it was concluded that the peak flood flow recorded in April 1960 at the Wilmot Dam of 7,520 cfs was equivalent to a 37-year recurrence interval flood flow, while at Waukesha the same flood peak was equivalent to a 50-year recurrence interval flood flow. A 100-year recurrence interval flood was selected as the plan design flood and was used to delineate the outer limits of the floodplains of the watershed. Analysis indicates that urbanization within the watershed will not appreciably change the peak discharge of this design flood.

OVERRIDING CONSIDERATIONS

In the application of the watershed development objectives, principles, and standards in the preparation, test, and evaluation of the watershed plans, several overriding considerations must be recognized. First, it must be recognized that any proposed water control facility plan must constitute an integrated system. It is not possible from an application of the standards alone, however, to assure such a system since the standards cannot be used to determine the effect of individual facilities on each other or on the system as a whole. This requires the application of the hydrologic simulation model to quantitatively test the proposed system, thereby permitting adjustment of the spatial distribution and capacities of the system to the existing and future runoff loadings as derived from the land use plan. Second, it must be recognized that it is unlikely that any one plan proposal will meet all the standards completely; and the extent to which each standard is met, exceeded, or violated must serve as a measure of the ability of each alternative plan proposal to achieve the specific objectives which the given standard complements. Third, it must be recognized that certain objectives and standards may be in conflict and require resolution through compromise. Finally, it must be recognized that an overall evaluation of each combination of land and water control facility plans must be made on the basis of cost. This concept is so important that it warrants special attention herein.

Economic Criteria

The concepts of economic analysis and economic selection are vital to the public planning process. Sound economic analysis of benefits and costs should be an important guide to planners and decision-makers in the selection of the most suitable plan from an array of alternatives. All decisions concerning monetary expenditures, either private or public, are based on an evaluation of benefits and costs. This is not to imply that a formal economic analysis is made before every expenditure. The process of decision itself, however, consists of a consideration of whether the benefit received would be worth the amount paid. Benefits are not necessarily accountable in monetary terms and may be purely intangible, but the very act of expending money, or resources, for an intangible benefit implies that the benefit is worth to the purchaser at least the amount spent.

In addition to the consideration involved in deciding that a potential benefit is worth its cost, consideration is also given to possible alternative benefits that could be received for alternative expenditures within the limits of available resources. Alternative benefits are compared, either objectively or subjectively; and the one which is considered to give the greatest value for its cost is selected. Again, the benefits may be purely intangible; but the decision-making process itself implies an evaluation of which alternative is considered to be worth the most. When consideration is made of investment for future benefits, one alternative that should always be considered is the benefit which could be received from investment in the money market. This benefit is expressed in the prevailing interest rate.

Personal and private decisions, while implying at least subjective consideration of benefits and costs, broadly defined, are not necessarily based upon either formal or objective evaluation of monetary benefits and costs. Public officials, however, have a responsibility to evaluate objectively and explicitly the monetary benefits and costs of alternative investments to assure that the public will receive the greatest possible benefits from limited monetary resources.

It is then a fundamental principle that every public expenditure should return to the public a value at least equal to the amount expended plus the interest income foregone from the ever-present alternative of private investment. This principle may also be stated that the public should receive a value return from its tax investment at least equal to what it could receive from private investment, since government exists, presumably, solely to serve its citizens.

Therefore, economic analysis is a fundamental requirement of responsible public planning; and all plans should promise a return to the public at least equal to the expenditure plus interest. It is emphasized that public expenditures should not be expected to "make money" but that they should be expected to return a value in goods and services which is worth to the public the amount expended plus interest.

Benefit-Cost Analysis

The benefit-cost analysis method of evaluating government investments in public works came into general use after the adoption of the Federal Flood Control Act of 1936. The Act stated that waterways should be improved "if the benefits to whomsoever they may accrue are in excess of the estimated costs." Monetary value of benefits has since been defined as the amount of money which an individual would pay for that benefit if he were given the market choice of purchase. Monetary costs are taken as the total value of resources used in the construction of the project.

Benefits must exceed costs in order for a project to be justified, but this criterion alone is not sufficient to justify the investment. Although a project may have a benefit-cost ratio greater than 1.0, the ratio may be less than the benefit-cost ratio of an alternative project which would accomplish the same objectives. Therefore, in order to assure that public funds are invested most profitably, alternative plans or projects should be investigated and analyzed.

Implementation of comprehensive plans for the Fox River watershed could include benefits of flood control, recreation, efficient community utilities and facilities, enhancement of property values, and an aesthetically pleasing community environment. Costs which could be incurred in implementation of watershed plans include construction, land acquisition, and income foregone as a result of regulation of land use.

Time Value of Money—Interest

The benefits and often the costs of construction projects accrue over long periods of time. Each project or alternative, public and private, is likely to have a different time flow of benefits and costs. Benefits of one project may be realized earlier than those of another, while the time flow of costs may vary from one large initial investment for one project to small but continuously recurrent expenditures for another. In order to place these projects with varying time flows of benefits and costs on a comparable basis, the concept of the time value of money must be introduced.

A dollar has a greater value to the consumer today than does the prospect of a dollar in the future. Because of this time preference for money, a consumer will agree to pay more than one dollar in the future for one dollar today. Conversely, to an investor one dollar in the future is worth less than one dollar today because he can obtain one dollar in the future from the investment of less than one dollar today. By the same reasoning, for public projects a one dollar cost or a one dollar benefit at some time in the future has a value of less than one dollar today. The variation of value of capital, benefits, and costs with respect to time is expressed through the mathematics of compound interest.

Use of an interest rate automatically incorporates consideration of the ever-present possibility of private investment as an alternative. A project, to be economical, should return to the public at least as great a benefit as it might obtain through private investment. Money invested privately is expected to return generally from 6 to 10 percent interest. Since implementation of the watershed plan should return benefits to the public equal to, or greater than could be attained through, private investment, an interest rate of 6 percent is recommended for use in the economic evaluation of plans. It should be noted that certain government agencies use a lower interest rate in such evaluation. Therefore, benefit-cost analyses of the watershed plans were also made using a 3 1/4 percent interest rate in order to allow evaluation by the criteria of other agencies.

The benefit-cost analysis for a project must be based on a specified number of years, usually equal to the physical or economic life of the project. Most of the improvements proposed in the Fox River watershed plans, however, will continue to furnish benefits for an indefinite time, particularly the land use control and park reservation elements. In indefinite situations, such as this, government agencies have generally selected 50 years for the period of analysis; and this period is recommended for the Fox River watershed plan. Using 6 percent interest, benefits accrued after 50 years, when discounted to the present, are very small. For example, given a uniform annual benefit of one dollar, the total present worth of the entire 50-year period from year 51 through year 100 would be only one dollar. The total present worth of the benefits for the 50-year period from year 1 through year 50 would, however, be almost $16. A final reason for using a 50-year period as a basis for benefit-cost analysis is the inability to anticipate the social, economic, and technological changes which may occur in the more distant future and which may influence project benefits and costs.

Project Benefits

The benefits from a project can be classified as direct, or measurable in monetary terms, and as intangible. Intangible benefits either are of such a nature that no monetary value can be assigned to them or are so obscure that calculation of the monetary value is impracticable. In the Fox River watershed planning studies, direct benefits include flood-damage reduction, enhancement of property values, and that part of recreation to which a monetary value can be assigned. Intangible benefits include aesthetic factors deriving from natural beauty and a pleasant environment. Intangibles also include benefits, such as improved efficiencies in community utilities and facilities, that have monetary values but which are impracticable to calculate.

Direct benefits attributable to flood control were calculated by subtracting annual flood-damage risk for each plan alternative from annual flood-damage risk in an unplanned situation. Annual flood-damage risk was calculated for each alternative by means of the damage-frequency curves prepared for the study as described in Chapter VII, "Flood Characteristics and Damage," Volume 1, of this report.

The direct benefits from land use controls and from the provision of recreational opportunities are more difficult to establish. A partial account of the benefits resulting from the implementation of sound land use plans was made in terms of increased land values for housing sites adjacent to attractive natural environments. The remainder of the benefits of the land use plans were considered to be intangible. These intangibles include benefits from the provision of a more attractive and pleasant environment for living and working and benefits to communities and individuals because community facilities, such as drainage, water supply, roads, schools, and waste disposal, cost less per capita in a well-planned land use situation.

Project Costs

The direct costs of water resource development include the construction costs of physical elements of the plan and the cost of acquiring land. Costs of structural facilities were calculated using unit prices which reflect the magnitude of work, the location in urban areas, and regional labor costs.

The cost of land acquisition was based on present market prices for urban improved, urban unimproved, and rural agricultural land in the Fox River watershed. The cost of land use controls, such as would occur in a zoning-only plan, was taken as the difference in present market price between urban unimproved land and rural agricultural land. This is based upon the assumption that the present market price of land is equivalent to the present worth of the future income expected to be derived from that land. Under floodplain zoning the principal profitable land use would remain agriculture.

Relationship of Economic and Financial Analysis

The distinction between economic feasibility and financial feasibility is of particular importance in the consideration of the costs of land already under public ownership. A financial analysis involves an examination of the liquidating characteristics of the project from the point of view of the particular government agency undertaking the project. The relevant matters are the monetary disbursements and monetary receipts of the project. The financial analysis determines whether or not the prospective available funds are adequate to cover all of the costs.

On the other hand, an economic analysis by a government body determines if the project benefits to whomsoever they accrue exceed the costs to whomsoever they accrue. Since one of the legitimate objectives of government is to promote the general welfare, it is necessary to consider the effect of a proposed project on all of the people who may be affected, not just the income and expenditures of a particular agency. The economic valuation of the benefits and costs may differ considerably from the actual income and expenditures of a government agency. The present market value of publicly owned but uncommitted land, such as the undeveloped holdings of a park commission, is counted on the cost side of the economic analysis. Under the economic criterion of benefits and costs to whomsoever they accrue, this land must be considered to have an economic value for alternative uses which are foregone when the land is committed to another use, such as open space or recreation. The costs of public lands already developed with facilities for recreation are considered as sunk costs and not included in the economic analysis because alternative uses of the land can no longer be reasonably considered. The costs of land under public ownership, undeveloped or developed, are not considered in the financial analysis since no monetary outlay is required.

Staged Development

An attractive feature of many water resource developments is their divisibility into several individual projects which may be financed and built at different times. Staged construction requires lesser initial capital investments, reduces interest costs, and allows for flexibility of continued planning. Staging developments may also allow deferring an element until increased demands raise its benefit-cost ratio. In planning for staged development, however, consideration must be given to possibilities of higher costs in the future and the possible unavailability of land. In any development staging also serves to lower risks incurred through inavailability of data during preparation and partial implementation of initial plans.

SUMMARY

The process of formulating objectives and standards to be used in plan design and evaluation is a difficult but necessary part of the planning process. It is readily conceded that regional and watershed development plans must advance development proposals which are physically feasible, economically sound, aesthetically pleasing, and conducive to the promotion of public health and safety. Agreement on development objectives beyond such generalities, however, becomes more difficult to achieve because the definition of specific development objectives and supporting standards inevitably involves value judgments. Nevertheless, it is essential to state such objectives for watershed development and to quantify them insofar as possible through standards in order to provide the framework within which watershed plans can be prepared. Moreover, so that the watershed plans will form an integral part of the overall long-range plans for the physical development of the Region, the watershed development objectives must be compatible with, and dependent upon, regional development objectives, while meeting the primary water development objectives. Therefore, the watershed development objectives and supporting principles and standards set forth herein are based upon, and incorporated in, previously adopted regional development objectives, supplementing these only as required to meet the specific needs of the Fox River watershed planning program.

Chapter III

LAND USE BASE AND ALTERNATIVE NATURAL RESOURCE PROTECTION AND OUTDOOR RECREATION AND RELATED OPEN-SPACE PLAN ELEMENTS

INTRODUCTION

The economic and demographic base and the existing land use pattern of the Fox River watershed were described in Chapter III, Volume 1, of this report. Forecasts of probable future population and economic activity levels and accompanying demands for various land uses within the watershed were set forth in Chapter VI, Volume 1, of this report. The population of the watershed was forecast to increase from its present (1963) level of 159,500 to a 1990 level of 359,000 persons, an increase of 125 percent in approximately 27 years. Employment within the watershed was forecast to increase from the present (1963) total of 33,500 jobs to a 1990 total of 96,800 jobs, an increase of 189 percent.

In the face of this rapid growth in population and employment, the amount of land devoted to urban land uses within the watershed was forecast to almost double, increasing from a total of 105 square miles, or about 11 percent of the total area of the watershed, in 1963 to 201 square miles, or about 21 percent of the total area of the watershed, by 1990. This demand for urban land will have to be satisfied primarily through the conversion from rural to urban uses of the remaining agricultural lands, woodlands, and wetlands of the watershed; and such rural land uses may be expected to decline collectively from 833 square miles in 1963 to 737 square miles in 1990, a decrease of about 12 percent. If existing development trends continue, much of this new urban development will not be related sensibly to soil capabilities; to long-established utility systems; to the floodlands of the Fox River system; or to the wetlands, woodlands, and surface water resources of the watershed; and the already serious developmental and environmental problems of the watershed, as documented in Volume 1 of this report, may be expected to continue to intensify.

If such intensification of developmental and environmental problems is to be avoided and the serious problems of flooding and water pollution already existing within the watershed are to be abated, new urban development within the watershed will have to be directed into a more orderly and efficient pattern, a pattern carefully adjusted to the ability of the underlying and sustaining natural resource base to support further urban development. A land use plan must, therefore, constitute a major element of any comprehensive plan for the development of the Fox River watershed. This land use plan element, although emphasizing the protection of riverine areas and of the recreational resource base of the watershed, must cover the entire watershed and must represent the major basic approach to the resolution of the growing problems of the watershed. Structural water control facility plan elements for flood control and pollution abatement must be subordinate to, and support, the land use plan element in that the structural water control facility plan elements do not affect the entire watershed and cannot alone offer sound solutions to the developmental and environmental problems of the watershed.

This chapter presents a brief description of the necessary basic land use plan element, with particular attention to the alternatives available in terms of preservation of the natural resource base and of recreational land use development both in the riverine areas of the watershed and in the watershed as a whole.

LAND USE BASE

Design Methodology

The land use plan element, which forms the basis for the comprehensive watershed plan, is set within the context of the adopted regional land use plan. The regional land use plan was designed to meet regional development objectives and standards and was selected after careful consideration of three alternative regional land use plans—a corridor, a satellite city, and a controlled existing trend plan—and after comparing these three alternative plans to an unplanned alternative. The unplanned alternative is described in Chapter VIII of this volume.

The methodology applied in the preparation of the regional land use plan has been described in SEWRPC Planning Report No. 7, Volume 2, Forecasts and Alternative Plans—1990, and consisted of a combination of design-oriented mapping activities concerned primarily with the spatial distribution of the various land uses, relating these to existing development and to the natural resource and public utility base through application of physical planning and engineering principles and a socio-economic oriented land use demand projection and allocation process employing both traditional and mathematical simulation model techniques.

Thus, the general land use base for the Fox River watershed plan was established through the preparation of a regional land use plan, a plan adopted by the Regional Planning Commission, as well as by all six counties in the Southeastern Wisconsin Region within which the Fox River watershed lies; namely, Kenosha, Milwaukee, Racine, Walworth, Washington, and Waukesha Counties. The regional land use development objectives, which the regional land use plan is designed to meet, as set forth in Chapter II of Volume 2, SEWRPC Planning Report No. 7, Forecasts and Alternative Plans—1990, remain valid and can be readily attained within the context of the more detailed watershed development plan. Therefore, these regional development objectives and their supporting principles and standards were made the basis of the watershed land use development objectives, principles, and standards set forth in Chapter II of this volume.

The adopted regional land use plan set forth broad recommendations for areawide land use development designed to meet the social, physical, and economic needs of the Region while protecting and enhancing the natural resource base. The resolution of the specific natural resource-related problems existing within the Fox River watershed, as set forth in Chapter XII of Volume 1 of this report, however, requires more intensive land use investigation, more detailed land use plan design, and more specific land use plan implementation recommendations, particularly with respect to the riverine areas of the watershed, in order that these problems may be abated through appropriate private, as well as local, state, and federal governmental, actions. Therefore, this chapter, in addition to describing the already adopted regional land use plan as it applies to the Fox River watershed, sets forth detailed alternative proposals for the protection and wise use of the natural resources of the watershed in order to achieve a favorable natural environment and alternative proposals for the preservation and proper development of the recreation-related resource base of the watershed in order to meet the growing demand for outdoor recreation within the watershed. Two important and interrelated elements of the natural resource base requiring protection through sound land use development and management have been identified in the inventories and analyses made as a part of the watershed study: the primary environmental corridors and the remaining prime outdoor recreation and related open-space sites within the watershed. Specific alternatives for the preservation of these two elements are explored in this chapter, with specific attention to preservation of the following subelements of the primary environmental corridors: lakes and streams and the associated shorelands and floodlands, wetlands, woodlands, and wildlife habitat areas.

Land Use Base

As already noted, the adopted regional land use plan forms the recommended land use base for the Fox River watershed plan. The recommended land use base would meet the social, physical, and economic needs of the future watershed population by allocating sufficient land to each of the various major land use categories to satisfy the known and anticipated demand for each use, meeting both the demands of the urban land market and the adopted land use plan design standards. The allocation of the future land uses within each county of the watershed is such as to meet the demand for land which may be expected to be created by the forecast population growth within each county through the plan design year 1990. To the extent possible, the proposals contained in existing community development plans and ordinances are accommodated in the land use base. The land use base seeks to protect and enhance the natural resource base of the watershed and allocates new urban development only to those areas of the watershed that are covered by soils well suited to such development. It further seeks to encourage urban development in those areas of the watershed that can be readily provided with gravity drainage sanitary sewer service and public water supply.

The land use base emphasizes continued reliance upon the effects of the urban land market in determining the location, intensity, and character of future development within the Region and the watershed for residential, commercial, and industrial land uses. It does, however, propose to regulate in the public interest the effect of this market on development in order to provide for a more orderly and economical land use pattern and in order to avoid intensification of developmental and environmental problems within the Region and the watershed. This land use base is shown in graphic summary form on Map 1 and is more specifically described in the following paragraphs and subsequent sections of this chapter.

The land use base proposes the conversion of approximately 39 square miles of land within the watershed from rural to urban use over the next two decades, or about 57 square miles less than the forecast conversion of 96 square miles of land noted earlier in this chapter. This forecast conversion was based upon forecast population levels and recent trends in land development. The planned conversion of 39 square miles of land in the land use base would also be about 126 square miles less than would be converted under recent land development trends as fostered by adopted local land use plans and zoning ordinances, as discussed later in this volume in Chapter VIII, "The Unplanned Alternative."

It is important to note that the land use base, as shown on Map 1, represents a refinement of the adopted regional land use plan in the riverine areas of the watershed. This plan refinement was primarily directed at delineation of the boundaries of the primary environmental corridors within the watershed and was made possible by the hydrologic investigations and floodland delineations carried out as a part of the Fox River watershed study. Because floodlands are an important determinant of environmental corridor boundaries, the floodland information provided by the Fox River study affected and was used to refine the corridor boundaries as those boundaries were originally delineated in the adopted regional land use plan. It is also important to note that the major public outdoor recreation site designated on the land use base in the Racine County portion of the watershed has been located approximately 4 miles downstream on the Fox River from the location originally designated on the adopted regional land use plan. This change in location was made at the specific request of the Racine County Highway and Parks Committee. The newly designated site was, along with the original site, ranked as one of the ten best Racine County sites in the regional potential park site inventory. The new site has adequate size and the equivalent multiple-use development potential of the original site and, therefore, warrants its designation as the proposed major outdoor recreation site in western Racine County.

Residential Land Use: As indicated in Table 3, the land use base proposes to add 13,468 acres to the existing stock of residential land within the watershed in order to supply land to meet the housing needs of the anticipated population increase. Approximately 1,578 acres, or about 12 percent of this new residential land, are proposed to be developed at low population densities, with lot sizes ranging from approximately one-half acre to five acres per dwelling unit and with gross residential population densities ranging from 350 to 3,499 persons per square mile. About 11,862 acres, or about 88 percent of this new residential land, are proposed to be developed at medium population densities, with lot sizes ranging from approximately 6,000 square feet to approximately one-half acre per dwelling unit and with gross residential population densities ranging from 3,500 to 9,999 persons per square mile. The remaining 28 acres, or less than 1 percent of this new residential land, are proposed to be developed at high population densities, with lot sizes ranging from approximately 2,400 to 6,000 square feet per dwelling unit and with gross residential population densities ranging from 10,000 to 25,000 persons per square mile.

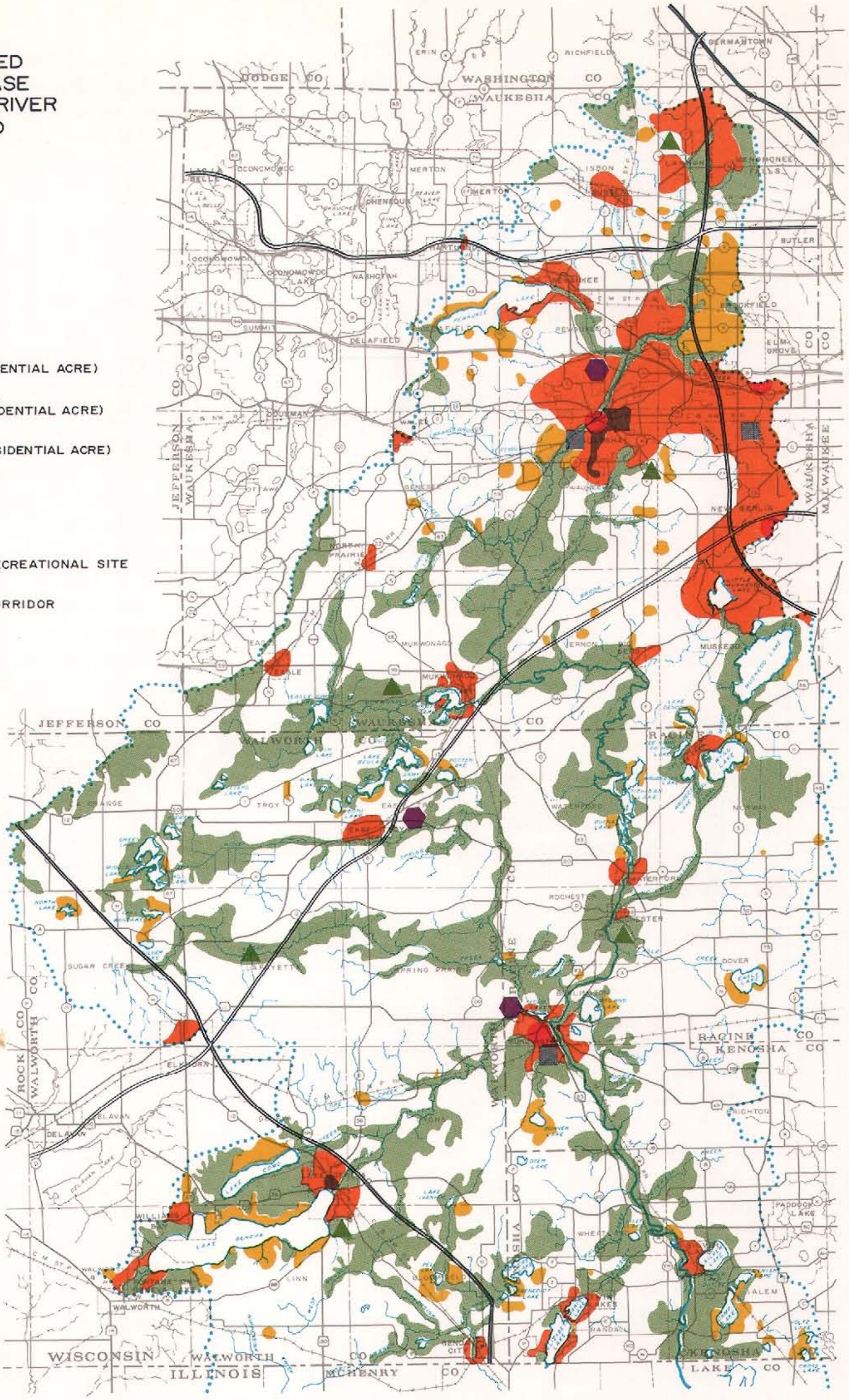
All of the new medium- and high-density residential development is proposed to be served by public sanitary sewer and public water supply facilities, so that by 1990, 82 percent of the total urban area within the watershed and 93 percent of the total watershed population would be served by such facilities, as compared to only 32 and 41 percent, respectively, in 1964.

Retail and Service Land Use: Four major multipurpose commercial centers are proposed in the land use base for 1990, including the two existing centers in the Cities of Waukesha and Burlington and two new centers, one in the City of Brookfield and the other in the City of New Berlin. The two new major commercial centers would add approximately 150 acres of retail and service land to the existing 1,324 acres of retail and service land in the watershed. In addition, approximately 565 acres of new community and local retail and service land would be added during the plan design period. As shown in Table 3, these additions to the existing stock of retail and service land in the watershed would total 715 acres, or an increase of 54 percent over the existing supply.

Industrial Land Use: Based on the employment forecasts, three major industrial centers are proposed in the land use base, including the

Map 1

RECOMMENDED LAND USE BASE FOR THE FOX RIVER WATERSHED (1990)



LEGEND

- LOW DENSITY RESIDENTIAL (0.5 – 7.2 PERSONS PER RESIDENTIAL ACRE)
- MEDIUM DENSITY RESIDENTIAL (7.3 – 22.8 PERSONS PER RESIDENTIAL ACRE)
- HIGH DENSITY RESIDENTIAL (22.9 – 59.2 PERSONS PER RESIDENTIAL ACRE)
- MAJOR RETAIL AND SERVICE
- MAJOR INDUSTRIAL
- PUBLIC AIRPORT
- MAJOR PUBLIC OUTDOOR RECREATIONAL SITE
- PRIMARY ENVIRONMENTAL CORRIDOR
- WATER
- AGRICULTURAL
- PROPOSED FREEWAY

The recommended land use base for the comprehensive Fox River watershed plan represents a refinement of the adopted regional land use plan. The allocation of future land uses within each county of the watershed is such as to meet the demand for land which may be expected to be generated by the forecast population growth through 1990. This land use base emphasizes continued reliance upon the effects of the urban land market in determining the location, intensity, and character of future development. In doing so, however, it proposes to regulate more effectively in the public interest this market effect on development in order to promote a more attractive and economical land use pattern, a pattern which will be properly adjusted to the underlying and sustaining natural resource base.

Source: SEWRPC.

Table 3

EXISTING AND PROPOSED LAND USE IN THE FOX RIVER WATERSHED: 1963 AND 1990 RECOMMENDED LAND USE PLAN

Land Use Category	Existing (1963)			Planned Increment (1963-1990)			Total (1990)		
	Acres	Square Miles	Percent of Major Category	Acres	Square Miles	Percent Change	Acres	Square Miles	Percent of Major Category
Urban Land Use									
Residential	30,664	47.91	45.3	13,468	21.04	43.9	44,132	68.95	47.7
Low-Density	*24,675*[a]	*38.56*	*36.4*	*1,578*	*2.47*	*6.3*	*26,253*	*41.03*	*28.4*
Medium-Density	*5,740*[a]	*8.96*	*8.5*	*11,862*	*18.53*	*206.6*	*17,602*	*27.49*	*19.0*
High-Density	*249*[a]	*0.39*	*0.4*	*28*	*0.04*	*11.2*	*277*	*0.43*	*0.3*
Commercial	1,324[b]	2.07	2.0	715	1.12	54.0	2,039	3.19	2.2
Industrial	1,297[c]	2.03	1.9	1,038	1.62	80.0	2,335	3.65	2.5
Mining	2,909	4.56	4.3	0	0.00	0.0	2,909	4.56	3.1
Transportation	22,793[d]	35.61	33.7	5,880	9.19	25.8	28,673	44.80	31.0
Governmental	2,204[e]	3.44	3.3	1,467	2.29	66.6	3,671	5.73	4.0
Recreational	6,446	10.07	9.5	2,318	3.62	36.0	8,764	13.69	9.5
Total Urban Land Use	67,637	105.69	100.0	24,886	38.88	36.7	92,523	144.57	100.0
Rural Land Use									
Agricultural and Open Land	533,142	833.04	100.0	-24,886	-38.88	-4.7	508,256	794.16	100.0
Total Rural Land Use	533,142	833.04	100.0	-24,886	-38.88	-4.7	508,256	794.16	100.0
Total	600,779	938.73	--	--	--	--	600,779	938.73	--

[a] *Estimated from 1963 land use inventory data.*

[b] *Includes 242 acres of on-site parking.*

[c] *Includes 121 acres of on-site parking.*

[d] *Includes utilities; excludes 484 acres of off-street parking.*

[e] *Includes institutional uses and 121 acres of on-site parking.*

Source: SEWRPC.

existing center in the City of Waukesha and two proposed centers, one in the City of Burlington and the other in the City of New Berlin. The two major industrial centers would add approximately 740 acres to the existing 1,297 acres of industrial land in the watershed. In addition, approximately 300 acres of new industrial land not located in the two new major industrial centers would be added during the plan design period. As shown in Table 3, these additions to the existing stock of industrial land would total 1,038 acres, or an increase of 80 percent over the existing supply.

Transportation, Communication, and Utility Facility Land Use: As indicated in Table 3, the land use base proposes to add approximately 5,880 acres of transportation, communication, and utility facility land use to the existing stock of such land uses within the watershed, for an increase of about 26 percent.

Governmental and Institutional Land Use: As also indicated in Table 3, the land use base would add approximately 1,467 acres of governmental and institutional land use to the existing stock of such land uses within the watershed, for an increase of about 67 percent.

Agricultural Land Use: The previously described increases in urban land uses in the watershed by 1990 would result in a corresponding decrease in agricultural and other rural and related open-space uses. The existing stock of rural land within the watershed could, therefore, be expected to decrease from 533,142 acres in 1968 to 508,256 acres in 1990, a decrease of nearly 5 percent. Of this agricultural and related open-space land which is proposed to be converted to urban uses, 982 acres, or slightly less than 4 percent, would, under the land use base, be prime agricultural land; that is, land which has a relatively high potential crop yield capability, which has consistently produced higher than average yields, and in which the farm sizes and capital investments in agricultural improvements are relatively large. The majority of this prime agricultural land would be lost to urban development in the rapidly urbanizing headwater areas of the watershed in Waukesha County.

Other Land Uses: The land use base also includes proposals for the reservation and development of outdoor recreation and related open-space land uses and for preservation of the primary environmental corridors. These land uses will be described in greater detail in the following sections of this chapter.

ALTERNATIVE NATURAL RESOURCE PROTECTION PLAN ELEMENTS

The concept of the environmental corridor was set forth in Chapters IV and XII of Volume 1 of this report. In addition, these chapters discussed the importance of the preservation of the primary environmental corridors to the protection of the best remaining elements of the natural resource base, including the surface waters and associated shorelands and floodlands; woodlands; wetlands; and wildlife habitat areas, as well as the best remaining potential park and related open-space sites, including high-value historic, scientific, and scenic sites within the watershed. The primary environmental corridors encompass about 198 square miles, or approximately 21 percent of the total watershed area of 939 square miles. These primary environmental corridors, however, contain 92 percent of the perennial stream channel length, 66 percent of the shoreline of the 45 major lakes within the watershed, 69 percent of all remaining wetlands, 40 percent of all remaining woodlands, 28 percent of all unused lands, 56 percent of all remaining wildlife habitat area, and 50 percent of all potential park and related open-space sites remaining within the watershed (see Table 4). Any plan for the preservation, protection, and wise use of the natural resource base within the watershed must, therefore, be centered on the preservation and protection of primary environmental corridors.

The complex of resource elements contained within the primary environmental corridors includes 22,405 acres of water area, 36,638 acres of wetland area, 26,851 acres of woodland area, 3,061 acres of unused land area, and 37,740 acres

Table 4

DISTRIBUTION OF SELECTED NATURAL RESOURCE ELEMENTS IN THE FOX RIVER WATERSHED AND IN THE PRIMARY ENVIRONMENTAL CORRIDOR IN THE WATERSHED: 1966[a]

Resource Element	Acres or Miles		Percent in Corridor
	In Watershed	In Corridor	
Streams (Miles)	300	277	92
(Acres)	6,083	5,510	91
Lakes (Acres)	22,349	16,895	76
Wetlands (Acres)	53,226	36,638	69
Woodlands (Acres)	67,270	26,877	40
High-Value	*30,420*	*15,858*	*52*
Medium-Value	*28,870*	*8,063*	*28*
Low-Value	*7,980*	*2,956*	*37*
Agricultural and related Land (Acres)	388,848	37,740	9
Unused land (Acres)	11,055	3,061	28
Wildlife habitat (Acres)	119,539	66,550	56
Existing outdoor recreational sites (Acres)	36,312	21,044	58
Potential outdoor recreational sites (Acres)	36,860	23,206	63
Total area (Acres)	600,779	126,695	21

[a]The areas indicated for the natural resource elements set forth in this table will not total to the area of the watershed since these elements are not mutually exclusive in nature; that is, such elements as woodlands and wetlands also constitute area delineated as wildlife habitat and potential outdoor recreational sites.

Source: Wisconsin Department of Natural Resources and SEWRPC.

of agricultural and agricultural-related land area. Any plan for the preservation, protection, and wise use of the primary environmental corridors of the Fox River watershed must, in turn, consist of a carefully selected mosaic of proposals for the protection of the complex of individual resource elements comprising these corridors.

Three alternative natural resource protection plan elements were developed in the process of detailing and refining the regional land use plan for the Fox River watershed. Each of these three alternative plan elements was designed to provide for the preservation, protection, and wise use of the best remaining elements of the natural resource base, with emphasis on protecting and preserving the regenerative qualities of that base, including the soils, surface and ground water, wetlands, woodlands, and wildlife. All of the alternatives are centered on the preservation of the primary environmental corridors, with each alternative including all of the elements of the preceding alternative, thereby more completely attaining the watershed land use development objectives as these objectives relate to the protection and enhancement of the natural resource base. Detailed studies supporting each of these alternative plans are contained in technical memoranda retained in the files of the Commission.

Minimum Alternative Natural Resource Protection Plan Element

The first alternative natural resource protection plan element considered was a minimum design intended to protect through public acquisition, zoning, and management the primary environmental corridors of the watershed as delineated in the adopted regional land use plan. This alternative plan element consists of seven specific subelements:

1. Public acquisition of all undeveloped primary environmental corridor lands lying within those areas of the watershed expected to be in urban use by 1990. These lands total 14,472 acres, or 2.4 percent of the total watershed area.

2. Public acquisition of the undeveloped primary environmental corridor lands constituting the Vernon Marsh and associated potential flood control and water supply reservoir area. This area proposed to be acquired totals 2,651 acres, or 0.4 percent of the total watershed area.

3. Public acquisition of the undeveloped primary environmental corridor lands constituting the proposed Sugar Creek multiple-purpose reservoir area. This area totals 3,424 acres, or 0.5 percent of the total watershed area.

4. Public acquisition of selected remaining high-value wetlands located in the primary environmental corridors adjacent to existing publicly owned and leased woodland, wetland, and wildlife areas. These areas total 4,549 acres, or 0.7 percent of the total watershed area.

5. Public acquisition of selected remaining high-value woodlands located in the primary environmental corridors adjacent to existing publicly owned woodland, wetland, and wildlife areas. These areas total 4,369 acres, or 0.7 percent of the total watershed area.

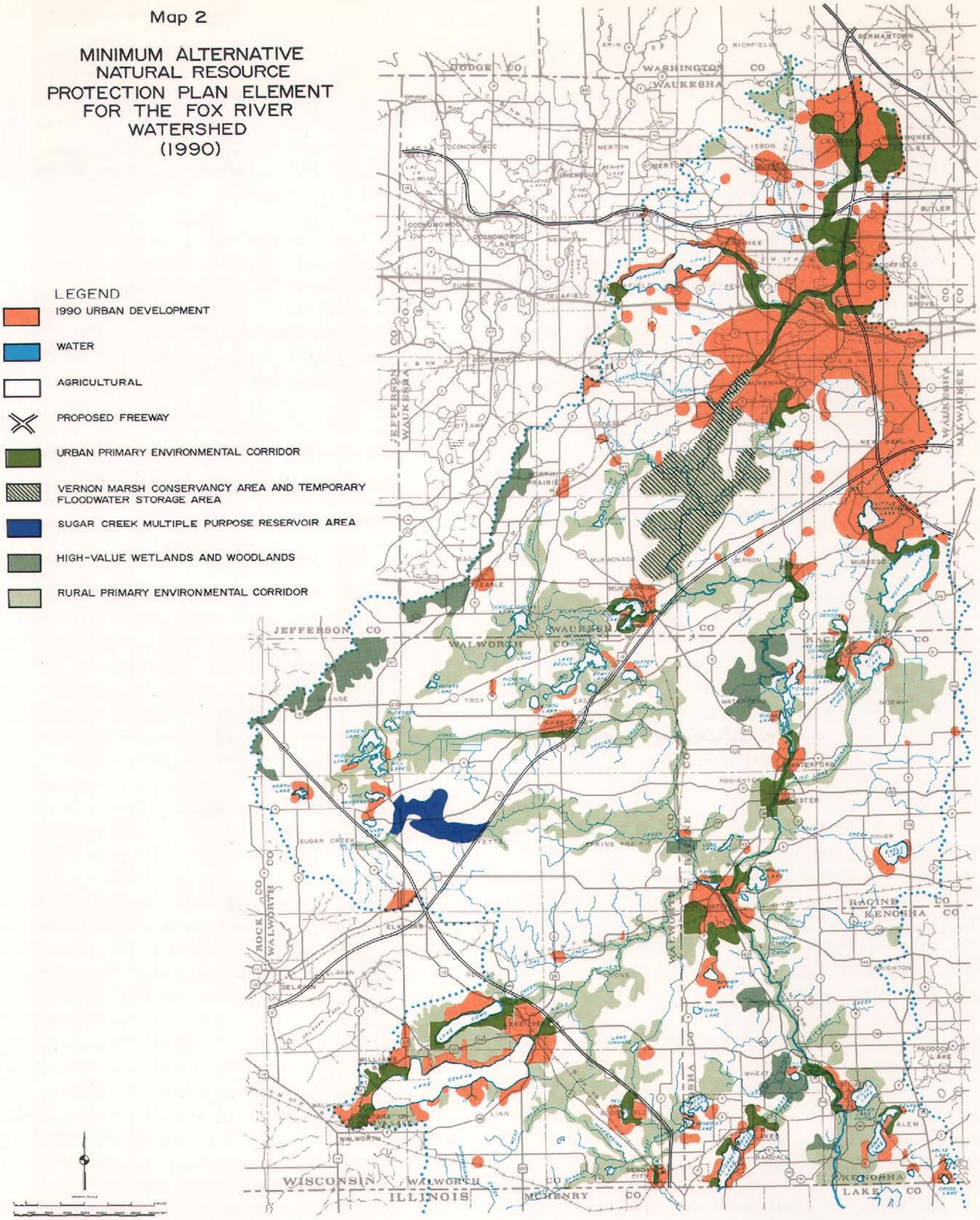
6. Protection of all remaining environmental corridor areas in rural portions of the watershed through appropriate agricultural, floodland, shoreland, conservancy, and low-density residential zoning. These areas total 65,441 acres, or 10.8 percent of the total watershed area.

7. Promotion of good management of all remaining woodland and wetland resources of the watershed.

Urban Environmental Corridor Acquisition: This proposal consists of the acquisition for public use of all remaining undeveloped primary environmental corridors lying in areas of the watershed expected to be in urban use in 1990 (see Map 2). This would require the staged acquisition of a total of 14,472 acres of urban environmental corridor lands within the watershed, in addition to the 656 acres presently in public ownership (see Table 5). Waukesha County would have the largest share, 6,179 acres, of the primary environmental corridor area to be acquired under this proposal. The acquisition of these urban environmental corridor lands would permanently protect 6,065 acres of wetland, 3,718 acres of woodland, and 4,376 acres of potential park site within the watershed. These urban environmental corridor lands also comprise 14.5 percent of the total environmental corridor acreage proposed to be utilized for park and open-space uses in the 1990 regional land use

Map 2

MINIMUM ALTERNATIVE NATURAL RESOURCE PROTECTION PLAN ELEMENT FOR THE FOX RIVER WATERSHED (1990)



The first alternative natural resource protection plan element considered in the Fox River watershed study was a minimum proposal intended to protect, through, minimal public land acquisition, the primary environmental corridors of the watershed. This alternative proposes public acquisition of only those primary environmental corridor lands lying within those areas of the watershed expected to be in urban use by 1990, the Vernon Marsh wildlife conservancy and temporary floodwater storage area, the Sugar Creek multiple-purpose reservoir area, and certain selected high-value wetlands and woodlands in the environmental corridors along the main stem of the Fox River and in the Kettle Moraine area of the watershed. Total public acquisition proposed under this alternative is about 29,500 acres, or 23 percent, of the primary environmental corridor land in the watershed.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 5

EXISTING AND PROPOSED PUBLIC OWNERSHIP OF SELECTED ENVIRONMENTAL CORRIDOR LANDS BY COUNTY: 1967 AND 1990 ALTERNATIVE NATURAL RESOURCE PROTECTION PLAN ELEMENTS[a]

County	Urban Environmental Corridor						Vernon Marsh Environmental Corridor						Sugar Creek Multiple-Purpose Reservoir Area					
	Existing Public Ownership (1967)		Proposed Public Acquisition		Total (1990)		Existing Public Ownership (1967)		Proposed Public Acquisition		Total (1990)		Existing Public Ownership (1967)		Proposed Public Acquisition		Total (1990)	
	Acres	Percent of Watershed	Acres	Percent Change	Acres	Percent of Watershed	Acres	Percent of Watershed	Acres	Percent Change	Acres	Percent of Watershed	Acres	Percent of Watershed	Acres	Percent Change	Acres	Percent of Watershed
Kenosha	--	--	2,014	--[b]	2,014	13.3	--	--	--	--	--	--	--	--	--	--	--	--
Racine	--	--	2,832	--[b]	2,832	18.7	--	--	--	--	--	--	--	--	--	--	--	--
Walworth	--	--	3,447	--[b]	3,447	22.8	--	--	--	--	--	--	--	--	3,424	--[b]	3,424	100.0
Waukesha	656	100.0	6,179	941.9	6,835	45.2	3,896	100.0	2,651	68.0	6,547	100.0	--	--	--	--	--	--
Watershed Total	656	100.0	14,472	2,206.0	15,128	100.0	3,896	100.0	2,651	68.0	6,547	100.0	--	--	3,424	--[b]	3,424	100.0

County	High-Value Wetland Area						High-Value Woodland Area						Total					
	Existing Public Ownership (1967)		Proposed Public Acquisition		Total (1990)		Existing Public Ownership (1967)		Proposed Public Acquisition		Total (1990)		Existing Public Ownership (1967)		Proposed Public Acquisition		Total (1990)	
	Acres	Percent of Watershed	Acres	Percent Change	Acres	Percent of Watershed	Acres	Percent of Watershed	Acres	Percent Change	Acres	Percent of Watershed	Acres	Percent of Watershed	Acres	Percent Change	Acres	Percent of Watershed
Kenosha	690	51.6	1,209	175.2	1,899	32.3	--	--	--	--	--	--	690	8.3	3,223	467.1	3,913	10.4
Racine	647	48.4	3,193	493.5	3,840	65.2	--	--	--	--	--	--	647	7.6	6,025	931.2	6,672	17.6
Walworth	--	--	147	--[b]	147	2.5	912	37.1	2,967	325.3	3,879	56.8	912	10.9	9,985	1,094.8	10,897	28.8
Waukesha	--	--	--	--	--		1,545	62.9	1,402	90.7	2,947	43.2	6,097	73.2	10,232	167.8	16,329	43.2
Watershed Total	1,337	100.0	4,549	340.2	5,886	100.0	2,457	100.0	4,369	177.8	6,826	100.0	8,346	100.0	29,465	353.0	37,811	100.0

[a]*The proposed public acquisition of various environmental corridor lands as set forth in this table is included in the minimum, intermediate, and optimum natural resource protection plan elements as described in this chapter.*

[b]*The percent change is infinity and cannot be determined.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

plan. The total cost of acquiring the urban environmental corridors is estimated at $28,944,000.

Vernon Marsh Environmental Corridor Acquisition: This proposal consists of the acquisition of the entire Vernon Marsh area in Waukesha County for its natural resource conservation value. Such acquisition would also serve to protect the area for potential use as a surface water storage area for flood control and water supply purposes beyond the design year of the watershed plan (see Map 2). These potential uses are discussed in Chapters IV and VI of this volume, respectively. This proposal would require the staged acquisition of a total of 2,651 acres of environmental corridor lands within the watershed in addition to the 3,896 acres presently owned by the Wisconsin Department of Natural Resources. Included within the area of proposed acquisition are 876 acres of wetland and 222 acres of woodland, which would be permanently protected by acquisition of this area. The total cost of acquiring the remaining Vernon Marsh acreage is estimated at $1,417,700.

Sugar Creek Multiple-Purpose Reservoir Area Acquisition: This proposal consists of the acquisition of the lands required for development of a multiple-purpose reservoir on Sugar Creek in the Towns of LaFayette and Sugar Creek, Walworth County, to be used for floodwater storage, recreational development, and low-flow augmentation (see Map 2). The floodwater storage plan element is discussed in Chapter IV of this volume. The total area proposed to be acquired is 3,424 acres. Included within this total are 936 acres of woodland, 518 acres of wetland, and 1,820 acres of potential park site available for outdoor recreation use. The total cost of acquiring this site is estimated at $2,396,800.

High-Value Wetland Acquisition: Continued acquisition of selected high-resource-value wetlands within the primary environmental corridors of the watershed is proposed in this plan element in order to protect and enhance existing public ownership (see Map 2). Additional wetland acreage proposed to be acquired includes the best remaining wetlands within the watershed adjacent to the existing wildlife-wetland conservancy areas of the watershed. Acquisition of these areas would total 4,549 acres, which includes 2,413 acres of wetland (see Table 5). The proposed acquisition represents 4.9 percent of the wetlands within the watershed. Areas proposed for additional high-value wetland acquisition are the Tichigan Wildlife Area, the Honey Creek Wildlife Area, and the Karcher Marsh Wildlife Area in Racine County; the New Munster Wildlife Area in Kenosha County; and scattered wetland parcels in Kenosha, Racine, and Walworth Counties. The total cost of acquiring these high-value wetlands is estimated at $909,800.

High-Value Woodland Acquisition: The continued acquisition of selected high-resource-value woodlands within the primary environmental corridors of the watershed is also recommended to meet woodland preservation objectives (see Map 2). Acquisition of high-value woodlands within the watershed should be continued in order to complete acquisition of the Kettle Moraine State Forest. It is extremely important that certain areas of the watershed, such as the Kettle Moraine area, remain in open space and woodland cover for all time. The Kettle Moraine is the major ground water recharge area for the deep sandstone aquifer, which serves and must continue to serve as the major source of municipal and industrial water supply for all that part of the seven-county Region lying west of the subcontinental divide, including the upper Fox River watershed. The existing woodlands in this recharge area should be preserved and managed in order to protect both the quality and quantity of this important water resource.

In addition to continued acquisition in the Kettle Moraine area, it is recommended that selected high-value woodlands adjacent to existing parks or recreation areas in the watershed be acquired for public use. Acquisition of buffer zones or "backup area" for these parks can supply much needed woodland and open-space reserve for the watershed. The total such woodland area recommended for acquisition is 4,369 acres, in addition to the 2,457 acres presently in public ownership (see Table 5). These 4,369 acres include 2,072 acres of high-value woodland, or 47 percent of the total selected high-value woodland acquisition. This figure also represents 3.7 percent of the woodlands in the watershed. The total cost of acquiring these high-value woodlands is estimated at $3,058,300.

Primary Environmental Corridor Zoning: Public acquisition of the primary environmental corridor lands within the watershed is the best means of protecting and enhancing the natural resource base of the watershed, providing needed park and open space, protecting floodlands from incompatible urban uses, and lending form and structure to urban development. Those areas of the primary environmental corridors which are not actually acquired for public use, however, should be kept in compatible, essentially natural open uses. This can largely be achieved through the use of agricultural, floodland, shoreland, conservancy, and very low-density residential zoning within the watershed. This zoning should, at minimum, encompass all of the riverine areas of the watershed lying within the 100-year recurrence flood hazard line and all areas within 1,000 feet of the shoreline of the 45 major lakes within the watershed. Such zoning will assist in protecting the remaining woodlands, wetlands, and wildlife habitat areas, as well as water quality, within the watershed from continued deterioration and destruction by fragmented urban development. These zoning measures would also serve to prevent intensification of flood problems within the watershed, constituting the major flood control element in the watershed plan. It is proposed that 66,441 acres, or 51.6 percent, of primary environmental corridors within the watershed be zoned in a manner appropriate to the preservation of the natural resource element (see Map 2). Those areas of the corridors proposed to be acquired for public use should be initially zoned as exclusive agricultural, floodland, park land, or conservancy districts in order to achieve immediate protection from urban encroachment pending public acquisition.

Wetland and Woodland Resource Management: In addition to the foregoing environmental corridor acquisition and zoning proposals, it is recommended that adequate management practices be instituted for all remaining natural resource base elements within the watershed. These management practices should be extended to the 40,419 acres of woodlands and 16,546 acres of wetlands in the watershed which lie outside the environmental corridor boundaries, as well as to the corridor areas themselves. The continued function of these areas in sustaining a varied biota, including the production of wildlife; in the protection and enhancement of water quality; and in the maintenance of a natural well-regulated flow regimen within the watershed can only be ensured by applying good forestry and wetland management measures.

The woodlands should be protected and managed to meet the watershed area standard regarding woodland cover. This standard requires that a minimum of 10 percent, or 60,078 acres, of the total watershed area be devoted to woodland cover. There are presently 67,270 acres of woodlands in the watershed. The total area of woodlands recommended to be preserved through existing and proposed public ownership, however, totals only 9,549 acres, or 1.6 percent of the total area of the watershed. There remain a minimum 50,529 acres of woodlands, including 33,227 acres outside the primary environmental corridor areas, which will have to be protected by management practices to ensure that the woodland standard is met.

To ensure complete protection for all wetlands of 50 acres or more in size, management procedures must be established throughout the watershed outside, as well as within, the primary environmental corridors. There is presently a total of 53,184 acres of wetlands in the watershed. The total area of wetlands proposed to be protected by existing and proposed public ownership is 14,597 acres, leaving 38,587 acres of wetlands, including 16,546 acres lying outside the primary environmental corridors, to be protected by good management practices.

Concluding Remarks—Minimum Alternative Natural Resource Protection Plan Element: The total primary environmental corridor acreage to be acquired for public use under this alternative plan element is 29,465 acres, including 14,472 acres of urban environmental corridor lands, 6,075 acres of land in proposed reservoir areas, and 8,918 acres of additional high-value woodland and wetland acquisitions for environmental protection and preservation of wildlife, open space, recreation, and natural biotic functions (see Table 5). The total cost of acquiring this corridor land is estimated at $36,726,600. Including the 9,384 acres of the primary environmental corridor presently in public ownership, a total of 38,849 acres of corridor lands would be held in public trust. This total area of 38,849 acres constitutes 30.6 percent of the primary environmental corridor area delineated within the Fox River watershed and 6.5 percent of the total area of the watershed. Also under this alternative, a total of 65,441 acres of primary environmental corridor land would be protected by appropriate agricultural, floodland, shoreland, conservancy, and low-density residential zoning.

This natural resource protection plan alternative would provide a minimum program for preservation of the resource base of the watershed through public acquisition of selected primary environmental corridor areas subject to urbanization, zoning of the remaining environmental corridor area, and application of good management practices to all woodlands and wetlands lying both within and outside the primary environmental corridors. It would result in an integrated system of public greenways and resource protection districts within the watershed which would ensure the provision of needed park and related open-space lands within the rapidly urbanizing Region, lend form and structure to urban development, and prevent intensification of flooding and water pollution within the watershed. Less than 31 percent of the primary environmental corridors in the watershed, however, would be permanently protected from urban encroachment through public acquisition.

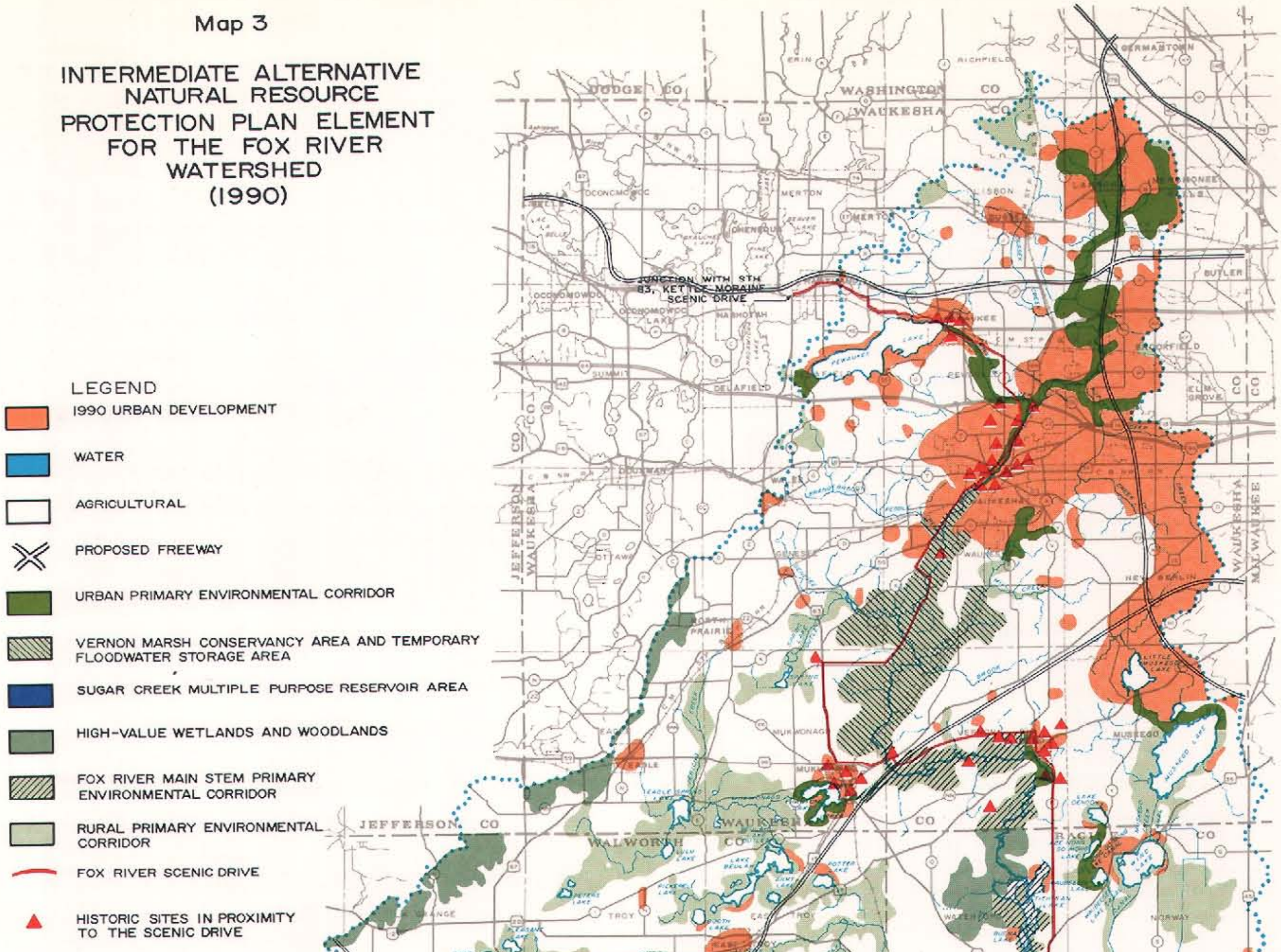
Intermediate Alternative Natural Resource Protection Plan Element

The second alternative natural resource protection plan element considered included all of the subelements proposed in the first alternative natural resource protection plan element, and, in addition, public acquisition of all other undeveloped primary environmental corridor lands remaining along the main stem of the Fox River in southeastern Wisconsin. This proposal would entail the acquisition of the remaining 7,446 acres of primary environmental corridor along the main stem of the Fox River not previously proposed for acquisition under the first alternative natural resource protection plan element and not already in public ownership (see Map 3). Such acquisition would include the preservation and protection of an additional 2,311 acres of wetland and 1,733 acres of woodland encompassed within the primary environmental corridors of the watershed (see Table 6). The total cost of acquiring this additional environmental corridor land is estimated at $5,212,200.

Public acquisition of all of the primary environmental corridor lands along the main stem of the Fox River would not only assure preservation of the singularly most important environmental corridor within the watershed but would also facilitate the establishment of a continuous scenic parkway drive along the main stem of the Fox River, as shown on Map 3. The proposed scenic parkway drive would utilize existing street and highway facilities for its total length of 63 miles. The route as proposed would begin with a con-

Map 3

INTERMEDIATE ALTERNATIVE NATURAL RESOURCE PROTECTION PLAN ELEMENT FOR THE FOX RIVER WATERSHED (1990)



The second alternative natural resource protection plan element considered in the Fox River watershed study was an intermediate proposal designed to permanently protect a greater proportion of the environmental corridor lands through public acquisition. In addition to the land acquisition proposed under the first alternative, the second alternative proposes to acquire for public use all remaining undeveloped environmental corridor lands along the main stem of the Fox River. Such acquisition would not only assure permanent preservation and protection of the most important environmental corridor area within the waterhed but would also facilitate the establishment of a continuous scenic parkway drive along the main stem of the Fox River. Total additional public land acquisition proposed under this alternative is 7,446 acres, or an additional 6 percent, of the primary environmental corridor area within the watershed.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 6

EXISTING AND PROPOSED PUBLIC OWNERSHIP OF ADDITIONAL FOX RIVER MAIN STEM ENVIRONMENTAL CORRIDOR LANDS BY COUNTY: 1967 AND 1990 INTERMEDIATE ALTERNATIVE NATURAL RESOURCE PROTECTION PLAN ELEMENT

County	Fox River Main Stem Environmental Corridor[a]					
	Existing Public Ownership (1967)		Proposed Public Acquisition		Total (1990)	
	Acres	Percent of Watershed	Acres	Percent Change	Acres	Percent of Watershed
Kenosha	65	100.0	1,244	1,913.8	1,309	17.4
Racine	--	--	2,166	--[b]	2,166	28.8
Walworth	--	--	--	--	--	--
Waukesha	--	--	4,036	--[b]	4,036	53.8
Watershed Total	65	100.0	7,446	11,455.3	7,511	100.0

[a] *Does not include environmental corridor lands along the main stem of the Fox River proposed for public acquisition as urban environmental corridor, Vernon Marsh environmental corridor, or high-value wetland areas in Table 5.*

[b] *The percent change is infinity and cannot be determined.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

nection to STH 173 in Illinois near the Illinois-Wisconsin State line and extend along the main stem of the Fox River through all of the cities and villages located along the Fox River to a point just north of the City of Waukesha where it would follow the Pewaukee River to a connection just outside the watershed with STH 83, a part of the Kettle Moraine Scenic Drive.

The proposed Fox River scenic parkway drive would not be developed as are the urban parkway drives along many of the watercourses in Milwaukee County. Rather, the proposal envisions a scenic drive which would have along most of its length expansive areas of agricultural land uses; natural conservancy and wildlife habitat areas, in both public and private ownership; and very low-density residential areas. Areas or sites of historical and cultural significance located adjacent to or near the proposed parkway drive would serve to enhance its value for pleasure driving and sightseeing. There have been identified 176 such sites within the watershed and of this total, 42 sites, or 23.9 percent, lie on or in proximity to the proposed parkway drive, as shown on Map 3. Urban-type parkway development would, however, be appropriate in selected, intermittent urban areas along the route. This scenic drive would thus provide an interesting contrast in environmental quality. The entire Fox River scenic parkway drive could be established, through appropriate roadway markings, over existing streets and highways; and no additional costs have been assigned for implementation of this plan subelement. The drive could, however, be expected to be well utilized since pleasure driving and sightseeing constitute two of the major outdoor recreation activities in terms of total demand.

The adoption and implementation of this second alternative natural resource protection plan element would place a total of 46,295 acres, or 36.5 percent of the primary environmental corridor lands within the watershed and 7.7 percent of the total area of the watershed, in public ownership. Of the total acreage recommended for public ownership, 9,384 acres, or 20.2 percent, are presently publicly owned. A total of 11,299 acres of woodlands, or 16.8 percent of the remaining woodlands and 1.9 percent of the total watershed area, and 16,942 acres of wetlands, or 21.9 percent of the remaining wetlands and

2.8 percent of the total watershed area, would be protected through public ownership under this plan alternative.

The second alternative natural resource protection plan differs from the first alternative only in proposing public acquisition of additional primary environmental corridor lands along the main stem of the Fox River from its source in Waukesha County to the Wisconsin-Illinois State line and in the provision of a scenic parkway drive along the main stem of the Fox River. Thus, through existing public ownership, proposed public acquisition, zoning, and management, a total of 126,695 acres of primary environmental corridor area within the watershed would be protected. In addition, a total of 27,373 acres of high-value wetlands and woodlands would be protected through existing public ownership and proposed zoning and management outside of the primary environmental corridors. This second alternative would better meet the natural resource-related development objectives and standards set forth in this volume than would the first alternative resource protection plan element, since more high-value environmental corridor land would be permanently protected and preserved through public acquisition. It would also assist in carrying out parkway acquisition and development proposals along the main stem of the Fox River as expressed in the county park and parkway plan adopted by the Waukesha County Park and Planning Commission[1] and the environmental corridor preservation proposals contained in the county park plans prepared by the Kenosha County Park Commission[2] and the Racine County Highway and Parks Commission.[3] It should be noted in this respect that proposals for the development of a continuous Fox River parkway from the headwater area to the Wisconsin-Illinois State line date back as far as 1939.[4]

---

[1] *Park and Parkway Plan, Waukesha County, Wisconsin,* Waukesha County Park and Planning Commission, August 6, 1964.

[2] *Kenosha County Outdoor Recreation Plan, Kenosha, Wisconsin,* Kenosha County Park Commission, March 1, 1967.

[3] *Comprehensive Park and Recreation Plan for Racine County,* Racine County Highway and Park Commission, 1969.

[4] Wisconsin State Planning Board and Conservation Commission Bulletin No. 8, *A Park, Parkway, and Recreational Area Plan,* January 1939, Madison, Wisconsin.

Optimum Alternative Natural Resource Protection Plan Element

The third alternative natural resource protection plan element considered included all of the subelements proposed in the first and second alternative plan elements with the addition of the following three major subelements:

1. Public acquisition of additional selected undeveloped primary environmental corridor areas. These areas total 5,506 acres, or 0.9 percent of the total watershed area.

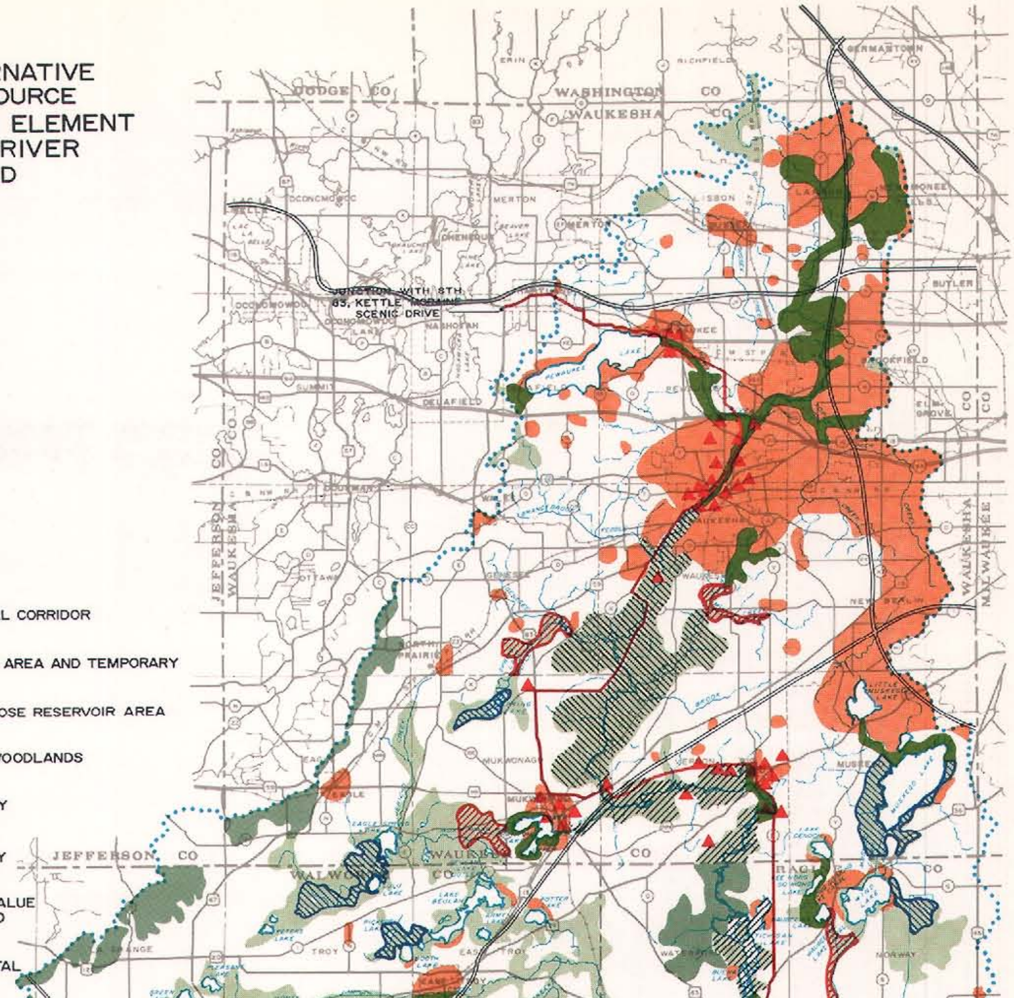
2. Public acquisition of additional selected high-value lake-oriented woodlands and wetlands within the primary environmental corridor areas. These areas total 5,689 acres, or 0.9 percent of the total watershed area.

3. Conservancy zoning of all remaining woodlands, wetlands, and lakeshore areas within the watershed, both within and without the primary environmental corridor areas. These areas total 44,341 acres, or 7.3 percent of the total watershed area.

Selected Additional Primary Environmental Corridor Acquisition: This subelement proposes the acquisition of additional primary environmental corridor lands for the purpose of expanding urban parkways, increasing lake and stream protection, and enlarging the potential for public park and related open-space areas within the watershed. Additional environmental corridor areas recommended for acquisition include the Pebble Brook corridor in the Town of Waukesha; the Spring Lake Creek corridor in the Town of Genesee; the Mukwonago River corridor in the Town of Mukwonago, all in Waukesha County; the Wind Lake Canal corridor in the Towns of Dover, Norway, and Rochester and the Long Lake corridor in the Town of Burlington, both in Racine County; the Bassett Creek corridor in the Town of Randall in Kenosha County; and the White River corridor in the Town of Lyons and the east branch of the Nippersink Creek corridor in the Town of Bloomfield, both in Walworth County (see Map 4). These additional primary environmental corridor acquisitions would encompass a total of 5,506 acres and account for 4.34 percent of the total primary environmental corridor in the watershed (see Table 7). Included in these additional acres would be 2,070 acres of wetland and 1,004 acres of woodland. The total cost of acquiring this addi-

Map 4

OPTIMUM ALTERNATIVE NATURAL RESOURCE PROTECTION PLAN ELEMENT FOR THE FOX RIVER WATERSHED (1990)



LEGEND

- 1990 URBAN DEVELOPMENT
- WATER
- AGRICULTURAL
- PROPOSED FREEWAY
- URBAN PRIMARY ENVIRONMENTAL CORRIDOR
- VERNON MARSH CONSERVANCY AREA AND TEMPORARY FLOODWATER STORAGE AREA
- SUGAR CREEK MULTIPLE PURPOSE RESERVOIR AREA
- HIGH-VALUE WETLANDS AND WOODLANDS
- FOX RIVER MAIN STEM PRIMARY ENVIRONMENTAL CORRIDOR
- SELECTED ADDITIONAL PRIMARY ENVIRONMENTAL CORRIDOR
- SELECTED ADDITIONAL HIGH-VALUE LAKE-ORIENTED WETLANDS AND WOODLANDS
- RURAL PRIMARY ENVIRONMENTAL CORRIDOR
- FOX RIVER SCENIC DRIVE
- HISTORIC SITES IN PROXIMITY TO THE SCENIC DRIVE

The third alternative natural resource protection plan element considered in the Fox River watershed study was an optimum proposal which was intended to permanently protect and preserve additional portions of the primary environmental corridor lands. In addition to the land acquisition proposed under the first and second alternatives, this third alternative proposes to acquire for public use additional selected high-value corridor areas totaling 11,195 acres. These areas together represent an additional 9 percent of the primary environmental corridor area within the watershed, over and above the acquisition proposed in the first and second alternatives.
Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 7

EXISTING AND PROPOSED PUBLIC OWNERSHIP OF ADDITIONAL SELECTED ENVIRONMENTAL CORRIDOR LANDS BY COUNTY: 1967 AND 1990 OPTIMUM ALTERNATIVE NATURAL RESOURCE PROTECTION PLAN ELEMENT

County	Selected Primary Environmental Corridor						Selected High-Value Lake-Oriented Woodland and Wetland Areas						Total					
	Existing Public Ownership (1967)		Proposed Public Acquisition		Total (1990)		Existing Public Ownership (1967)		Proposed Public Acquisition		Total (1990)		Existing Public Ownership (1967)		Proposed Public Acquisition		Total (1990)	
	Acres	Percent of Watershed	Acres	Percent Change	Acres	Percent of Watershed	Acres	Percent of Watershed	Acres	Percent Change	Acres	Percent of Watershed	Acres	Percent of Watershed	Acres	Percent Change	Acres	Percent of Watershed
Kenosha	57	15.9	102	178.9	159	2.7	95	100.0	926	974.7	1,021	17.6	152	33.6	1,028	676.3	1,180	10.1
Racine	21	5.9	2,480	11,809.5	2,501	42.6	--	--	594	--[a]	594	10.3	21	4.6	3,074	14,638.1	3,095	26.6
Walworth	60	16.8	1,740	2,900.0	1,800	30.7	--	--	1,735	--[a]	1,735	30.0	60	13.2	3,475	5,791.7	3,535	30.3
Waukesha	220	61.4	1,184	538.2	1,404	24.0	--	--	2,434	--[a]	2,434	42.1	220	48.6	3,618	1,644.5	3,838	33.0
Watershed Total	358	100.0	5,506	1,537.9	5,864	100.0	95	100.0	5,689	5,988.4	5,784	100.0	453	100.0	11,195	2,471.3	11,648	100.0

[a]*The percent change is infinity and cannot be determined.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

tional environmental corridor land is estimated at $3,539,200.

Selected Additional High-Value Lake-Oriented Woodland and Wetland Acquisition: This subelement proposes public acquisition of additional selected high-value wetlands and woodlands within the primary environmental corridors and in proximity to major lakes within the watershed for the purpose of lake water quality enhancement, wildlife habitat protection, and general open-space preservation. Selected woodlands and wetlands recommended for acquisition include areas around Spring Lake, Eagle Spring Lake, and Big Muskego Lake in Waukesha County; Wind Lake in Racine County; Camp Lake and Silver Lake in Kenosha County; and Lulu Lake in Walworth County (see Map 4). This additional acquisition of high-value woodlands and wetlands adjacent or in close proximity to these seven major lakes would encompass a total of 5,689 acres and account for 5.23 percent of the total woodlands and wetlands within the watershed (see Table 7). In addition, all of these seven major lake areas lie within primary environmental corridors; and such acquisition would, therefore, have multiple open-space and resource protection benefits. Detailed lake use reports have been prepared under the Fox River watershed study for all of the 45 major lakes in the watershed, and these reports delineate the lake-related resource areas requiring some level of protection. The total cost of acquiring these additional lake-oriented woodland and wetland areas is estimated at $3,982,300.

Woodland, Wetland, and Lakeshore Area Zoning: This subelement proposes the extension of conservancy zoning to all remaining high-value woodlands, wetlands, and all undeveloped lake shoreland areas lying outside the primary environmental corridors within the watershed. Such recommended zoning would serve to protect 28,260 acres of woodlands, 16,081 acres of wetlands, and six miles of as yet undeveloped lake shoreline lying outside the primary environmental corridors of the watershed.

Concluding Remarks—Optimum Alternative Natural Resource Protection Plan Element

This alternative plan element would provide optimum protection of not only the primary environmental corridors but all other high-value woodlands, wetlands, and undeveloped lake shoreland areas remaining within the Fox River watershed. Through existing public ownership, proposed public acquisition, zoning, and management, a total of 154,068 acres of primary environmental corridor area and related high-value woodlands and wetlands within the watershed would be protected. Of this total, 58,282 acres, or 38.3 percent, would be permanently preserved through public ownership. This total includes 57,481 acres, which represent 45.4 percent of the total primary environmental corridor area within the watershed. The total cost of acquiring all of the additional environmental corridor and related land proposed in this alternative is estimated at $7,521,500.

Concluding Remarks—Alternative Natural Resource Protection Plan Elements

The relative effectiveness of the three alternative natural resource protection plan elements in meeting the watershed development objectives and standards relating to lakes and streams, woodlands, wetlands, and wildlife habitat area is summarized in Table 8. All three plan elements perform well with respect to these standards. The second alternative would better meet the natural resource development objectives and standards than the first alternative because more woodland and wetland area would be publicly acquired, thus providing greater assurance of permanent protection and preservation of a larger amount of such area. Similarly, the third alternative would better meet the objectives and standards than either the first or second alternative because, again, there would be greater public acquisition of primary environmental corridor lands. All three alternative plan elements require the use of sound floodland, shoreland, and conservancy zoning techniques to supplement public land acquisition.

It is apparent that the adoption and implementation of any one of the three alternative natural resource protection plan elements would have a far-reaching effect on the quality of life within the Fox River watershed, particularly in those areas of the watershed which will be urbanized by 1990. The basic difference between the three alternatives is the amount of public land acquisition, and hence the degree of assurance of the permanent protection and preservation of the primary environmental corridor areas of the watershed.

It is recommended that the second alternative natural resource protection plan element be included in the recommended comprehensive plan. This second alternative plan element would provide permanent preservation of the primary riverine areas of the watershed—along the main stem of the Fox River—where potential flood damages would be greatest if urban development were allowed to encroach and where many of the high-value resources are concentrated. The incremental cost of the second alternative plan element over the first alternative plan element is \$5.2 million. The incremental cost of the third alternative plan element over the second is \$7.5 million. The third alternative was not recommended for inclusion in the comprehensive watershed plan primarily because the additional resource areas protected by this plan element would not be highly

Table 8

COMPARISON OF THE RELATIVE ABILITY OF THE ALTERNATIVE NATURAL RESOURCE PROTECTION PLAN ELEMENTS TO MEET WATERSHED DEVELOPMENT STANDARDS

Objective	Minimum Alternative Natural Resource Protection Plan Element	Intermediate Alternative Natural Resource Protection Plan Element	Optimum Alternative Natural Resource Protection Plan Element
Natural Resources Related Standards[a]			
Inland Lakes and Streams			
1. Large inland lakes over 50 acres (45 lakes)			
a. 25% of shore in natural state	Met for 28 of 45 lakes	Met for 28 of 45 lakes	Met for 28 of 45 lakes
b. 10% of shore in public use	Met for 6 of 45 lakes	Met for 9 of 45 lakes	Met for 13 of 45 lakes
c. 50% of shore in nonurban uses	Met for 16 of 45 lakes	Met for 19 of 45 lakes	Met for 23 of 45 lakes
2. Small inland lakes--under 50 acres (31 lakes)			
a. 25% shore in natural state[b]	Could be met.	Could be met	Could be met
3. Perennial streams (30 streams)			
a. 25% of shore in natural state[c]	Met for 25 of 30 streams	Met for 25 of 30 streams	Met for 25 of 30 streams
b. 50% of shore in nonurban uses[c]	Met for 25 of 30 streams	Met for 25 of 30 streams	Met for 25 of 30 streams
c. Restrict urban uses in floodplains[d]	Met	Met	Met
d. Restrict development in channels and floodways[d]	Met	Met	Met
Wetlands			
1. Protect wetlands over 50 acres and those with high resource values[d]	Met	Met	Met
Woodlands			
1. 10% of the watershed[c]	Met.	Met	Met
2. 40 acres of each forest type[b]	Could be met	Could be met	Could be met
3. 5 acres/1,000 population for recreational pursuits[e]	75 acres/1,000 population	75 acres/1,000 population	75 acres/1,000 population
Wildlife			
1. Maintain a wholesome habitat	Could be met	Could be met	Could be met

[a] *The indicated standards and the development objectives which they support are set forth in full in Chapter II of this volume.*

[b] *This standard could be met by local community action.*

[c] *This standard is met under each alternative plan element because all of the primary environmental corridors are proposed to be protected through public acquisition or effective local zoning.*

[d] *This standard is met under each alternative plan element because it served as an input to the plan design process.*

[e] *Only that woodland within the primary environmental corridors was assumed to be preserved.*

Source: SEWRPC.

susceptible to extensive urban encroachment during the plan design period; and, hence, the additional expenditure of $7.5 million could not be justified at this time.

ALTERNATIVE OUTDOOR RECREATION AND RELATED OPEN-SPACE PLAN ELEMENTS

Three alternative outdoor recreation and related open-space plan elements were prepared under the Fox River watershed planning program, all based upon and constituting refinements of the adopted regional land use plan. Each of these three alternative plan elements was designed to provide areas for the expansion of existing outdoor recreation facilities, as well as to provide areas for the development of new outdoor recreation facilities, while, at the same time, protecting and preserving selected high-value elements of the natural resource base encompassed by each of the specific outdoor recreation sites under consideration. As was true of the three alternative resource protection plan elements considered, the three alternative recreation plan elements are cumulative in nature; that is, the second plan element includes all subelements of the first, and the third includes all subelements of the first and second. The three alternative plan elements differ only in their relative ability to meet, through public acquisition and development of park and outdoor recreation sites, the forecast 1990 demand for recreational land for each of the major outdoor recreation activities.

Outdoor Recreation Demand

The rapidly increasing demand within the Fox River watershed for land and water for outdoor recreation activities was described in Chapter XIII of Volume 1 of this report. A total of 16 outdoor recreation activities were examined in terms of existing (1967) and forecast (1990) participant demand.[5] These 16 outdoor recreation activities were grouped into five classifications based on the type or degree of site development required in order to meet demands of participants in each activity.

The first group contains the five major outdoor recreational activities—swimming, golfing, picnicking, camping, and skiing—that require specific intensive site development. Specific forecasts were made of 1990 demand for land for each of these five major activities. The second group contains only one activity—hunting—which can generally be accommodated on both publicly and privately owned recreational and resource conservancy lands and on lands in other uses, such as agriculture. Thus, no specific 1990 land demand forecast was made for this activity. The third group contains four water-based activities—boating, fishing, water skiing, and canoeing—which require extensive areas of surface water with only a minimal amount of intensive land development, such as boat-launching sites. Since such development is usually undertaken in conjunction with other land- and water-based outdoor recreation activities, no specific 1990 land demand forecasts were made for these activities. The fourth group contains three activities—hiking, horseback riding, and nature walking—the participant demand for which, it was assumed, could be met on existing public recreation and conservancy lands, as well as on nonpublic recreation, agricultural, or other open-space lands. The fifth group contains three activities—pleasure driving, bicycling, and sightseeing—the participant demand for which, it was assumed, could be met on existing and future public highway rights-of-way. Thus, no specific 1990 land demand forecasts were made for any of the activities in the fourth and fifth groups.

Based on the foregoing assumptions, it was determined that a total of 24,102 acres of land in the Fox River watershed would be needed in 1990 to meet the forecast demand for the five major outdoor recreational activities. Existing land area in the watershed, both public and private, devoted to the five major activities totals 7,089 acres. This amount was subtracted from the forecast total demand, resulting in a forecast need of 17,071 acres of additional outdoor recreation land in the watershed. This forecast of additional outdoor recreation land demand became the basis for the preparation of the alternative outdoor recreation and related open-space plan elements.

Potential Park and Related Open-Space Sites

As indicated in Chapter IV of Volume 1 of this report, an inventory of potential park sites conducted by the Commission revealed that there are a large number of potential park and related out-

[5] *These 16 activities, by rank order of forecast demand, are: swimming, pleasure driving, sightseeing, boating, fishing, picnicking, golfing, camping, nature walking, water skiing, hunting, bicycling, skiing, hiking, canoeing, and horseback riding.*

door recreation sites in the Fox River watershed. Of the 255 potential park sites found in the watershed, totaling 36,860 acres, 77 sites, totaling 19,559 acres, were classified as high-value sites.[6] This represents over 40 percent of the total number of, and over 42 percent of the area represented by, such high-value sites in the Southeastern Wisconsin Region. Thus, the Fox River watershed serves as an important recreational resource base, not only for watershed residents but also for residents of the entire Region. These high-value potential park sites, whether developed publicly or privately, can best serve as the basis for the satisfaction of the forecast 1990 recreational land use demand in the watershed. It should be pointed out, however, that rapid urbanization within the watershed may destroy many of these potential park sites for outdoor recreation and related open-space use unless measures are taken to preserve these sites for such use.

Recreational Land Standards
in the Regional Land Use Plan

As discussed in Chapter II of this volume, the Commission has, in its planning efforts to date, adopted regional land use development objectives with supporting principles and standards. One of these objectives and two of these standards deal with recreational land and are of particular importance in the designed alternative outdoor recreation plans for the Fox River watershed. These two standards, as set forth in Chapter II, specify that, for each additional 1,000 persons expected to reside within the Region, 4 acres of land should be set aside for regional public park development and 10 acres should be set aside for local public park development. These standards were used in the design of the adopted regional land use plan and, therefore, are fully met in that plan.

Minimum Alternative Outdoor
Recreation Plan Element

The first alternative outdoor recreation and related open-space plan element considered was based primarily upon application of the aforementioned recreational land use standards to the forecast resident population of the watershed. In an effort to eliminate existing deficits—a feasible objective within the recreational resource-rich and relatively undeveloped Fox River watershed but not in the Region as a whole—the standards were applied to the total forecast watershed population rather than to the incremental population growth, as was done in the preparation of the regional land use plan. The existing (1963) population of the watershed was estimated at 159,500 persons; and the 1990 population of the watershed was estimated at 359,000 persons, an increase of 199,500 persons over the 1963 level. Applying the standard of 4 acres of regional park land to the 1990 resident population of the watershed results in the need for a total of 1,436 acres of regional park land within the watershed. Applying the standard of 10 acres of local park land to the 1990 resident population of the watershed results in the need for a total of 3,590 acres of local park land within the watershed. Thus, the estimated total park land need within the watershed under this alternative is 5,026 acres.

There are four existing regional outdoor recreation sites in the Fox River watershed, totaling 871[7] acres in area (see Map 5). These four sites are:

1. Menomonee County Park in the Village of Menomonee Falls, Waukesha County, with a total existing site area of 233 acres.
2. Mukwonago County Park in the Town of Mukwonago, Waukesha County, with a total existing site area of 169 acres.
3. Naga-Waukee County Park in the Town and City of Delafield, Waukesha County, with a total existing site area of 211 acres.
4. Big Foot Beach State Park on Geneva Lake in the Town of Linn, Walworth County, with a total existing site area of 138 acres.

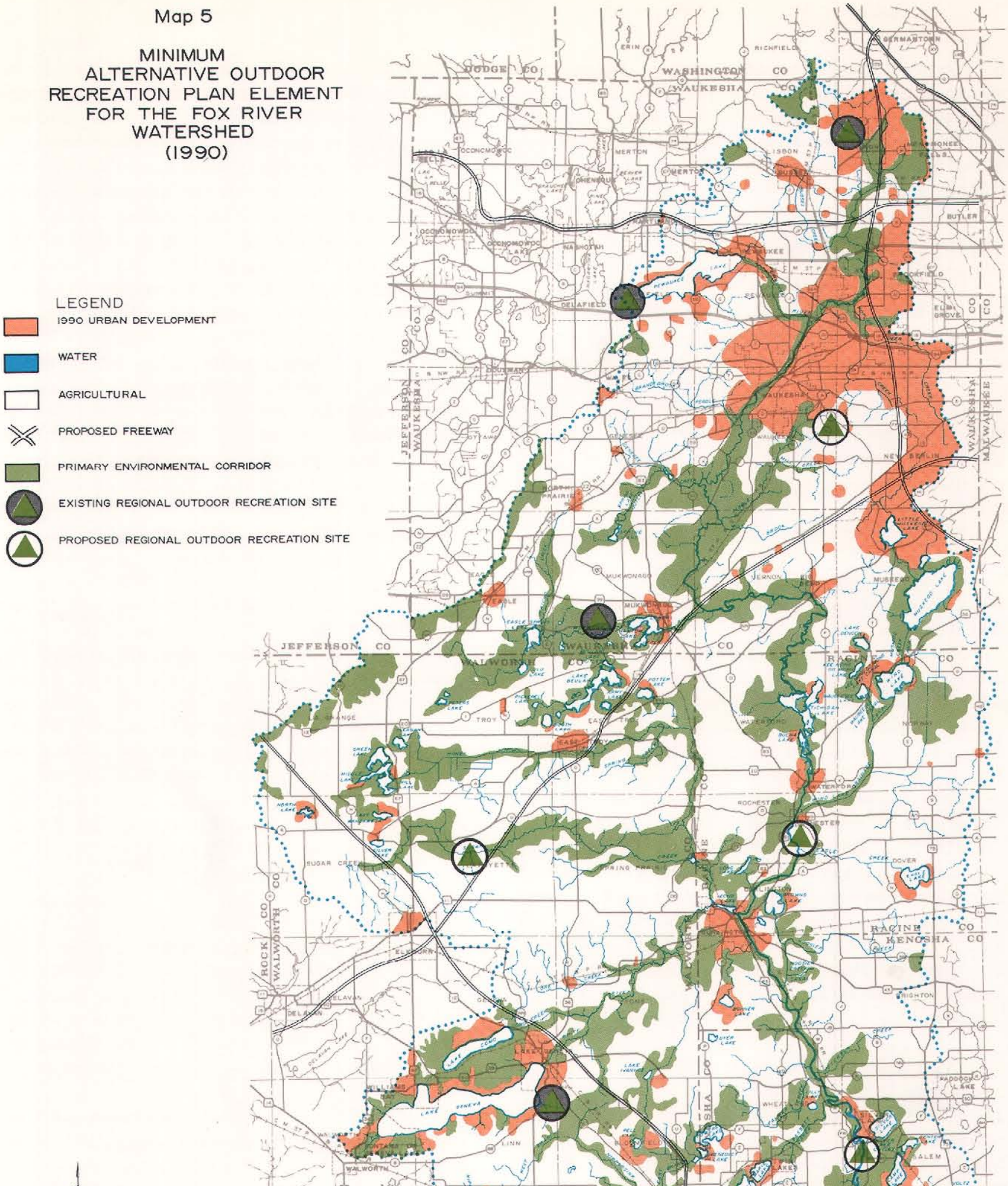
The first alternative outdoor recreation plan element includes the maintenance and further development of these four regional park sites. These four park sites presently encompass 185 acres of woodland and wetland, and all four sites lie within, or adjacent to, primary environmental corridors.

[6] *Of the 255 potential park sites identified in the watershed, 144 sites, totaling 23,206 acres, or 56 percent of the total sites and 63 percent of the acreage, lie within, or are adjacent to, the primary environmental corridor.*

[7] *This total includes, in addition to the 4 enumerated sites, 120 acres of existing park land in the Fox River County Park in Kenosha County, a park proposed to be expanded to regional status.*

Map 5

MINIMUM ALTERNATIVE OUTDOOR RECREATION PLAN ELEMENT FOR THE FOX RIVER WATERSHED (1990)



The first alternative outdoor recreation plan element considered in the Fox River watershed study was a minimum design intended to meet only the outdoor recreation demand expected to be generated by residents of the watershed and, with respect to the need for regional parks, the demand generated by residents of the Southeastern Wisconsin Region. This plan element was based upon application of the adopted recreational land use standards of the 10 acres of local park and 4 acres of regional park per thousand resident population. The plan would add 2,617 acres of regional park land at four sites and 2,383 acres of local park land within the watershed.

Source: Wisconsin Department of Natural Resources and SEWRPC.

An additional 565 acres of regional park land is needed within the watershed to meet the aforementioned standard of 4 acres per 1,000 resident population, or a total of 1,436 acres. Because the Fox River watershed, however, contains a high proportion of the total remaining potential high-value park sites within the Region and because park sites should be developed around high-value recreational resources as these resources occur in nature, the Fox River watershed serves as a valuable recreational resource, in terms of needed potential multi-purpose regional park sites, for the entire Region of which it is an integral part. The first alternative outdoor recreation plan element, therefore, includes proposals for the acquisition and development within the watershed of three entirely new regional outdoor recreation sites and a major expansion of an existing local park site to meet regional park standards. These four sites, which are the best remaining potential park sites within the watershed, are:

1. The Minooka Park site in the Town of Waukesha, Waukesha County,[8] with a total proposed site area of 297 acres.

2. The Sugar Creek park site in the Town of LaFayette, Walworth County, proposed to be developed in conjunction with a multipurpose reservoir as described in Chapter IV of this volume, with a total proposed site area of 1,820 acres.

3. A western Racine County park site on the Fox River in the Town of Rochester, with a total proposed site area of 250 acres.

4. The existing Fox River Park site in the Town of Salem, Kenosha County, proposed to be expanded in area by 250 acres to regional status, with a total proposed site area of 370 acres.

One of these four, the Sugar Creek site, was rated as one of the eight best remaining potential park sites within the entire seven-county Region. These four proposed regional outdoor recreation sites would encompass a total area of 2,617 acres and would bring the total regional park area within the watershed to 3,488 acres, 2,052 acres in excess of the regional park standard as applied to the forecast total 1990 Fox River resident watershed population (see Map 5 and Table 9). Of the 2,617 acres proposed to be acquired for regional park sites, 1,820 acres would be acquired under the primary environmental corridor land acquisition recommended in the natural resource protection plan element at an estimated cost of $1,264,000. The cost of acquiring the remaining 797 acres of regional park site land is $557,900. The estimated cost of developing the entire 2,617 acres is $3,925,500.

Existing local park lands in the Fox River watershed total 1,207 acres. The first alternative outdoor recreation plan element includes the maintenance and further development as necessary of this existing local park acreage. In addition, the plan proposes the acquisition and development as community and neighborhood parks of an additional 2,383 acres of land in order to meet fully the standard of 10 acres of local park land per 1,000 resident population. It is estimated that up to one-fourth of this additional local park land could be acquired through dedication during land subdivision development in expanding urban areas of the watershed. The remaining acreage could be provided within the primary environmental corridors in urban areas. Therefore, acquisition of the primary environmental corridors lying within urban areas of the watershed, as proposed earlier in this chapter, would provide all of the land needed for three-fourths of the required additional local park land development. The estimated cost of developing these sites is $16,145,000, the acquisition cost of $3,694,000 having been included in the recommended natural resource protection plan element.

The total outdoor recreation land proposed to be acquired and developed under the first alternative plan element is 5,000 acres, or about 29 percent of the 17,071 acres of land required to meet the total recreation demand which can be expected to be exerted on the watershed by 1990 from both resident and nonresident and in-Region and out-of-Region populations. It is assumed under this alternative that the demand not met through public action will be met through private recreational development. If such private development is not forthcoming, the excess demand will result in overcrowding and overuse of the available public park and recreation areas and in the deterioration and destruction of the recreation-related resource base.

[8] *This site has already been purchased and is under development by Waukesha County.*

Table 9

EXISTING AND PROPOSED LOCAL AND REGIONAL PARKS IN THE FOX RIVER WATERSHED BY COUNTY: 1967 AND 1990 ALTERNATIVE OUTDOOR RECREATION PLAN ELEMENTS[a]

County	Local Parks						Regional Parks						Total					
	Existing (1967)		Planned Increment		Total (1990)		Existing (1967)		Planned Increment		Total (1990)		Existing (1967)		Planned Increment		Total (1990)	
	Acres	Percent of Watershed	Acres	Percent Change	Acres	Percent of Watershed	Acres	Percent of Watershed	Acres	Percent Change	Acres	Percent of Watershed	Acres	Percent of Watershed	Acres	Percent Change	Acres	Percent of Watershed
Kenosha	33	2.7	90	272.7	123	3.4	120	13.8	250	208.3	370	10.6	153	7.4	340	222.2	493	7.0
Racine	191	15.8	247	129.3	438	12.2	--	--	250	--[b]	250	7.2	191	9.2	497	260.2	688	9.7
Walworth	461	38.2	--	--	461	12.9	138	15.8	1,820	1,318.8	1,958	56.1	599	28.8	1,820	303.8	2,419	34.2
Waukesha	522	43.3	2,046	391.9	2,568	71.5	613	70.4	297	48.4	910	26.1	1,135	54.6	2,343	206.4	3,478	49.1
Watershed Total	1,207	100.0	2,383	197.4	3,590	100.0	871	100.0	2,617	300.4	3,488	100.0	2,078	100.0	5,000	240.6	7,078	100.0

[a]*The planned increment in local and regional parks set forth in this table is included in the minimum, intermediate, and optimum alternative outdoor recreation and related open-space plan elements as described in this chapter.*

[b]*The percent change is infinity and cannot be determined.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Intermediate Alternative Outdoor Recreation Plan Element

As noted earlier in this section, the three alternative outdoor recreation and related open-space plan elements prepared for the Fox River watershed are cumulative in nature. Thus, the second alternative plan includes all of the elements of the first alternative plan (see Table 9). In addition, the second alternative plan element proposes public acquisition and development of an additional 23 high-value potential park sites within the watershed (see Map 6 and Table 10). These 23 sites are primarily located near, or adjacent to, bodies of water. Public development of such sites would provide a greater recognition of the need to meet through public action the increasing demand for water-based outdoor recreational activities. The total amount of land proposed to be acquired for these 23 high-value sites is 7,227 acres. Of this total, 3,283 acres, or 45 percent, lying within the environmental corridors would be acquired at an estimated cost of $2,298,100 for public use under the recommended natural resource protection plan element. The cost of acquiring the remaining 3,944 acres is estimated at $2,760,800. The estimated cost of developing the entire 7,227 acres is $7,227,000.

The total outdoor recreation land proposed to be acquired under the second alternative plan element is 12,227 acres, or 76 percent of the 17,071 acres of land required to meet fully the forecast recreation demand. Like the first alternative, this second alternative assumes that the demand not met through public action will be met through private recreational development. If such pri-

Table 10

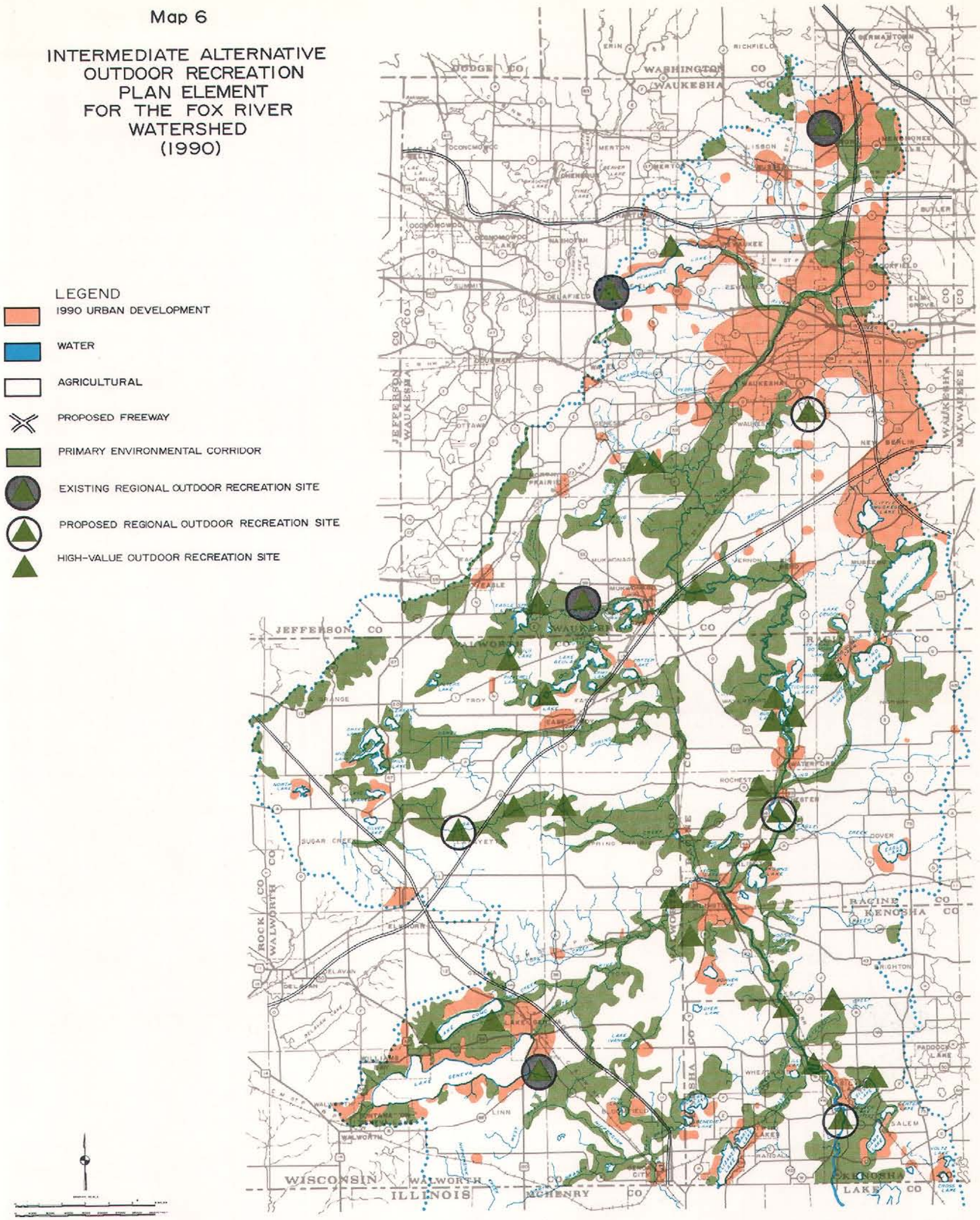
PROPOSED ADDITIONAL PARKS AT SELECTED POTENTIAL HIGH-VALUE PARK SITES IN THE FOX RIVER WATERSHED BY COUNTY: 1990 INTERMEDIATE ALTERNATIVE OUTDOOR RECREATION PLAN ELEMENT

County	Additional Parks		
	Number	Acres	Percent of Total Acres
Kenosha	4	834	11.5
Racine	7	1,927	26.7
Walworth	7	3,065	42.4
Waukesha	5	1,401	19.4
Watershed Total	23	7,227	100.0

Source: Wisconsin Department of Natural Resources and SEWRPC.

Map 6

INTERMEDIATE ALTERNATIVE OUTDOOR RECREATION PLAN ELEMENT FOR THE FOX RIVER WATERSHED (1990)



The second alternative outdoor recreation plan element considered in the Fox River watershed study was an intermediate design intended to meet not only the recreational demand expected to be generated by residents of the watershed and the Region but also a portion of the demand expected to be generated by persons residing outside the Region. In addition to the regional and local parks proposed under the first alternative, this intermediate plan element proposes to establish an additional 23 parks at high-value potential park sites in the watershed. These additional sites, totaling 7,227 acres, are primarily located near, or adjacent to, bodies of water so as to provide a better base for meeting the increasing demand for water-based outdoor recreational activities.

Source: Wisconsin Department of Natural Resources and SEWRPC.

vate development is not forthcoming, the excess demand will result in overcrowding and overuse of the public park and recreation areas and in the deterioration and destruction of the recreation-related resource base.

Optimum Alternative Outdoor Recreation Plan Element

The third alternative outdoor recreation and related open-space plan element prepared for the Fox River watershed included all of the elements proposed in the first two alternative plan elements. In addition, the third alternative plan element proposes public acquisition and development of an additional 16 high-value potential park sites within the watershed (see Map 7 and Table 11). The total amount of land proposed to be acquired for these 16 sites is 5,379 acres. Of this total, 2,798 acres, or 52 percent, lying within the environmental corridors would be acquired at an estimated cost of $1,958,600 for public use under the recommended natural resource protection plan element. The cost of acquiring the remaining 2,581 acres is estimated at $1,806,700. The estimated cost of developing the entire 5,379 acres if $5,379,000.

Total outdoor recreation lands proposed to be acquired under the third alternative plan is 17,606 acres. Thus, the third alternative plan would meet and, indeed, slightly exceed, the 17,071 acres of land needed to meet the forecast recreational demand. Of the required 17,071 acres, 9,981 acres, or 58.4 percent, are estimated to be needed to meet the forecast recreational demand generated by out-of-state residents. Any private recreational development would provide additional land to meet the forecast demands and would serve, in effect, to increase the minimum standards utilized in preparing the recreational activity demand forecasts.

Concluding Remarks—Alternative Outdoor Recreation and Related Open-Space Plan Elements

The three alternative outdoor recreation development plan elements meet to varying degrees, through public acquisition and development, the forecast 1990 land use demand for recreation land for major outdoor recreational activities. The first alternative considered would meet about 29 percent of the total land use demand. The second alternative would meet about 76 percent of the total land use demand. The third alternative would meet the entire anticipated land use demand through public acquisition and development. The forecast demand includes expected use of the watershed recreation-related resource base by watershed residents; by residents in the remainder of the Southeastern Wisconsin Region; and by residents outside the Region, primarily residents of the populous northeastern Illinois metropolitan region. The relative effectiveness of the three alternative outdoor recreation plan elements in meeting the watershed development objectives and standards relating to park and recreation lands is summarized in Table 12.

It is not anticipated that the forecast 1990 recreational demand will be lessened to any significant degree by any failure to provide the necessary outdoor recreation land within the watershed. Instead, such failure would result in overcrowding

Table 11

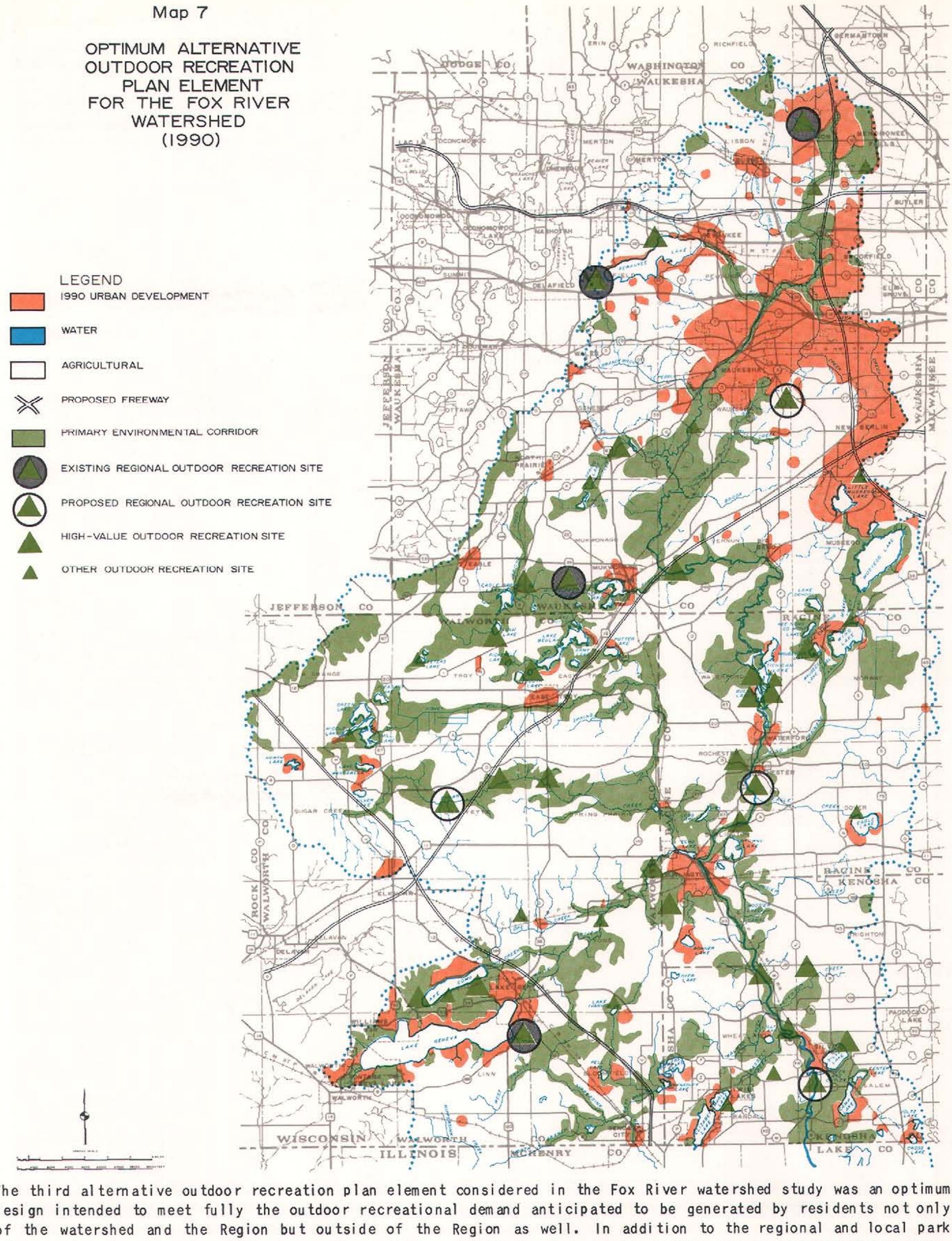
PROPOSED ADDITIONAL PARKS AT SELECTED POTENTIAL HIGH-VALUE PARK SITES IN THE FOX RIVER WATERSHED BY COUNTY: 1990 OPTIMUM ALTERNATIVE OUTDOOR RECREATION PLAN ELEMENT

County	Additional Parks		
	Number	Acres	Percent of Total Acres
Kenosha	2	351	6.5
Racine	3	513	9.6
Walworth	7	1,673	31.1
Waukesha	4	2,842	52.8
Watershed Total	16	5,379	100.0

Source: Wisconsin Department of Natural Resources and SEWRPC.

Map 7

OPTIMUM ALTERNATIVE OUTDOOR RECREATION PLAN ELEMENT FOR THE FOX RIVER WATERSHED (1990)



The third alternative outdoor recreation plan element considered in the Fox River watershed study was an optimum design intended to meet fully the outdoor recreational demand anticipated to be generated by residents not only of the watershed and the Region but outside of the Region as well. In addition to the regional and local park sites proposed under the first alternative and the 23 additional parks proposed under the second alternative, this optimum plan element proposes to establish an additional 16 parks at remaining high-value sites in the watershed.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 12

COMPARISON OF THE RELATIVE ABILITY OF THE ALTERNATIVE OUTDOOR RECREATION PLAN ELEMENTS TO MEET ADOPTED DEVELOPMENT STANDARDS

Objective	Minimum Alternative Outdoor Recreation Plan Element	Intermediate Alternative Outdoor Recreation Plan Element	Optimum Alternative Outdoor Recreation Plan Element
Park and Recreation-Related Standards[a]			
Park and Recreation Land Allocation			
a. Local--1.00 acre/100 added population	1.19 acres/100 [b]	1.19 acres/100 [b]	1.19 acres/100 [b]
b. Regional--0.40 acre/100 added population	1.31 acres/100 [c]	1.31 acres/100 [c]	1.31 acres/100 [c]
c. Swimming--0.45 acre/100 participants	Partially met [d]	Could be met [e]	Met
d. Picnicking--12.50 acres/100 participants	Partially met [d]	Could be met [e]	Met
e. Golfing--32.79 acres/100 participants	Partially met [d]	Partially met [d]	Met
f. Camping--133.33 acres/100 participants	Partially met [d]	Partially met [d]	Met
g. Skiing--3.70 acres/100 participants	Met on existing[f] acres	Met on existing[f] acres	Met on existing[f] acres

[a]*The indicated standards are set forth in full in Chapter II of this volume.*

[b]*Additional local acres assigned to make up deficit between existing local park acres and existing population.*

[c]*Additional regional acres assigned because of Fox River watershed's high proportion of the Region's prime regional recreation sites.*

[d]*Activity needs would be partially met by local and regional detailed park development.*

[e]*Activity needs could be met by plan design which focuses on water-oriented park sites; detailed design of these park sites could provide these activities.*

[f]*Skiing demand currently being met by existing commercially operated ski areas.*

Source: SEWRPC.

and overuse of the facilities provided, in serious conflicts between user demands, and in the deterioration and destruction of the recreation-related natural resources where the outdoor recreation areas are located and upon which they depend for their value. It is, therefore, recommended that the third alternative outdoor recreation and related open-space plan element, as described above, be included as an integral part of the recommended comprehensive Fox River watershed plan. This plan element would provide an additional 17,606 acres of public outdoor recreation land in the watershed and would meet fully the forecast recreational demand. Of the total of 17,606 acres of additional outdoor recreation land recommended to be acquired, 9,748 acres, or about 55 percent, would be acquired at an estimated cost of $9,214,700 under the recommended natural resource protection plan element. An additional 536 acres would be acquired at no cost through subdivision development. The cost of acquiring the remaining 7,322 acres is estimated at $5,125,400. The estimated cost of developing the entire 17,606 acres is $35,426,500.

In making this recommendation, it is fully recognized that private recreational development has been and will continue to play an important role in meeting outdoor recreation demands within the watershed. The future extent of such private outdoor recreation development cannot, however, be reliably forecast. It is known that at the present time about one-half of the developed recreation land in the watershed devoted to the five major outdoor recreational activities upon which the 1990 forecast demand is based is in private ownership and operation. This level of private activity may continue in the future. To the extent that it does, it will reduce the need to publicly acquire and develop the needed land. Thus, in a very real sense, the outdoor recreation plan element recommendation is conservative in nature because it represents the maximum necessary public involvement, assuming very little additional private recreation land development. It should also be pointed out that initial public implementation of the recommended plan through acquisition programs and through land reservation by sound zoning and official mapping measures will ensure that the recommended outdoor recreation sites are preserved for recreational development, whether ultimately that development is accomplished through public or private investment.

SUMMARY

The recommended land use plan element of the comprehensive Fox River watershed plan is set within the context of the adopted regional land use plan. Under this plan the adopted regional and watershed development objectives and standards serve, in effect, to control the 1990 spatial distribution of land uses within the Region and the watershed in order to achieve a safer, more healthful, pleasant, and efficient land use pattern, while meeting the gross land use demand requirements of the forecast population and employment levels. The land use plan element emphasizes efficient utility services, cohesive urban development on suitable soils, preservation of prime agricultural lands, preservation of unique resource areas, protection of floodplain areas, and the eventual removal of incompatible uses from these floodplain areas.

Under the land use plan element, residential development within the watershed would be channeled into low-, medium-, and high-density residential areas developed as planned neighborhood units providing the necessary supporting community facilities; and prime agricultural lands, environmental corridor areas, and potential park sites would be protected from incompatible development. Specific regulations would govern the use of surface waters and of shorelands and floodlands. Existing land uses and structures not developed in conformance with these proposals would be considered nonconforming, and regulations would provide for their eventual discontinuance or removal. The attainment of a sound land use pattern throughout the watershed, as well as within the riverine areas, is thus made a basic objective of the comprehensive watershed plan.

In the adaptation, refinement, and detailing of the adopted regional land use plan for the Fox River watershed, three alternative natural resource protection plan elements and three alternative outdoor recreation and related open-space plan elements were considered. The resource protection plan element recommended for incorporation into the comprehensive watershed plan is the second such alternative presented in this chapter. This alternative recommends the public acquisition for resource conservation, recreation, and related open-space purposes of all of the remaining, undeveloped primary environmental corridors of the watershed lying within those areas of the watershed expected to be in urban use by 1990 and of all of the remaining undeveloped environmental corridor along the main stem of the Fox River. Included in the public acquisition of the primary environmental corridor lands along the main stem of the Fox River are 2,651 acres of land in, and adjacent to, the Vernon Marsh in Waukesha County. These lands are recommended to be acquired for conservancy purposes and would provide the land reservation for potential use as a flood control and water supply reservoir site beyond the design year of the plan. The recommended alternative further proposes the acquisition of 3,424 acres of land located in the Sugar Creek environmental corridor for the construction of a multi-purpose flood control, recreation, and low-flow augmentation reservoir.

This plan element would serve to permanently protect through public acquisition 11,299 acres of woodlands, or 16.8 percent of the remaining woodlands of the watershed, covering 1.9 percent of the total watershed area, and 16,942 acres of wetlands, or 31.9 percent of the remaining wetlands in the watershed, covering 2.8 percent of the total watershed area. This plan element would also serve to permanently protect through public acquisition a total of 46,295 acres, or 36.5 percent of the primary environmental corridors of the watershed, covering 7.7 percent of the total watershed area, of which 14,472 acres would be within areas expected to be in urban use by 1990. The remaining primary environmental corridors of the watershed lying in areas expected to remain in rural use through 1990 would be protected through appropriate agricultural, shoreland, floodland, conservancy, and low-density residential zoning.

The outdoor recreation and related open-space plan alternative recommended for incorporation into the comprehensive watershed development plan is the third alternative presented in this chapter. It recommends the acquisition of 17,606 acres of park and related open-space land for public use to fully meet the total 1990 forecast outdoor recreational demand within the watershed. Of this total, 9,748 acres, or about 55 percent, are located within primary environmental corridor areas proposed to be acquired for public use under the recommended natural resource protection plan element. Consequently, implementation of the natural resource protection plan element would serve to significantly implement the recommended outdoor recreation plan element. Encompassed within this total land area are 2,617 acres for the development of four new regional parks in the watershed and 2,383 acres for the development of neighborhood and community parks as urban development proceeds within the watershed.

Under the recommended outdoor recreation and related open-space plan, the total recreational user demand in the watershed would be met and damaging overuse of the facilities and the concomitant damaging effects on the resource base thereby avoided. Not only will the residents of the Region and the watershed be provided with sufficient recreation areas to meet their day-to-day needs, but such needs would be met without extensive conflict between recreation users in the watershed.

Chapter IV

ALTERNATIVE FLOOD CONTROL PLAN ELEMENTS

INTRODUCTION

As urban development within the Fox River watershed continues, the problems and monetary losses associated with flooding can, in the absence of a sound flood abatement program, be expected to increase. Because of the relatively large amount of lake, wetland, and floodplain storage area still present in the watershed, the Fox River system, as it exists today, does not generate the very high-peak flood flows that have occurred on the river systems of other watersheds in Wisconsin. Watersheds of similar size within the state have recorded peak flood flows five times as large as the flood that occurred in 1960 on the Fox River. Although flood peaks on the Fox River may never approach this size, the continued loss of wetland and floodplain storage, which can be expected to accompany continued development of floodlands within the watershed, and the increased runoff potential resulting from areawide urban development may be expected to combine to increase both the size of, and the damage produced by, floods. Because urbanization increases storm water runoff, because floodplain storage is so vital in reducing flood peaks, and because sound land use development in relation to the riverine areas of the watershed is so essential to prevention of flood damage, the basic flood control element in any comprehensive plan for the watershed must consist of proposals for sound land use development, not only in the riverine areas but also in the watershed as a whole.

This chapter describes the structural flood control plan elements that were considered in the Fox River watershed study as possible adjuncts to the basic land use development proposals advanced to facilitate the attainment of regional and watershed development objectives. These structural elements are considered subordinate to the basin-wide land use plan element, and their incremental benefits and costs can be separated from those of the basin-wide land use plan element. All of the structural flood control facility plan elements could be incorporated into any of the land use plan alternatives considered, although some are unnecessary with certain land use plan alternatives.

Three types of structural measures—levee construction and channel improvement; reservoir construction; and lake level control facility construction—were considered as possible methods of controlling floods. These three basic types of structural measures were used to develop eight alternative structural flood control plan elements. Analysis indicated that four of these alternatives would provide both urban and agricultural flood damage reduction along relatively long channel reaches. Two of the alternatives would provide urban flood damage reduction along short channel reaches. The remaining two alternatives were concerned solely with reducing agricultural flood damage and improving agricultural drainage in specific rural locations.

A physical description of each structural plan element is presented in this chapter, along with a discussion of anticipated performance, an evaluation of the attendant costs and benefits, and an evaluation of the effect of the proposal on watershed development objectives and standards. Certain alternative accessory plan elements are also discussed, including the provision of adequate bridge waterway openings, the removal of certain existing residences from the floodlands, and floodproofing of residences and other structures located in the floodlands.

In calculating the benefits associated with the alternative structural flood control measures, it was assumed that existing land use development trends within the watershed would continue. The benefits attendant to each alternative were then calculated as the reduction of flood damages associated with the resulting 1990 uncontrolled land use pattern within the watershed. Implementation of the recommended watershed land use plan could be expected to reduce these calculated benefits somewhat. Any such reduction would be slight, however, since the major benefits are derived from the protection of existing development in the floodplains.

The quantitative hydrologic and hydraulic analyses necessary to evaluate the effectiveness of each alternative involved the preparation of a forecast of the amount of water to be carried by the existing and proposed water control facilities. This forecast was based upon the assumption that the regional land use plan element recommended for adoption would be implemented as a part of this watershed program. Departures from the recommended land use plan could be expected to increase the hydraulic loadings on the water control facilities only to the extent that such departures encroach on existing floodways or eliminate existing floodplain storage. The alternative water control facility plan elements are thus subordinate to the land use plan element. Each of the water control facility elements affects only a portion of the entire watershed and alone offers only a partial solution to flood problems of the watershed.

ALTERNATIVE STRUCTURAL FLOOD CONTROL FACILITY PLAN ELEMENTS

Levee Construction and Channel Improvements Within the City of Waukesha

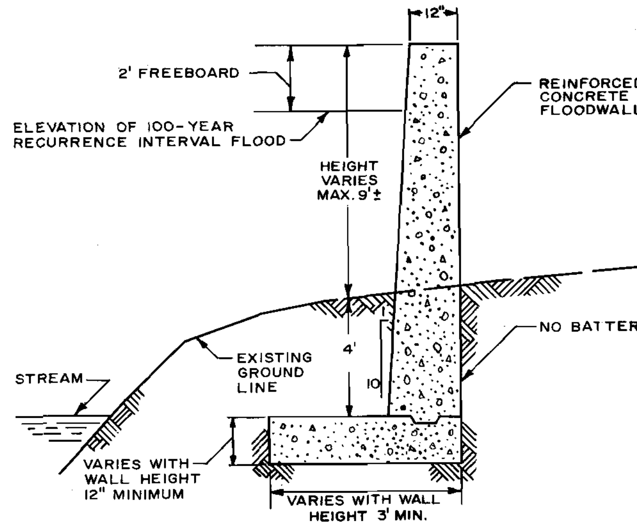
One of the alternative structural water control facility plan elements considered was the construction of a system of intermittent dikes and floodwalls in the City of Waukesha. This alternative was developed as a method of protecting those portions of the city that experienced heavy damages in the 1960 flood and which may, in the absence of the provision of flood control works, be expected to experience even heavier damages in the future. The proposal consists of a series of sections of earth dike and concrete floodwall and of minor amounts of channel clearing and shaping.

Earth dikes are an economical means of providing flood protection to a developed area where sufficient space is available between the river and the land uses to be protected to permit such construction. The dikes would be constructed of compacted earth fill, with a minimum top width of eight feet and three-on-one side slopes. The tops and slopes would be vegetated. In confined areas the earth dikes would have to be replaced by concrete floodwalls or by specially reinforced variations of the earth dike. Floodwall dimensions and design would vary with side conditions and location (see Figure 1).

The dike and floodwall improvements, as proposed, would originate between the Moreland Boulevard Bridge and the Barstow Street Dam. Above the Barstow Street Dam, the dike and floodwall development would be continuous. Down-

Figure 1

TYPICAL FLOODWALL CROSS-SECTION



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

stream from the dam, the diking would be intermittent. At road crossings the diking would be tied into either the road embankments or bridge abutments. The height of the dikes or floodwalls above the natural ground would vary with the topography but would average about four feet. The elevation of the top of the dikes or floodwalls would also vary, depending on location, but would be constructed to an elevation at least two feet above the high water surface elevation produced by a 100-year recurrence interval flood. The dikes would be built as far back from the river as practical in order to keep both the height of the dike and the loss of floodplain storage area to a minimum.

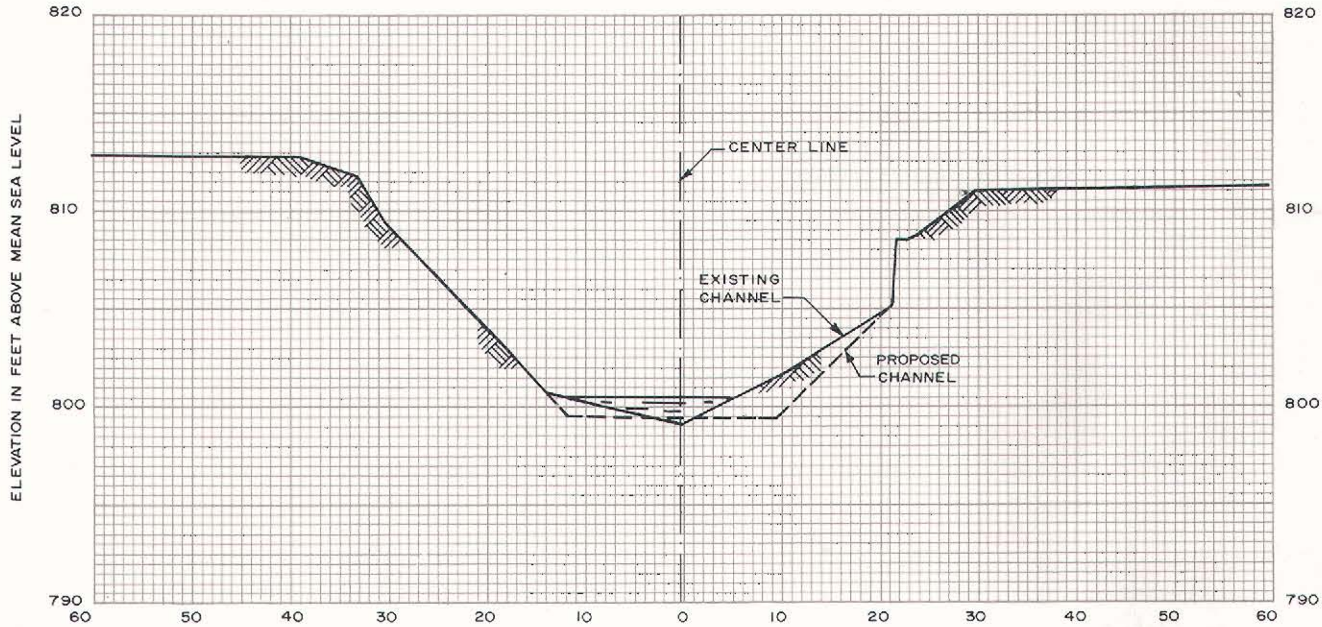
It is also proposed under this alternative that some channel clearing and shaping be done below the Barstow Street Dam to improve the hydraulic capacity of this channel reach. This would involve clearing and debrushing and some shaping of the banks, but not deepening of the channel, a typical cross section of which is shown in Figure 2. Automatic drainage gates would be installed on 17 storm sewer outlets to prevent storm sewer backup. A storm sewer would be constructed from the low point in St. Paul Avenue, located between Wisconsin Avenue and Fuller Street, to the river in order to alleviate flooding in this area.

The essential features of this alternative plan element are shown on Map 8. Estimated quantities of materials and estimated unit costs for the major work items are: 5,600 lineal feet of earth and stone diking, requiring approximately 25,000 cubic yards of embankment at $9 per lineal foot;

Figure 2

TYPICAL CHANNEL CROSS-SECTION

CITY OF WAUKESHA[a]



[a] This channel cross-section is designed for a point 25 feet upstream from the Bank Street bridge in City of Waukesha, but is typical of the proposed cross-sections in the entire reach.

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

1,800 lineal feet of concrete floodwall at \$90 per lineal foot; 2,900 lineal feet of channel clearing at \$8 per lineal foot; the construction of 200 lineal feet of approximately 48-inch diameter storm sewer at \$40 per foot and the installation of 17 automatic drainage gates on storm sewer outfalls, similar to those shown in Figure 3, at an average cost of \$240 each. Miscellaneous costs are estimated to total \$119,400,[1] including engineering and administrative services, various small construction items, and contingencies.

Benefits: The average annual monetary benefit, which could be attributed to this alternative through the reduction of flood damage in the City of Waukesha, is estimated at \$16,850. This benefit would be achieved not by lowering the hydraulic grade line (high water surface elevation) of the 100-year recurrence interval flood but by protecting existing land uses from inundation by such a flood.

Costs: The total installation cost of the proposed flood control works is estimated at \$367,000, including construction, engineering and administrative services, and the cost of obtaining land easements. Amortized at 3 1/4 and 6 percent interest, over a 50-year period, average annual costs would be \$14,950 and \$23,280, respectively. Annual operation and maintenance costs are estimated at \$500.

Benefit-Cost Ratio: The benefit-cost ratio of the proposal, calculated at 3 1/4 percent interest, would be 1.09 to 1.0.

Average Annual Benefit	
Flood-damage alleviation	\$16,850
Average Annual Cost	
Installation	\$14,950
Operation and maintenance	500
Total	\$15,450

$$\text{Benefit-Cost Ratio} = \frac{16,850}{15,450} = 1.09$$

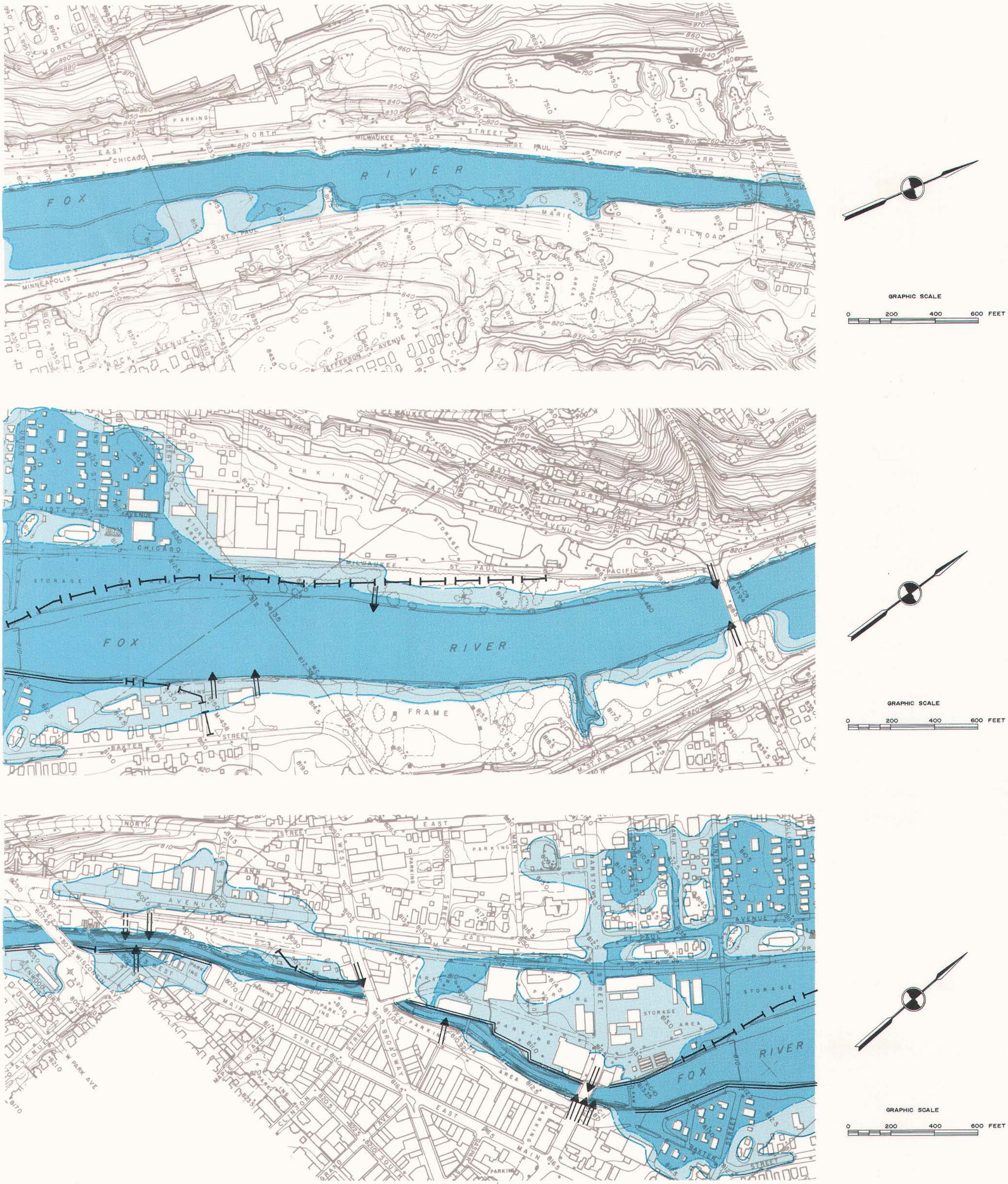
$$\text{At 6 percent interest} = \frac{16,850}{23,780} = 0.71$$

Permanent pumping stations, located at the outlets of the storm sewers serving the area to be protected, have not been included in this alternative

[1] *Miscellaneous costs, as used in this chapter, refer to engineering and administrative services, to land acquisition and land easements in some cases, and to various small construction items.*

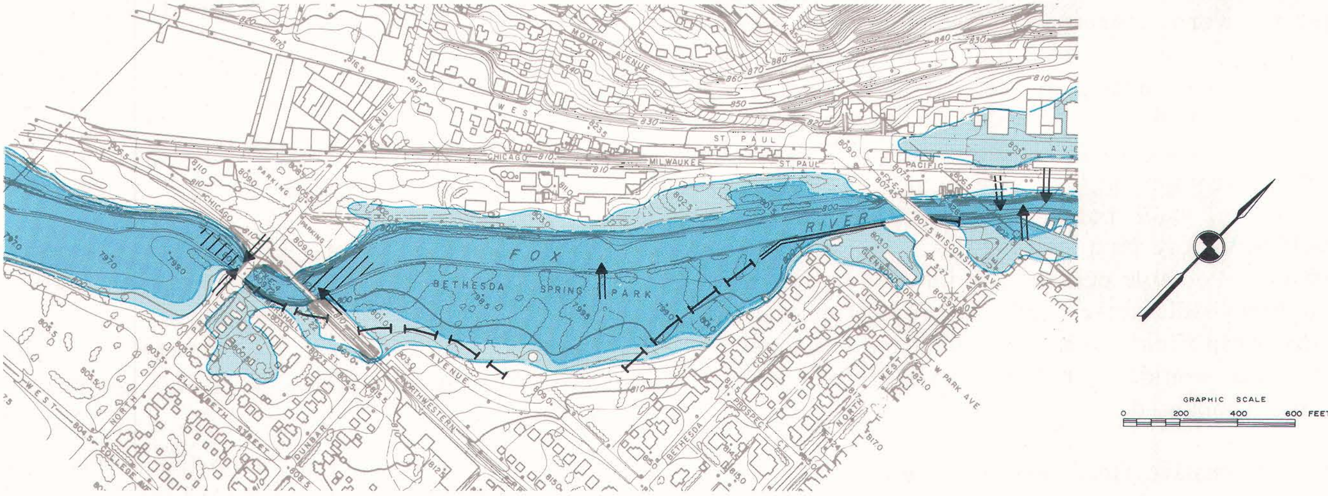
Map 8

PROPOSED LEVEE CONSTRUCTION
CITY OF WAUKESHA



Map 8 (Continued)

PROPOSED LEVEE CONSTRUCTION
CITY OF WAUKESHA



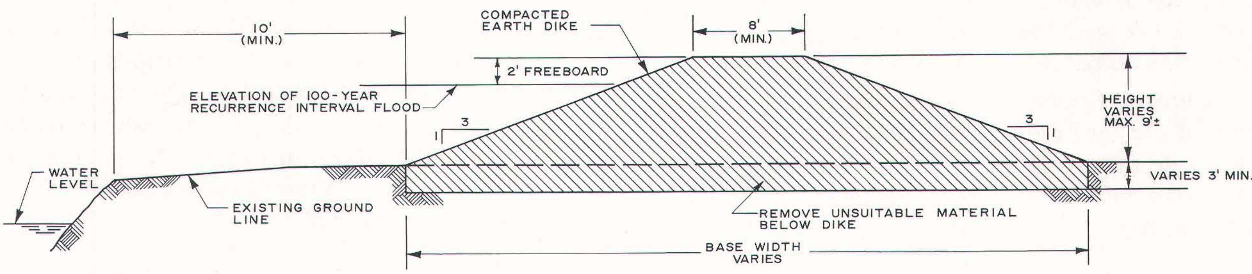
LEGEND

- CONCRETE FLOODWALL
- EARTH DIKE
- BACKWATER GATES TO BE INSTALLED ON ALL STORM SEWER OUTLETS WHERE TOP OF STREET INLETS ARE ONE FOOT OR LESS ABOVE 100 YEAR FLOOD ELEVATION
- PROPOSED STORM SEWER
- 100 - YEAR RECURRENCE INTERVAL FLOOD HAZARD LINE
- 10 - YEAR RECURRENCE INTERVAL FLOOD HAZARD LINE
- CHANNEL CLEARING REQUIRED

NOTE:

1. AREA TO LANDWARD SIDE OF FLOODWALLS AND DIKES TO BE DRAINED AS NECESSARY THROUGH APPROPRIATELY LOCATED AND SIZED CULVERTS EQUIPPED WITH BACKWATER GATES.
2. FOR TYPICAL FLOODWALL CROSS-SECTION SEE FIGURE 1.

TYPICAL CROSS-SECTION OF EARTH DIKE



The City of Waukesha experienced heavy flood damages in the 1960 flood, a flood subsequently determined to have a recurrence interval of approximately 37 years. In order to protect adequately those portions of the City of Waukesha subject to severe flooding from future flood damages caused by floods of up to a 100-year recurrence interval, a system of intermittent dikes and floodwalls, as shown above, will be necessary. Earth dikes are an economical means of providing flood protection. In confined areas the earth dikes would have to be replaced by concrete floodwalls or by specially reinforced variations of the earth dike. This alternative plan element also would require minor amounts of channel clearing and shaping.

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

since the chance of a major rainfall occurring over the local storm sewer drainage area at the same time as the peak of a major flood event on the main channel would be remote. Such pumping stations were, therefore, considered to be uneconomical. Standby portable pumping equipment with intakes ranging in size from 2- to 6-inch diameter could be rented during emergencies or borrowed from City Departments which already own such equipment for other purposes. Even the purchase of such portable equipment could not be justified solely on a standby basis for flood protection. Portable pumps with intakes larger than 6 inches in diameter would be more effective but are more difficult to handle and place into operation and would, therefore, have to be trailer or truck mounted.

This alternative flood control plan element would serve to virtually eliminate flood damages within the City of Waukesha, including those caused by overland flow, and would serve to reduce, but not eliminate, the damages resulting from storm sewer backup. The proposal would have no significant effect on flood peaks or flood damages beyond the confines of the City of Waukesha

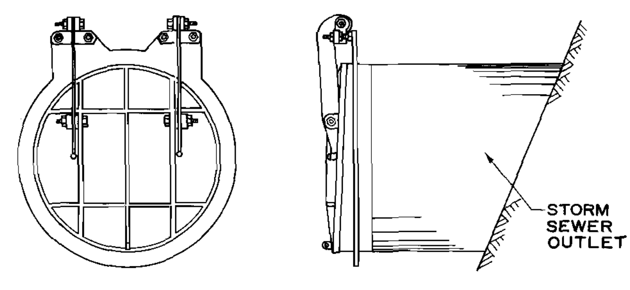
Levee Construction and Channel Improvements Within the City of Burlington

A reduction in flood damages could also be obtained in the City of Burlington through the construction of a system of earth dikes and floodwalls. As in Waukesha, compacted earth dikes would be used where the space available between the river bank and the land uses to be protected permits this type of construction. In restricted areas concrete floodwalls would be used. Minor amounts of channel clearing and the installation of automatic drainage gates on 22 storm sewer outlets are also recommended as an integral part of this alternative.

The earth dikes would be constructed of compacted earth fill, with a minimum top width of eight feet and three-on-one side slopes. The tops and slopes would be vegetated. Floodwall dimensions and design would vary with site conditions and location. In areas of the city where floodwalls presently exist, it may be possible to add to the existing walls and eliminate the need to construct new walls. The elevation of the top of the dikes and floodwalls would vary with location, but would be at least two feet above the high water surface elevation produced by a 100-year recurrence interval flood.

Figure 3

TYPICAL AUTOMATIC DRAINAGE GATE FOR STORM SEWER OUTLET



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

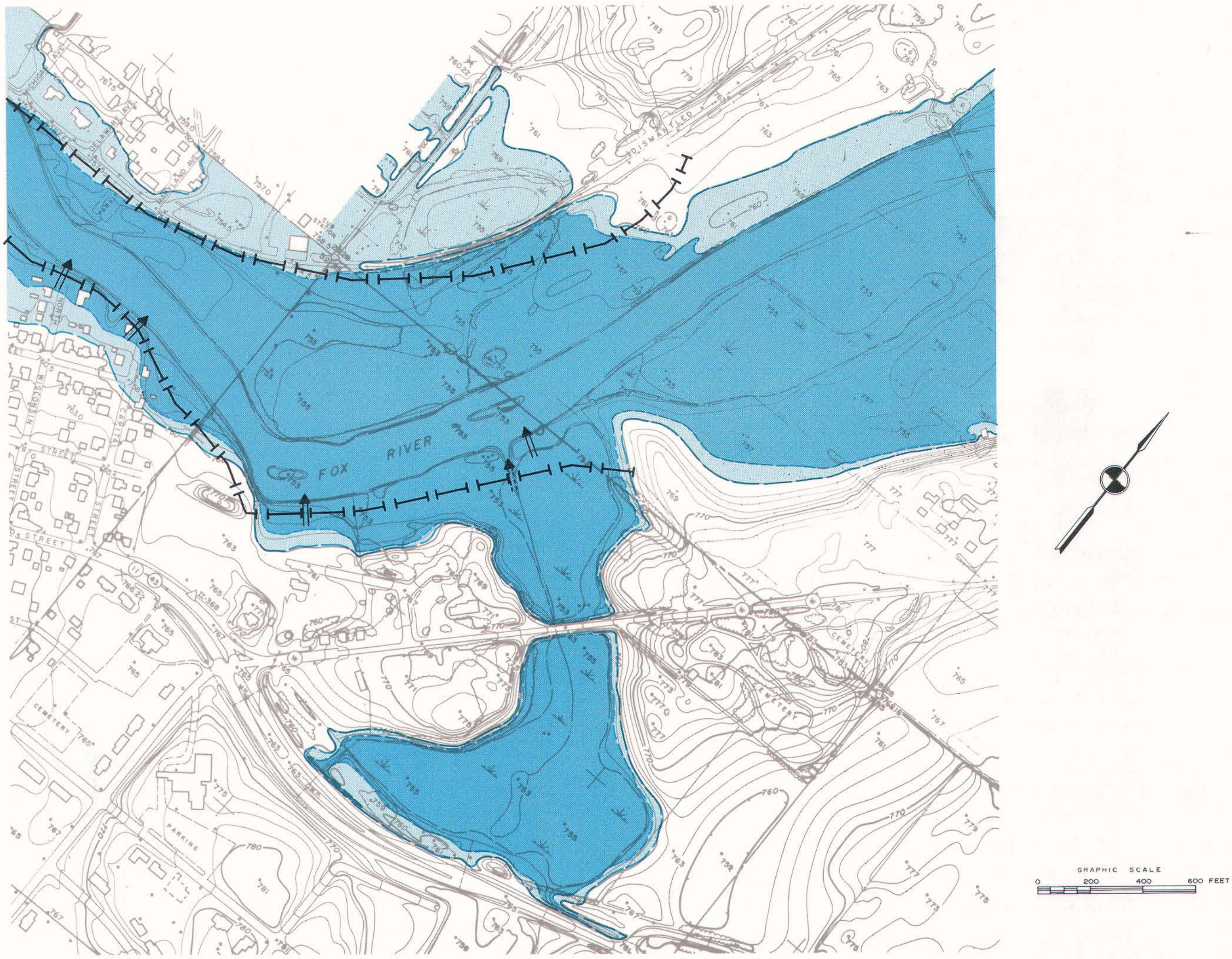
The dikes would begin near the upstream city limits and be required along both sides of the Fox River throughout most of the city. Portions of both sides of the White River, between the Echo Lake Dam and the junction with the Fox River, would also require protection. The stream banks would be debrushed, with all heavy vegetation removed, as well as clearing of any stream bed obstructions. No widening or deepening of the channel is anticipated, however.

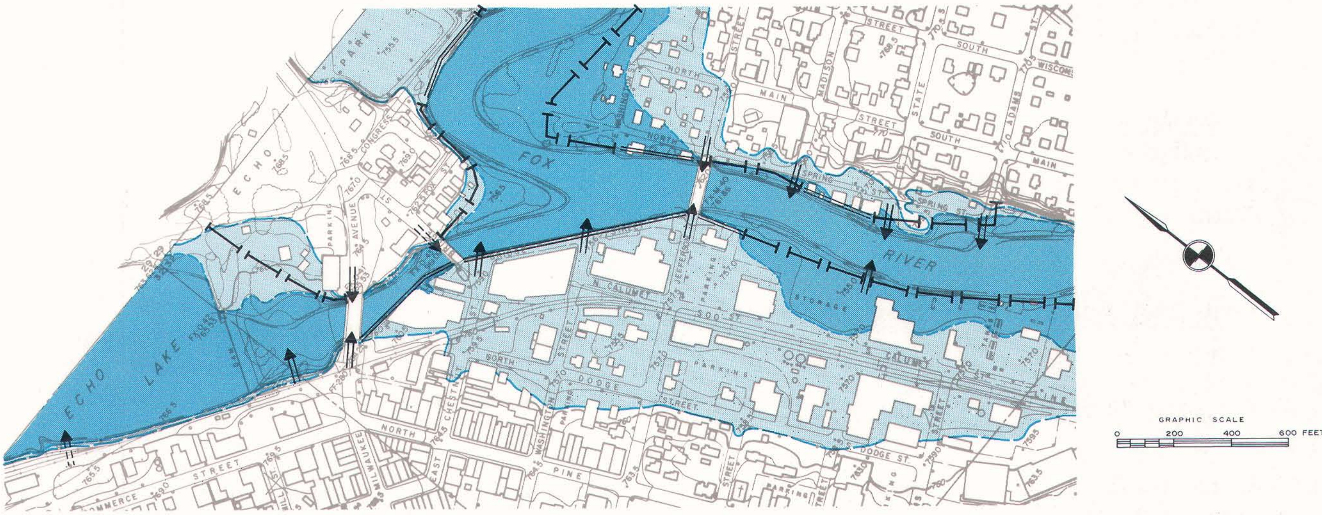
The essential features of this alternative plan element are shown on Map 9. Estimated quantities of materials and estimated unit costs for the major work items are: 12,500 lineal feet of earth diking, requiring approximately 43,000 cubic yards of embankment at $3.50 per lineal foot; 2,100 lineal feet of concrete floodwall at $90 per lineal foot; and the installation of 22 automatic drainage gates on existing storm sewer outfalls, similar to those shown in Figure 3, at an average cost of $150 each. Miscellaneous costs are estimated to total $115,900.

Benefits: The average annual monetary benefit, which could be attributed to the reduction of flood damage in the City of Burlington, is estimated at $9,000.

Costs: The total installation cost of the proposed flood control works is estimated at $350,000, including construction, engineering and administrative services, and the cost of obtaining land easements. Amortized at 3 1/4 and 6 percent interest, over a 50-year period, average annual costs would be $14,260 and $22,220, respectively. Annual operation and maintenance costs are estimated at $500.

Map 9
PROPOSED LEVEE CONSTRUCTION
CITY OF BURLINGTON





Map 9 (Continued)

PROPOSED LEVEE CONSTRUCTION
CITY OF BURLINGTON

LEGEND

CONCRETE FLOODWALL

EARTH DIKE

BACKWATER GATES TO BE INSTALLED ON ALL STORM SEWER OUTLETS WHERE TOP OF STREET INLETS ARE ONE FOOT OR LESS ABOVE 100-YEAR FLOOD ELEVATION.

PROPOSED STORM SEWER

100 - YEAR RECURRENCE INTERVAL FLOOD HAZARD LINE

10 - YEAR RECURRENCE INTERVAL FLOOD HAZARD LINE

NOTE:

1. AREA TO LANDWARD SIDE OF FLOODWALLS AND DIKES TO BE DRAINED AS NECESSARY THROUGH APPROPRIATELY LOCATED AND SIZED CULVERTS EQUIPPED WITH BACKWATER GATES.

2. FOR TYPICAL CROSS-SECTION OF EARTH DIKE SEE MAP 8.

3. FOR TYPICAL FLOODWALL CROSS-SECTION SEE FIGURE 1.

A system of earth dikes and concrete floodwalls in the City of Burlington is proposed to serve in abating flood damages in those areas of the City of Burlington subject to inundation by the 100-year recurrence interval flood. As shown, concrete floodwalls would only be used where the space available between the river bank and the land uses to be protected does not permit construction of earth dikes. Minor amounts of channel clearing are also proposed in this plan alternative.

Source: U. S. Conservation Service and SEWRPC.

Benefit-Cost Ratio: The benefit-cost ratio of this plan element, calculated at 3 1/4 percent interest, would be 0.62 to 1.0.

Average Annual Benefit	
Flood-damage alleviation	$ 9,000
Average Annual Cost	
Installation	$14,260
Operation and maintenance	500
Total	$14,760

$$\text{Benefit-Cost Ratio} = \frac{9,000}{14,760} = 0.62$$

$$\text{At 6 percent interest} = \frac{9,000}{22,720} = 0.40$$

This alternative flood control plan element would serve to virtually eliminate flood damages within the City of Burlington, including those caused by overland flow, and would serve to reduce, but not totally eliminate, the damages that result from storm sewer backup. The proposal would have no significant effect on flood peaks or flood damage beyond the confines of the City of Burlington.

Channel Improvements on Sugar Creek and Honey Creek

Agricultural flood damages and the adverse effects of inadequate drainage in the upper reaches of Sugar Creek and Honey Creek could be substantially reduced if the hydraulic capacity of the stream channel in these areas were increased. Improving the channel would provide protection for flood-vulnerable cropland and would also provide an improved outlet for those agricultural areas that are damaged as a result of a lack of adequate drainage facilities. Inadequate drainage in this area in the past has often caused delays in planting and harvesting, prevented tillage operations, and reduced crop growth and crop yields.

Approximately seven miles of channel improvement would be required on Sugar Creek to provide the necessary flood damage reduction and drainage improvement; and about five miles of improvement, on Honey Creek. Channelization of Honey Creek would include portions of the stream between the Village of East Troy and the Lauderdale Lakes. Improvements on Sugar Creek would include portions of the main creek above Abells Corners and portions of a tributary stream joining Sugar Creek about 2,000 feet above Abells Corners.

The hydraulic capacity of the improved channel would vary, the channel being designed to carry floods within its banks up to the 10-year recurrence interval event in size. The elevation of the channel bottom would be established at a depth that would assure adequate outlets for agricultural drainage facilities in the tributary drainage area. Construction of the improvements would include excavating material from the present channel, spreading the excavated material, seeding the channel and the areas over which spoil is spread, and installing necessary surface water drainage inlets to the channel.

This alternative plan element would provide flood protection to approximately 2,000 acres of flood-vulnerable cropland and would provide improved drainage for a total of approximately 3,000 acres of cropland that are damaged because of a lack of proper drainage facilities. The benefited areas are delineated on Figure 4, which also shows the location and type of channel improvements proposed. Estimated quantities of materials and estimated unit costs for the major work items are: 63,000 lineal feet of channel improvement, requiring approximately 324,000 cubic yards of excavation at $1.50 per lineal foot; 90 acres of seeding at $185 per acre; and the construction of 85 surface water outlets, similar to those shown in Figure 5, at an average cost of $230 each.

Benefits: The average annual monetary benefit, which could be attributed to this plan element, is estimated at $29,300, including both the benefits from flood prevention and improved drainage. These benefits would be achieved not by lowering the hydraulic grade line of the 100-year recurrence interval flood on Sugar and Honey Creeks but by protecting existing land uses from inundation by such flood and by improving agricultural drainage.

Costs: The total installation cost of this proposed plan element is estimated at $183,900, including construction, engineering and administrative services, and the cost of obtaining the necessary land easements. Amortized at 3 1/4 and 6 percent interest, over a 50-year period, average annual costs would be $7,490 and $11,670, respectively. Average annual operating and maintenance costs are estimated at $2,400.

Benefit-Cost Ratio: The benefit-cost ratio, calculated at 3 1/4 percent interest, would be 2.96 to 1.0.

Average Annual Benefit	
Flood-damage alleviation and improved agricultural water management	$29,300
Average Annual Cost	
Channel installation	$ 7,490
Operation and maintenance	2,400
Total	$ 9,890

$$\text{Benefit-Cost Ratio} = \frac{29,300}{9,890} = 2.96$$

$$\text{At 6 percent interest} = \frac{29,300}{14,070} = 2.08$$

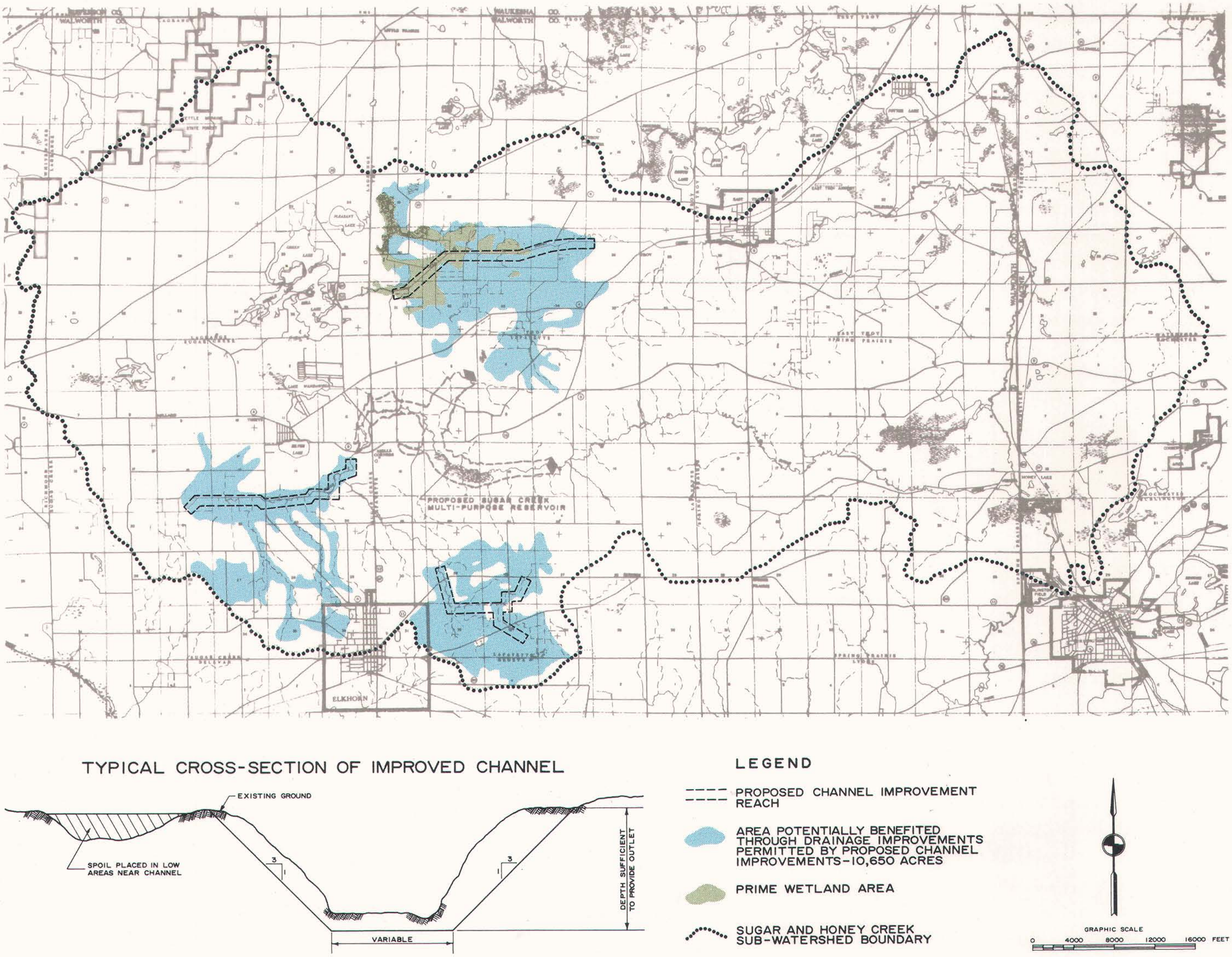
Channel Improvements on Hoosier Creek

A reduction in agricultural damages could also be obtained in the Hoosier Creek area by increasing the hydraulic capacity of the present channel system, by constructing dikes to protect flood-vulnerable cropland, and by establishing improved outlets for areas that have inadequate drainage. The size and depth of approximately 9.3 miles of the Hoosier Creek channel would have to be increased, approximately 8 miles of tributary channel would have to be improved, and approximately 3.9 miles of earth dike would have to be constructed to effect the improvements.

The improved channel would be enlarged to carry up to the 10-year recurrence interval floods within its banks as caused by runoff from the Hoosier Creek drainage basin and would be deepened to provide an improved outlet for areas

Figure 4

PROPOSED CHANNEL AND AGRICULTURAL DRAINAGE IMPROVEMENTS ON SUGAR AND HONEY CREEKS
TOWNS OF LAFAYETTE, TROY, AND SUGAR CREEK, WALWORTH COUNTY



Agricultural flooding and drainage problems in the upper reaches of Sugar and Honey Creeks could be substantially reduced by increasing the hydraulic capacity of the stream channels draining these areas. The alternative plan element shown above proposes to widen and deepen about 7 miles of channel on Sugar Creek and 5 miles of channel on Honey Creek in order to provide flood protection to approximately 2,000 acres of flood-vulnerable cropland. In addition, about 10,650 acres would be potentially benefited through agricultural drainage improvements permitted by the proposed channel improvements.

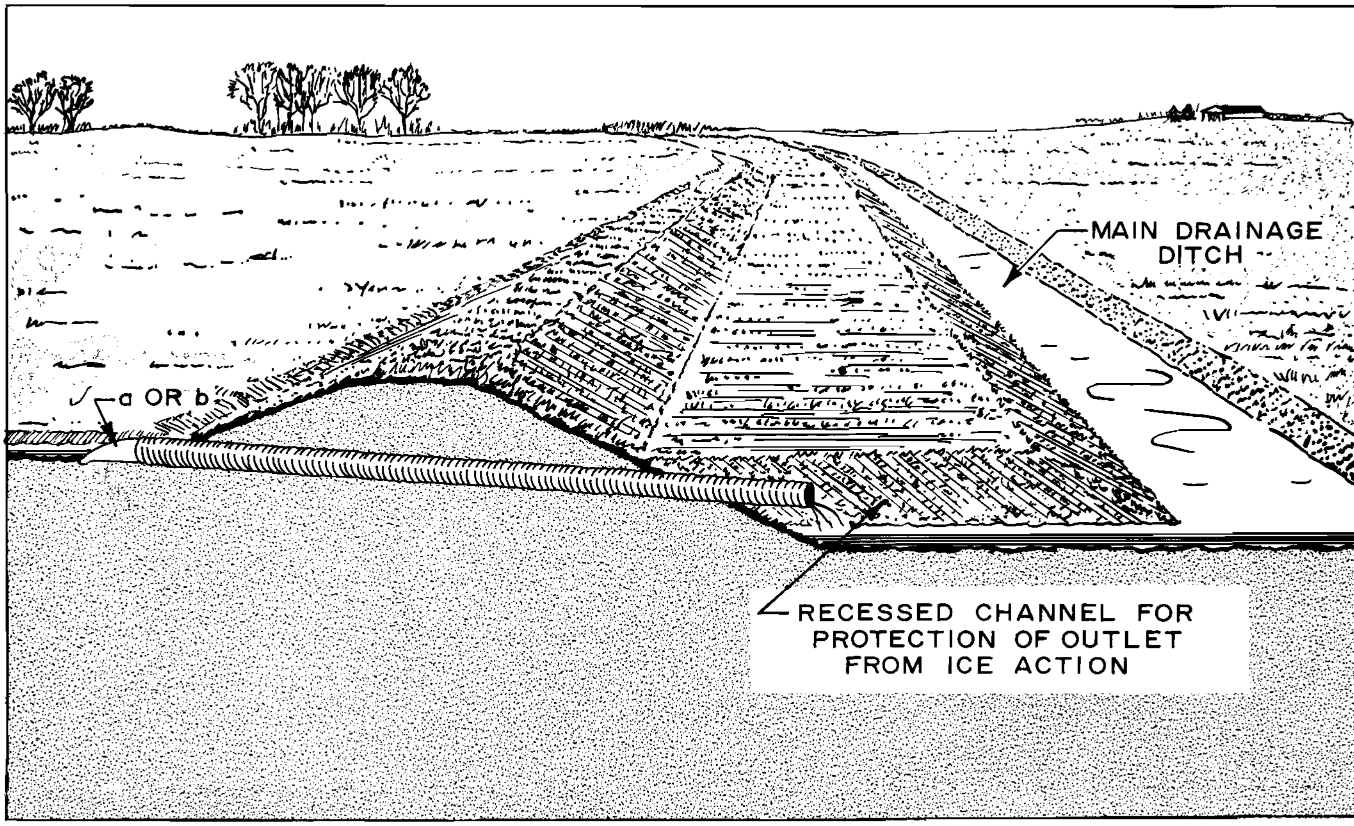
Source: U. S. Soil Conservation Service and SEWRPC.

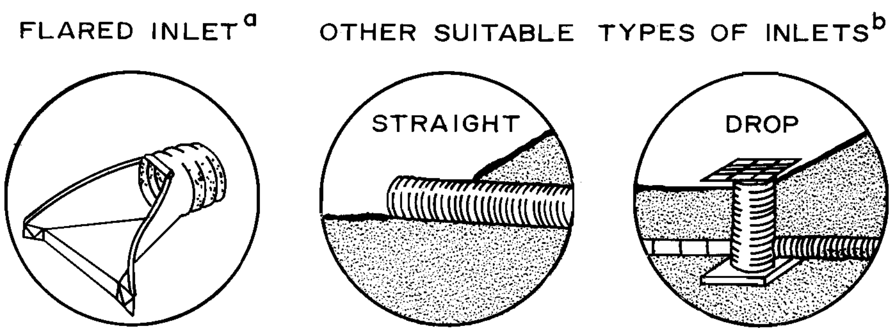
that need subsurface agricultural drainage facilities. Earth dikes would be constructed in the lower reaches of Hoosier Creek and along the Hoosier Branch Canal to prevent backwater from the Fox River from damaging the flood-vulnerable lands adjacent to these channels. The dikes would begin at the right-of-way of the Soo Line Railroad and continue upstream to a point where adequate flood protection could be provided by enlarging the channel. Installation of the dikes would require that Brever Road be raised to an elevation level with or above the elevation of the top of the protective dikes.

Surface runoff would be carried through the dikes by a drop inlet structure similar to that shown on

Figure 5

TYPICAL SURFACE WATER OUTLET FOR USE WITH AGRICULTURAL DRAINAGE IMPROVEMENTS





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

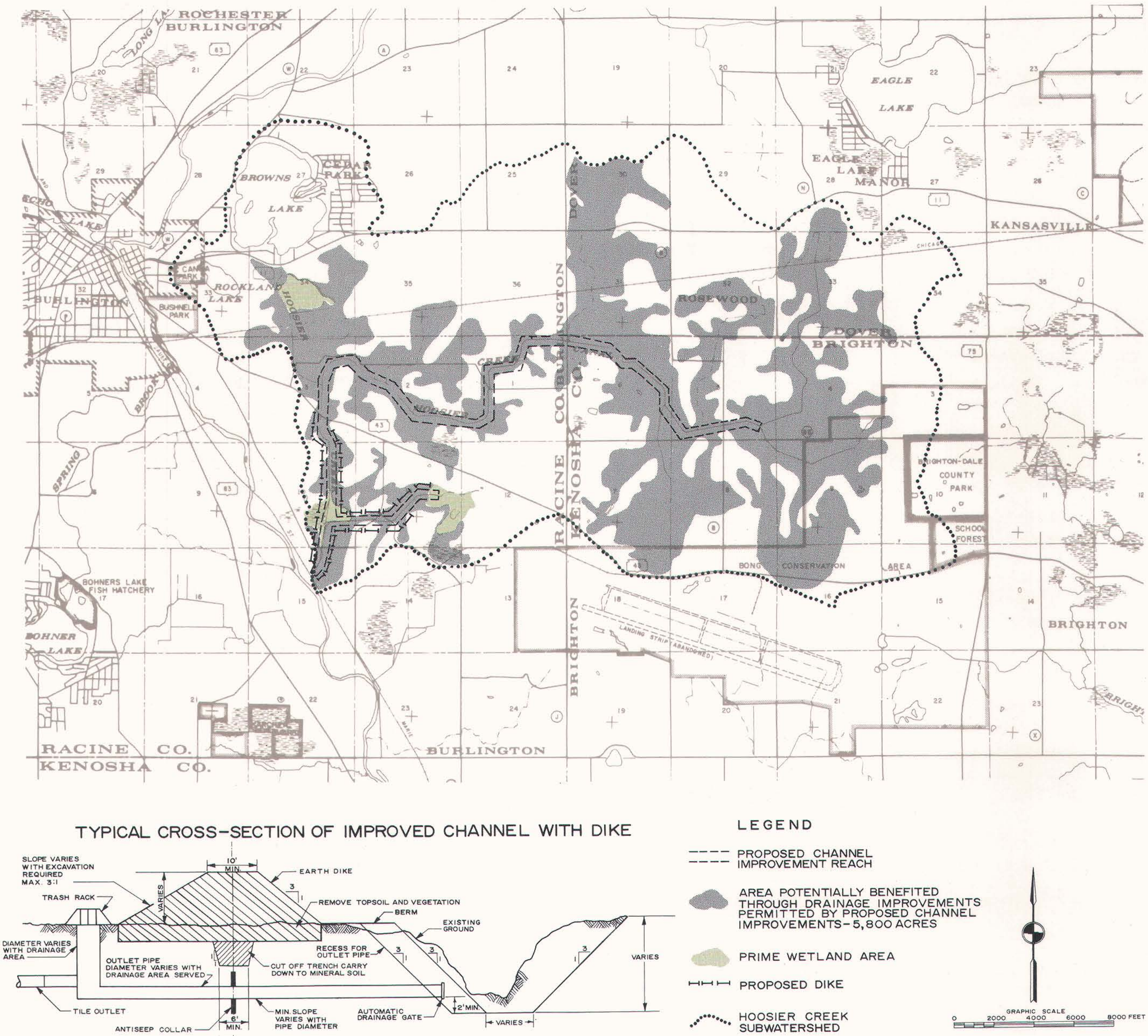
Figure 6. The outlet structure would be equipped with an automatic drainage gate and could also serve as an outlet for subsurface agricultural drainage facilities. In the extreme lower reaches of the benefited area, surface and subsurface runoff would have to be pumped over the dike, utilizing portable pumping equipment, when river stages do not permit a gravity flow outlet. In these instances, the inlet structure could be modified to function as a wet well for the pump intakes.

This alternative plan element would protect an estimated 1,200 acres of cropland subject to flood damage and would provide improved drainage for a total of approximately 3,000 acres of inadequately drained cropland. The benefited areas are shown on Figure 6.

The suggested location and type of improvements are shown on Figure 6. Estimated quantities of materials and estimated unit costs for the several major items of work are: 49,000 lineal feet of

Figure 6

PROPOSED CHANNEL AND AGRICULTURAL DRAINAGE IMPROVEMENT ON HOOSIER CREEK
TOWNS OF DOVER, BRIGHTON, AND BURLINGTON; KENOSHA AND RACINE COUNTIES



The hydraulic capacity of the present Hoosier Creek channel system is proposed to be increased in order to reduce agricultural flood damages in the Hoosier Creek area. The channel would be enlarged to carry up to the 10-year recurrence interval floods within its banks and deepened to provide an improved outlet for areas needing subsurface agricultural drainage facilities. In addition, earth dikes would be constructed to protect flood-vulnerable cropland. Nearly 1,200 acres of flood-vulnerable cropland would be protected by this plan alternative, with a total of 5,800 acres potentially benefited through agricultural drainage improvements permitted by the proposed channel improvements.

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

channel improvement, requiring approximately 243,000 cubic yards of excavation at $1.50 per lineal foot; 20,600 lineal feet of dike, requiring approximately 16,500 cubic yards of earth fill at $0.80 per lineal foot; 112 acres of seeding at $185 per acre; and the construction of 15 surface water inlets similar to those shown in Figure 6 at $500 each and 51 water inlets, similar to those shown in Figure 5, at an average cost of \$230 each. Miscellaneous costs are estimated to total \$111,800.

Benefits: The average annual monetary benefits, which could be attributed to this plan element, are estimated at \$37,700, including both the benefits from flood prevention and improved drainage. These benefits would be achieved not by lowering the hydraulic grade line of the 100-year recurrence interval flood on the Fox River but by protecting the existing land uses from inundation by such a flood and by improving agricultural drainage.

Costs: The total installation cost of this proposed plan element is estimated at \$240,700, including construction, engineering and administrative services, and the cost of obtaining the necessary land easements. Amortized at 3 1/4 and 6 percent interest, over a 50-year period, average annual costs would be \$9,810 and \$15,270, respectively. Average annual operation and maintenance costs are estimated at \$2,790.

Benefit-Cost Ratio: The benefit-cost ratio, calculated at 3 1/4 percent interest, would be 2.99 to 1.0.

Average Annual Benefit	
Flood-damage alleviation and improved agricultural water management	\$37,700
Average Annual Cost	
Channel installation	\$ 9,810
Operation and maintenance	2,790
Total	\$12,600

$$\text{Benefit-Cost Ratio} = \frac{37,700}{12,600} = 2.99$$

$$\text{At 6 percent interest} = \frac{37,700}{18,060} = 2.09$$

Channel Improvements and Dam Construction on Hoosier Creek

An alternative means of reducing agricultural flood damages in the Hoosier Creek area was also investigated. This alternative would require the same channel improvements as the alternative described above, along with the reconstruction of Brever Road. Dikes, however, would be required only from the Soo Line Railroad tracks to a dam which would be constructed across Hoosier Creek just above the Brever Road Bridge. This dam would be equipped with a backwater gate and a low head pumping station. The dikes and gate would prevent the Fox River from backing up Hoosier Creek during floods having a recurrence interval of up to 100 years, while the pumping facilities could be used to draw down the level of Hoosier Creek immediately after a heavy rainfall, thereby permitting the tributary farm drainage tile outlets to function properly.

This proposal would benefit the same agricultural land uses as the alternative described above. It would require the following estimated quantities of materials and estimated unit costs for the several major items of work: 49,000 lineal feet of channel improvement, requiring approximately 243,000 cubic yards of excavation at \$1.50 per lineal foot; 3,000 lineal feet of dike, requiring approximately 12,000 cubic yards of earth fill at \$2.50 per lineal foot; 112 acres of seeding at \$185 per acre; the construction of 16 water inlets at a cost of \$500 each; and the construction of a low head pumping station and gate structure at a cost of \$33,800. Miscellaneous costs are estimated to total \$95,900.

Benefits and Costs: The average annual monetary benefits, which could be attributed to this plan element, would be the same as for the alternative for Hoosier Creek described above, while the estimated installation costs would total \$240,400, including construction, engineering and administrative services, and the costs of obtaining land easements. Amortized at 3 1/4 and 6 percent interest, over a 50-year period, average annual costs would be \$9,792 and \$15,251, respectively. Average annual operation and maintenance costs are estimated at \$5,790.

Benefit-Cost Ratio: The benefit-cost ratio, calculated at 3 1/4 percent interest, would be 2.42 to 1.0.

Average Annual Benefit	
Flood-damage alleviation and improved agricultural water management	\$37,700
Average Annual Cost	
Channel improvements and structures	\$ 9,792
Operation and maintenance	5,790
Total	\$15,582

$$\underline{\text{Benefit-Cost Ratio}} = \frac{37,700}{15,582} = 2.42$$

$$\text{At 6 percent interest} = \frac{37,700}{21,041} = 1.79$$

Neither the cost estimate for this alternative nor for the first alternative presented for Hoosier Creek includes costs for road or bridge replacement. Because of the poor condition of the existing road land bridge, it is assumed that replacement would be necessary in any event during the planning period.

Multiple-Purpose Reservoir on Sugar Creek

Another of the alternative structural flood control facility plan elements considered was a multiple-purpose reservoir on Sugar Creek. This reservoir would provide for both the permanent storage of water for recreational use and the temporary storage of floodwater. The proposed structure would create an artificial lake with a surface area of approximately 1,300 acres and a maximum depth of about 20 feet. The volume between the normal recreational pool level and the spillway crest would be utilized for floodwater storage. This volume, totaling 9,200 acre-feet, could be released in a nine-day period and would provide storage for the equivalent of a 4.4 inch runoff from the tributary drainage area of 38.9 square miles. A 4.4 inch runoff could, under normal summer conditions, be expected to result from an 8.2 inch rainfall over the tributary watershed area.

The reservoir would be created by constructing an earth embankment across Sugar Creek near the center of Section 15, Town 3 North, Range 17 East, in the Town of Lafayette, Walworth County. In addition to the primary embankment on Sugar Creek, the construction of a smaller earth embankment in Section 5, Town 3 North, Range 17 East, would be required several miles upstream from this dam in order to prevent the proposed reservoir from discharging into Honey Creek. The primary embankment would have a maximum height of 34 feet and an estimated length of 1,450 feet. The secondary embankment would have a maximum height of 11 feet and an estimated length of 2,000 feet.

A reinforced concrete box spillway, with an inlet opening at elevation 865.0 feet above mean sea level datum, would control the outflow from the impoundment. A secondary 350-foot wide vegetated spillway would be provided in the south abutment of the embankment. The crest elevation of this secondary spillway would be set at elevation 871.2 feet and the spillway would operate only if the 100-year flood were exceeded. The elevation of the top of the embankment would be set at 878.3 feet.

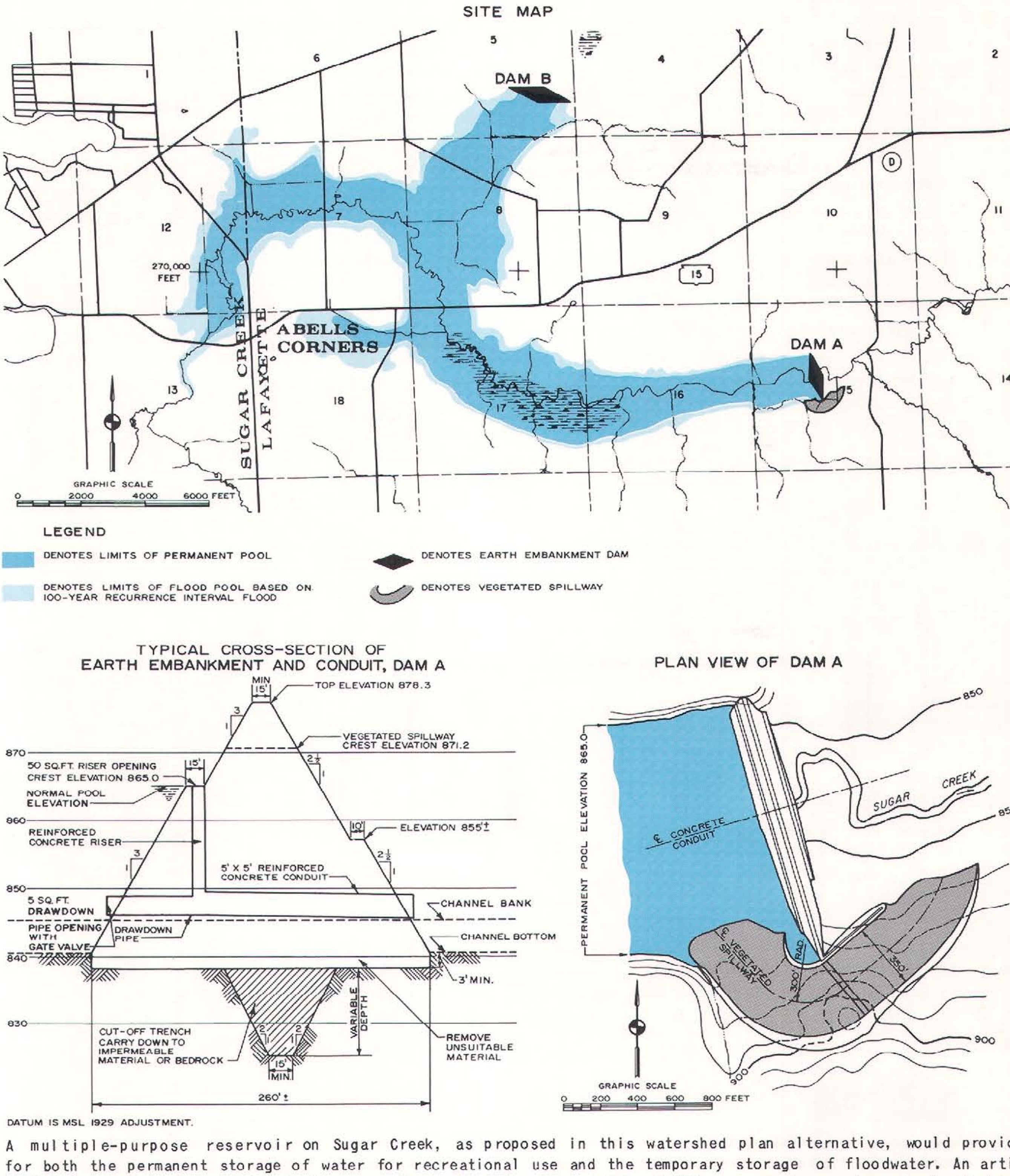
The proposed location of the structure and of the reservoir area is shown on Figure 7. Estimated quantities of materials and unit costs for the major work items are: 279,200 cubic yards of embankment at $0.55 per cubic yard; 96,000 cubic yards of common excavation at $2 per cubic yard; 220 cubic yards of reinforced structural concrete at $150 per cubic yard; and 900 cubic yards of rip rap at $12 per cubic yard. Miscellaneous costs are estimated at $199,900; and land costs are estimated at $1,514,000.

Benefits: Construction of the multiple-purpose reservoir could be expected to reduce average annual flood damages by an amount estimated at $7,220 and to provide an estimated $2,102,950 in annual recreational benefits. Recreational benefits would accrue as a result of the use of recreational facilities proposed in conjunction with the reservoir. The flood control benefits would be achieved by lowering the hydraulic grade line (high water surface elevation) of the flood flows on Sugar Creek and Honey Creek and on the White River below the proposed reservoir. The proposed reservoirs may be expected to lower the high water elevation of the 100-year recurrence interval flood approximately two feet at Brever Road, one foot and Hargraves Road, and 0.5 foot at Potter Road.

Costs: The total installation cost of the proposed reservoir is estimated at $2,420,000, including construction, engineering and administrative services, and the cost of obtaining land easements and road relocations. Amortized at 3 1/4 and 6 percent interest, over a 50-year period, the average annual cost would be $98,570 and $153,525, respectively. Average annual operation and maintenance costs are estimated at $900. The total installation cost of the recreational facilities is estimated at $5,600,000. Amortized at 3 1/4 and 6 percent, the average annual cost of recreation facilities would be $228,110 and $355,300, respectively.

Figure 7

PROPOSED SUGAR CREEK MULTI-PURPOSE RESERVOIR AND STRUCTURE
TOWNS OF LAFAYETTE AND SUGAR CREEK, WALWORTH COUNTY, WISCONSIN



A multiple-purpose reservoir on Sugar Creek, as proposed in this watershed plan alternative, would provide for both the permanent storage of water for recreational use and the temporary storage of floodwater. An artificial lake would be created having a surface area of approximately 1,300 acres and a maximum depth of about 20 feet. Flood peaks and associated flood damages would be substantially reduced on Sugar Creek from the proposed structure to Honey Lake. The reservoir would also form an integral part of a major regional park and outdoor recreation facility, providing needed land and water-based recreational opportunities.

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

Benefit-Cost Ratio: The benefit-cost ratio of the Sugar Creek multiple-purpose reservoir, calculated at 3 1/4 percent interest, would be 2.26 to 1.0.

Average Annual Benefit	
Flood-damage alleviation	$ 7,220
Recreational benefits	2,102,950
Total	$2,110,170
Average Annual Cost	
Structure installation	$ 98,570
Structure operation and maintenance	900
Recreation facilities installation	228,110
Recreation facilities, operation, maintenance, and replacement	606,180
Total	$ 933,760

$$\text{Benefit-Cost Ratio} = \frac{2,110,170}{933,760} = 2.26$$

$$\text{At 6 percent interest} = \frac{2,110,170}{1,115,900} = 1.89$$

This plan element would serve the watershed land use development objectives, including those relating to recreational uses, as well as the watershed flood control facility construction development objectives. As already noted, flood peaks and associated flood damages would be substantially reduced on Sugar Creek from the structure to Honey Lake. Below Honey Lake the reduction in damage would be less marked, and below Echo Lake only minor reductions would be effected. The structure would eliminate the need to replace the bridge on Hargraves Road, which replacement would otherwise be required solely for the purpose of providing an adequate waterway opening. A benefit could also be realized at the location of the proposed STH 15 crossing of Sugar Creek. Here the size of bridge that would be required could be reduced substantially with the dam in place.

Flood Control Reservoir on the Fox River

A reduction in flood peaks and an associated reduction in flood damage could be obtained on portions of the Fox River if a floodwater retarding structure were constructed near the outlet of the Vernon Marsh. The proposed structure would consist of an earth embankment, with a concrete box outlet as a primary spillway and a vegetated channel as a secondary spillway. The structure would be located across the Fox River in Section 24, Town 5 North, Range 18 East, in the Town of Mukwonago, Waukesha County. The embankment would have a maximum height of 20 feet and a length of approximately 650 feet. The drainage area tributary to the proposed structure is 220 square miles in extent.

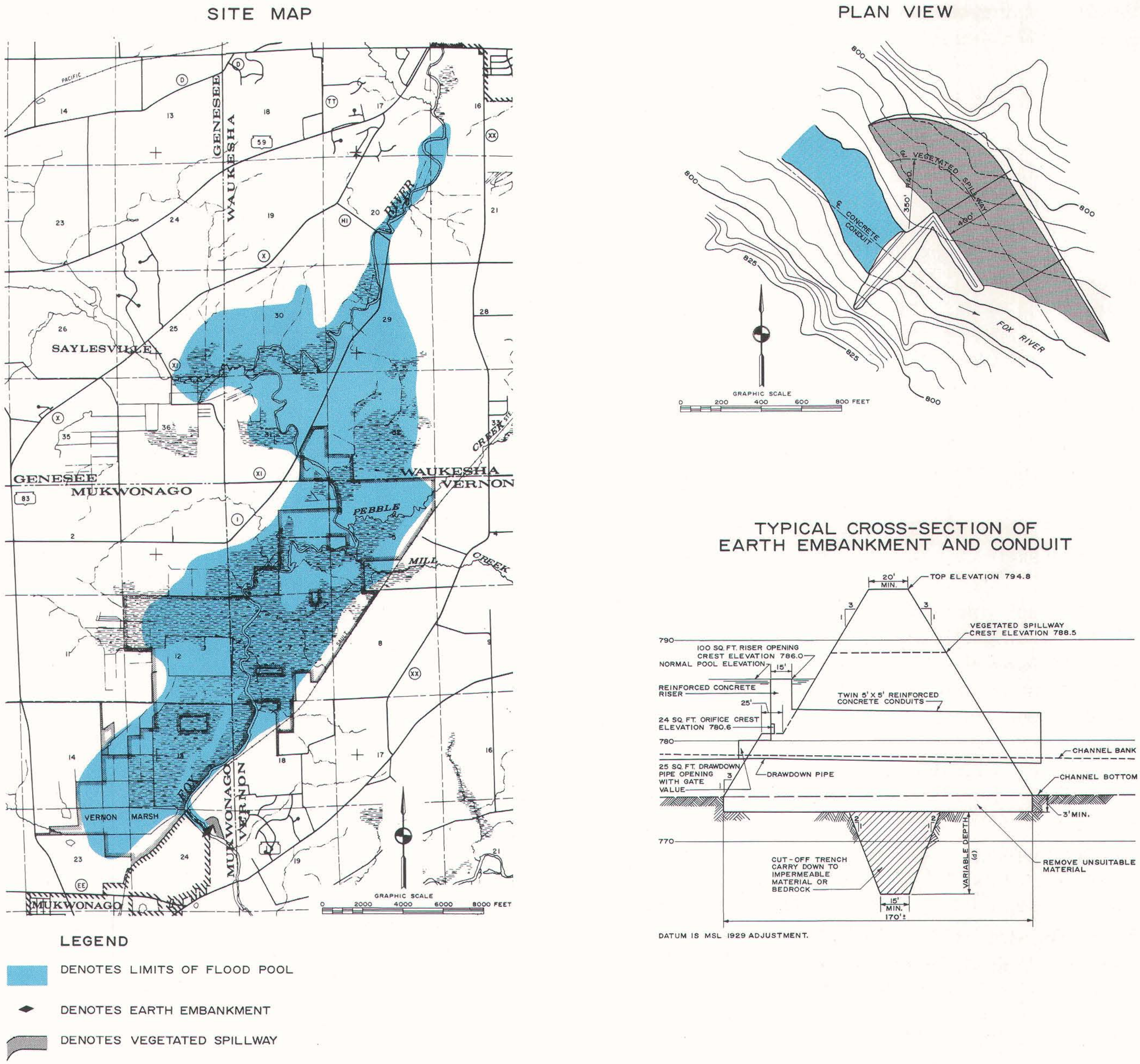
Spillways set at three elevations would regulate outflow from the structure. An orifice with its bottom set at elevation 780.5 feet above mean sea level datum would be used to reduce the magnitude of the smaller, more frequent flood peaks; a reinforced concrete box spillway with an inlet opening set at elevation 786.0 feet would regulate the outflow from floods up to the 100-year recurrence interval in size; a 400-foot vegetated spillway, designed to operate only when the 1 percent chance flood is exceeded, would be provided with a spillway crest set at elevation 788.5 feet. The elevation of the top of dam would be set at 795.0 feet. Storage in the pool area up to elevation 780.5 feet would be allocated to sediment, and drawdown pipes would be provided to remove water completely from behind the dam after periods of flood flow.

The maximum water surface area created by the temporary storage of floodwater would be about 5,400 acres. The reservoir would be completely emptied between flood events because the land-based recreational and wildlife conservancy value of the marsh are deemed to outweigh the water-based recreational benefits associated with the permanent storage of water in the area. The full 5,400-acre temporary lake would be produced only by the occurrence of a 100-year recurrence interval flood; and the entire lake volume, totaling 31,000 acre-feet, could be released in a 30-day period and would provide storage for the equivalent of a 2.8 inch runoff from the tributary drainage area of 220 square miles. A 2.8 inch runoff could, under normal summer conditions, be expected to result from a 5.4 inch rainfall over the tributary watershed area.

The proposed location of the structure and the reservoir area is shown on Figure 8. Estimated quantities of materials and unit prices for the major work items are: 31,000 cubic yards of embankment at $0.55 per cubic yard; 23,000 cubic yards of common excavation at $2 per cubic yard; 215 cubic yards of reinforced structural concrete at $150 per cubic yard, and 3,000 cubic yards of

Figure 8

PROPOSED FOX RIVER FLOOD CONTROL RESERVOIR AND STRUCTURE
VERNON MARSH AREA, WAUKESHA COUNTY, WISCONSIN



One alternative flood control plan element considered for the Fox River involves the construction of a floodwater retarding structure near the outlet of the Vernon Marsh in Waukesha County. Only temporary storage of floodwater is proposed under this alternative, with the reservoir being completely emptied between flood events, in order to preserve the land-based recreational and wildlife conservancy value of the marsh. While this plan alternative would serve to reduce flood damages downstream from the Marsh, it would not eliminate the need to construct dikes in the City of Burlington nor would it provide adequate protection to the Silver Lake area.

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

rip rap at $10 per cubic yard. Miscellaneous construction costs are estimated at $105,700, with land and easement costs estimated at $819,000.

Benefits: Construction of the floodwater retarding reservoir could be expected to reduce average annual flood damages by $12,800. These benefits would be achieved by lowering the hydraulic grade line of the flood flows on the Fox River below the proposed reservoir. The proposed reservoir may be expected to lower the high water elevation of the 100-year recurrence interval flood on the Fox River approximately 4 feet at STH 15, 2.2 feet at Big Bend, 1.5 feet at Waterford, 0.8 foot at Burlington, and 0.2 foot at Wilmot.

Costs: The total installation cost of the proposed structure is estimated at $1,050,000, including construction, engineering and administrative services, the cost of road relocation, and the cost of obtaining land easements. Amortized at 3 1/4 and 6 percent, over a 50-year period, average annual costs would be $42,770 and $66,600, respectively. Average annual operation and maintenance costs are estimated at $350.

Benefit-Cost Ratio: The benefit-cost ratio for the Vernon Marsh floodwater retarding reservoir, calculated at 3 1/4 percent, would be 0.30 to 1.0.

Average Annual Benefit	
Flood-damage alleviation	$12,800
Average Annual Cost	
Structure installation	$42,770
Structure operation and maintenance	350
Total	$43,120

$$\text{Benefit-Cost Ratio} = \frac{12,800}{43,120} = 0.30$$

$$\text{At 6 percent interest} = \frac{12,800}{66,950} = 0.19$$

This proposal would provide a degree of protection to flood-vulnerable urban and agricultural areas along the main stem of the Fox River below the Vernon Marsh. This proposal would not eliminate the need to construct dikes in Burlington nor would it provide an acceptable level of protection in the Silver Lake area, where 100-year recurrence interval high water surface elevations would be reduced only 0.8 foot and 0.2 foot, respectively. Installation of the structure would eliminate the need to replace the bridges on Center Drive, STH 24, Tichigan Drive, and CTH F solely for the purpose of providing adequate waterway openings. The foregoing evaluation of this plan element is based upon the construction of only a single-purpose reservoir. The use of the reservoir for an additional purpose, municipal water supply for the City of Waukesha, is discussed in Chapter VI, Volume 2, of this report.

MANAGEMENT OF EXISTING WATER CONTROL FACILITIES

The structural flood control facilities described in the preceding sections would begin to function as soon as construction was completed and the facilities placed in service. The facilities, if designed as proposed, would require nothing other than normal maintenance to continue to provide protection throughout the physical life of the facilities. The following two alternative flood abatement proposals would require both structural improvements and the management of these improvements in order to perform flood control functions. The management requirements attendant to these two proposals consist of temporarily lowering existing lake levels in order to establish storage volumes for floodwaters. This would require relatively minor modifications to existing lake outlet control structures. It would also require approval from the Wisconsin Department of Natural Resources to alter legally established lake levels and the assignment of the management responsibilities to some unit or agency of government. Proper regulation of the lake levels for flood control purposes would not detract from the recreational value of the existing lakes.

Management of the Impoundment at Waterford

A degree of flood control could be established on the Fox River downstream from Waterford by operating the Waterford impoundment so as to provide storage for floodwater. Such operation for flood control would require that a system of gates be installed in the existing dam at Waterford. The gates would provide a means for removing water held in storage below the crest of the dam. The volume so vacated by drawing down the level of the impoundment would become available for the storage of floodwater. An estimated 1,000 acre-feet of potential floodwater storage could be obtained for each foot of depth that the impoundment was lowered.

Ideally, the impoundment would be managed so that maximum storage would be available just prior to the occurrence of a flood. As the flood passed through the impoundment, it would return the water surface of the impoundment to its normal level. Only the timing of snowmelt floods, however, can be readily anticipated. Therefore, operation of the impoundment would, as a practical matter, be limited to the control of spring runoff.

Streamflow records indicate that about 80 percent of the snowmelt floods on the Fox River occur in the four-week period beginning in the second week of March. Therefore, drawdown of the impoundment would have to be initiated around the first of March; and the impoundment could remain lowered for periods of time up to six weeks from that date.

The impoundment at Waterford was originally created by constructing a low dam across the Fox River. This dam has two concrete weir spillways and at one time also contained a sluiceway controlled by five wooden slide gates. The area originally occupied by the gates has since been filled with concrete, and the channel leading away from the gates has been filled with earth so that the gate is no longer operable (see Figures 9 and 10. In order to operate the structure for flood control purposes, the exit channel below the original sluiceway would have to be reconstructed and modified to permit installation of three radial gates, each four feet by ten feet in cross section. The gates, when opened, would allow the water level in the impoundment to be lowered four feet in a period of 10 to 14 days. Approximately 4,200 acre-feet of floodwater storage would be obtained in this way, equivalent to 0.2 inch of runoff from the tributary watershed area of 360 square miles. A 0.2 inch runoff could, under normal summer conditions, be expected to result from a 1.8 inch rainfall over the tributary watershed area.

Details of the proposed modifications to the existing dam are shown in Figure 11. Estimated quantities of materials and unit costs for the major work items are: clearance of existing sluiceway and channel, lump sum $7,000; 120 cubic yards of reinforced structural concrete at $150 per cubic yard; and installation of three radial gates at $2,400 each. Miscellaneous costs are estimated at $28,100.

Benefits: Modification of the dam at Waterford and its proper operation for flood control purposes would reduce average annual flood damages by an estimated $4,550. This benefit was calculated by assuming that snowmelt floods will account for 50 percent of the average annual damages which the dam could abate and that the management could be used effectively on 50 percent of the snowmelt floods. This assumes that 50 percent of the snowmelt floods will occur after the reservoir is drawn down.

Costs: The total cost of effecting the necessary modifications to the existing dam is estimated at $61,100, including construction and engineering and administrative services. Annual maintenance costs are estimated at $130. The costs do not include an estimate of the cost of the attendant management services, it being assumed that these would be minor and could be absorbed by whatever unit or agency of government is assigned the operational responsibilities. Amortized at 3 1/4 and 6 percent interest, over a 50-year period, average annual cost would be $2,580 and $3,870, respectively.

Benefit-Cost Ratio: The benefit-cost ratio of this proposal calculated at 3 1/4 percent would be 1.7 to 1.0.

Average Annual Benefit	
Flood-damage alleviation	$4,550
Average Annual Cost	
Installation	$2,580
Maintenance	130
Total	$2,710

$$\text{Benefit-Cost Ratio} = \frac{4,550}{2,710} = 1.70$$

$$\text{At 6 percent interest} = \frac{4,550}{4,000} = 1.14$$

The effects of this proposal would be most noticeable on the smaller, more frequent spring snowmelt flood events, because in these events the storage volume available will accommodate a larger proportion of the total runoff, and a larger reduction in flood peaks will consequently be achieved. Flood stages generated by the five-year recurrence interval flood would be reduced by an estimated one foot in the City of Burlington and in the Silver Lake area. Implementation of this flood control proposal would not eliminate the need for the construction of dikes in Burlington nor would it provide a substantial reduction in damage at Silver Lake due to the more severe floods.

In addition to the downstream effects, upstream benefits could also accrue as a result of this proposal. Gates could be partially opened after flood peaks had passed in order to return the impoundment to its normal level as rapidly as possible.

Figure 9

WATERFORD DAM SLUICEWAY PRIOR TO FILLING OPERATIONS

The Waterford impoundment on the Fox River was originally created by constructing a low dam across the river having two concrete weir spillways and a sluiceway controlled by five wooden slide gates. The sluiceway with its attendant exit channel is shown in this photo taken in the summer of 1966. The sluiceway provided flood control capabilities at the Waterford impoundment. The sluiceway and gates were, however, abandoned in 1967 and the channel filled by the Village of Waterford, which owns the dam, upon the issuance of a permit by the Wisconsin Public Service Commission, so that the dam now has no water management or flood control capabilities.

Source: SEWRPC.

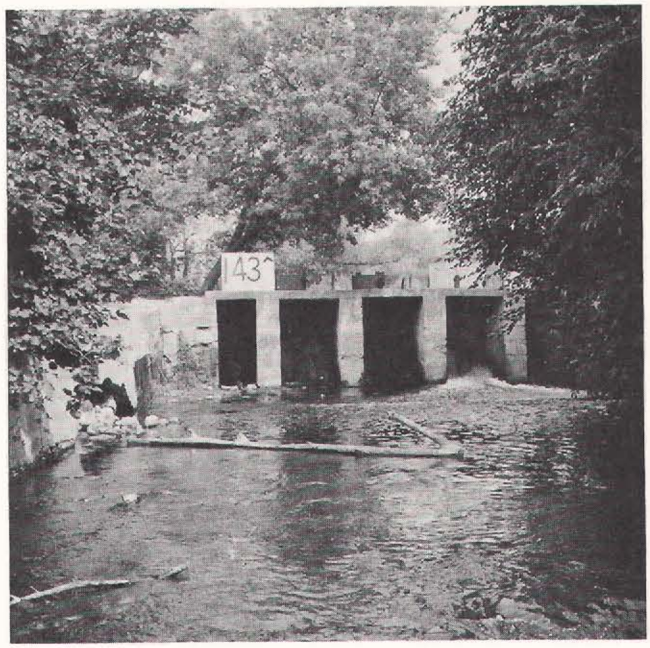


Figure 10

WATERFORD DAM SLUICEWAY AREA SUBSEQUENT TO FILLING OPERATIONS

The original sluiceway and exit channel at the Waterford impoundment were abandoned and filled in late 1967, thus removing any water management capability. In order to be able to operate this structure for flood control purposes, the exit channel below the original sluiceway would have to be reconstructed and gates reinstalled in a reconstructed sluiceway.

Source: SEWRPC.

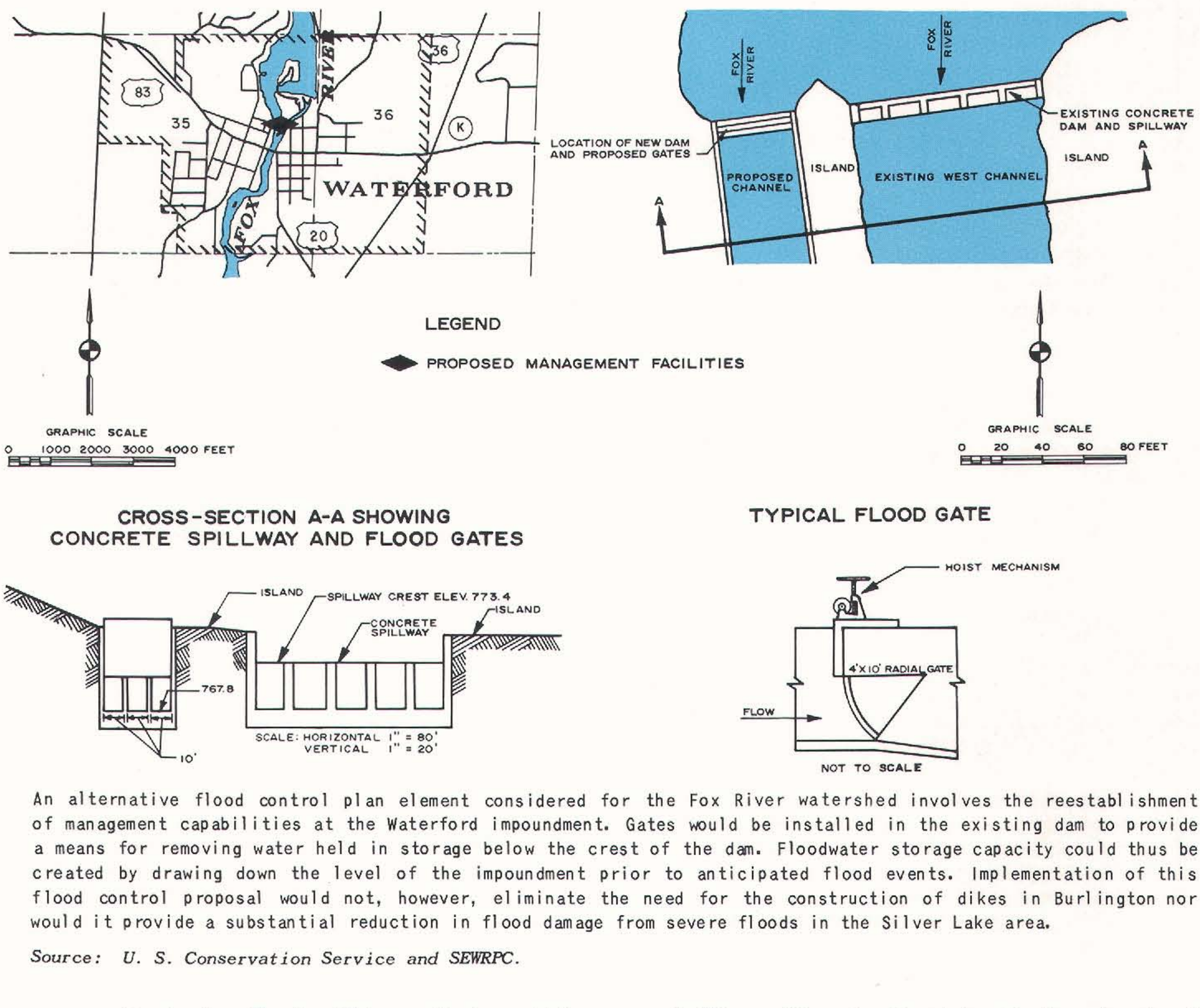
For example, outflow from the structure could be doubled by opening gates one foot when the pool level was one-half foot above the spillway crest or by opening gates two feet with the pool level one foot above the spillway crest. The ability to lower the impoundment level more rapidly could reduce flood damage and improve drainage in upstream areas, particularly those areas around Tichigan Lake. The pool could also be maintained at spillway crest instead of overflowing.

Management of Major Lakes

A degree of flood control could also be established in the Fox River watershed by improving the floodwater storage characteristics of 10 of the major lakes within the watershed. Such improvement would be accomplished by either or both of the following methods:

1. Floodwater storage could be created by lowering lake levels prior to the occur-

Figure 11
PROPOSED WATERFORD IMPOUNDMENT MANAGEMENT FACILITIES



An alternative flood control plan element considered for the Fox River watershed involves the reestablishment of management capabilities at the Waterford impoundment. Gates would be installed in the existing dam to provide a means for removing water held in storage below the crest of the dam. Floodwater storage capacity could thus be created by drawing down the level of the impoundment prior to anticipated flood events. Implementation of this flood control proposal would not, however, eliminate the need for the construction of dikes in Burlington nor would it provide a substantial reduction in flood damage from severe floods in the Silver Lake area.

Source: U. S. Conservation Service and SEWRPC.

rence of a flood. This method would be applicable only to spring snowmelt floods, which can be readily anticipated.

2. Floodwater storage could be increased by making provisions for the temporary storage of floodwater above normal lake levels. This method would require that existing lake outlet structures be altered.

The 10 lakes considered for such management were Pewaukee, Eagle Spring, Beulah, Big Muskego, Eagle, Lauderdale, Como, Geneva, Browns, and Silver (Kenosha County). Various levels of management could be applied on all of these 10 lakes.

Outlet structures on four of the lakes—Pewaukee, Eagle Spring, Big Muskego, and Geneva—are now equipped with control facilities by which the lake level can be lowered. Therefore, the level of these lakes could be readily managed to provide some storage prior to the arrival of spring runoff. Flashboards could be added at the outlet structures of the other six lakes, at approximately the same time of year, to provide for the storage of floodwater above the normal lake levels. The water stored above the existing spillway crest could be released when the risk of flood damage had passed by removal of the flashboards or could be retained in the lake for longer periods and used to augment streamflow and improve stream water quality.

This basic approach, while the most inexpensive, would have several disadvantages: 1) the installation of flashboards and attendant raising of lake levels could induce property damages around some lakes; 2) the lowering of lake levels would have to be done in a conservative manner in order to assure that the lakes would return to normal levels when floods had passed; and 3) the control would usually be effective only for the spring snowmelt flood.

More effective flood control could be realized if more extensive structural alterations were made in the existing lake outlet control structures and if integrated operation of the structures were based upon detailed study of anticipated runoff. In some areas of the state, forecasts of spring runoff volumes are prepared from snow surveys; and the preparation of such forecasts could be made the responbility of the managing agency.

A discussion of how each of the 10 major lake outlets could be most effectively altered and the lake level managed follows:

1. Geneva Lake

   The lake level could be readily managed for flood control purposes using the gates presently provided in the existing outlet control structure. Lowering the lake level 1 foot would take about 13 days and would provide approximately 5,000 acre-feet of floodwater storage, equivalent to 3.2 inches of runoff from the 28.8 square mile tributary drainage area. A 3.2 inch runoff could, under normal summer conditions, be expected to result from a 5.5 inch rainfall over the tributary watershed area. The only cost involved would be the cost of the management services.

2. Eagle Lake

   The existing outlet control structure would have to be structurally modified or replaced with a box inlet structure similar to the one shown in Figure 12. The modified existing structure or the proposed structure would have its spillway crest set at the normal lake level and would contain facilities for lowering the lake level. Lowering the lake level 2 feet below the normal level would require about 9 days and would provide approximately 1,000 acre-feet of floodwater storage, equivalent to 2.6 inches of runoff from the 7.2 square mile tributary drainage area. A 2.6 inch runoff could, under normal summer conditions, be expected to result from a 4.8 inch rainfall over the tributary watershed area. The estimated total installation cost of the modified structure proposal is $7,000.

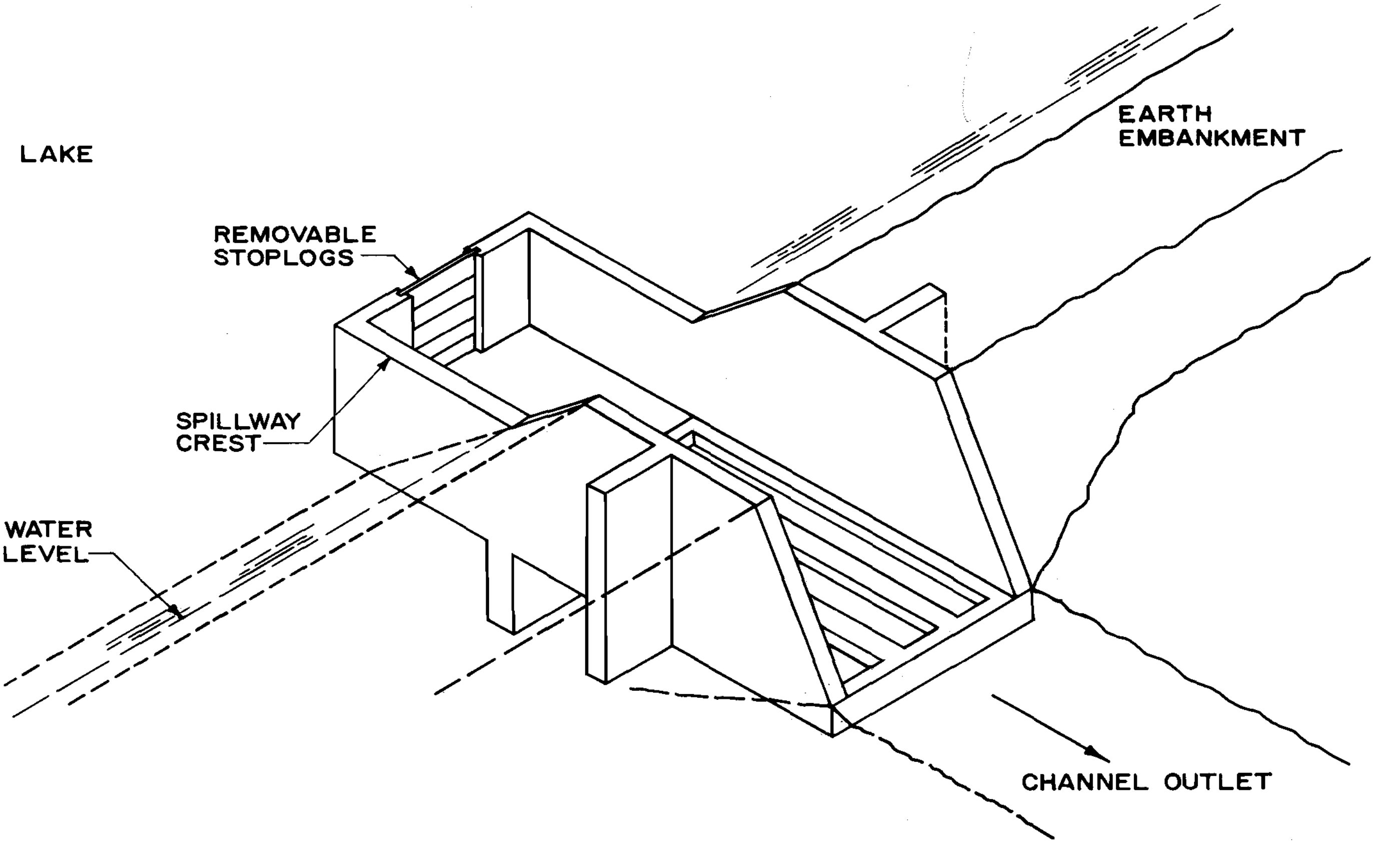
3. Browns Lake

   The existing outlet control structure would have to be removed and replaced with a box inlet structure similar to that shown in Figure 12. The proposed structure would have its spillway crest set 0.5 foot above the normal lake level and would contain facilities for lowering the lake level. Lowering the lake level 1 foot below the spillway crest (0.5 foot below the present normal level) would take about 13 days and would provide approximately 400 acre-feet of floodwater storage, equivalent to 4.5 inches of runoff from the 1.6 square mile tributary watershed area. A 4.5 inch runoff could, under normal summer conditions, be expected to result from a 6.8 inch rainfall over the tributary watershed area. The estimated total installation cost of the proposed structure is $6,100.

4. Lauderdale Lakes

   The existing outlet control structure would have to be structurally modified or replaced with a box inlet structure similar to that shown in Figure 12. The proposed structure would have its spillway crest set 0.5 foot above the normal lake level and would contain facilities for lowering the lake level. Lowering the lake level 2 feet (1.5 feet below the present normal level) would require about 13 days and would provide approximately 1,500 acre-feet of floodwater storage, equivalent to 1.2 inches of runoff from the 24.1 square mile tributary drainage area. A 1.2 inch runoff

Figure 12
TYPICAL BOX-INLET DROP SPILLWAY
STRUCTURE PROPOSED FOR INSTALLATION AT LAKE OUTLETS



NOTE: THIS TYPE OF STRUCTURE COULD BE:

1. USED TO REPLACE EXISTING OUTLET STRUCTURE.
2. ATTACHED TO THE EXISTING OUTLET STRUCTURE TO PERMIT LAKE LEVEL MANAGEMENT.
3. INSTALLED IN THE EMBANKMENT OF THE EXISTING STRUCTURE TO PERMIT LAKE LEVEL MANAGEMENT.

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

could, under normal summer conditions, be expected to result from a 4.9 inch rainfall over the tributary watershed area. The total installation cost of the modified structure proposal is estimated at $7,000.

5. Eagle Spring Lake

The lake level could be readily managed for flood control purposes using the facilities presently provided in the existing outlet control structure. These facilities would allow the lake level to be drawn down 2 feet or more. Lowering the level of the lake 2 feet would require about 4 days and would provide approximately 500 acre-feet of floodwater storage, equivalent to a runoff of 0.25 inch from the 35.5 square mile tributary drainage area. A 0.25 inch runoff could, under normal conditions, be expected to result from a 2.7 inch rainfall over the tributary watershed area. The only cost involved would be the cost of the management services.

6. Silver Lake

The existing outlet control structure would have to be removed and replaced with a box inlet structure similar to that shown in Figure 12. The proposed structure would have its spillway crest set 0.5 foot above the normal lake level and would contain facilities for lowering lake levels. Lowering the lake level 1 foot (0.5 foot below the present normal level) would require about 15 days and would provide approximately 450 acre-feet of floodwater storage, equivalent to a runoff of 1.4 inches from the 5.9 square mile tributary watershed area. A 1.4 inch runoff could, under normal summer conditions, be expected to result from a 3.4 inch rainfall over the tributary watershed area. The total installation cost is estimated at $6,100.

7. Big Muskego Lake

The existing outlet control structure would have to be structurally modified or replaced with a box inlet structure similar to that shown in Figure 12. The proposed structure would have its spillway crest set 0.5 foot above normal lake level and would contain facilities for lowering the lake level. Lowering the lake level 1.5 feet (1.0 foot below the present normal level) would require about 20 days and would provide approximately 3,000 acre-feet of floodwater storage, equivalent to a runoff of 2.0 inches from the 28 square mile tributary watershed area. A 2.0 inch runoff could, under normal summer conditions, be expected to result from a 3.8 inch rainfall over the tributary watershed area. The total installation cost of the modified structure proposal is estimated at $7,500.

8. Pewaukee Lake

The existing outlet control structure would have to be removed and replaced with a box inlet structure similar to that shown in Figure 12.[2] The proposed structure would have its spillway crest 0.5 foot above the normal lake level and would contain facilities for lowering lake levels. Lowering the lake level 1.5 feet (1.0 foot below present normal lake level) would require about 21 days and would provide approximately 4,700 acre-feet of floodwater storage, equivalent to a runoff of 3.2 inches from the 27.6 square mile tributary drainage area. A 3.2 inch runoff could, under normal summer conditions, be expected to result from a 5.7 inch rainfall over the tributary watershed area. The total installation cost is estimated at $11,500.

9. Beulah Lake

The existing outlet control structure would have to be structurally modified or replaced by a box inlet structure similar to that shown in Figure 12. The proposed structure would have its spillway crest set 0.5 foot above normal lake level and would contain facilities for lowering the lake level. Lowering lake levels 2 feet (1.5 feet below present normal level) would require about 13 days and would provide approximately 1,500 acre-feet of floodwater storage, equivalent to 2.2 inches of runoff from the 12.8 square mile tributary drainage area. A 2.2 inch runoff could, under normal summer conditions, be expected to result from a 5.7 inch rainfall over the tributary watershed area. The total installation cost of the modified structure proposal is estimated at $7,000.

10. Como Lake

The existing structure would have to be removed and replaced with a box inlet structure similar to that shown in Figure 12. The proposed structure would have its spillway crest 0.5 foot above the normal lake level and would contain facilities for lowering lake levels. Lowering the lake level 1 foot (0.5 foot below present normal lake level) would require about 18 days and would provide approximately 1,350 acre-feet of floodwater storage, equivalent to 3.1 inches of runoff from the 8.1 square mile tributary drainage area. A 3.1 inch runoff could, under normal summer conditions, be expected to result from a 5.9 inch rainfall over the tributary watershed area. The total installation cost is estimated at $13,300.

The amount that each lake would be lowered would be based on estimates of the expected runoff and,

[2] *The Pewaukee Lake Dam should be replaced because the present structure permits only an approximate one-foot drawdown, which is not enough control for lake water management purposes. To raise the lake level six inches, a broader weir would also be needed to avoid inducing flood damages around the lake when rapid water releases are needed.*

in many instances, would not need to be as great as even the very modest values indicated in the preceding discussion, which values can be considered to be probable maximums. On those structures for which raising of the spillway crest has been suggested, the proposed structure would have an overflow length greater than the overflow length of the existing structure in order to ensure that serious damages are not induced on lake properties as a result of raising the spillway crest.

Approximately 19,400 acre-feet of storage could be created by using all of these 10 lake management proposals. This is equivalent to 0.4 inch of runoff from the entire tributary watershed above Wilmot. As noted, the period required to lower the lake levels would vary from 4 to 21 days. This factor would restrict the management practices to spring runoff events and would require that the lowering procedure be started in the middle of February.

Benefits: Installation and operation of the lake management plan element would reduce average annual flood damages by $3,900. This benefit was calculated by assuming that snowmelt floods will account for 50 percent of the average annual damages.

Costs: The total cost of the proposed flood control element is estimated at $65,500, including construction and engineering and administrative services. Annual maintenance costs are estimated at $350. These costs do not include the cost of management services, it being assumed that these would be minor and would be absorbed by whatever unit or agency of government is assigned the operational responsibilities. Amortized at 3 1/4 and 6 percent interest, over a 50-year period, average annual costs would be $2,670 and $4,155, respectively.

Benefit-Cost Ratio: The benefit-cost ratio of this proposal calculated at 3 1/4 percent would be 1.3 to 1.0.

Average Annual Benefit	
Flood-damage alleviation	$3,900
Average Annual Cost	
Installation	$2,670
Maintenance	350
Total	$3,020

$$\text{Benefit-Cost Ratio} = \frac{3,900}{3,020} = 1.30$$

$$\text{At 6 percent interest} = \frac{3,900}{4,505} = 0.86$$

The reduction in damage that could be attributed to this plan element would be essentially confined to the main stem of the Fox River. Only minor reductions in stage would be realized along most of the river in Wisconsin; however, the storage of large volumes of water, up to a total of 19,400 acre-feet, as already noted, would assist in abating flood problems below the state line.

ALTERNATIVE ACCESSORY FLOOD CONTROL PLAN ELEMENTS

Adequate Waterway Openings of Bridges

The water control facility standards set forth in Chapter II of this volume recommended that bridge waterway openings be considered as an integral part of any comprehensive watershed plan in order to achieve an integrated and effective drainage system within the watershed. Application of the hydrologic and hydraulic information set forth in Appendices D and E, together with an analysis of data on the hydraulic performance of bridge openings, provides a basis for recommending bridge removal and replacement within the watershed. Seventy-five existing bridges will have substandard waterway openings under 1990 land use conditions; and when replaced by the local or state highway agencies concerned as a part of the highway improvement program, these bridges should have adequate waterway openings provided in order to achieve an effective drainage system within the watershed. These bridges are listed in Table 13. Additional related information presenting pertinent hydraulic data is presented in Appendix E. Benefit-cost analyses were not considered as a valid factor in evaluating bridge replacement because the structures requiring replacement have, with few exceptions, served their useful life and will, in any case, require replacement for transportation system construction, operation, and maintenance purposes.

Floodland Evacuation

The structural flood control plan elements discussed in the preceding sections of this report would singly or in combination serve to abate flooding and reduce flood damages in two of the three areas of the watershed which experienced major damages in the 1960 flood: the Waukesha and Burlington areas. No economically sound means exist for the abatement of potential flood damages by the construction of flood control works in the third major damage area of the watershed, the Silver Lake area, since the cost of any practical flood control works to protect existing development in this area would exceed the flood abatement benefits. The removal of certain residences in the floodlands of the Fox River located in Sections 1 and 12, Town 1 North, Range 19 East, Town of Wheatland, Kenosha County, and in Sections 7 and 18, Town 1 North, Range 20 East, Village of Silver Lake and Town of Salem, would, however, accomplish flood damage abatement, reduce the public health and safety hazards attendant to flooding in this area, and provide additional land for park and related open-space use. Evacuation of the floodlands in the Silver Lake area of the watershed must, therefore, be considered as a possible adjunct to any comprehensive watershed plan for the Fox River watershed.

Criteria relating to the removal of residences located within floodlands are largely economic. Flood damages mount rapidly per unit depth of flooding as first floors of dwellings are inundated. It is also generally difficult to floodproof residences when floodwaters rise above the first floor level.

Benefits and Costs: As shown in Figure 13, there are 160 residences located within the 10-year recurrence interval flood hazard lines in that reach of the Fox River watershed extending from Section 1 in the Town of Wheatland through Section 18 in the Town of Salem, Kenosha County. These 160 residences have a present (1968) estimated combined property value of $1,235,115. Amortized at 3 1/4 and 6 percent interest, over a 50-year period, average annual costs of acquiring these residences would be $50,330 and $78,360, respectively. The average annual monetary benefit which could be attributed to this plan element is estimated at $44,500 all of which is attributable to flood damage alleviation.

Benefit-Cost Ratio: Assuming that the salvage value of the residences at the time of public acquisition and removal would be sufficient to cover demolition costs and subsequent landscaping of the vacated sites, the benefit-cost ratio, calculated at 3 1/4 percent interest, would be 0.88 to 1.0.

Average Annual Benefit
Flood-damage alleviation $44,500

Average Annual Cost
Property acquisition $50,330

$$\text{Benefit-Cost Ratio} = \frac{44,500}{50,330} = 0.88$$

$$\text{At 6 percent interest} = \frac{44,500}{78,360} = 0.57$$

It should be noted that the above benefit-cost ratio is very conservative in that no benefits have been assigned for the ultimate use of the land to be evacuated as an integral part of the recommended Fox River parkway.

As noted earlier in this section, no economically sound means exist for the abatement of potential flood damages in the Silver Lake area through the construction of flood control works. Not only would the cost of any practical flood control works, such as earth levees and concrete floodwalls to protect existing development in this area, greatly exceed the flood abatement benefits but the construction, for example, of earth levees would in many instances require the removal of the very residences the levees were designed to protect in order to provide room to construct the levees, which would necessarily be up to 80 feet in width at the base. The construction of concrete floodwalls nearly six miles in length and up to eight feet in height would not only destroy the aesthetic value of the river sought by the shoreline residents to be protected but by the general public as well and would be prohibitively expensive, greatly exceeding the cost of acquiring the residences themselves. Thus, it should be noted that, while the above benefit-cost ratios for floodplain evacuation are less than 1.0, they are necessarily greater than any potential corresponding ratio for the construction of flood control works in this area.

Floodproofing of Residences

It is possible and generally practicable for homeowners, as individuals, to make certain structural adjustments or to impose certain use restrictions on private properties in order to reduce flood damage. These structural measures and use restrictions applied to buildings and contents are known as "floodproofing." The flood damage survey revealed that many private indi-

Table 13

PUBLIC HIGHWAY BRIDGES IN THE FOX RIVER WATERSHED HAVING SUBSTANDARD HYDRAULIC CAPACITIES[a]

Bridge Location	Structure Number[b]	Tributary
CTH HI, Waukesha County	98	Lower Fox
Center Drive, Waukesha County	139	Lower Fox
STH 24, Waukesha County	140	Lower Fox
Tichigan Drive, Racine County	141	Lower Fox
STH 11, Racine County	246	Lower Fox
CTH J, Kenosha and Racine Counties[c]	259	Lower Fox
STH 83 and 50, Kenosha County	265	Lower Fox
CTH F, Kenosha County	269	Lower Fox
CTH B, Kenosha County	272	Silver Lake
CTH X (Saylesville Road), Waukesha County	106	Spring Creek
CTH XI (Holcomb Road), Waukesha County	107	Spring Creek
Hahn Road, Kenosha County	261	Peterson Creek
Richter Road, Kenosha County	262	Peterson Creek
CTH W, Kenosha County	264	Peterson Creek
Darling Road, Walworth County	275	Nippersink Creek
CTH B (Main Street), Walworth County	278	Nippersink Creek
CTH A, Racine County	168	Eagle Creek
CTH J, Racine County	169	Eagle Creek
CTH F, Kenosha County	266	Bassett Creek
Lilly Lake Road, Kenosha County	267	Bassett Creek
Fox River Road, Kenosha County	268	Bassett Creek
STH 43, Racine County	256	Hoosier Creek
Brever Road, Racine County	257	Hoosier Creek
CTH B, Kenosha County	253	Hoosier Creek (Hoosier Creek Canal)
CTH J, Kenosha and Racine Counties	254	Hoosier Creek (Hoosier Creek Canal)
Mt. Tom Road, Racine County	255	Hoosier Creek (Hoosier Creek Canal)
S. Church Street, Walworth County	235	White River (Ore Creek)
Yahnke Road, Walworth County	238	White River
STH 11, Walworth County	240	White River
CTH H, Walworth County	191	Sugar Creek
CTH D, Walworth County	193	Sugar Creek
Hodges Road, Walworth County	195	Sugar Creek
CTH D, Walworth County	196	Sugar Creek
Hargraves Road, Walworth County	200	Sugar Creek
Marsh Road, Walworth County	177	Honey Creek
Carver Road, Walworth County	182	Honey Creek
Bell School Road, Walworth County	185	Honey Creek
Helbach Road, Walworth County	186	Honey Creek
STH 20, Racine County	187	Honey Creek
CTH D, Walworth County	188	Honey Creek
Spring Prairie Road, Racine County	206	Honey Creek
CTH Y, Waukesha County	147	Wind Lake
Woods Road, Waukesha County	148	Wind Lake
Muskego Dam Road, Waukesha County	150	Wind Lake

Table 13 (continued)

Bridge Location	Structure Number[b]	Tributary
CTH X, Waukesha County	122	Mukwonago River
CTH NN, Waukesha County	124	Mukwonago River
CTH E, Waukesha County	127	Mukwonago River
CTH E, Waukesha County	128	Mukwonago River
Beulah Road, Waukesha County	130	Mukwonago River
CTH J, Walworth County	130A	Mukwonago River
CTH I, Waukesha County	131	Mukwonago River
CTH K, Waukesha County	21	Upper Fox (Sussex Creek)
CTH JF, Waukesha County	22	Upper Fox (Sussex Creek)
Lincoln Road, Waukesha County	46	Upper Fox (Poplar Creek)
STH 59, Waukesha County	50	Upper Fox (Poplar Creek)
CTH SS, Waukesha County	51	Upper Fox (Poplar Creek)
CTH Y, Waukesha County	56	Upper Fox (Poplar Creek)
CTH TT (Merrill Hills Road), Waukesha County	93	Pebble Creek
CTH D (Sunset Drive), Waukesha County	96	Pebble Creek
CTH I (Lawnsdale Road), Waukesha County	110	Pebble Brook
CTH U (Guthrie Road), Waukesha County	111	Pebble Brook
Glendale Road, Waukesha County	114	Pebble Brook
Joanne Drive, Waukesha County	42	Upper Fox (Deer Creek)
CTH KX (Calhoun Road), Waukesha County	43	Upper Fox (Deer Creek)
Brookfield Road, Waukesha County	44	Upper Fox (Deer Creek)
Custer Lane, Waukesha County	4	Upper Fox (Main Stem)
CTH W, Waukesha County	5	Upper Fox (Main Stem)
Mill Road, Waukesha County	9	Upper Fox (Main Stem)
CTH Y, Waukesha County	11	Upper Fox (Main Stem)
CTH VV, Waukesha County	12	Upper Fox (Main Stem)
River Road, Waukesha County	28	Upper Fox (Main Stem)
CTH M, Waukesha County	31	Upper Fox (Main Stem)
Barker Road, Waukesha County	32	Upper Fox (Main Stem)
Town Line Road, Waukesha County	59	Upper Fox (Main Stem)
CTH SS, Waukesha County	60	Upper Fox (Main Stem)

[a] *This table indicates those bridges which have substandard hydraulic capacities causing overtopping of the bridge deck or the bridge approach road sections (see Appendix E).*

[b] *See Map 33 in Volume 1 of this report.*

[c] *In 1969 this bridge was replaced with a new structure designed in accordance with the hydraulic recommendations set forth in Appendix E.*

Source: U.S. Soil Conservation Service.

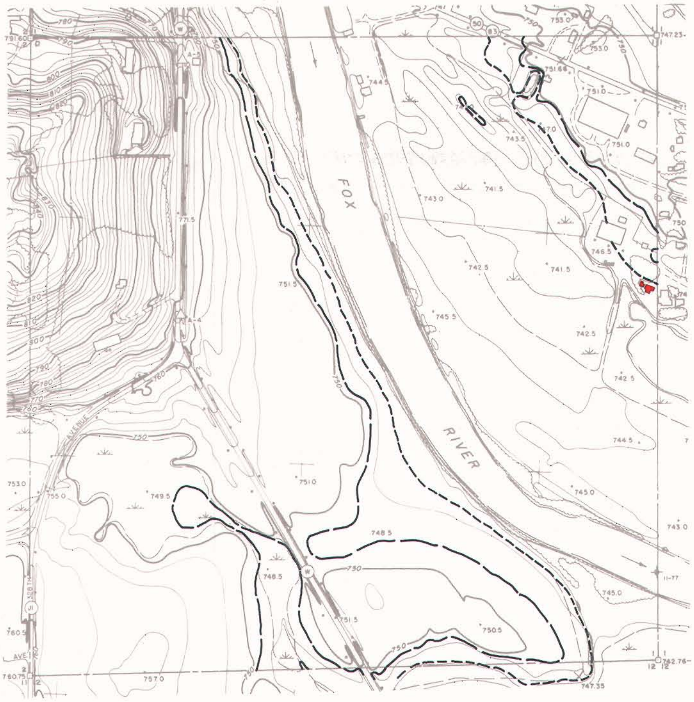
viduals have practiced and may be expected to continue to practice various kinds of floodproofing measures, and these floodproofing measures have undoubtedly contributed substantially to a reduction of historic flood damages. The calculation of future flood damages in this report (see Chapter VII, Volume 1) is based, in part, upon the implied assumption that private floodproofing measures will continue to be applied to reduce future damages in a proportion equivalent to the reduction of historic damages. A review of the technical literature and of the reports of the flood damage survey of the Fox River watershed supports the following presentation of floodproofing elements which can be applied by private individuals.

It should be noted that selection of the specific floodproofing elements to be applied to a partic-

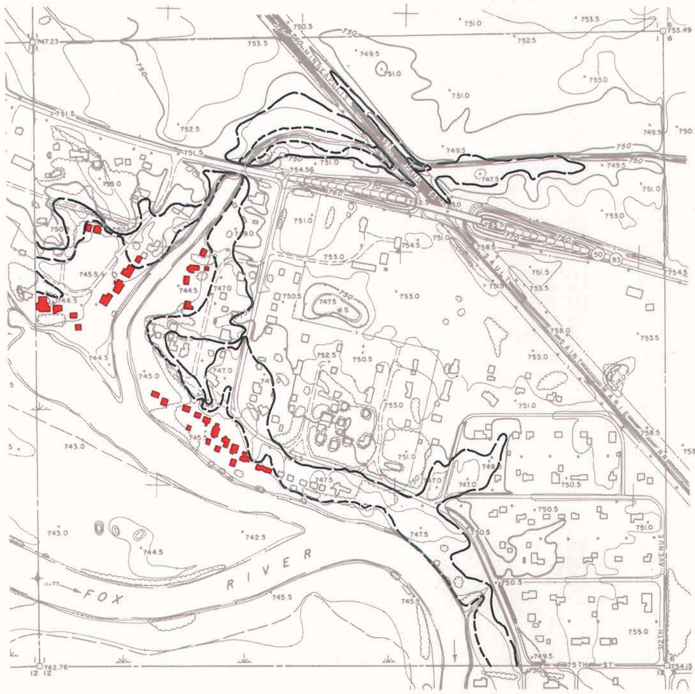
Figure 13

PROPOSED FLOODLAND EVACUATION IN THE SILVER LAKE AREA, KENOSHA COUNTY

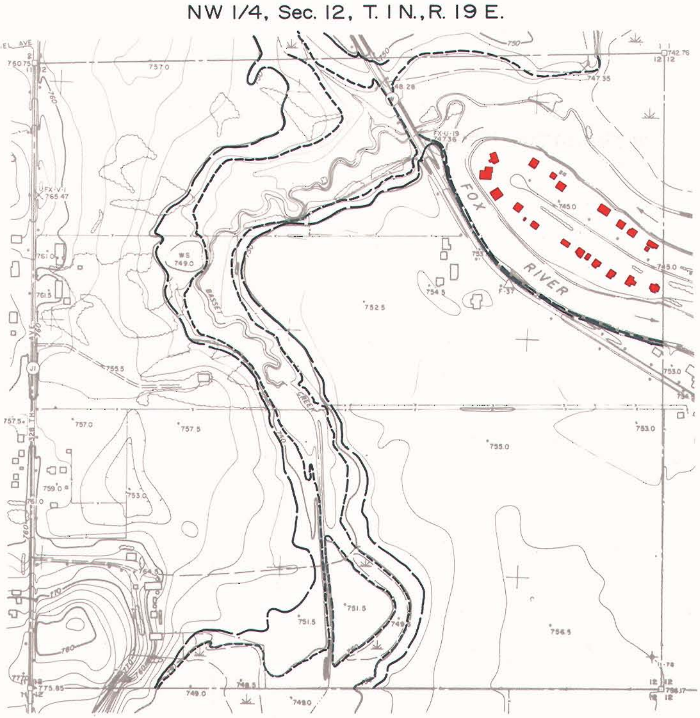
SW 1/4, Sec. 1, T. 1 N., R. 19 E.



SE 1/4, Sec. 1, T. 1 N., R. 19 E.



NW 1/4, Sec. 12, T. 1 N., R. 19 E.



NE 1/4, Sec. 12, T. 1 N., R. 19 E.

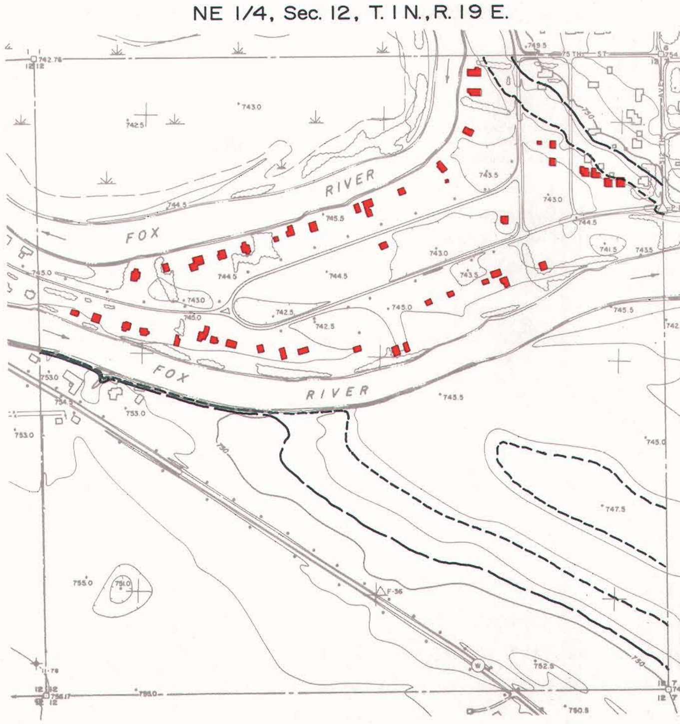
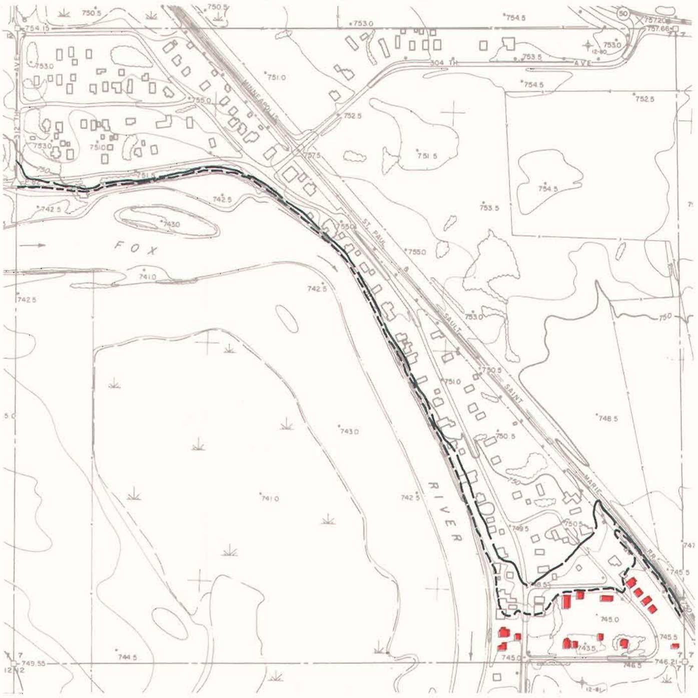


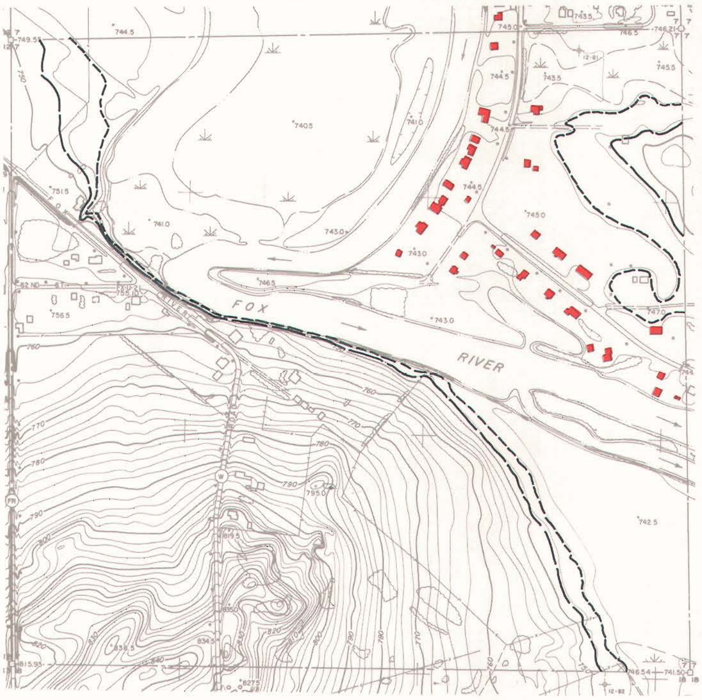
Figure 13 (continued)

PROPOSED FLOODLAND EVACUATION IN THE SILVER LAKE AREA, KENOSHA COUNTY

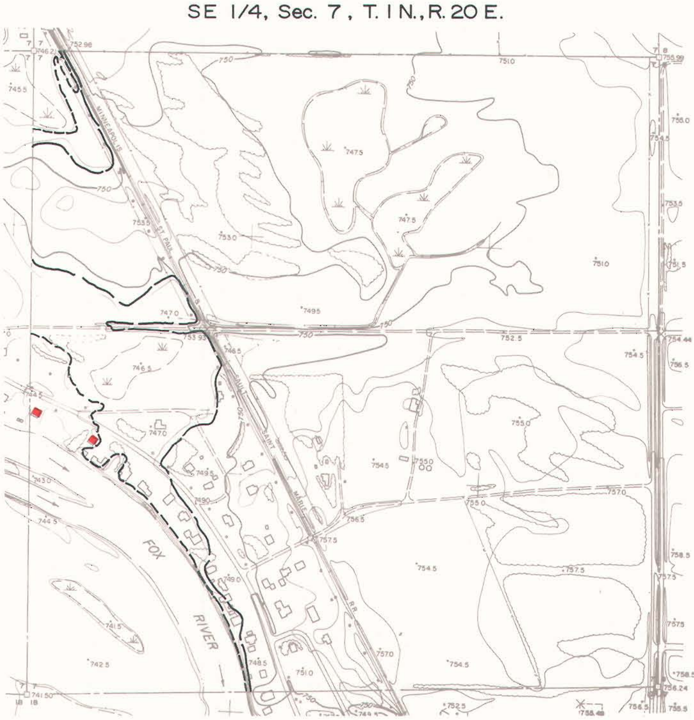
NW 1/4, Sec. 7, T. 1 N., R. 20 E.



SW 1/4, Sec. 7, T. 1 N., R. 20 E.



SE 1/4, Sec. 7, T. 1 N., R. 20 E.



NE 1/4, Sec. 18, T. 1 N., R. 20 E.

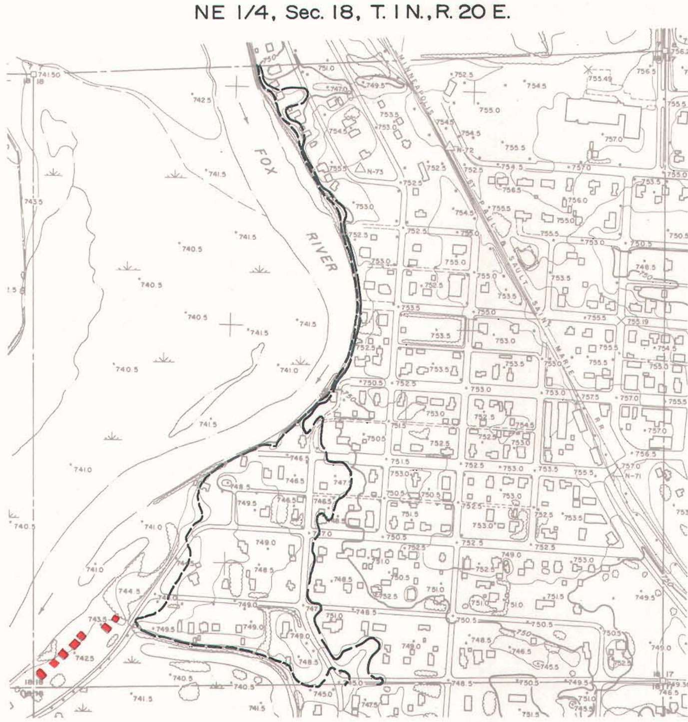
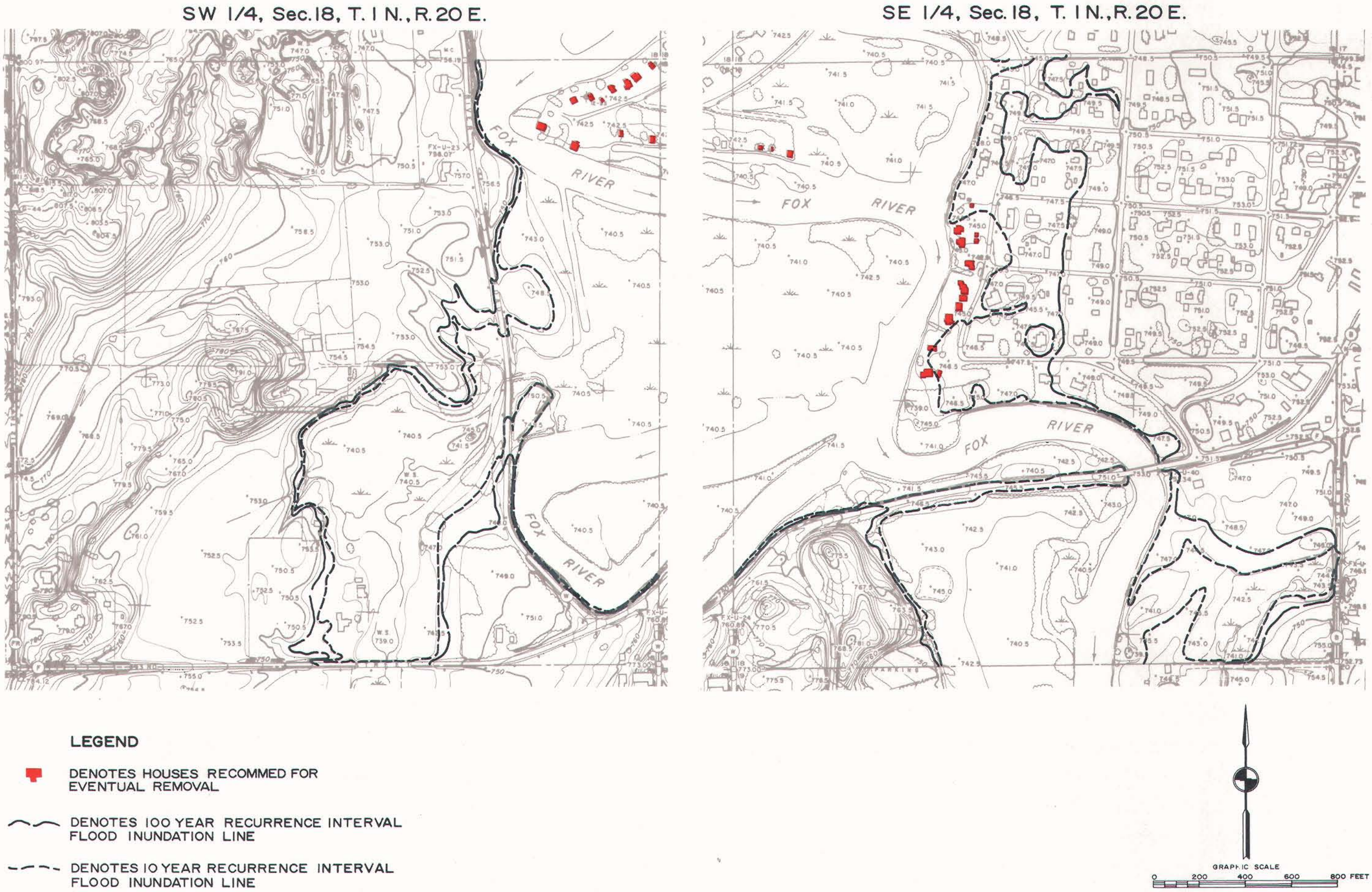


Figure 13 (continued)

PROPOSED FLOODLAND EVACUATION IN THE SILVER LAKE AREA, KENOSHA COUNTY



No feasible means exist for the abatement of potential flood damages through the construction of flood control works in the Silver Lake area, one of the three major flood damage areas of the watershed. It is proposed in this alternative plan element, therefore, to eventually remove 160 residences located in the floodway and having first-floor flooding by a 100-year recurrence interval flood. These 160 residences would be purchased for removal gradually over time as they came onto the real estate market.

Source: *SEWRPC.*

ular structure depends upon the features of the individual house, such as the kind of structural material, age of structure, substructure conditions, nature of the exposure to floodwaters, height of water table, sewerage facilities, and uses demanded of the structure. Extensive floodproofing should be applied only under the guidance of a registered professional engineer who has carefully inspected the building and its contents.

Categorized according to function, floodproofing elements are of four types: 1) general floodproofing independent of the type of flooding, 2) seepage control, 3) relief from sewer backup, and 4) protection from overland flow.

General Measures: A number of floodproofing measures apply to flood-damage prevention regardless of the manner of flooding. These include the following: 1) keeping valuable items away from areas which could be flooded; 2) using waterproof cement in laying tile or linoleum; 3) having adequate electrical fuse protection in all homes; 4) unplugging, disconnecting, or removing from flood-vulnerable areas all electrical appliances; and 5) anchoring all fuel tanks securely so that the force of buoyancy of floodwater will not cause floating and spillage.

Some flood damages can be avoided by removing electric motors from furnaces and appliances and by removing perishable items from basements. Severe flood damages can be caused by fuel oil storage tanks floating loose from anchorage, rupturing, and spilling oil over the contents and interior of homes. Other instances of high flood damages can be caused by unsuitable uses of basements or by impractical designs of floodland homes. Use of floodland basements as bedrooms, kitchens, or living rooms can result in high flood damages.

Seepage Control: During periods of flooding and accompanying high water tables, basements situated in floodlands on permeable soils are particularly susceptible to seepage through walls. Experience has shown that basements can be severely flooded by seepage within a few hours. Where structures are sound and hydrostatic pressure from ground water is low, basements may be waterproofed against seepage by sealing walls with either asphalt or quick-setting hydraulic compounds. In many instances, however, because it is not practical to exclude all seepage water, it becomes necessary to operate a sump pump. As a safeguard against power failure, some homeowners have installed an auxiliary gasoline-fueled pump. As a general principle, all homes constructed in floodlands where the water table is high should have basement walls sealed for maximum waterproofing and should be equipped with a sump pit and with a sump pump that is actuated automatically as waters rise.

Relief From Sewer Backup: Because of flat topography, high water tables, and surface overflow into manholes, floodland homes often experience flood damage problems from the backing up of floodwaters and sewage through a basement floor drain connected to the sanitary sewerage system. It would, therefore, be advisable for floodland homeowners to guard against sewer backup.

A number of relatively inexpensive standard devices can be installed in sewer lines to prevent reverse flow of water. These include standard backwater valves, horizontal swing check valves, and a closed end pipe threaded into a floor drain. It is important to note that, in order for these devices to accomplish flood damage relief, the floor drain must be of adequate strength to resist the hydrostatic pressure without rupturing and thus introducing floodwaters.

Under certain conditions of rapidly rising floodwaters, more flood damage prevention may be accomplished by letting a basement flood than by trying to exclude the inflow of floodwater through sewer lines or in other ways. Severe damage can be caused by the differential pressure between floodwaters and empty basements. Basement floors can be uplifted by hydrostatic pressure and ruptured, and basement walls can be collapsed by the differential pressure. Basement floors, walls, and floor drains should not be floodproofed without consideration of the probable forces which the structure must withstand.

Protection From Overland Flow: Generally, it is not practicable to floodproof residences when floodwaters rise above first floor levels. Exceptions are offered by particularly sturdy structures, such as well-constructed brick buildings; but most frame structures are difficult to floodproof at first floor levels. Below first floor levels, overland flow can sometimes be excluded from homes by the installation of seal-tight, wire-reinforced glass on all basement windows. An alternative measure is to seal all exterior openings to basements and depend entirely on artificial light and air conditioning for light and air in the basement area.

Floodland Regulations

The hydraulic function of the floodplain portion of a river valley is to provide storage area for floodwaters. Major reductions in the storage potential of the floodplain caused by land filling or the construction of substantial structures will result in increased peak flood discharges downstream. If such filling and urban development is allowed to continue to preempt the natural floodplains of the stream system of the watershed, flood hazards and concomitant dangers to property, health, and life may be expected to increase sharply. This will, in turn, lead to increasing demands for the construction of structural flood control measures, such as retention reservoirs, channel improvements, dikes, floodwalls, and cutoff channels. As urban development proceeds on an areawide basis over the watershed, such an approach can only become self-defeating since the number of persons and value of property in the path of floodwaters will increase at a more rapid rate than that at which protection through public works construction can be afforded. Moreover, the actions of upstream communities to prevent damage to land uses located in the natural floodplains may commit the downstream communities to the construction of extensive and expensive flood control works. The intelligent exercise of floodland use regulations is, therefore, required in conjunction with the development of any structural flood control measures.

Prohibition and regulation of flood-vulnerable uses in the floodlands under local police powers are two of the most efficient, economical, and logical methods of preventing flood damage. Generally, the use of the floodplain should be restricted to open uses; and any filling of the floodplains should be avoided. The structural flood control measures considered in this volume are designed to protect development which has already been allowed to occur in the floodlands of the Fox River system. The costs and benefits associated with these works are, therefore, predicated on a sound associated public policy of preventing further flood-prone development in the floodlands of the Fox River watershed.

SUMMARY

Based upon the analyses presented in this chapter, the following flood control elements are recommended for inclusion in the comprehensive Fox River watershed plan:

1. The construction of dikes and floodwalls in the City of Waukesha to protect the existing flood-vulnerable land uses and abate the high flood damages in this channel reach.

2. The construction of dikes and floodwalls in the City of Burlington to protect the existing flood-vulnerable land uses and abate the high flood damages in this channel reach.

3. The construction of channel improvements in the headwater areas of Sugar and Honey Creeks to protect flood-vulnerable agricultural areas and improve agricultural production by providing better drainage.

4. The construction of a multi-purpose reservoir on Sugar Creek to provide flood protection, low-flow augmentation, and recreational benefits.

5. The construction of dikes and channel improvements along the lower reaches of Hoosier Creek to protect flood-vulnerable agricultural areas.

6. The protection of floodland areas along the perennial stream channels from further flood-prone urban development in order to avoid intensification of the flood damage problem within the watershed, to provide for maintenance of the necessary floodwater storage, and to assist in the protection of the primary environmental corridors of the watershed and their maintenance in primarily natural, open uses.

7. The removal of 160 existing residences lying within the 10-year recurrence interval flood hazard lines of the main stem of the Fox River in the Towns of Wheatland and Salem, Kenosha County, in order to abate the serious flood problems existing within this area.

The foregoing structural flood control and floodland evacuation elements not only support both the watershed land use and water facility control development objectives but also provide the least costly and most effective method for reducing major flood damage potentials within the watershed. These flood control elements and the related multiple-purpose reservoir and agricultural water management elements would together provide an average annual flood damage reduction benefit of $144,550 and an average annual recreational benefit of $2,102,950. Together these elements would have an annual average cost of $1,036,790 and would have a combined benefit-cost ratio of 2.27 to 1.0 at a 3 1/4 percent interest rate and of 1.76 to 1.0 at a 6 percent interest rate. The nonstructural element, floodland protection, is absolutely essential if the need for future structural flood control works beyond those recommended herein is to be avoided, with the attendant necessary expenditures of large amounts of public monies.

The construction of the dikes and floodwalls in Burlington would eliminate the need for the management proposals associated with operation of the Waterford impoundment for flood control purposes and with the control of the levels of the 10 lakes within the watershed, as well as the need for the Vernon Marsh reservoir. Therefore, these other alternative structural flood control measures are not recommended for inclusion in the final comprehensive plan for the Wisconsin portion of the Fox River watershed. If, however, additional flood control benefits for the Illinois portion of the Fox River watershed are to be sought by the Federal Government, it is recommended that only the management of the Waterford impoundment, the Vernon Marsh reservoir, and the lake level control alternatives be explored insofar as the Wisconsin portion of the Fox River watershed is concerned.

Chapter V

ALTERNATIVE SURFACE WATER POLLUTION CONTROL PLAN ELEMENTS

INTRODUCTION

Chapter IX, Volume 1, of this report described the existing surface water quality conditions within the Fox River watershed; set forth the water use objectives and standards established by the state for the streams within the watershed; and described the factors affecting existing and probable future levels of surface water quality, including an identification of major sources of pollution within the watershed. Dissolved oxygen, coliform bacteria, and temperature were identified as the most significant water quality indicators because of their direct relationship to the established water use objectives and standards.

Existing stream water quality conditions were generally found to be poor in the headwater reaches, mediocre in the middle reaches, and reasonably good in the lower reaches of the watershed. Specific problems requiring resolution with respect to stream water quality were found to include: low dissolved oxygen levels in those reaches of the Fox River above Mukwonago and in the Pewaukee River and Poplar Creek; very high coliform counts in those reaches of the Fox River above Mukwonago and from the state line to Waterford and in those reaches of the major tributaries below sewage treatment plant outfalls; and overfertilization, with accompanying excessive growths of algae and other aquatic plants, in certain reaches of the Fox River itself and of its major tributaries. Of the 13 streams within the waterhsed, pollution was found to have rendered four unsuitable for the preservation and enhancement of aquatic life and nine unsuitable for any recreational activity, either in some significant reaches of the stream or throughout the entire stream length.

Forecasts of future water quality conditions indicate that, in the absence of a sound surface water management plan and plan implementation program, pollution may be expected to cause water quality levels in six of the 13 streams within the watershed to become unsuitable for the preservation of aquatic life and three of the 13 streams to become unsuitable for any recreational use or for even minimal aesthetic enjoyment. These stream water quality forecasts were based upon the assumption that by the forecast year of 1990 all of the sewage treatment plants within the watershed would be providing secondary treatment and adequate disinfection of the effluent. If disinfection is not provided, the forecasts indicate that 11 of the 13 streams may be expected to become unsuitable for any recreational use, either in significant reaches or throughout the entire stream lengths. The continued discharge of large amounts of nutrients to the streams may be expected to stimulate the growth of algae and other aquatic plants and further limit the use of the streams for recreational and even minimal aesthetic enjoyment.

The lakes of the Fox River watershed were generally found to be in an advanced state of eutrophication as exhibited by high phosphorus content, dissolved oxygen depletion, and heavy growths of algae and aquatic weeds. Coliform levels were found to be high in certain lakes, indicative of pollution from domestic sewage and the possible existence of a public health hazard. Most lakes, acting as the natural sediment traps of the waterway system of the watershed, were found to be polluted by urban and agricultural runoff and by septic tank overflow, containing nutrients that stimulate algae and aquatic weed growth. Forecasts indicate that eutrophication, the natural aging of lakes which causes lakes eventually to fill with sediment and organic matter and become marshes choked with aquatic plants, may be expected to occur at an accelerating rate and become more intense and widespread. Unless appropriate action is taken, the number of lakes suitable for various types of recreational activities may be expected to decrease in the future.

Because the surface water drainage system of a watershed is made up of a network of streams and watercourses, some of which begin at or flow through lakes, and because pollution sources at individual locations have varying effects on downstream water quality levels, water quality management within a watershed is a most complex problem. Many alternative management possibilities exist, each with a different performance level and attendant cost. In order to select the best scheme from among these alternatives, it is necessary to evaluate the potential measures in terms of both cost and performance. Accordingly, this chapter describes the alternative plans for water quality management considered in the Fox River watershed study, together with an evaluation of each alternative's cost and performance and of its ability to meet the recommended water use objectives and water quality standards set forth in Chapter II of this report.

Five alternative stream water quality management plans, which would provide a level of stream water quality in the Fox River and its 12 major tributaries[1] adequate to meet the recommended watershed development objectives and standards and which would, therefore, be in compliance with the state water use objectives and concomitant water quality standards established pursuant to the State Water Resources Act of 1965, were investigated. Eleven alternative means of lake water quality management were also investigated, and alternative plans for maintaining or improving water quality were prepared for 22 of the major lakes within the watershed.

There are a total of 45 major lakes within the watershed, a major lake being defined as one having a water surface area of 50 acres or more. The 22 major lakes for which alternative lake water quality management plans were prepared included the 15 largest and most important lakes within the watershed.[2] Plans were prepared for four other major lakes—Marie, Center, Upper Phantom, and Benedict—each of which is interconnected with one of the 15 largest lakes. In addition, plans were prepared for three major lakes—Bohner, Pell, and Echo—as examples typical of the remaining smaller lakes within the watershed, in order to estimate the magnitude of the costs attendant to the restoration and protection of lake water quality. In general, the 22 major lakes selected for consideration include the largest lakes; the most important recreational lakes; the most highly urbanized lakes; and the lakes with the most severe water quality problems within the watershed.

ALTERNATIVE STREAM WATER QUALITY MANAGEMENT PLAN ELEMENTS

All of the major waste discharges in the Fox River watershed are now receiving or will, in the near future, receive secondary treatment.[3] Even at present, however, this level of treatment is not sufficient to prevent degraded water quality conditions in the upper portion of the Fox River and in the Pewaukee River. Anticipated population growth and urbanization in the watershed, with continued reliance on secondary treatment alone, may be expected to cause further deterioration of water quality conditions throughout the watershed. Future waste discharges from sewage treatment plants serving the Cities of Brookfield and Waukesha; the Villages of Pewaukee, Sussex, and

---

[1] *The 12 major tributaries are: Sussex Creek, Poplar Creek, Pewaukee River, Pebble Creek, Genesee Creek, Mukwonago River, Wind Lake Drainage Canal, Honey Creek, Sugar Creek, White River, Bassett Creek, and Nippersink Creek.*

[2] *These lakes, in order of size, are: Geneva, Pewaukee, Big Muskego, Como, Wind, Tichigan, Beulah, Elizabeth, Eagle, Little Muskego, Silver (Kenosha County), Camp, Powers, Lower Phantom, and Browns.*

[3] *Sewage treatment may be defined as any artificial process to which sewage is subjected in order to remove or so alter its objectionable constituents as to render it less offensive and dangerous and less damaging to the receiving environment. Sewage treatment may be classified as primary, secondary, tertiary, and advanced.*

Primary sewage treatment may be defined as treatment in which untreated sewage is the influent and in which coarser floating and settleable solids (suspended matter) are removed by screening and sedimentation. Primary treatment provides 50 to 60 percent reduction of the influent suspended matter and 25 to 35 percent reduction of the influent biochemical oxygen demanding organic matter (BOD). It removes little or no colloidal and dissolved matter.

Secondary sewage treatment may be defined as biological treatment of the effluent from primary treatment by means of trickling filters or activated sludge tanks and additional sedimentation. Secondary treatment provides up to 90 percent overall removal of the suspended matter and 75 to 95 percent overall removal of BOD.

Tertiary sewage treatment may be defined as additional solids and BOD removal following secondary treatment. Processes include detention of secondary effluent in shallow ponds to provide additional biochemical treatment and settling of solids or filtration either by sand or mechanical filters. Ponding may provide overall removal of up to 99 percent of the suspended matter and 95 to 97 percent of the BOD.

Advanced treatment may be defined as additional treatment processes, following secondary treatment *or combined with tertiary treatment, to provide removal of additional constituents, particularly phosphorus and nitrogen compounds, by such means as chemical coagulation, sedimentation, charcoal filtration, and aeration.*

Advanced treatment may remove up to 90 percent of the nitrogen and 95 percent of the phosphorus in the influent sewage. The expression ''advanced treatment'' ordinarily is understood to encompass tertiary treatment, but the expression ''tertiary treatment'' does not include advanced treatment.

An auxiliary treatment which may be used in combination with all treatment methods is disinfection by chlorination or other chemical treatment. The combinations of the various unit operations usually provided to effect the various levels of treatment are shown in Figure 14.

Lannon; and the Poplar Creek subwatershed may be expected to render Sussex Creek, the Pewaukee River, and the Fox River, from its headwaters to Mukwonago, grossly polluted and unable to meet established water use objectives and standards. In the lower portion of the watershed, waste discharge from the Villages of East Troy, Lake Geneva, and Twin Lakes may be expected to render portions of Honey Creek, the White River, and Bassett Creek, respectively, polluted and unable to meet established water use objectives and standards.

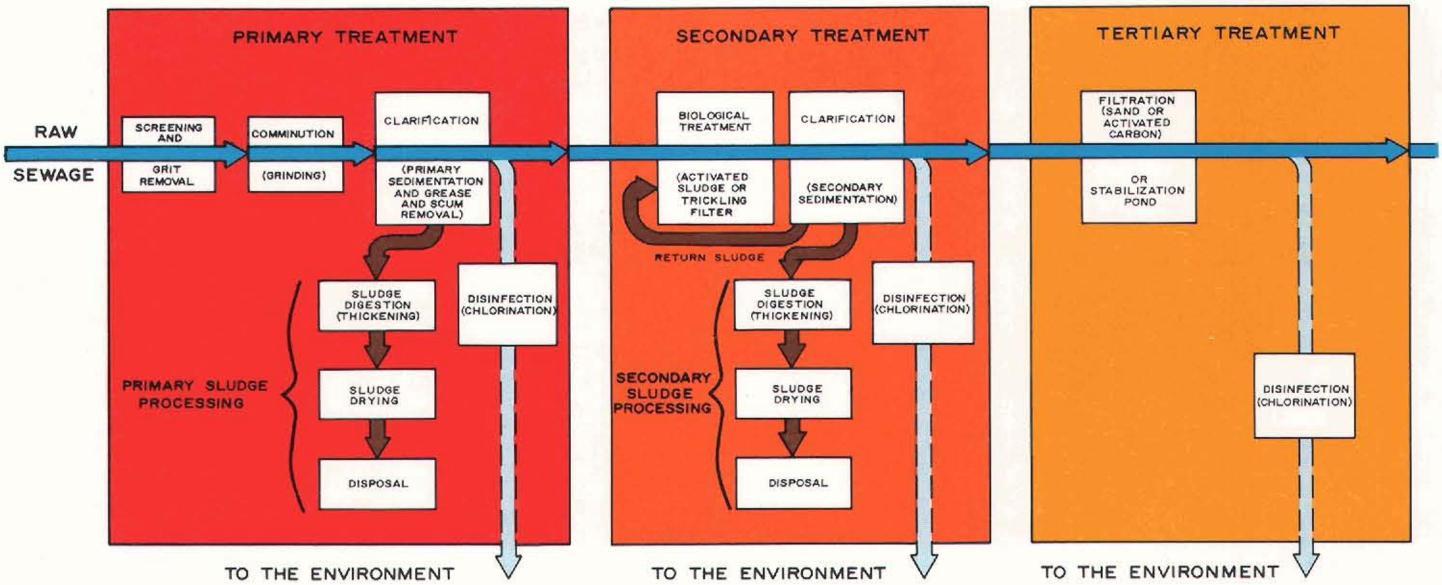
It is anticipated that the State of Wisconsin will, in the near future, require disinfection of the treated effluent, in addition to secondary treatment, for all major waste discharges in the watershed. If the established water use objectives and standards are to be met, however, it will be necessary to provide a higher degree of treatment for major waste discharges in the Fox River watershed. This higher degree of treatment could be in the form of advanced waste treatment to remove more biochemical oxygen demand (BOD) and nutrients from the wastes before discharge; in the form of in-stream treatment, such as low-flow augmentation, to provide more dilution of the wastes and chemical treatment of the stream to reduce excessive algae and weed growths; or in the form of a combination of advanced waste treatment and in-stream treatment.

The effects on water quality of discharging various amounts of BOD to a stream can be predicted with a fair degree of certainty. The effects of discharging various amounts of nutrients, contributing to weed and algae growth in streams, cannot be accurately predicted at present, however, due to the limitations of existing knowledge about the interactions among nutrients, growth of aquatic life, and the stream environment. It is reasonable to expect, however, that the large amounts of nitrogen and phosphorus which will be discharged to surface waters in the effluent from secondary sewage treatment plants will cause excessive growths of algae and aquatic weeds, which will, in turn, severely interfere with recreational and aesthetic uses of the Fox River and several of its major tributaries. Excessive daily fluctuations in the dissolved oxygen content of the stream sufficient to render the stream unsuitable for fish life may be expected to occur as a result of algal respiration and weed growths. Such fluctuations already occur frequently in the reach of the Fox River immediately downstream from the City of Waukesha sewage treatment plant. Unless corrective measures are taken, the nitrogen and phosphorus being discharged to the Fox River by 1990 may be expected to be more than double the present amounts. Approximately 75 percent of the nitrogen and 90 percent of the phosphorus added to the river above Waterford may be expected to be contributed by municipal sewage treatment plants if such plants continue to provide only secondary treatment. In the Wisconsin portion of the Fox River watershed as a whole, about 55 percent of the nitrogen and 80 percent of the phosphorus are presently contributed by municipal sewage treatment plants. Thus, by removing nitrogen and phosphorus from the treated municipal wastes, the amount present in the streams can be greatly reduced, effecting a significant improvement in water quality conditions.

Seven alternative stream water quality management plan elements were investigated, of which five were found to meet the established water use objectives. In addition, three variations of one of the basic seven alternatives were explored. The sizes of the facilities needed to accommodate the hydraulic and biological loading for each alternative were based upon the forecast future (1990) population levels as derived from the land use plan base element, design waste flows developed in the study for this purpose, and upon accepted engineering design criteria.

Plan design sewage flow rates for the year 1990 were derived from the data presented in SEWRPC Technical Report No. 4, Water Quality and Flow of Streams in Southeastern Wisconsin. The average flow rates used for plan design were: 120 gal-

Figure 14
SEWAGE TREATMENT PROCESSES



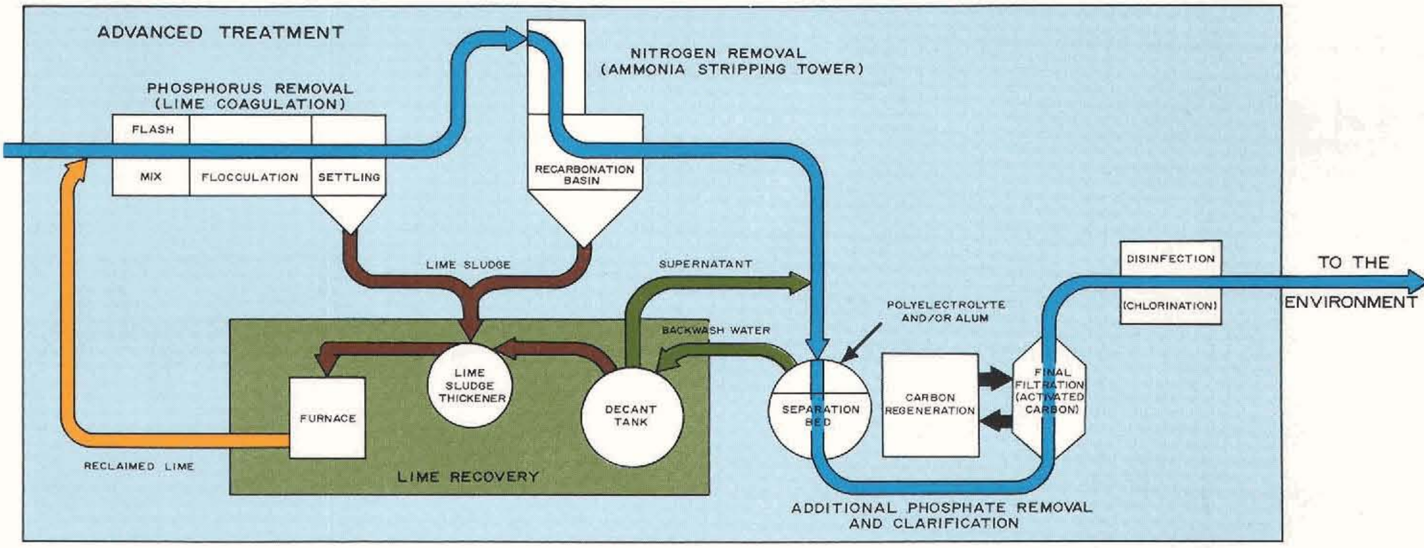
The above diagram schematically illustrates the sequential steps in the sewage treatment process. Sewage treatment may be defined as any physical, biological, or chemical process to which sewage is subjected in order to remove or alter its objectionable constituents and thus render it less damaging to the receiving environment. Four degrees or levels of treatment are shown in this diagram, with each level providing a better quality of effluent that is eventually discharged into receiving waters. Only three of these levels of treatment are presently in common use, and most sewage treatment plants now operating in the Southeastern Wisconsin Region provide only secondary treatment.

In the first, or primary, level of treatment, metal screens remove large objects, such as sticks and rags, from the raw sewage. The sewage then passes into a grit chamber where coarse suspended materials, such as sand and gravel, settle to the bottom. From the grit chamber the sewage flows through a comminutor, which grinds any remaining large suspended solids, and then into a sedimentation tank where the velocity of flow is reduced so that the suspended particles sink to the bottom, forming a sludge blanket. Floating solids, oils, and greases are removed through skimming. Up to this point the primary treatment process is essentially physical (mechanical) in nature. The sludge is pumped to a heated tank where it is reduced by anaerobic bacteria --that is, bacteria which can exist without free oxygen--to a stable residue. The sludge digestion process is essentially biological in nature. By itself, this primary treatment removes only about 30 percent of oxygen-demanding organic matter in the raw sewage, the matter removed representing the coarser suspended solids in the sewage. Primary treatment removes little or none of the colloidal and dissolved matter in the sewage.

In secondary treatment most of the remaining oxygen-demanding organic matter is consumed by bacteria in the presence of oxygen. The effluent from the primary treatment facilities is further treated by such means as trickling filters or activated sludge tanks and additional sedimentation. The secondary treatment process is both physical and biological in nature. Secondary treatment removes up to 90 percent of the suspended matter and from 75 to 95 percent of the oxygen-demanding organic matter present in the raw sewage. In tertiary treatment additional solids and oxygen-demanding material are removed through detention of the secondary effluent in oxidation or stabilization ponds and through filtration by either sand or mechanical filters. Tertiary treatment, which may be either physical or biological or both in nature, removes up to 99 percent of the suspended matter and from 95 to 97 percent of oxygen-demanding organic matter present in the raw sewage.

lons per capita per day (gpcd) for communities having a resident population under 5,000 persons, and 180 gpcd for communities having a resident population over 5,000 persons. These average per capita sewage flow rates were used to size the required sewage treatment plants and estimate their cost. Trunk sewers were sized to carry a peak hourly flow of two times the average sewage flow rate, or 240 gpcd and 360 gpcd, respectively. The selection of this ratio of peak hourly flow to average flow was based on recommendations contained in the American Society of Civil Engineers Manual of Engineering Practice No. 37, Design and Construction of Sanitary and Storm Sewers. The values selected for the average daily and peak hourly design flows compare favorably with the minimum average trunk sewer design flow requirement of 100 gpcd and the minimum peak hourly design flow requirement of 250 gpcd recommended in the 1968 Edition of Recommended Standards for Sewage Works, Great Lakes-Upper Mississippi River Board of State Sanitary Engineers.

The peak flow rates used in the alternative plan design were compared to design flow rates currently used by the Metropolitan Sewerage Commission of the County of Milwaukee. The latter are expressed in terms of cubic feet per second of sewage contribution per acre of tributary service area and range from 0.015 cfs per acre to 0.020 cfs per acre for population densities ranging from 14 to 20 persons per gross acre. This population density range used, however, is not compatible with either the adopted regional land use plan medium-density range of 5.6 to 15.6 persons per gross acre or the high-density range of 15.7 to 39.1 persons per gross acre. The peak flow



Secondary and tertiary treatment processes remove and stabilize the oxygen-demanding organic waste materials in sewage but do not normally remove at best more than about 40 percent of the total phosphorus and 40 percent of the total nitrogen in the raw sewage, materials that are essentially good fertilizers. In advanced waste treatment, the effluent from either the secondary treatment or tertiary treatment facilities is further treated by essentially chemical processes to achieve the removal of the dissolved phosphorus and nitrogen compounds in the sewage that cause undesirable algae and weed growths in the receiving waters. The particular method of advanced waste treatment shown in the above diagram is only one of several possible methods. The method shown includes chemical coagulation, sedimentation, charcoal filtration, and aeration. Advanced waste treatment may be expected to remove up to 90 percent of the nitrogen and 95 percent of the phosphorus in the raw sewage. An auxiliary chemical treatment which should be used in combination with all four sewage treatment processes is disinfection by chlorination.

rate of 360 gpcd used in the alternative plan design is equivalent to a flow rate of 0.004 cfs per acre for an average population density of approximately 7 persons per gross acre, which falls within the regional land use plan medium-density population range and is thus about one-half of the design flow rate used by the Metropolitan Sewerage Commission.

As a further check on the design flow rates selected, flow records obtained at the Waukesha sewage treatment plant were analyzed to determine actual current average and peak rates of sewage flow. These records, for the year 1968, indicate average daily flows ranging from 150 to 220 gpcd, with peak flow rates ranging from 200 to 330 gpcd for an estimated connected population of 38,300 persons and a tributary drainage area of 6,245 acres. Ratios of peak daily to average daily flows ranged from 1.1 to 1.5. Assuming a peak-to-average daily flow ratio of 1.35, a flow rate of 0.0043 cfs per acre of service area was computed for an average population density of 8.5 persons per gross acre, again falling within the regional plan medium-density population range.

Consideration was also given in the analysis to the possibility that peak inflows to the sewage treatment plant may be limited by in-plant or up-system hydraulic capacity. Under such conditions bypassing of sewage at the treatment plant or at locations up-system from the plant would have occurred. Such bypassing, however, was reported only at times of power failure. The examination of the Waukesha data indicated that the average per capita flow at Waukesha may be somewhat higher than that assumed for the alternative plan design purposes but that the peak flows are somewhat lower. The flow charts from the Waukesha sewage treatment plant indicate a relatively high average rate of flow, with relatively low fluctuations in the rate of flow, a condition which may be ascribed to the presence of relatively large quantities of industrial waste waters in the sewer system. Future urban development in the upper watershed should not contribute as much industrial inflow and thus may be expected to produce a somewhat lower per capita flow.

Factors that may explain the difference in per acre flow rates between the Milwaukee area and the Waukesha area are the higher population densities in the Milwaukee area, the higher proportion of industrial contribution, the general condition of the sewer systems, and the effect of roof and footing drain connections on flows in the systems.

In addition to the flow rates, the following salient design criteria were used in determining the size and cost of necessary trunk sewer facilities: all sewers were designed to flow full using the Manning Formula with an "n" value of 0.013; the minimum design velocity was set at 2.0 feet per second; and the minimum depth of cover to the top of the sewer was set at 7.0 feet.

Ground surface elevations along the proposed trunk sewer alignments were obtained from U. S. Geological Survey 7.5 minute quadrangle topographic maps or, where available, from Waukesha County 1" = 200' scale, 5 foot contour interval maps, or SEWRPC 1" = 200' scale, 4 foot-2 foot contour interval maps. Only generalized soil and geologic investigations were carried out along the proposed trunk sewer alignments since the designs were of a preliminary nature, intended to be used only as a basis for the selection between alternative plan proposals.

Construction and maintenance costs were developed for each of the alternative plans utilizing appropriate unit prices. The cost of each alternative so developed did not include the costs of the expansion of the community sewer systems to serve future areas of urban development nor land costs, unless otherwise noted. If per capita water consumption and sewage flows should, contrary to the forecasts, decrease in the future rather than increase, the associated costs for each alternative plan would also decrease slightly; but the relative desirability of one alternative versus another could be expected to remain the same.

Alternative 1—Advanced Waste Treatment (Three Variations)

The first alternative stream water quality management plan element considered consisted of the provision of advanced waste treatment at all major municipal sewage treatment plants within the watershed. This alternative would provide water quality levels suitable to meet the established water use objectives and standards by providing a high level of advanced waste treatment before discharge at all treatment plants serving the following areas of the watershed: Lannon, Sussex, Brookfield, Poplar Creek, Pewaukee, Waukesha, Mukwonago, East Troy, Lake Geneva, Waterford-Rochester,[4] Burlington, and Twin Lakes.[5] The waste treatment provided at each plant would consist of standard secondary treatment and disinfection plus advanced treatment to remove 95 to 99 percent of the BOD, 95 to 99 percent of the phosphorus, and 95 percent of the nitrogen.

It was concluded in Chapter IX of Volume 1 of this report that industrial and resort waste discharges represent a relatively minor contribution to the surface water quality problems of the Fox River watershed. Nineteen major industrial and four major resort waste discharges were found to exist within the Fox River watershed, of which six were found to have a particularly serious adverse effect upon local water quality conditions. Since the completion of the inventory of the sources of pollution within the watershed in 1967, several of

[4] *Sanitary sewerage service for the Waterford-Rochester area of the watershed is now provided by the Western Racine County Sewerage District. A new sewage treatment plant located south of Rochester and providing secondary treatment was placed into operation during 1969. The old primary treatment plant located at Waterford has been abandoned. All references in Volume 2 of this report to municipal sewage treatment at Waterford and Rochester refer to the new plant operated by the Western Racine County Sewerage District.*

[5] *Sewage treatment plants are currently in operation at all of the indicated locations except Lannon and the Poplar Creek area in Brookfield. Plans for a municipal sewerage system and treatment plant have been prepared and approved by the Wisconsin Department of Natural Resources for the Lannon area. A temporary sewage treatment facility consisting of a series of stabilization ponds is in operation in the Poplar Creek area, with plans prepared and approved by the Wisconsin Department of Natural Resources for a permanent plant providing secondary treatment. It should be noted also that the Wisconsin Department of Natural Resources on August 4, 1969, ordered the creation of a sanitary district in the area known as the unincorporated Village of Lyons in the Town of Lyons, Walworth County, and further ordered the planning, design, and construction of a sewage collection system and treatment facility to serve the sanitary district. While this development came too late to be included in a meaningful way in the Fox River watershed study, the regional sanitary sewerage system planning program now being conducted by the Commission will explore alternative methods of providing sanitary sewerage service to the unincorporated Village of Lyons and provide a recommended plan for such service.*

the industries cited as polluters have taken action toward compliance with orders issued by the Wisconsin Department of Natural Resources directing these industries to improve in-plant pre-treatment of wastes; to connect with centralized municipal sanitary sewerage systems; or to provide improved industrial waste treatment facilities. Wherever possible, all remaining major industrial and resort waste discharges in the watershed should be eliminated as sources of surface water pollution through connection to centralized public sanitary sewerage systems if such discharges lie within the existing or proposed service area of a municipal sewerage system. Sixteen of the 19 industrial waste sources and one of the four waste sources would be eliminated in this way. Of these, 14 of the industrial waste sources would be provided with advanced waste treatment facilities through connection with the centralized sewerage system. In addition, all other industrial and resort waste discharges not connected to centralized public sanitary service systems would be given a level of treatment equivalent to secondary treatment and disinfection.

By substantially reducing the amounts of BOD and nutrients being discharged to streams in the Fox River watershed through higher degrees of sewage treatment, this alternative plan element would provide dissolved oxygen levels suitable for the preservation of fish and aquatic life in all stream reaches and would serve to improve the suitability of the streams for recreational and aesthetic uses. In addition, adequate disinfection of all effluent before discharge to the stream system would reduce coliform counts in the streams and should provide a water safe for all contemplated recreational uses.

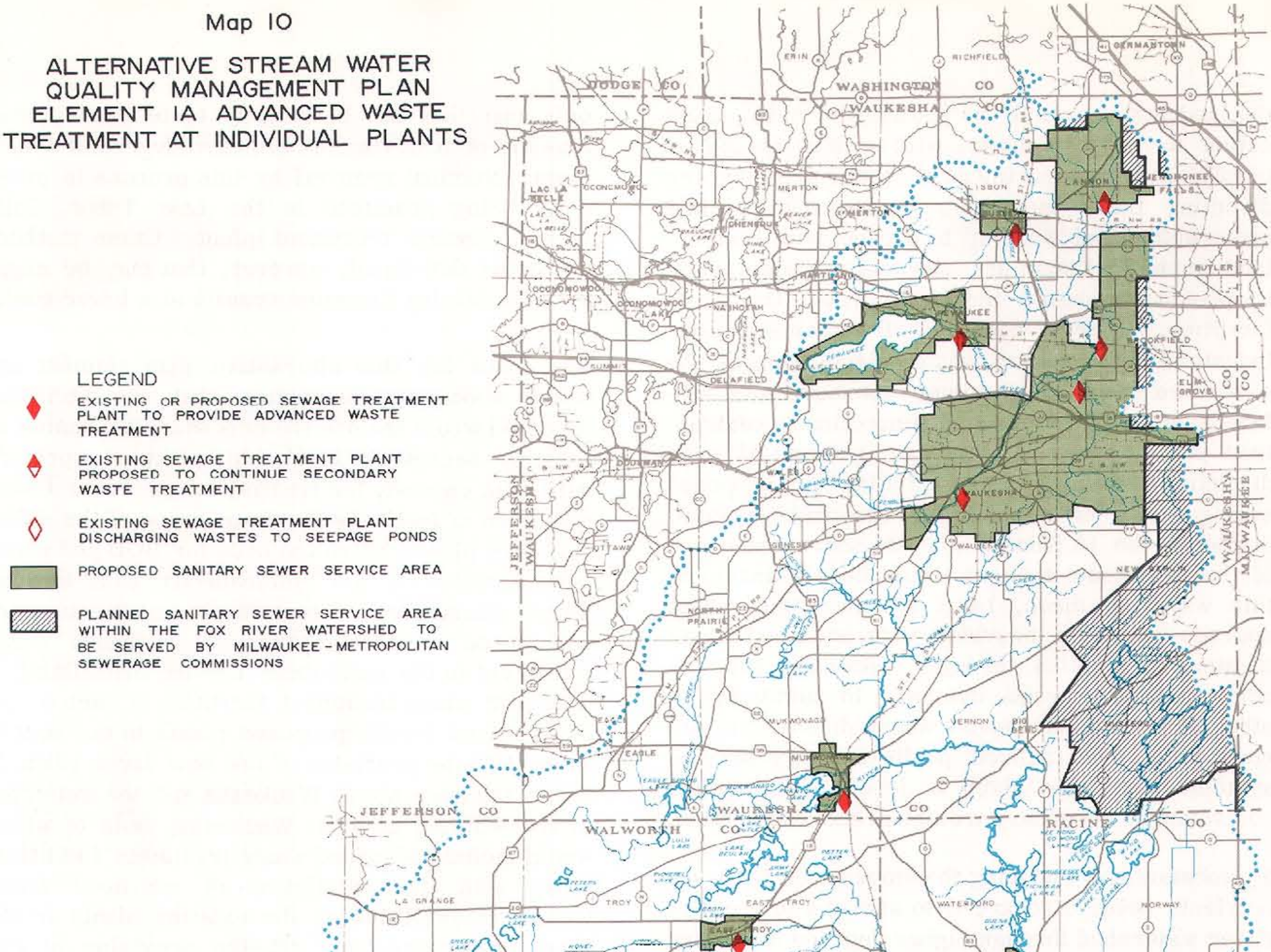
The following process could be used to accomplish the required advanced treatment for nutrient removal: 1) standard secondary treatment by trickling filter or activated sludge, 2) phosphorus and additional BOD removal by lime coagulation and precipitation followed by filtration, 3) ammonia nitrogen removal by ammonia-stripping towers, and 4) disinfection by chlorination. Sludge disposal from the various treatment steps could be by any suitable method that would not result in pollution of air, land, or water, such as digestion and land fill, incineration, or land reclamation. Cost and performance information utilized in the evaluation of this alternative are based on the foregoing process of nutrient removal, rather than other potential methods, since this process is the only one that has been fully tested and proved feasible of achieving the required degree of treatment. Nutrient removal by this process is presently being practiced at the Lake Tahoe, California, sewage treatment plant. Other methods are being developed, however, that may be capable of achieving the same results at a lower cost.

The costs for this alternative plan element are based upon the assumption that the facilities required would include the necessary expansion of existing secondary treatment plants to provide sufficient capacity for treating future waste flows, provision of facilities for disinfection of the effluent at all plants, filtration beds for BOD and phosphorus removal, and ammonia-stripping towers. Three alternative subsystem plan elements were considered for the provision of advanced waste treatment in the watershed: 1A—the installation of advanced waste treatment facilities at each of the existing and locally proposed plants in the watershed; 1B—the provision of one new large plant to serve the area above Waukesha and the retention of the existing plant at Waukesha, both of which would include advanced waste treatment facilities, along with the installation of advanced waste treatment facilities at the existing plants in the lower watershed; and 1C—the provision of one large advanced waste treatment plant to serve the entire upper watershed, along with the installation of advanced waste treatment facilities at the existing plants in the lower watershed.

<u>Alternative 1A—Advanced Waste Treatment at Individual Plants:</u> The first alternative subsystem plan element considered would provide separate sewage treatment plants at each of the following 12 locations within the watershed: Lannon, Sussex, Brookfield, Poplar Creek, Pewaukee, Waukesha, Mukwonago, Waterford-Rochester, East Troy, Lake Geneva, Burlington, and Twin Lakes (see Map 10). Implementation of this plan for the entire watershed would entail an estimated initial capital cost of $22,305,000, with total annual costs, including operation and maintenance, over a 50-year period estimated to be $3,646,700, or $25 per capita per year. The present worth of this alternative for 50 years at 6 percent interest is $57,478,700. These estimates include the costs of all required plant improvements and additions, including secondary treatment, disinfection, and advanced waste treatment facilities. Cost estimates for each major element comprising this alternative are summarized in Appendix G.

Map 10

ALTERNATIVE STREAM WATER QUALITY MANAGEMENT PLAN ELEMENT IA ADVANCED WASTE TREATMENT AT INDIVIDUAL PLANTS



Three alternative subsystem plan elements were considered for the provision of advanced waste treatment facilities at the municipal sewage treatment plants in the upper Fox River watershed. Under the first alternative subsystem, advanced waste treatment facilities would be provided at each of six existing and locally proposed sewage treatment plants in the upper watershed, as well as at existing plants in the lower watershed. The provision of advanced waste treatment facilities would permit the removal of up to 95 percent of the phosphorus and 95 percent of the biochemical oxygen-demanding organic matter in the municipal sewage. The estimated total cost of this alternative subsystem is about $57.5 million, with an initial capital cost of about $22.3 million. This subsystem alternative, as well as the other two alternatives providing advanced waste treatment, would serve a 1990 connected population of about 230,000 persons.

Source: Harza Engineering Company and SEWRPC.

Alternative 1B—Advanced Waste Treatment at Two Large Plants in Upper Watershed and at Individual Plants in Lower Watershed: The second alternative subsystem plan considered would provide a large treatment plant to serve all of that portion of the upper watershed area that would otherwise be served by separate plants at Lannon, Sussex, Brookfield, Pewaukee, and Poplar Creek, along with a system of trunk sewers to convey the wastes to this plant; a separate plant to serve the Waukesha area; and individual plants in the lower watershed at Mukwonago, Waterford-Rochester, East Troy, Lake Geneva, Burlington, and Twin Lakes (see Map 11). The treatment plant serving the area above Waukesha would be located near the confluence of Poplar Creek and the Fox River. The plant serving the Waukesha area would be an expanded facility at the present treatment plant site. The trunk sewer system serving the plant at Poplar Creek would extend from the plant to Lannon with extensions to Sussex and Pewaukee. The layout of the trunk sewer system would be the same as that for the third alternative subsystem plan (Alternative 1C) discussed below and shown in Figure 15, except that the trunk sewer through Waukesha would be eliminated and the trunk sewer extending from Section 24, Town 7 North, Range 19 East, to the Poplar Creek plant in Section 19, Town 7 North, Range 20 East, would become a 30-inch diameter line, laid at a slope of 0.0008, to convey wastes from the Pewaukee area to the plant site. All of the existing sewage treatment plants above the Poplar Creek site—Sussex, Brookfield, and Pewaukee—would be abandoned upon completion of the proposed system. The initial capital cost entailed in implementation of this plan for the entire watershed, including construction of the necessary trunk sewers and the required secondary and advanced waste treatment facilities, is estimated at $24,897,000. Total annual costs over a 50-year period, including operation and maintenance costs, are estimated at $3,482,000, or $24 per capita. The present worth of this alternative for 50 years at 6 percent interest is estimated at $54,909,700. Cost estimates of each major element comprising this alternative are summarized in Appendix F.

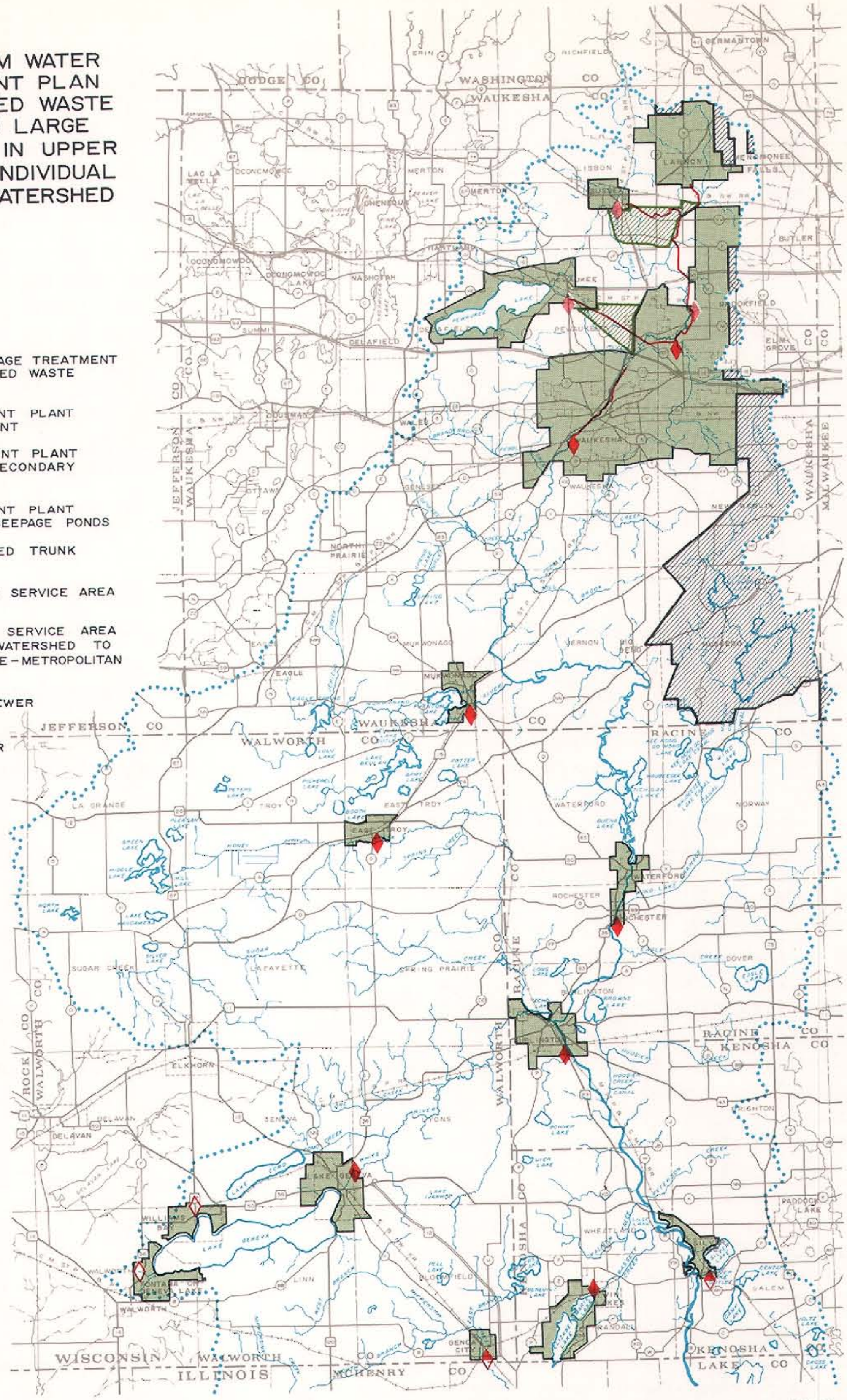
Alternative 1C—Advanced Waste Treatment at One Large Plant in Upper Watershed and at Individual Plants in Lower Watershed: The third subsystem plan considered would provide a single large sewage treatment plant to serve all of the upper watershed area, a system of trunk sewers to convey the wastes to this plant, and individual sewage treatment plants in the lower watershed at Mukwonago, Waterford-Rochester, East Troy, Lake Geneva, Burlington, and Twin Lakes (see Map 12). The sewage treatment plant for the upper watershed would be located downstream from the site of the existing Waukesha sewage treatment plant. The trunk sewer system would extend from the plant site below Waukesha to Lannon with the sewers generally following the course of the Fox River and with extensions to Pewaukee and Sussex to provide service to these areas. The recommended location of the trunk sewers would permit gravity flow throughout the system, as indicated by the profiles in Figure 15. All of the existing sewage treatment plants above Waukesha would be abandoned upon completion of the proposed system. Implementation of this plan, including construction of the necessary trunk sewers and the required secondary and advanced waste treatment facilities for the entire watershed, would entail an estimated initial capital cost of $29,600,000, with total annual costs, over a 50-year period, including operation and maintenance, estimated at $3,614,700, or $25 per capita. The present worth of this alternative for 50 years at 6 percent interest is estimated at $56,960,700. Cost estimates of each major element comprising this alternative are summarized in Appendix G.

Comparison of the Three Variations to Alternative 1: Although Table 14 indicates an apparent cost advantage, in terms of present worth, for Alternative Plan 1B, the difference in cost between the highest cost alternative plan, Plan 1A, and the lowest cost alternative, Plan 1B, is only 5 percent, well within the range of precision with which the costs of each of these three alternative plans could be estimated. The economic analysis concept of present worth cost is discussed in Chapter II of this volume. It is clear that the cost differentials are not large enough to be significant and thereby do not alone provide a sound basis for selection from among the alternatives. Other features of each of these three alternative plans must, therefore, be considered in the selection of the best alternative.

Alternative Plan 1A has the advantage of augmenting streamflows in the upper reaches of the Fox River watershed during periods of dry weather. It has the disadvantage of continuing the discharge of sewage treatment plant effluent to the Pewaukee River, Sussex Creek, and the Fox River above Waukesha; it has the disadvantage of being contrary to the state's policy of discouraging the

Map 11

ALTERNATIVE STREAM WATER QUALITY MANAGEMENT PLAN ELEMENT IB ADVANCED WASTE TREATMENT AT TWO LARGE TREATMENT PLANTS IN UPPER WATERSHED AND AT INDIVIDUAL PLANTS IN LOWER WATERSHED



LEGEND

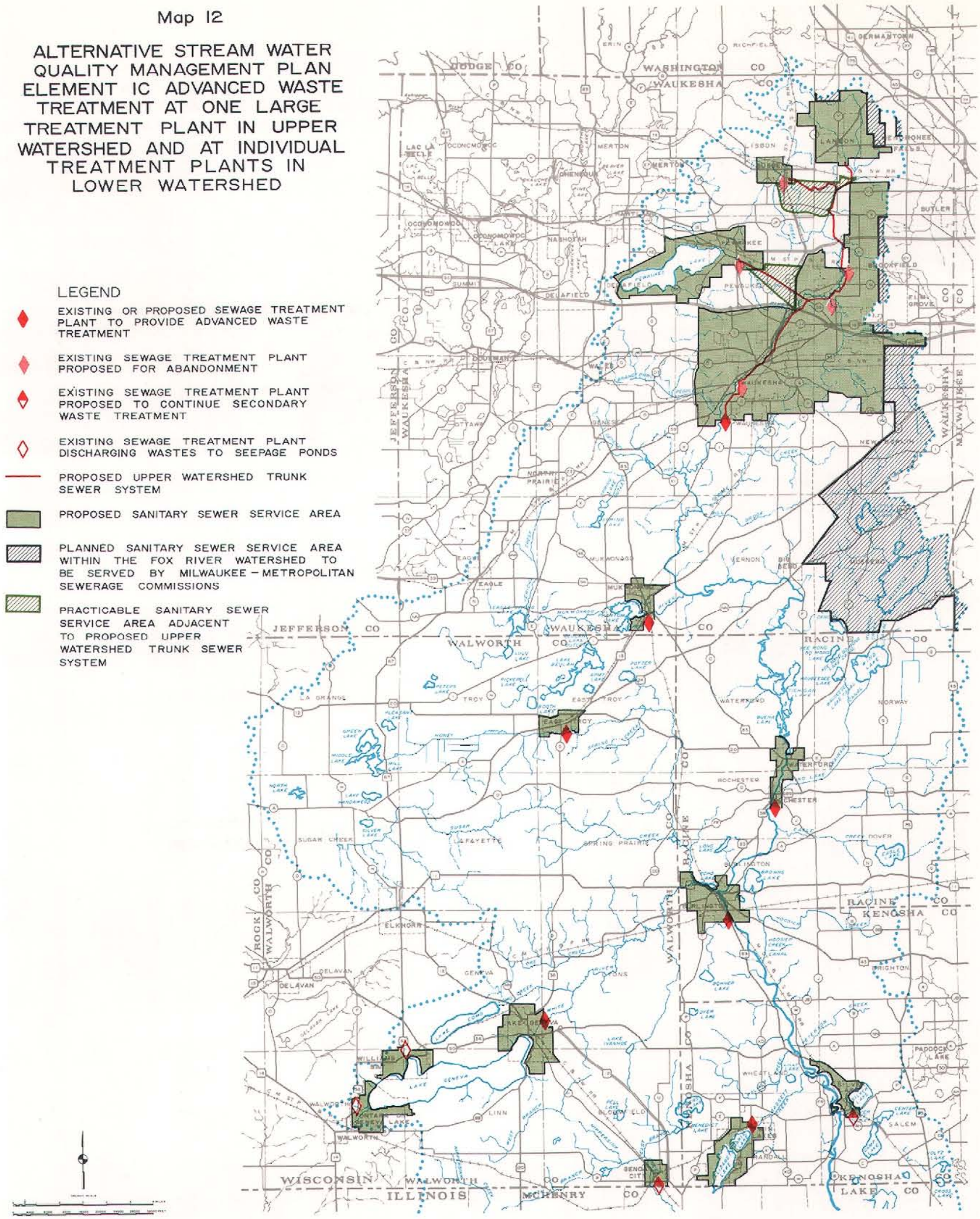
- EXISTING OR PROPOSED SEWAGE TREATMENT PLANT TO PROVIDE ADVANCED WASTE TREATMENT
- EXISTING SEWAGE TREATMENT PLANT PROPOSED FOR ABANDONMENT
- EXISTING SEWAGE TREATMENT PLANT PROPOSED TO CONTINUE SECONDARY WASTE TREATMENT
- EXISTING SEWAGE TREATMENT PLANT DISCHARGING WASTES TO SEEPAGE PONDS
- PROPOSED UPPER WATERSHED TRUNK SEWER SYSTEM
- PROPOSED SANITARY SEWER SERVICE AREA
- PLANNED SANITARY SEWER SERVICE AREA WITHIN THE FOX RIVER WATERSHED TO BE SERVED BY MILWAUKEE-METROPOLITAN SEWERAGE COMMISSIONS
- PRACTICABLE SANITARY SEWER SERVICE AREA ADJACENT TO PROPOSED UPPER WATERSHED TRUNK SEWER SYSTEM

The second alternative subsystem plan element considered for the provision of advanced waste treatment facilities at the municipal sewage treatment plants in the upper watershed differs from the first alternative in that two large sewage treatment plants would be provided to serve the upper watershed, including a large new plant located at the confluence of Poplar Creek and the Fox River in the City of Brookfield, and an enlarged plant located on the site of the present City of Waukesha treatment plant, together with the system of trunk sewers shown on this map. The estimated total cost of this subsystem is about $54.9 million, with an initial capital cost of about $24.9 million.

Source: Harza Engineering Company and SEWRPC.

Map 12

ALTERNATIVE STREAM WATER QUALITY MANAGEMENT PLAN ELEMENT IC ADVANCED WASTE TREATMENT AT ONE LARGE TREATMENT PLANT IN UPPER WATERSHED AND AT INDIVIDUAL TREATMENT PLANTS IN LOWER WATERSHED



The third alternative stream water quality subsystem plan element considered differs from the first two subsystem alternatives in that only one large sewage treatment plant would be provided to serve the entire upper watershed, together with a system of trunk sewers. The plant would be located downstream from the existing City of Waukesha sewage treatment plant. This plant could be built in stages leading toward the eventual abandonment of all other sewage treatment plants in the upper watershed. The new plant would have a 1990 capacity of 36 million gallons per day. The estimated total cost of this alternative is about \$57.0 million, with an initial capital cost of \$29.6 million.

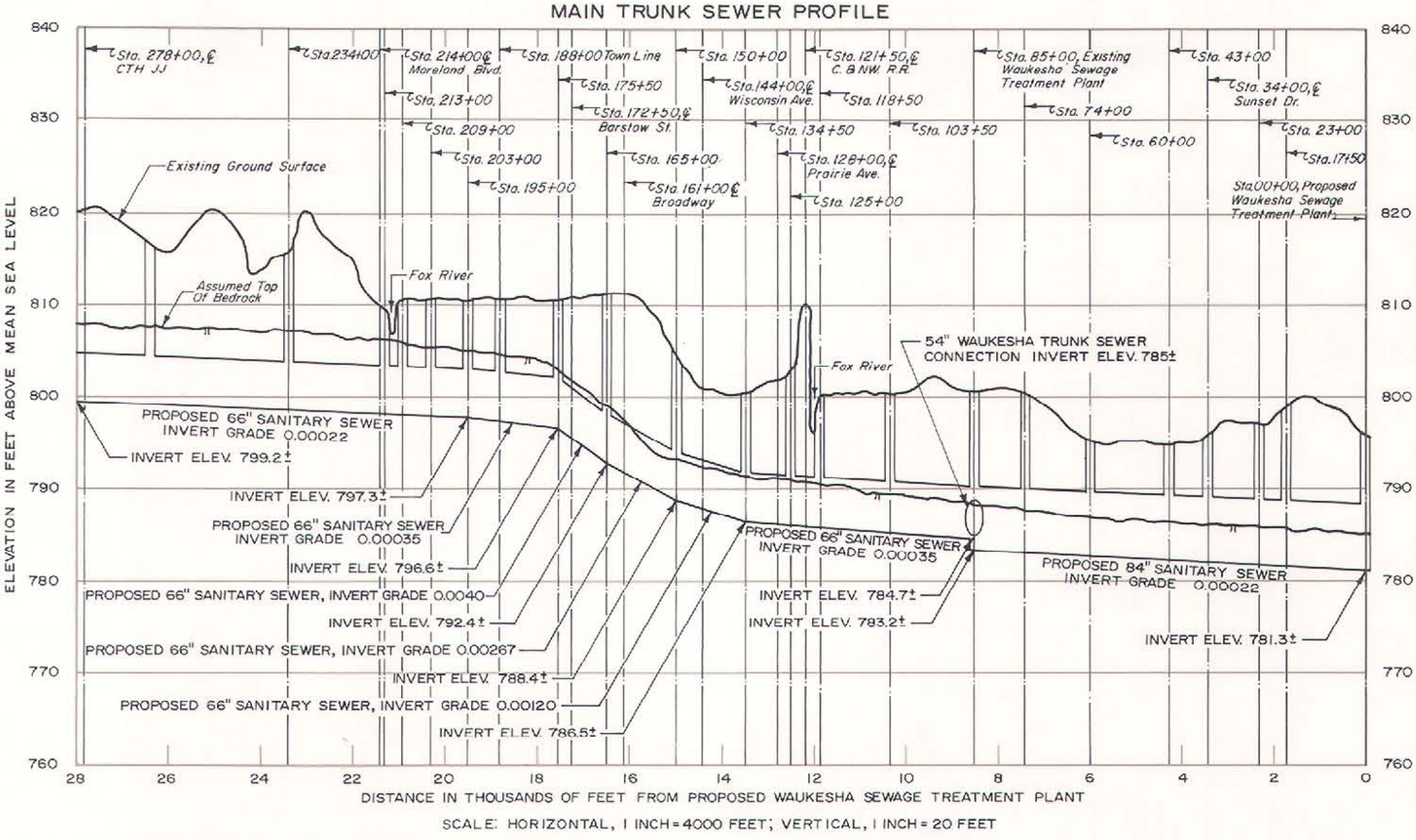
Source: Harza Engineering Company and SEWRPC.

Figure 15

RECOMMENDED UPPER FOX RIVER WATERSHED TRUNK SEWER SYSTEM ALTERNATIVE STREAM WATER QUALITY MANAGEMENT PLAN ELEMENT IC

MAIN TRUNK SEWER PLAN

MAIN TRUNK SEWER PROFILE

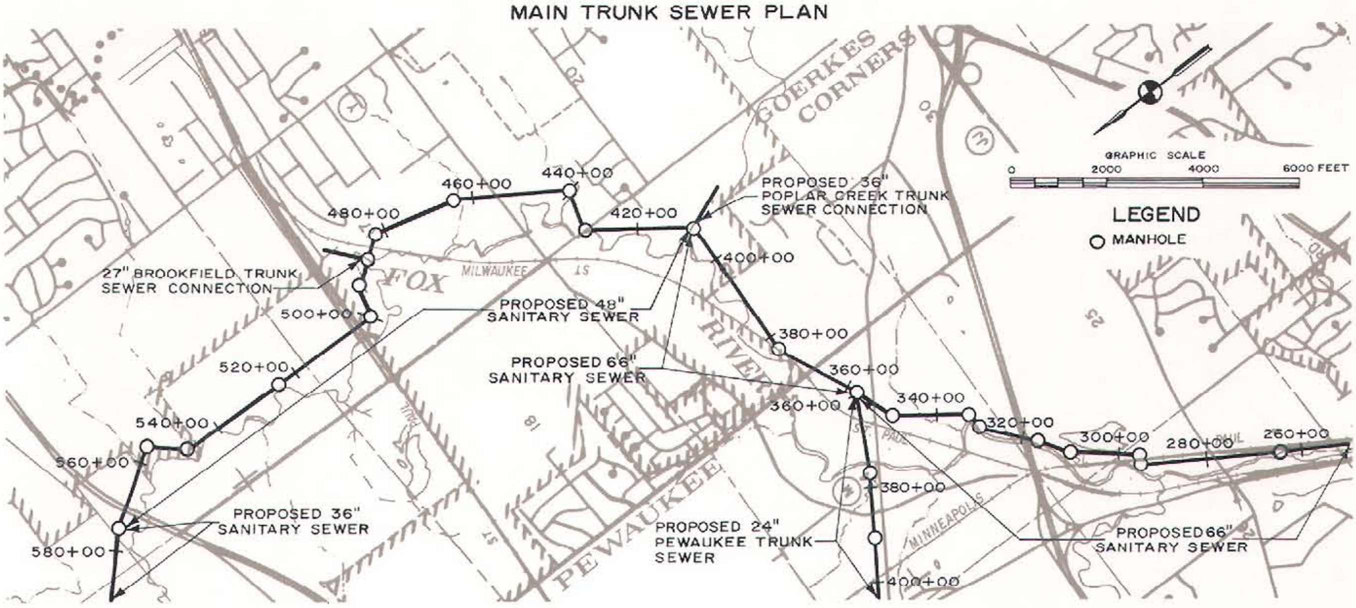


NOTE: 1. DITCH AND CHANNEL DEPTHS ESTIMATED
2. ELEVATION OF BEDROCK ESTIMATED FROM HIGHWAY STRUCTURE BORING AND WELL LOG DATA

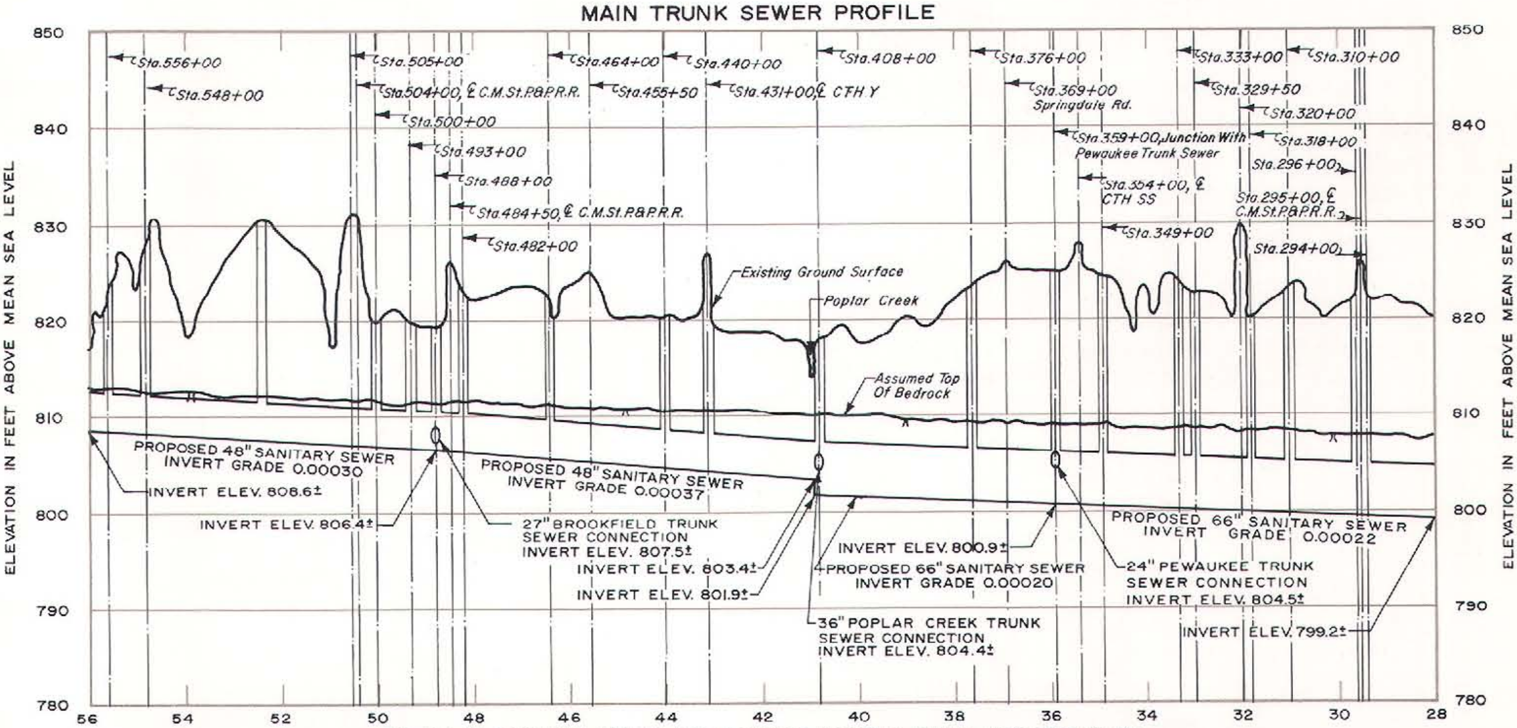
Figure 15 (continued)

RECOMMENDED UPPER FOX RIVER WATERSHED TRUNK SEWER SYSTEM
ALTERNATIVE STREAM WATER QUALITY MANAGEMENT PLAN ELEMENT IC

MAIN TRUNK SEWER PLAN



MAIN TRUNK SEWER PROFILE



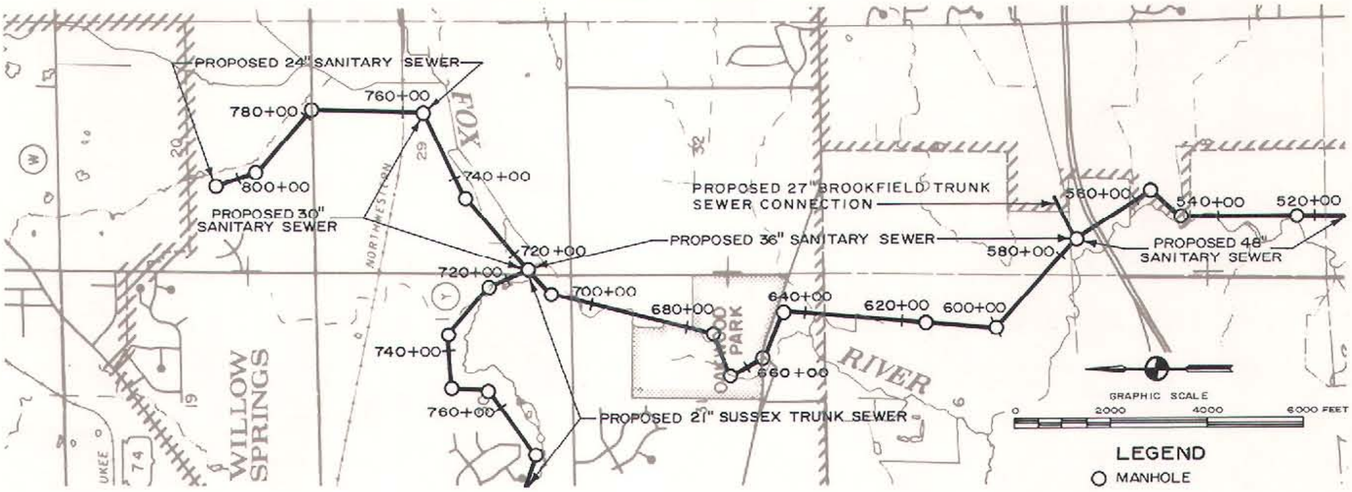
SCALE: HORIZONTAL, 1 INCH = 4000 FEET; VERTICAL, 1 INCH = 20 FEET

NOTE: 1. DITCH AND CHANNEL DEPTHS ESTIMATED
2. ELEVATION OF BEDROCK ESTIMATED FROM HIGHWAY STRUCTURE BORING AND WELL LOG DATA

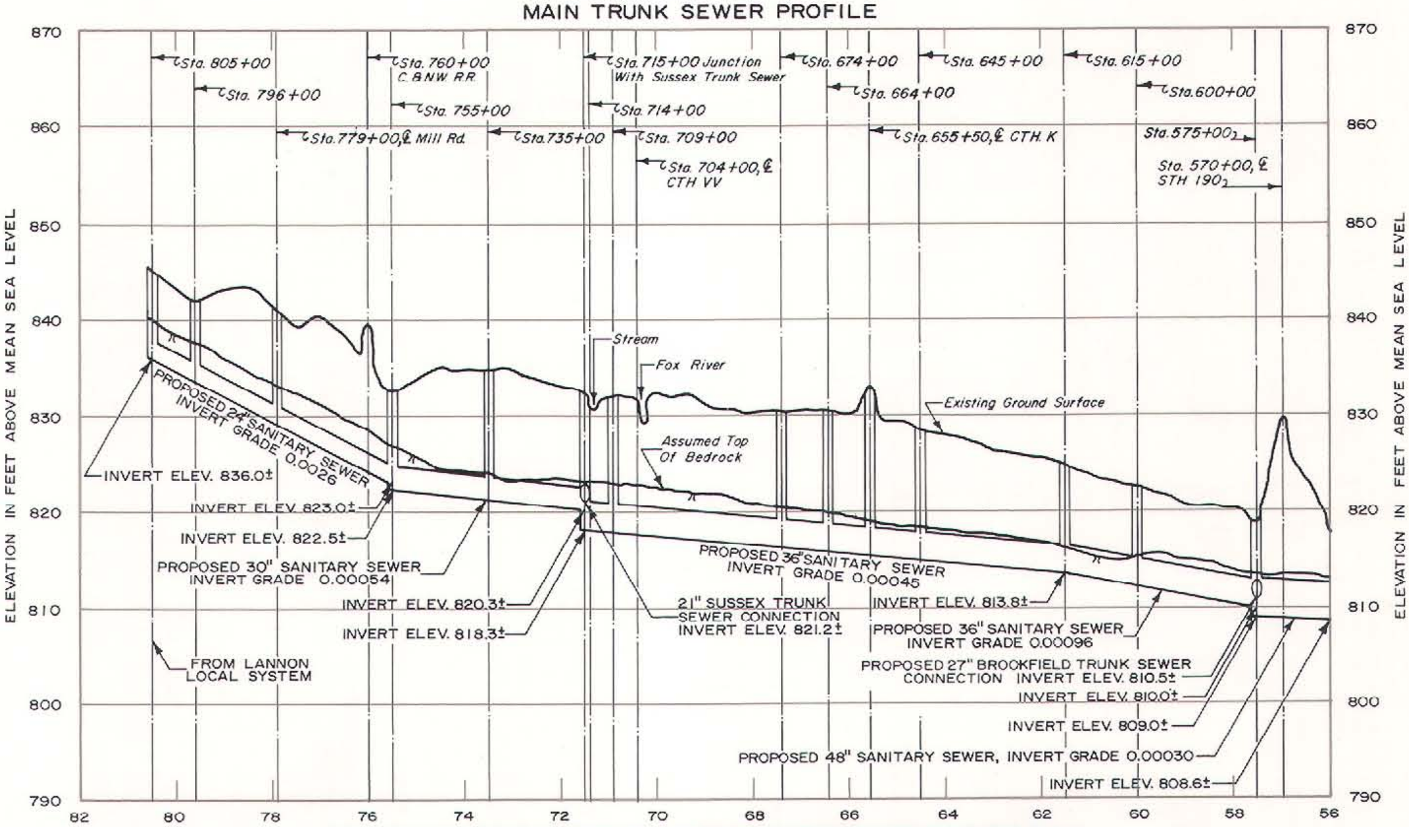
Figure 15 (continued)

RECOMMENDED UPPER FOX RIVER WATERSHED TRUNK SEWER SYSTEM ALTERNATIVE STREAM WATER QUALITY MANAGEMENT PLAN ELEMENT IC

MAIN TRUNK SEWER PLAN



MAIN TRUNK SEWER PROFILE



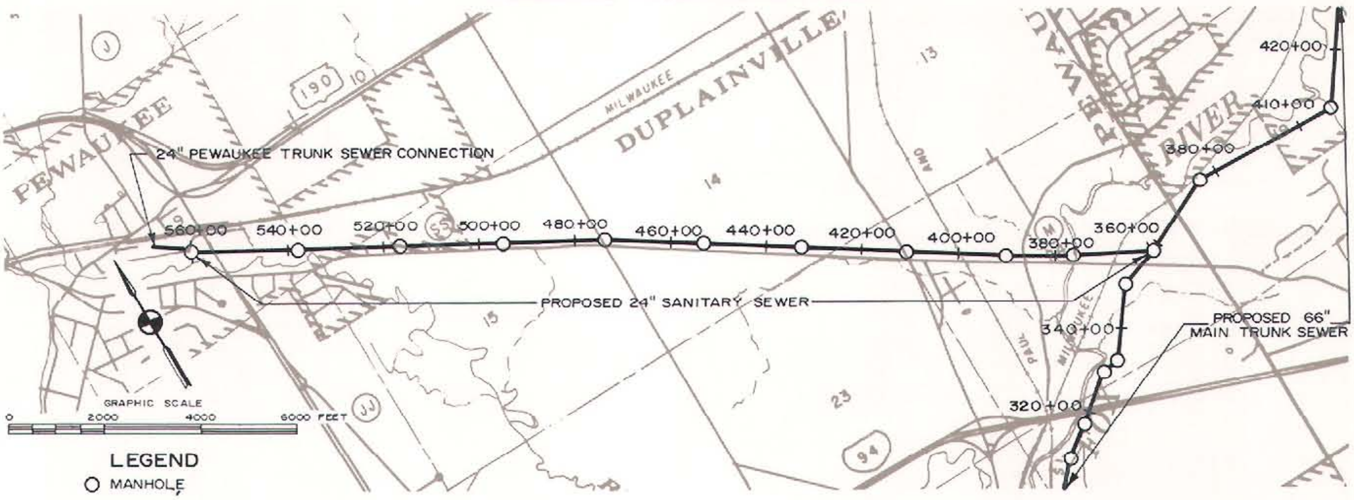
SCALE: HORIZONTAL, 1 INCH = 4000 FEET; VERTICAL, 1 INCH = 20 FEET

NOTE: 1. DITCH AND CHANNEL DEPTHS ESTIMATED
2. ELEVATION OF BEDROCK ESTIMATED FROM HIGHWAY STRUCTURE BORING AND WELL LOG DATA

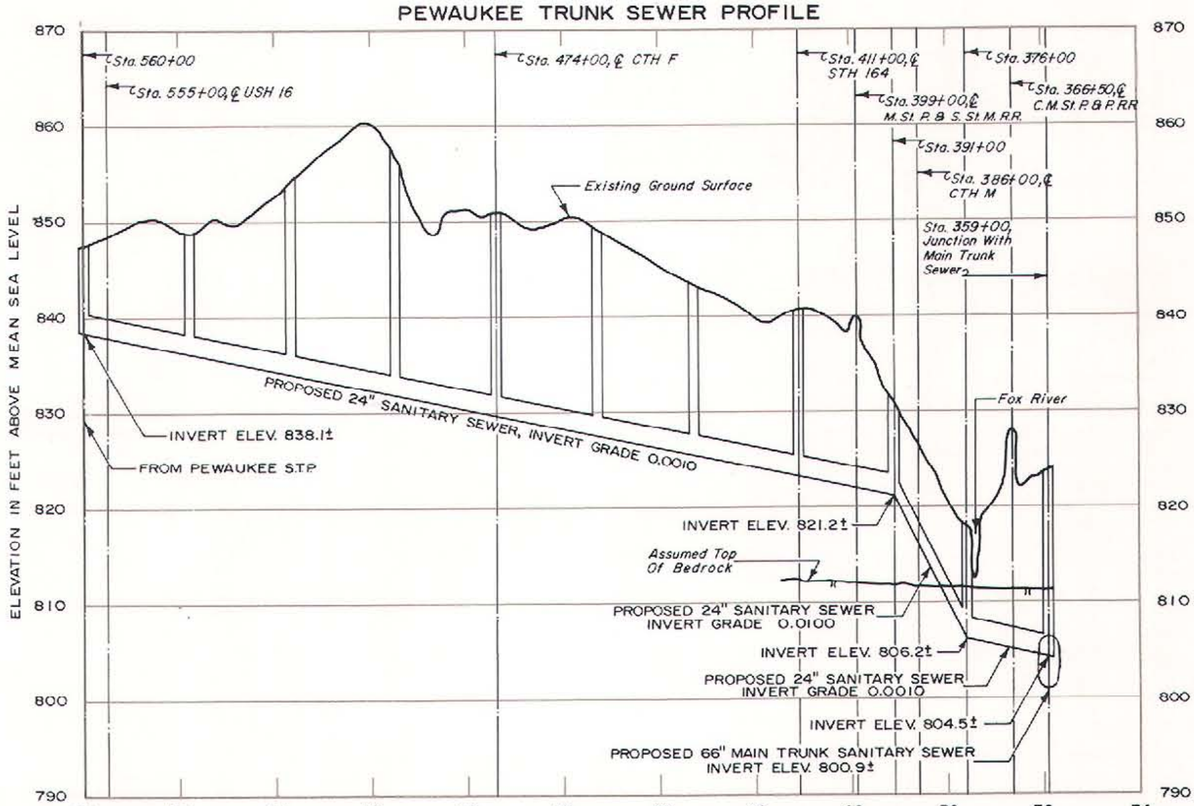
Figure 15 (continued)

RECOMMENDED UPPER FOX RIVER WATERSHED TRUNK SEWER SYSTEM ALTERNATIVE STREAM WATER QUALITY MANAGEMENT PLAN ELEMENT IC

PEWAUKEE TRUNK SEWER PLAN



PEWAUKEE TRUNK SEWER PROFILE



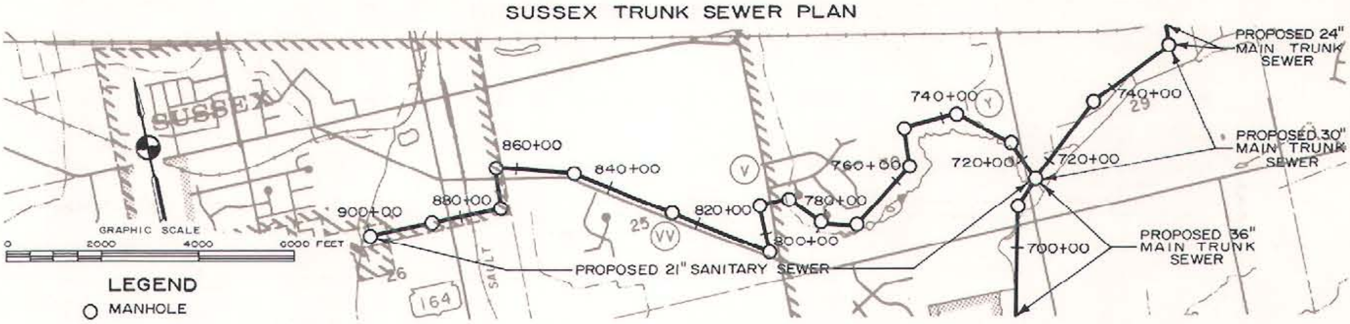
SCALE: HORIZONTAL, 1 INCH = 4000 FEET; VERTICAL, 1 INCH = 20 FEET

NOTE: 1. DITCH AND CHANNEL DEPTHS ESTIMATED
2. ELEVATION OF BEDROCK ESTIMATED FROM HIGHWAY STRUCTURE BORING AND WELL LOG DATA

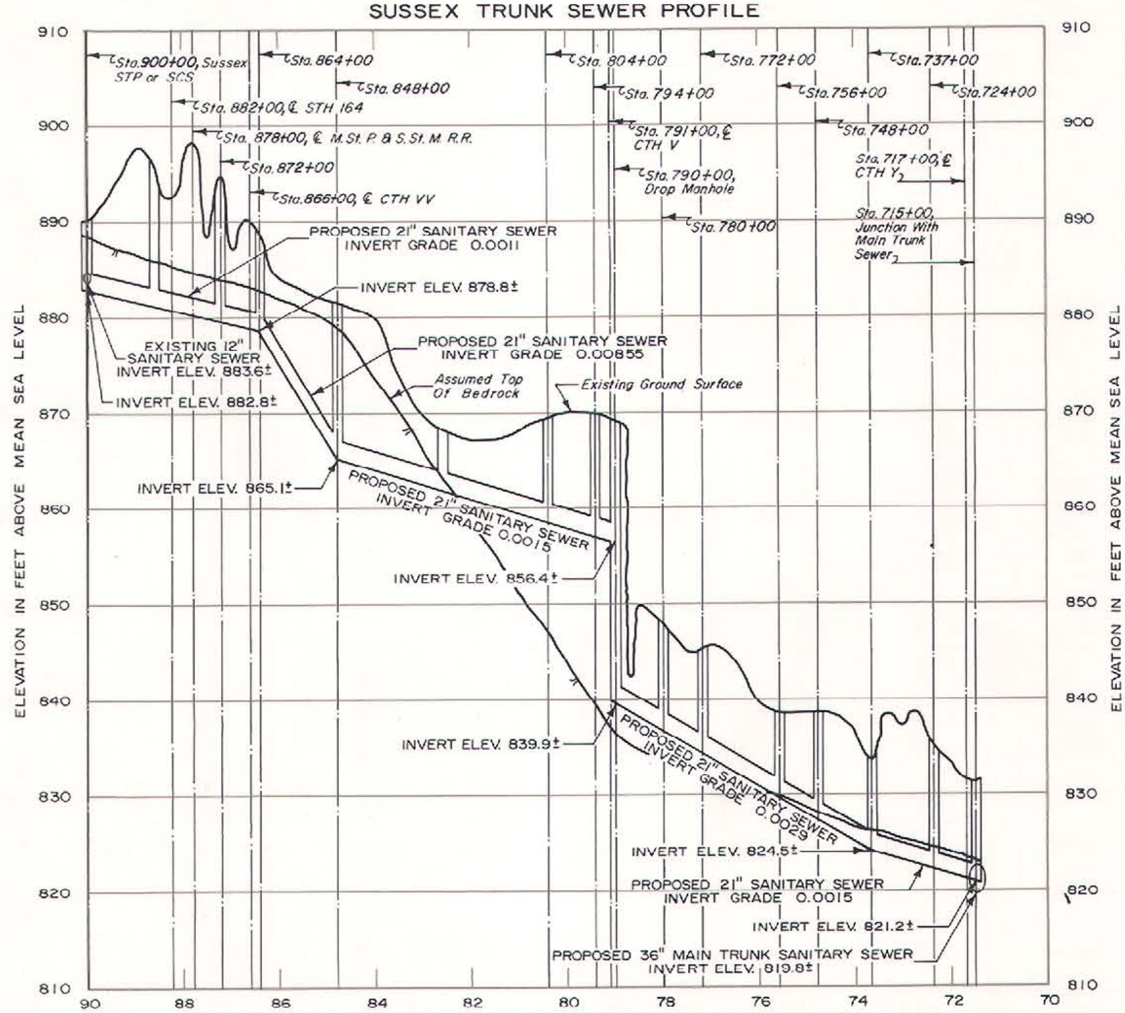
Figure 15 (continued)

RECOMMENDED UPPER FOX RIVER WATERSHED TRUNK SEWER SYSTEM ALTERNATIVE STREAM WATER QUALITY MANAGEMENT PLAN ELEMENT IC

SUSSEX TRUNK SEWER PLAN



SUSSEX TRUNK SEWER PROFILE



SCALE: HORIZONTAL, 1 INCH = 4000 FEET; VERTICAL, 1 INCH = 20 FEET

NOTE: 1. DITCH AND CHANNEL DEPTHS ESTIMATED
2. ELEVATION OF BEDROCK ESTIMATED FROM HIGHWAY STRUCTURE BORING AND WELL LOG DATA

proliferation of small sewage treatment plants, a policy which recognizes not only the economies of scale inherent in the operation of larger plants, as opposed to smaller plants, but also the difficulties involved in obtaining the same level of treatment and of avoiding the bypassing of raw or partially treated sewage in smaller as opposed to larger plants; and it has the disadvantage of relying on the action of individual municipalities for the provision of costly advanced waste treatment facilities at each of the individual treatment plants involved. Failure of each of the individual communities to act in a timely manner in this respect would seriously jeopardize attainment of the recommended water use objectives.

Alternative Plan 1B has the advantages of eliminating the discharge of all sewage treatment plant effluent to the Pewaukee River, Sussex Creek, and those reaches of the Fox River above Poplar Creek, while augmenting the low flow of the Fox River through the City of Waukesha and the Waukesha impoundment, and of achieving some of the economies of scale inherent in the elimination of four of the five smaller plants otherwise required in the headwater reaches of the Fox River watershed. Presently about 25,000 pounds of phosphorus are discharged annually in sewage treatment plant effluent to the Fox River above Waukesha. If the large treatment plant proposed for construction at Poplar Creek removed 95 percent of the phosphorus as proposed, the annual discharge of phosphorus in sewage treatment plant effluent to the Fox River above Waukesha could be expected to be reduced to 12,000 pounds per year by 1990, or to less than one-half of the present loading, which loading represents approximately 55 percent of the total phosphorus loading on the entire river system. If the amounts of phosphorus added to the river system from sources other than treatment plant effluent can be held to their present levels, the effect of the proposed Poplar Creek treatment plant would be a 30 percent reduction in the phosphorus load on the river. The disadvan-
the phosphorus load on the river. The disadvan-
tages of Alternative Plan 1B include the necessity of constructing one new large treatment plant and expanding on a limited site the existing Waukesha treatment plant, both plants providing advanced waste treatment facilities in the headwater reaches of the Fox River watershed, with attendant duplication of staff and equipment; the continued discharge of treated wastes to the river above Waukesha; and, because of this, possible difficulty of implementation. It is important to note that the difference in the costs between the one-plant (Plan 1C) and the two-plant (Plan 1B) alternative lies primarily in the cost of constructing a trunk sewer from Poplar Creek to the proposed single plant located downstream from Waukesha, the annual cost of this large-diameter pipeline exceeding the annual savings in the operation and maintenance costs of the one plant as opposed to the two plants.

Alternative Plan 1C has the advantages of eliminating the discharge of all sewage treatment plant effluent to the stream system of the watershed above the City of Waukesha; of providing for the conveyance of sewage to a single large sewage treatment plant providing advanced waste treatment facilities, located on a new site below the City of Waukesha; of realizing the economies of scale inherent in the operation of a large plant and of avoiding needless duplication of staff and equipment; and of requiring the allocation of the costs involved in the provision of the costly advanced waste treatment facilities on a larger areawide basis, with an attendant better correlation between needs and available financial resources. Its disadvantages include a reduction of streamflow in the upper reaches of the Fox River and particularly through the Waukesha impoundment. If this alternative plan is implemented, the average dry weather flow through the impoundment could be expected to be decreased by the year 1990 from about 25 cfs under either Alternative Plans 1A or 1B to about 5 cfs, almost the same as the present average dry weather flow of 6 cfs, through the impoundment. A second disadvantage is the need to create a new institutional structure for the implementation of this alternative, since no agency presently exists in the watershed which can provide areawide sewerage services.

The foregoing discussion of the intangible considerations involved in the three alternatives indicates that Alternatives 1B and 1C are both preferable to Alternative Plan 1A. The choice between Alternative Plans 1B and 1C is a more difficult one. The relatively high cost of advanced treatment facilities, however, would favor plan implementation through the cooperative action of all of the local units of government concerned through the creation of a common institutional structure, such as a single central sewerage district; and this consideration, together with the desirability of eliminating the discharge of all sewage treatment plant effluent to the Fox River

Table 14

COST ESTIMATES OF THE ALTERNATIVE STREAM WATER QUALITY MANAGEMENT PLAN ELEMENTS FOR THE FOX RIVER WATERSHED

Alternative Plan Element		Estimated Cost					Meets State-Established Water Use Objectives and Standards
Number Designation	Description	Capital	Annual Operation and Maintenance (1970-2020)	Present Worth (50 Years - 6 Percent)	Total Annual (1970-2020)	Annual Per Capita (1970-2020)	
1	Advanced waste treatment for additional removal of oxygen-demanding materials and nutrients.						
1A	Advanced waste treatment at individual plants.	$ 22,305,000	$ 1,905,000	$ 57,478,700	$ 3,646,700	$ 25	Yes
1B	Advanced waste treatment at two large plants in upper watershed and at individual plants in lower watershed.	24,897,000	1,731,000	54,909,700	3,482,000	24	Yes
1C	Advanced waste treatment at one large plant in upper watershed and at individual plants in lower watershed.	29,600,000	1,616,000	56,960,700	3,614,700	25	Yes
2	Upper watershed sewage diversion to Milwaukee Metropolitan Sewerage System; advanced waste treatment for additional removal of oxygen-demanding materials and nutrients in lower watershed.	47,104,000	1,184,000	69,494,700	4,408,700	30	Yes
3	Secondary treatment with effluent disposal by land irrigation.	44,473,000	1,602,000	75,809,700	4,809,400	33	Yes
4	Stream treatment; tertiary treatment for additional removal of oxygen-demanding materials but not for nutrient removal; chemical spraying to control weeds and algae.	25,776,500	1,220,500	46,462,800	2,948,760	20	Yes
5	Secondary treatment with low-flow augmentation from Lake Michigan; chemical spraying to control weeds and algae.	32,802,500	1,152,700	52,876,300	3,355,460	23	Yes
6	Secondary treatment and chlorination.	16,027,000	866,000	33,250,000	2,107,900	14	No
7	Tertiary treatment for additional removal of oxygen-demanding materials but not for nutrient removal.	18,480,000	1,223,400	41,929,700	2,659,600	18	No

Source: Harza Engineering Company and SEWRPC.

above Waukesha, would appear to favor the adoption of Alternative Plan 1C.[6]

Alternative 2—Upper Watershed Diversion

The second alternative stream water quality management plan element considered would eliminate all major waste discharges to the streams in the upper watershed by diversion of the raw sewage to the treatment facilities of the Metropolitan Sewerage Commission of the County of Milwaukee, with final disposal of treated effluent to Lake Michigan. Advanced waste treatment for additional BOD and nutrient removal would be provided in the lower watershed to meet the established water use objectives in a manner identical to that proposed under the first alternative.

This alternative plan element, by eliminating all BOD and nutrient loading discharged from the existing sewage treatment plants to the streams, would increase the potential use of the waterways by supporting a wider variety of fish life and by reducing excessive growths of algae and aquatic weeds. In addition, coliform counts could be expected to decrease and the streams become more suitable for recreational uses. Streamflows would be reduced in the upper part of the Fox River, however, by the elimination of waste discharges.

The facilities required for this plan include a trunk sewer system to serve the upper watershed and to convey the wastes to the treatment facilities in Milwaukee County; expansion of the Milwaukee metropolitan sewage treatment facilities to provide adequate capacity for secondary and advanced treatment, sludge disposal, and disinfection for the added wastes; and the necessary expansion of secondary and disinfection facilities, together with the addition of advanced waste treatment facilities for additional BOD and nutrient

[6] *It should be emphasized at this point that neither Alternative 1A nor Alternative 1B provides for relocation of the existing Waukesha sewage treatment plant, as proposed in Alternative 1C. It is recognized, however, that expansion possibilities at the existing Waukesha site are limited because of site size. In addition, recent growth trends in the Waukesha area have tended to extend urban development downstream from the existing treatment facility, necessitating considerable pumping of sewage to the plant. Should such considerations lead to a local decision to relocate the Waukesha treatment facility even in the absence of any agreement to treat all upper watershed sewage below Waukesha as recommended in Alternative 1C, it is clear that, due to the increased costs that would be incurred in relocating the Waukesha treatment facility, Alternative 1C would become the preferred alternative.*

removal at all major plants in the lower watershed. All of the existing sewage treatment plants in the upper watershed would be abandoned upon completion of the trunk sewer system. The configuration of the required trunk sewer system is shown in Figure 16. This system, which would include four pumping stations, would convey raw sewage to the Puetz Road sewage treatment plant located on the Lake Michigan shore in the City of Oak Creek. This plant would be enlarged to provide secondary treatment, nutrient removal, and disinfection of the wastes before discharge to Lake Michigan. This level of treatment would be necessary to meet the standards established for discharge to Lake Michigan. The facilities required in the lower watershed would be the same as those required for the first alternative.

The initial capital cost entailed in implementation of the second alternative plan for the entire watershed is estimated as $47 million, including the trunk sewer system and appurtenant pumping station construction, the required expansions and additions to the Puetz Road sewage treatment plant, the required expansions of secondary and disinfection facilities, and the addition of advanced waste treatment facilities in the lower watershed. Total annual costs, including operation and maintenance, for this plan element are estimated at $4,408,700, or $30 per capita. The present worth of this alternative for 50 years at a 6 percent interest rate is estimated as $69 million. The costs of each major element of this alternative plan are summarized in Appendix G.

The major advantage of this alternative plan is that it eliminates all waste discharges in the upper watershed. There are several significant disadvantages to the plan, however. The cost of this plan is substantially greater than the cost of providing advanced waste treatment within the watershed. Also, streamflow in the Fox River would be reduced due to the elimination of existing waste discharges to the river and Lake Michigan, an already endangered resource would receive a significantly increased waste loading. Moreover, implementation of this plan would require a change in present legal constraints to permit major inter-basin diversion of water from the Mississippi River drainage basin to the Lake Michigan drainage basin. If a balance of water were required through the return of equal amounts of Lake Michigan water to the Fox River basin to compensate for the amounts of sewage diverted into the Lake Michigan watershed, the capital cost of the entire plan would be increased by an estimated additional $8.3 million; the annual costs, including operation and maintenance, by an additional $660,000, or $3 per capita; and the present worth, by an additional $10,400,000.

Alternative 3—Effluent Disposal by Land Irrigation

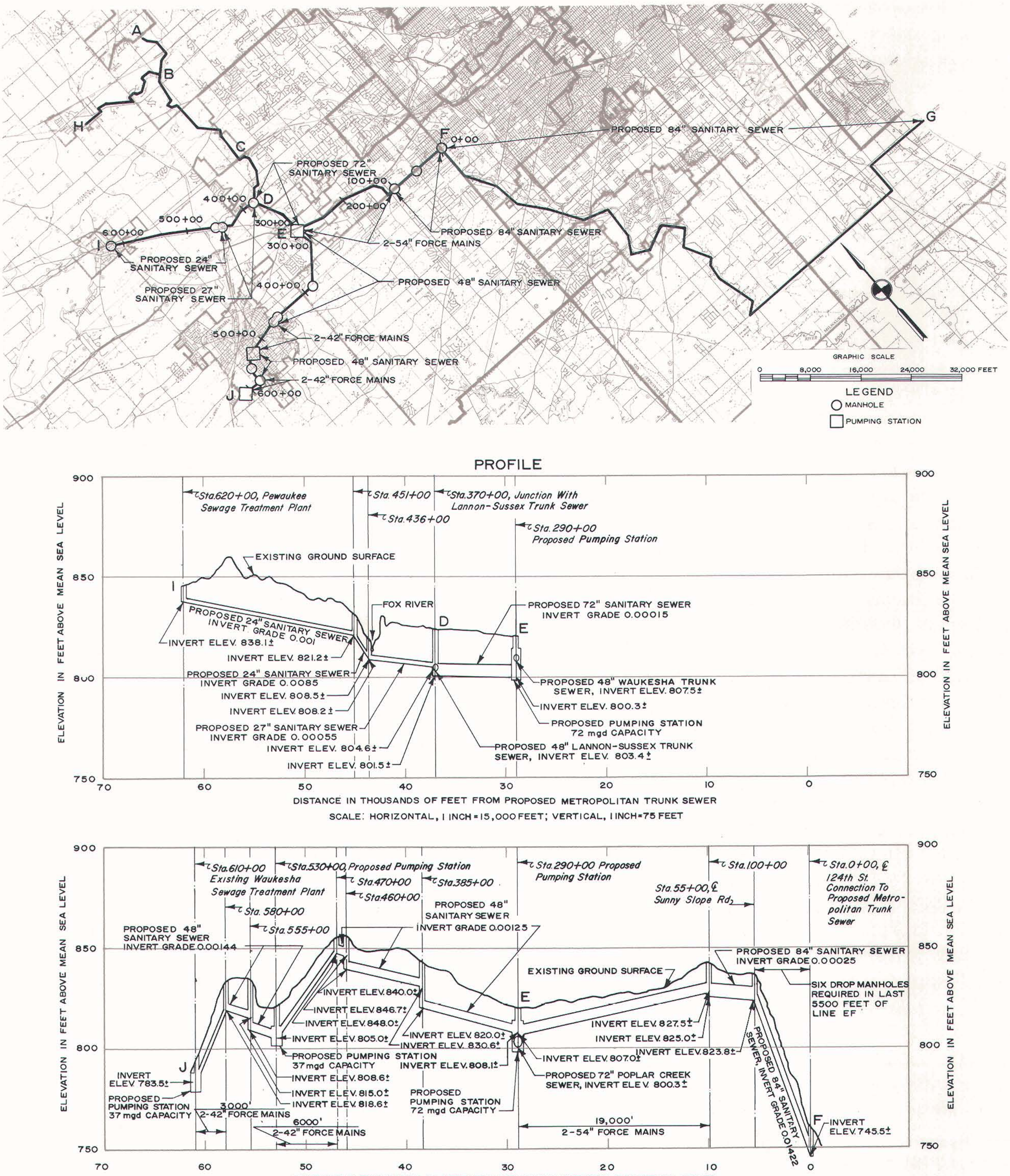
Water quality suitable for all desirable stream uses in the Fox River watershed could also be maintained by eliminating all major waste discharges to streams throughout the watershed through effluent disposal by land irrigation. Under the third alternative considered, secondary treatment and disinfection of all wastes would be provided; and the resulting effluent used for irrigating agricultural lands. This would provide for ultimate disposal of the wastes without polluting the surface waters of the watershed.

The feasibility of using secondary treatment plant effluent for land irrigation has been studied at Pennsylvania State University since 1962. These investigations indicate that effluent could be applied on agricultural land at the rate of at least one inch per week during the growing season without harmful effects. Passage of the effluent through several feet of soil may be expected to remove essentially all of the phosphorus, BOD, coliform bacteria, and viruses. In addition, the nutrients in the treated waste water are made available for plant growth. The removal of most contaminants in the first few feet of soil would prevent the pollution of ground and surface waters, although there could be an accumulation of inorganic minerals, such as nitrates and chlorides, in the shallow ground water supply. Utilization of the effluent on agricultural land would result in increased crop yields due to the supplemental irrigation and additional nutrients being applied to the land.

The facilities required for this plan include a trunk sewer system, with a configuration as shown in Figure 15, to serve the entire upper watershed and to convey the wastes to a single large treatment plant located downstream from Waukesha, with secondary treatment, sludge disposal, and disinfection facilities at this plant; expansion of secondary treatment, sludge disposal, and disinfection facilities at all plants in the lower watershed; and a complete irrigation system. Utilization of the effluent for irrigation would require suitable agricultural land areas, necessary pipelines and pumping stations to convey the

Figure 16
ALTERNATIVE STREAM WATER QUALITY MANAGEMENT PLAN ELEMENT 2
UPPER WATERSHED DIVERSION

PLAN



NOTE: 1. THE PROFILES FOR TRUNK SEWER LINES AB, HB, BC, AND CD ARE THE SAME AS THOSE SHOWN IN FIGURE 15.
2. LINE FG IS AN 84" TRUNK SEWER THAT FOLLOWS THE SAME GENERAL ALIGNMENT AND PROFILE AS THE MILWAUKEE METROPOLITAN INTERCEPTOR SEWER ALONG THE ROOT RIVER AND RYAN ROAD TO THE SOUTH SHORE SEWAGE TREATMENT PLANT OPERATED BY THE MILWAUKEE METROPOLITAN SEWERAGE COMMISSIONS.

effluent to these areas, irrigation distribution systems, and drainage facilities for the agricultural land.

For the upper watershed, preliminary investigations indicate that agricultural lands lying west and southwest of Waukesha could be utilized. The total agricultural land requirements to dispose of the wastes from the 1990 population of the upper watershed are estimated as 12,000 acres. A pumping station and about 10 miles of pipeline would be required to convey the effluent from the treatment plant below Waukesha to these areas.

In the lower watershed, agricultural land lying close to each treatment plant would be utilized. Total agricultural land required in the lower watershed is estimated to be 3,000 acres. Pipelines would be required to convey wastes from each treatment plant to the irrigation areas.

The land areas required for this plan would probably have to be purchased for public use since it is desirable to have complete control over the irrigation operation to assure that the effluent can be disposed of continuously. The land could also be obtained by long-term lease arrangements, but this would require assurance that the effluent could be applied whenever necessary. Initial capital cost for implementation of this alternative plan for the entire watershed, including addition and expansion of secondary treatment and disinfection facilities, a trunk sewer system in the upper watershed, and all required irrigation facilities, with the associated necessary lands, is estimated to be $44 million. Net annual costs, including an offset for estimated benefits derived from increased crop yields, are estimated to be $5 million, or $33 per person served by the facilities. The present worth of this plan for 50 years at 6 percent interest is $76 million. Costs of the major elements of this alternative plan are summarized in Appendix G.

Although this plan may be expected to provide a high level of stream water quality by elimination of all major waste discharges to streams in the watershed without diversion to Lake Michigan, it has several serious disadvantages. The most significant limitation would be the necessity of purchasing or leasing about 15,000 acres of land. This is an area almost three and one-half times larger than that presently occupied by the entire City of Waukesha. Other limitations include the problems that would be involved in continuous operation of the irrigation system, particularly during wet weather and during the winter months. A reduction in streamflow would occur as a result of removing the waste discharges from the streams; and ground water may be contaminated by inorganic minerals, such as nitrates and chlorides, which are not completely removed in passage through the soil complex.

Alternative 4—Stream Treatment

A fourth alternative stream water quality management plan element considered would achieve the established water use objectives by providing secondary treatment and disinfection for all major waste discharges, additional BOD removal where necessary, and algae and weed control through the use of algicides and herbicides in the streams. No specific nutrient removal measures would be employed under this alternative.

Higher degrees of treatment would be needed in the following areas: the entire upper watershed, 95 to 98 percent overall BOD removal; the Lake Geneva and Twin Lakes areas in Walworth and Kenosha Counties, 95 to 98 percent overall BOD removal; and East Troy in Walworth County, 90 to 95 percent overall BOD removal. These levels of treatment would be required to prevent the municipal organic waste discharges from reducing the dissolved oxygen content of the streams below 5.0 mg/l, the amount required for the preservation of fish life. In order to maintain oxygen levels above 5.0 mg/l under this alternative, it may also be necessary to operate the treatment plants to achieve a high degree of nitrification or to provide facilities for ammonia nitrogen removal to reduce the nitrogenous oxygen demand of the effluent. It would also be desirable to eliminate the discharge of treated effluent in the upper watershed above Waukesha since nutrients in the effluent would cause extensive algae growths that could not easily be treated by algicide spraying because the streams are not navigable and aerial spraying would not appear to be safe in the urban and suburban development occupying the upper portions of the watershed. Thus, a trunk sewer system would be necessary with treatment facilities and outfall located downstream from Waukesha.

Sufficient organic matter would be removed from the waste discharges to maintain average dissolved oxygen levels above 5.0 mg/l. The large amounts of nutrients remaining in the waste discharges, however, could be expected to stimulate extensive growths of algae and aquatic weeds that would, if uncontrolled, interfere with recreational and aesthetic uses of the streams and cause a diurnal fluctuation in dissolved oxygen levels that may harm fish and other aquatic life. These algae and weed growths could be controlled by weekly applications of suitable algicides and herbicides to the Fox River in the reach extending from the state line to Waukesha, to the White River, and to Honey Creek below East Troy during the spring, summer, and fall seasons. Great care would have to be used in applying these chemicals to prevent possible harm to anyone coming in contact with the streams and to fish and other aquatic life in the stream.

The facilities required for this plan would include the following: a trunk sewer system to serve the upper watershed, as shown in Figure 15; secondary treatment, sludge disposal, and disinfection facilities for the plant serving the upper watershed area and for all plants serving the lower watershed area; coagulation and filtration facilities to accomplish the required BOD removal at the plant serving the upper watershed and at the East Troy, Lake Geneva, and Twin Lakes plants; and the equipment required to carry on a program of chemical spraying for algae and weed control.

The initial capital cost of implementation of this plan, including the cost of all of the facilities required, is estimated as $26 million. Total annual costs are estimated to be $2,948,760, or $20 per person. Present worth of this alternative for 50 years at 6 percent interest is $46 million. Estimates of the costs of the major elements of this alternative are summarized in Appendix G.

There are several disadvantages to this plan, which, in effect, would suppress the symptoms rather than solve the basic pollution problem, passing that problem on into Illinois. The long-term effects of the application of toxic chemicals on the aquatic life and stream biota are not known. It is known, however, that various types of algae build up resistance to specific algicides over a period of time. Thus, it may become necessary to increase the amounts being used or use different chemicals to adequately control future growths. Since nutrients would not be removed from the stream, any areas not sprayed could be expected to develop profuse growths of algae and weeds. Under this alternative eutrophication problems would be intensified in the Illinois section of the Fox River and in the Fox Chain of Lakes as a result of the increasing quantity of nutrients being discharged to the river in Wisconsin.

Alternative 5—Low-Flow Augmentation

A fifth alternative stream water quality management plan element considered would seek to meet the established water use objectives by requiring secondary treatment and disinfection of all waste discharges, low-flow augmentation, additional BOD removal where necessary, and algae and weed control through the use of algicides and herbicides in the streams.

High degrees of BOD removal would be needed in the following areas: Lake Geneva and Twin Lakes, 95 to 98 percent overall BOD removal, and East Troy, 90 to 95 percent overall BOD removal. Low-flow augmentation would be substituted for high treatment levels in the upper watershed area. The amount of water needed for augmentation purposes in order to maintain suitable water quality levels while providing secondary treatment (85 percent BOD removal) in the upper watershed would be dependent upon the amount of waste discharged and the natural flow in the stream. For 1990 forecast waste loadings, it would be necessary to have capacity sufficient to supply 50 cfs of augmentation water during drought conditions. During average flow conditions, the amount of augmentation water required would vary from zero during the months of March, April, and May to an average of 32 cfs during the months of August and September. The average annual augmentation requirement with 1990 waste discharges is estimated at about 7,000 acre-feet.

Several potential sources for providing the required augmentation water were investigated, including lakes, reservoirs, and ground water supplies. No suitable reservoir sites exist in the upper watershed that could supply the amount of water needed. Use of ground water is not desirable because of the extremely large number of wells that would be needed and the substantial interference these wells could be expected to have on the numerous public and private wells in the upper watershed. The only potential source located that could provide sufficient quantities of water without seriously interfering with other water uses is Lake Michigan. Water could be pumped from Lake Michigan to the Fox River and discharged to the river above Waukesha for purposes of flow augmentation.

The secondary treatment and low-flow augmentation in the upper watershed, together with secondary treatment plus additional BOD removal where needed in the lower watershed, would be sufficient to prevent the anticipated organic waste discharges from reducing dissolved oxygen levels below 5.0 mg/l. The nutrients remaining in the waste discharges, however, could be expected to cause large growths of algae and aquatic weeds. It would be necessary to control these growths through the use of suitable algicides and herbicides in the same manner as described under Alternative 6.

The facilities required for this plan include: 1) a trunk sewer system, as shown in Figure 15, and combined secondary treatment, sludge disposal, and disinfection facilities at a plant serving the entire upper watershed area; 2) a pipeline, as shown in Figure 17, including necessary control facilities, and required pumping stations to divert water from Lake Michigan to the Fox River; 3) expansion of secondary treatment facilities and addition of disinfection facilities at all plants in the lower watershed; 4) coagulation and filtration facilities to accomplish the required additional BOD removal at plants serving East Troy, Lake Geneva, and Twin Lakes; and 5) the equipment required to carry on a program of chemical spraying for algae and weed control.

The initial capital cost entailed in implementation of this plan is estimated as $33 million. Total annual costs over a 50-year period are estimated to be $3,355,460, or $23 per capita. The present worth of this alternative for 50 years at a 6 percent interest rate is $53 million. Cost estimates for each major element of this plan are summarized in Appendix G.

The major advantages of this plan are its lower cost and the increase in streamflow that would be provided by diverting Lake Michigan water into the Fox River. There are several significant disadvantages, however. The most serious limitations are the same as those discussed under Alternative 6 and include the possibility of environmental contamination from the chemical spraying operations, the unknown long-term effects of frequent applications of toxic chemicals to a stream, and the potential weed and algae problems in any areas not being sprayed.

This plan would also require a change in present legal constraints to permit substantial diversion of water from the Lake Michigan drainage basin to the Mississippi River drainage basin. An alternative to accomplishing the necessary changes would be the return of equal amounts of water from the Fox River to Lake Michigan. This might be accomplished by diverting water from the Fox River near Big Bend into the Root River system, which flows into Lake Michigan. Since the water being diverted, however, would include treatment plant effluent discharged upstream, it would be necessary to provide nutrient removal at the upstream treatment plants to meet state and federal regulations for effluent discharged to Lake Michigan. This diversion scheme and the required nutrient removal would increase the capital cost of the entire plan by an estimated additional $4.6 million; the annual costs, including operation and maintenance, by an additional $510,000, or $4 per capita; and the present worth, by an additional $8 million. Together with the aforementioned legal constraints, this additional cost would make this plan undesirable.

Alternatives 6 and 7—Other Plan Elements

Two additional alternative stream water quality management plan elements were investigated, but neither was found to provide a level of water quality suitable for the established water use objectives. These plan elements are briefly discussed below.

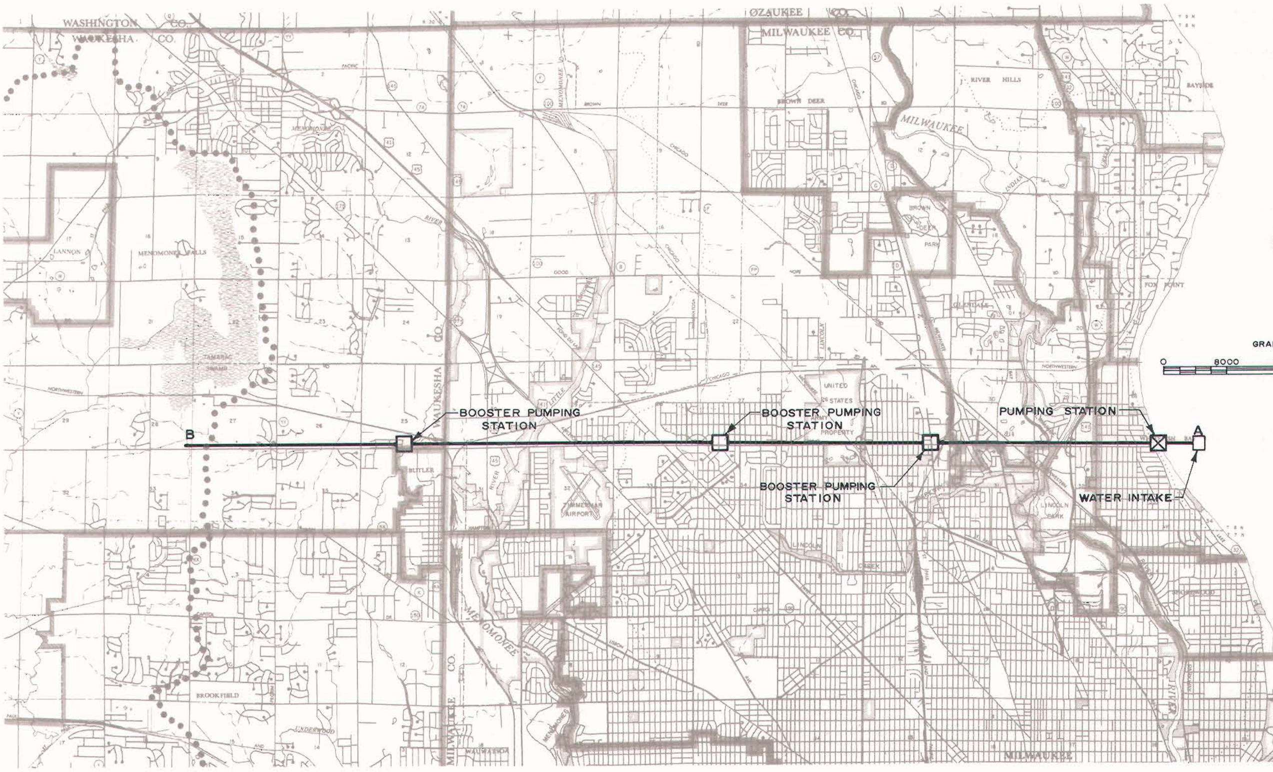
The first such plan would provide secondary treatment and disinfection of all major waste discharges in the watershed. Essentially this program would be a continuation of the present practice of providing secondary treatment. By 1990 under this plan, water quality in the Pewaukee River, Sussex Creek, and the Fox River above Mukwonago could be expected to be generally unsuitable for most uses of these streams. Water quality in the White River below Lake Geneva and in Honey Creek below East Troy could be expected to be unsuitable for the preservation of fish and other aquatic life. In addition, large growths of algae over most of the length of the Fox River could be expected to interfere with recreational and aesthetic uses of the stream. Detailed descriptions of the water quality that would prevail under this plan are provided in that section of Chapter IX of Volume 1 of this report which deals with present and future water quality characteristics of individual streams in the watershed.

Facilities needed for this plan would include expansion of existing treatment facilities to serve

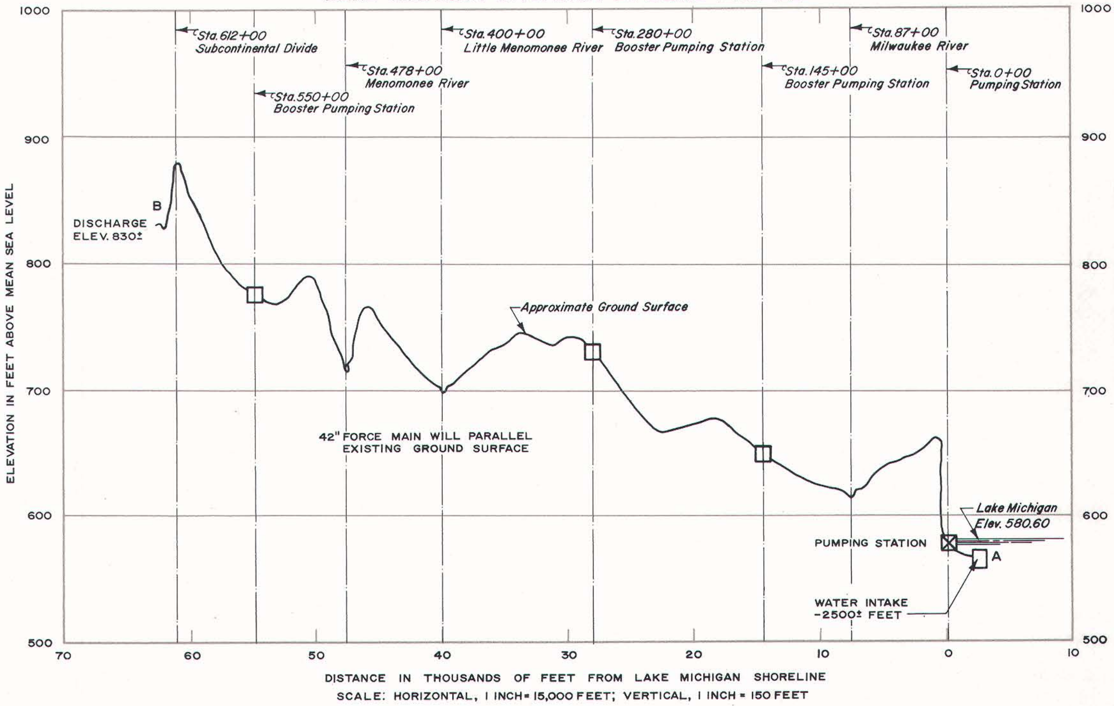
Figure 17

ALTERNATIVE STREAM WATER QUALITY MANAGEMENT PLAN ELEMENT 5 LOW-FLOW AUGMENTATION

LAKE MICHIGAN DIVERSION PIPELINE PLAN



LAKE MICHIGAN DIVERSION PIPELINE PROFILE



NOTE:
1. ONE PUMPING STATION AND THREE BOOSTER PUMPING STATIONS WILL BE REQUIRED ALONG THE LINE.
2. DISCHARGE IS TO A SMALL TRIBUTARY OF THE FOX RIVER SOUTH OF THE TAMARAC SWAMP.
3. VERTICAL DATUM = MEAN SEA LEVEL, 1929 ADJUSTMENT

the forecast increased population levels, addition of disinfection facilities at all plants, and construction of two new plants to serve the Lannon area and the Poplar Creek area. Estimated costs of this plan for the entire watershed are: capital cost, $16 million; total annual costs, including operation and maintenance, $2 million, or $14 per capita; and present worth at 6 percent, $33 million.

The second such plan investigated would provide secondary treatment and disinfection of all major waste discharges plus additional BOD removal at the following plants: Lannon, Sussex, Brookfield, Pewaukee, Poplar Creek, Waukesha, East Troy, Lake Geneva, and Twin Lakes. Sufficient organic matter would be removed under this plan to maintain average daily oxygen levels in the streams above 5.0 mg/l. Large amounts of nutrients in the waste discharges, however, could be expected to stimulate nuisance growths of algae and aquatic weeds, which would interfere with recreational and aesthetic uses of the streams and would cause daily fluctuations in oxygen levels that may interfere with fish life and also may result in oxygen levels that, for several hours each day, are lower than 4.0 mg/l, the minimum value according to state standards for most of the Fox River.

Facilities needed for this plan include the addition and expansion of secondary treatment and disinfection facilities throughout the watershed, construction of two new plants for the Lannon area and the Poplar Creek area, and the addition of coagulation and filtration facilities for achieving overall BOD removals of about 95 percent at all the plants listed above. Capital cost of this plan for the entire watershed is estimated to be $18 million, with total annual costs, including operation and maintenance, of $2,659,600, or $18 per capita. Present worth of this plan at 6 percent interest is $42 million.

Concluding Remarks—Alternative Stream Water Quality Management Plan Elements

Seven alternative stream water quality management plans for the Fox River watershed were investigated, of which five may be expected to provide water quality conditions able to meet the established water use objectives for the Fox River and its major tributaries. A summary description of each alternative considered, together with the estimated costs and the ability of the alternative to meet the water use objectives, is provided in Tables 14 and 15.

Although Alternatives 6 and 7 represent low-cost plans, these two plans are actually the least desirable alternatives because the established water use objectives would not be met even with chemical spraying for algae control. All the possible side effects of spraying toxic chemicals for algae and weed control are not known; and, therefore, there is a possibility of producing serious environmental pollution in such a program. Also, eutrophication problems would be intensified in the Illinois section of the Fox River and in the Fox Chain of Lakes because of the nutrients being discharged to the river in Wisconsin and carried downstream.

The remaining alternative plans, Nos. 1, 2, 3, 4, and 5, may all be expected to achieve satisfactory levels of water quality without the risks and hazards associated with Alternatives 6 and 7. Alternative 1 would produce the desired levels of water quality by removing, through advanced waste treatment, almost all of the organic matter and nutrients contained in the effluents discharged to the streams. The cost of this alternative is substantially less than that of Alternatives 2 and 3.

Alternatives 2 and 3 would be expected to produce the desired levels of water quality by eliminating all major waste discharges to streams in the Fox River watershed. Alternative 3 would dispose of all secondarily treated and disinfected effluent by using it to irrigate agricultural lands. A major disadvantage of this plan is the large amount of land that would be needed. Alternative 2 would eliminate all waste discharges in the upper watershed by diverting the sewage into the Milwaukee metropolitan sewerage system for treatment at the facilities in Milwaukee. Waste discharges in the lower watershed would be given advanced treatment to remove additional BOD and nutrients before discharge.

Based on the cost, performance, and limitations of each alternative considered, it is recommended that Alternative Plan 1, advanced waste treatment for BOD and nutrient removal, be adopted as the recommended stream water quality management plan for the Fox River watershed. The recommended plan includes the provision of waste treatment facilities to remove 95 to 99 percent of the BOD, 95 to 99 percent of the phosphorus, and 95 percent of the nitrogen from the wastes before they are discharged to streams in the watershed. The recommended plan could be realized in any one of three ways: by providing advanced waste

Table 15

COMPARISON OF THE RELATIVE ABILITY OF THE ALTERNATIVE STREAM WATER QUALITY MANAGEMENT PLAN ELEMENTS TO MEET WATERSHED DEVELOPMENT OBJECTIVES

Alternative Plan Element		Pertinent Land Use Objectives[a]				Pertinent Water Control Objectives[a]	
						Integrated and Efficient Systems For:	
Number Designation	Description	Meet Future Land Use Needs	Protection, Wise Use, and Development of Resource Base	Efficient Adjustment to Supporting Services and Facilities	Preservation of Prime Agricultural Areas	Stream Water Quality	Lake Water Quality
1	Advanced waste treatment for biochemical oxygen demand (BOD) and nutrient removal.						
1A	Advanced waste treatment at individual plants.	Supports	Supports	Supports	--	Standards met	Supports
1B	Advanced waste treatment at two large plants in upper watershed and at individual plants in lower watershed.	Supports	Supports	Supports	--	Standards met	Supports
1C	Advanced waste treatment at one large plant in upper watershed and at individual plants in lower watershed.	Supports	Supports	Supports	--	Standards met	Supports
2	Upper watershed sewage diversion to Milwaukee Metropolitan Sewerage System; advanced waste treatment for BOD and nutrient removal in lower watershed.	Supports	Supports	--	--	Standards met	Supports
3	Effluent disposal by land irrigation; secondary treatment.	Supports	Supports	--	Supports	Standards met	Supports
4	Stream treatment; tertiary treatment for additional BOD removal but not specified for nutrient removal; chemical spraying to control weeds and algae.	Supports	Detrimental	--	--	Standards met	--
5	Low-flow augmentation from Lake Michigan; secondary treatment; chemical spraying to control weeds and algae.	Supports	Detrimental	--	--	Standards met	--
6	Continued secondary treatment and chlorination; no nutrient removal.	Supports	Detrimental	--	--	Standards not met	Detrimental
7	Secondary treatment and chlorination; tertiary treatment for more BOD removal; no nutrient removal.	Supports	Detrimental	--	--	Standards not met	Detrimental

[a] *The land use and water control objectives, together with their supporting principles and standards, are set forth in full in Chapter II of this volume.*

Source: SEWRPC.

treatment facilities at each of the existing sewage treatment plants in the watershed; by developing an integrated sewerage system in the upper watershed by combining the existing plants into two large plants—one located at Poplar Creek and one below Waukesha—providing advanced waste treatment; or by combining the existing plants into one large plant providing advanced waste treatment located below Waukesha.

The costs of the three sub-alternatives possible under Alternative Plan 1 are so similar that the costs alone cannot provide a sound basis for selection from among the three sub-alternatives. Sub-Alternative Plan 1A, the provision of advanced waste treatment facilities at each of five sewage plants in the upper watershed, has the disadvantage of continuing to discharge sewage treatment plant effluent to the Pewaukee River, Sussex Creek, and the Fox River above Waukesha; is contrary to the state's policy of discouraging the proliferation of small sewage treatment plants; and must rely on the action of individual municipalities for the provision of costly advanced waste treatment facilities. The choice between Sub-Alternatives 1B and 1C is a most difficult one. Plan 1C is recommended, however, on the basis that it would eliminate the discharge of all sewage treatment plant effluent to the stream system of the watershed above the City of Waukesha; would most fully realize the economies of scale inherent in the operation of larger plants and would eliminate the need to duplicate expensive staff and equipment, permit better direction of field maintenance equipment and crews, and permit centralized purchase and storage of spare parts, chemicals, operating supplies, and equipment; and would best lend itself to the creation of one single, central sewerage district for plan implementation. Such a district would not only be responsible for the fully coordinated design, construction, operation, and maintenance of an areawide sewerage system in the upper watershed but could also be made responsible for a stream water quality monitoring program linked directly to the stream water quality control program. In this way a most effective pollution abatement operation could be achieved. Finally, one central sanitary sewerage district would be better able to finance and coordinate the construction of the necessary areawide sewerage system. Although a two-plant system could be operated by one sanitary district, it is doubtful whether such a single district could actually be formed around a plan which would continue to discharge sewage treatment plant effluent to the Fox River system above Waukesha.

ALTERNATIVE LAKE WATER QUALITY MANAGEMENT PLAN ELEMENTS

Degradation of lake water quality in the Fox River watershed, as evidenced by increased weed and algae growth, has occurred over the last half century and has accelerated in recent years. Some lakes, such as Geneva Lake and Powers Lake, evidence little change, while others, such as Como Lake and Pewaukee Lake, exhibit evidence of a sharp decline in water quality. The problems of eutrophication, the natural aging process of lakes, are caused by a complex series of actions and reactions between the lake itself, additives to the lake, and aquatic life. Although the process is not well understood, sunlight, basin hydrology, and the physical, chemical, and biological characteristics of the lake all affect the rate of eutrophication, as do human activities in the tributary drainage basins.

Phosphorus and nitrogen, the two elements generally considered as limiting weed and algae growth in lake waters, are supplied primarily by domestic sewage, either as septic tank seepage or as sewage treatment plant effluent, and by runoff containing fertilizers, either commercial types applied to urban lawns and agricultural lands or animal manure spread over agricultural lands. The spring runoff from frozen farmland receiving manure throughout the winter usually contributes a major part of the annual phosphorus input to the lakes. Progress in reducing the rate of weed and algae growth can be achieved either by preventing the discharge of phosphorus to a lake or by removing it from the lake. Although action to limit the input of phosphorus has retarded eutrophication in some lakes across the nation, such as Lake Washington near Seattle, Lake Waubesa near Madison, and Zoar Lake in Connecticut, results have not been consistent. Unitl such time that additional knowledge about this complex problem becomes available through more basic research, however, phosphorus reduction will have to continue to be the primary focus of any action to retard eutrophication.

A number of different methods have been considered in this study for phosphorus limitation or reduction. Some may be more appropriate for a particular lake than others. A description of each alternative plan element considered, including comments on cost and effectiveness, as set forth below, is followed by a description of alternative plans for improving lake water quality at 22 of the largest and most important lakes in the basin. Cost estimates for the alternative plans are included for each of the 22 lakes; however, the degree of improvement which may be expected from these investments cannot, given the present state of technology, be accurately nor quantitatively predicted. Evaluation of the effectiveness of alternative plans, therefore, must be limited to a general assessment of probable performance expressed in qualitative terms.

Alternative Plan Elements

As already noted, a number of plan elements were investigated for lake water quality management in the Fox River watershed. These elements, either singly or in combination, formed the basis for the alternative plans considered for each lake. The plan elements cover a wide range of costs and anticipated effectiveness. Costs vary from almost no initial capital investment with high operating expenses, an extreme which provides flexibility to adapt and change the procedures as knowledge of lakes and the technology to manage lake water quality increase, to a very large initial capital investment with low operating costs, an extreme which restricts flexibility because of the large sums of money initially committed under that particular plan. Effectiveness of the plan elements varies from removing substantial amounts of nutrients either entering or in the lake waters to removing no nutrients from the lake water but controlling the nuisances that result from overfertilization of the lakes. Each of the alternative plan elements considered is discussed in the following sections.

Installation of Sanitary Sewerage Systems: Provision of a sanitary sewerage system and treatment facilities to serve the developed areas around a lake would serve to eliminate the sanitary hazards and reduce nutrient inputs resulting from inoperative and malfunctioning septic tank sewage disposal systems. Discharge of the treated and disinfected effluent should be downstream from the lake outlet. Provision of a sewerage system is indicated for those lakes which have relatively large areas of intensely developed urban type land uses that are dependent upon soil absorption systems for waste disposal and are situated on soils having very severe to severe limitations for the use of such systems. It is in such areas that pollution of the lake will most probably cause serious public health hazards. In areas situated on soils suitable for waste disposal by soil absorption systems, these systems should not cause a public health hazard if they are properly constructed and maintained, although they may under certain ground water conditions contribute nutrients to the lake.

The provision of a sewerage system and treatment plant discharging to a stream below the lake outlet may be expected to reduce the phosphorus input by 5 to 60 percent and the nitrogen input by 5 to 65 percent, depending upon the particular lake being considered. The amount of nutrients prevented from entering the lake could be expected to increase in the future as further urbanization occurs around the lake.

Since the discharge from these sewage treatment plants would generally be to streams with little flow, a high degree of treatment would be necessary. Secondary treatment and disinfection, followed by effluent discharge to a seepage lagoon, would reduce the possibility of stream pollution and would eliminate the need for higher degrees of treatment. This type of treatment is presently being used within the watershed at Williams Bay and Fontana in Walworth County. Further investigations would be required at each lake to determine the size of seepage pond needed or the degree of treatment required if no pond were provided and the effluent were discharged to a stream.

Cost estimates for this plan element are based on present and anticipated future (1990) population levels around each lake and preliminary system plans showing the configuration of the required sewerage system, including the approximate length, size, and depth of sewers and the size of treatment and disinfection facilities needed. Design criteria used were based on the Recommended Standards for Sewage Works, adopted by the Great Lakes—Upper Mississippi River Board of State Sanitary Engineers, of which Wisconsin is a member state. Estimates of dry weather sewage flow are based on a per capita contribution of 100 gallons per day. Cost estimates include costs of lateral and sub-main sewers, main and trunk sewers, all required pumping stations, and waste treatment facilities providing advanced waste treatment. This plan element involves a large initial investment for construction of the required facilities, as well as substantial annual costs for operation and maintenance of the sewerage system and treatment facilities.

Agricultural Runoff Control: The nutrient budgets prepared for lakes in the Fox River watershed indicate that more than half of the phosphorus input to lakes results from agricultural lands fertilized with animal manure or inorganic fertilizers. It has been generally concluded that phosphorus movement from agricultural areas is almost exclusively by surface runoff. Much of the phosphorus is contributed by spring snowmelt and rainfall runoff carrying manure spread on frozen ground. Summer rainfall runoff may carry manure and phosphorus adsorbed on eroded soil particles. The phosphates are adsorbed by soil colloids and move from farmlands into lakes and streams through erosion of the surface soil. Thus, elimination of the practice of spreading manure on frozen ground and good soil conservation practices that prevent erosion are the most effective means of controlling pollution by agricultural phosphorus.

Two approaches for control of agricultural nutrient flows to lakes and streams have been considered. One is the storage of manure produced during the frozen-ground season, and the other is erosion control by means of bench terracing[7] with tile or blind outlets.

Provision of tanks in which manure could be stored during the months that the ground is frozen and then removed and applied to the ground after the spring runoff would eliminate much of the phosphorus input to the lakes from this source. In addition, more of the nutrients would be retained in the soil where they would be available as additional fertilizer for plant growth during the summer months.

---

[7] *The term bench terraces is herein defined as a small earth fill constructed across a field slope to store runoff and release it slowly through underground drainage tiles. Such bench terraces are also known as tile outlet terraces.*

Cost estimates for this plan element are based on providing concrete tanks with sufficient volume to store five to six months' production of manure at all farms within the watershed area tributary to the lake under consideration. The cost of construction and installation of each tank is estimated to be $4,600 for an average size farm in the watershed. This element would involve a relatively large initial capital investment for construction of the tanks, but there would be little annual cost involved in maintaining the tanks. The cost of spreading the manure would be incurred both with or without the holding tanks, although methods would differ. However, there are certain problems to be considered. The period of time available for spreading manure when the ground is not frozen coincides with the time of maximum demand for farm labor. Consequently, the adoption of this system of phosphorus control on a voluntary basis by farmers can be expected to be limited. Furthermore, this is not a completely satisfactory type of control since it does not prevent erosion and consequent movement of phosphorus from sloping lands. For complete elimination of agricultural phosphorus contribution to lakes, erosion must be controlled.

Construction of bench terraces on land subject to erosion will furnish almost complete erosion control and provide highly effective retention of nutrients on the agricultural lands. Bench terraces would be capable of trapping over 95 percent of the sediment runoff from cultivated fields and essentially all of the phosphorus associated with that sediment. Bench terraces would eliminate the need for grassed waterways, permit parallel terraces with relatively straight alignments, put more water into the soil, retain the nutrients on the land to improve crop production, and eliminate the need for manure holding tanks. Therefore, the use of bench terraces is recommended for control of nutrients derived from agricultural lands having slopes in excess of 2 percent.

To be acceptable to farmers, erosion and runoff control measures must maintain or improve the "farmability" of the land. Vegetative and mechanical measures, such as stripcropping, contouring, grassed waterways, and conventional terracing have had limited acceptance in modern farming. Bench terracing provides a system of erosion and runoff control that is finding acceptance by farmers because only minimal land areas are lost to cultivation and conventional cultivation methods and machinery can be used.

On slopes of 6 percent or less, permanently maintained rows lead runoff water to storage areas constructed by placing earth fills across natural draws and drainageways. These fills are constructed so as to provide storage for about two inches of runoff from the contributing area. On steeper slopes runoff would overtop the rows so that a fill must be made continuous across the slopes.

The fills are constructed by pushing up earth borrowed from the downhill side. The downhill sides of the fill slopes are usually constructed at a slope of one foot vertical to two feet horizontal and are seeded to grass. The uphill slope of the earth fill is proportioned to fit modern farming equipment. A typical cross section of a bench terraced slope is shown in Figure 18. Spacings recommended for various land slopes are given in Table 16. It should be noted that the Technical Guide used by the U. S. Soil Conservation Service recommends somewhat narrower spacing for tile outlet bench terraces. The width used will determine the number of terraces required for any given application and, therefore, the cost.

Originally this type of control was used only in deep soils where exposure of subsoils in the construction of the terraces was not a problem. The earth fill provides a barrier for collecting the eroded soil so that the combination of soil pushed into the earth fill and the collected soil produces a flattened slope—thus, the name "Bench Terrace."

Farmers working with shallower soils, as in north central Iowa and New Brunswick, Canada, realized the advantages of the more nearly straight rows and wider terrace spacing offered by the bench terrace system.[8] Here, where exposed subsoil might seriously depress yields, a system of construction is being used which provides for the replacement of topsoil on nearly all borrow areas. A 40 to 50 foot section of a terrace is constructed by pushing up earth from the downhill side. This procedure leaves the subsoil exposed in the borrow area. Before constructing the adjacent 40 to 50 foot section of the same bench terrace, the

[8] *Paul Jacobson, E. A. Olafson, and J. A. Roberts, ''Erosion Control in New Brunswick, Canada,'' ASAE Paper No. 69-226.*

Figure 18
TYPICAL BENCH TERRACE CROSS-SECTION

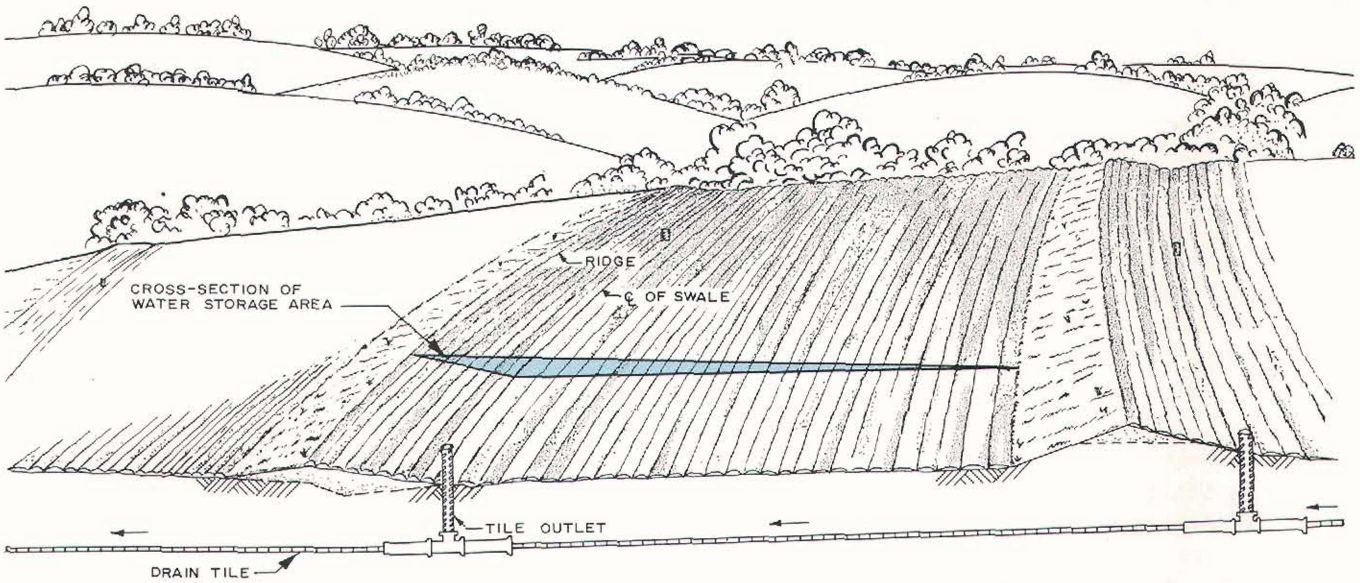
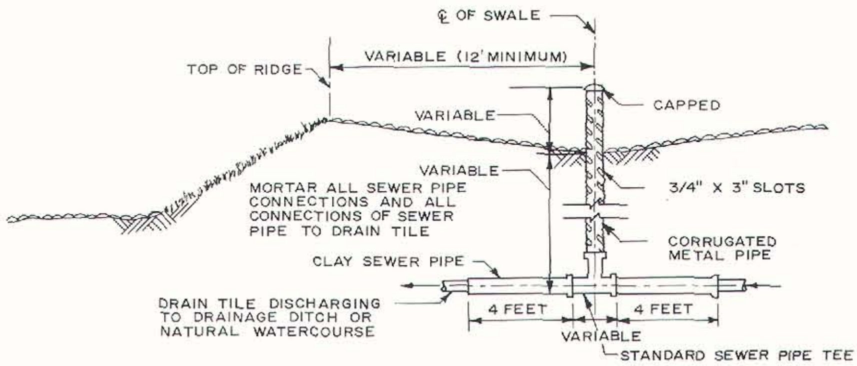


Figure 19
TILE OUTLETS FOR BENCH TERRACES



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

topsoil from the adjacent area is removed and spread over the borrow area for the previously constructed section of the terrace. The subsoil in the second area is then pushed up to construct the terrace in the adjacent area. This procedure is continued for adjacent areas until the entire length of the terrace is completed. In this way the terrace is built primarily by pushing up subsoil, with topsoil being replaced on all borrow areas but the very last 40 to 50 foot length of the terrace.

The water stored on the bench terraces is released into underground conduits usually made of field drain tile, as shown in Figure 18. The water enters the underground tile conduits through surface intakes along each terrace made of slotted, corrugated pipes. The pipe is attached vertically to the underground tile conduits, as shown in Figure 19. The slotted, corrugated nature of the tile inlets has a normal capacity of one inch of runoff in 24 hours, thus retarding peak inflows.

Table 16
RECOMMENDED TERRACE SPACING

Slope Percent	Spacing (In Feet)	Initial Number of 40-Inch Rows	Number of Rows After Benching 40-Inch	30-Inch	20-Inch	Final Bench Width (In Feet)
2	245	72	72	96	144	240
4	247	72	72	96	144	240
6	250	72	72	96	144	240
	171	48	48	64	96	160
8	132[a]	36	36	48	72	120
10	134[a]	36	36	48	72	120

[a] *These spacings should be increased if soils will permit benching the land.*

Source: Harza Engineering Company.

This retardation allows sediment to settle or drop out and, in so doing, traps about 95 percent of the sediment in the storage area while providing good agricultural drainage.

If the movement of phosphorus must be even more closely controlled, blind inlets can be installed to trap all of the sediment. With a blind inlet, the stored water percolates through the soil into the drain, allowing adsorption of organic phosphates. Research on blind inlets has been carried out by Iowa State University[9] in the Clarion-Webster Soil Association of north central Iowa. This soil association, of predominantly glacial origin, is similar to soils in the Fox River watershed. The general conclusion of these tests was that corncob backfill of the trench produced higher average discharge rates than backfill with soil or sand. The inlets filled with corncobs discharged a minimum flow of about 0.055 cfs per 100 feet of tile, therefore requiring about 100 feet of blind inlet per acre of drainage area to release one inch of runoff in 24 hours.

The storage fills or terraces are normally constructed with a bulldozer, although a carryall scraper is more efficient where extensive, long-distance, lateral movement of earth is required. Tile can be installed with conventional agricultural drainage equipment.

[9] *H. P. Johnson and D. B. Palmer, ''Field Evaluation of Flow Through Blind Inlets,'' Transactions of American Society of Agricultural Engineering, 1962.*

Terracing costs increase with slope since the steeper slopes require higher earth fills for storage and the terraces must be spaced closer together. The cost of constructing the bench terraces may vary from $10 per acre on 2 percent slopes to $100 per acre on 12 percent slopes. The cost of installing drain tiles may vary from $10 to $50 per acre normally, depending upon the amount of existing tile and distance to outlets. As with all practices, initial construction costs may run 10 percent to 15 percent higher until construction operators become proficient. Based on the average slope of land and the probable amount of existing tile in the Fox River watershed, the average cost of constructing bench terraces and drain tiles is estimated at $60 per acre.

The cost of the bench terrace system with tile outlets is usually justified by the improvements in farm operations and the more intensive cropping allowed by maintaining soil loss within permissible limits. Additional benefits accrue due to the erosion and runoff controlling features. Off-farm sediment and pollution damages are reduced, as are flood peaks. Manure can be spread in normal practice, and no manure holding tanks are required.

It should be emphasized that the foregoing discussion of the use of bench terraces with tile outlets to reduce lake nutrients by controlling agricultural runoff is not intended to preclude consideration of other farm management and soil conservation practices throughout all of the lake subwatersheds. In some cases bench terrace systems would not be appropriate or feasible because of landscape, soil, and cost considerations. Nutrient input to lakes can be reduced through the application of a variety of farm management and soil conservation practices. In the application of any soil and water conservation practices, expert technical advice should be sought by landowners from the U. S. Soil Conservation Service.

Weed Harvesting: Aquatic weed harvesting machines exist which can cut aquatic weeds to a maximum depth of seven feet and load them onto a barge for disposal on suitable land areas nearby. Cutting and removal eliminate the nuisance caused by excessive weed growths in a lake and remove from the lake a small amount of nutrients fixed in the plant tissues. The weed cutting must be done selectively at each lake to preserve major fish spawning areas. Although weed harvesting will do little to reduce the rapid rate of eutrophication in some of the lakes within the watershed, it would serve to reduce one of the nuisances accompanying this eutrophication.

Cost estimates for weed harvesting are based on two harvesting operations per lake per year, removal of weeds up to a depth of seven feet, and disposal of the weeds on suitable nearby land areas. The initial cost of a large weed harvesting machine is approximately $60,000, and operation and maintenance costs are estimated to be $150 per day. The harvesting machines could be rented from the manufacturer, or a regional harvesting program could be organized in which each lake community contributes a proportionate share of the cost of purchasing and operating the machines. Both initial investment cost and annual operation and maintenance costs for this plan element are relatively low.

Algae Control: Nuisance blooms of algae can be eliminated or controlled by the application of algicides. Several algicides are available for this purpose, but the one most commonly used is copper sulfate. It can be applied to a lake either by the addition of crystals or by spraying of solution from a boat or a barge. The use of an algicide will control the nuisance caused by excessive growths of algae, but it will not result in any nutrient removal from the lake since the decaying algae release their nutrients back into the water. Copper sulfate, if applied infrequently and in dosages just sufficient to control algal populations, should not produce any undesirable side effects. If used in excessive concentrations, however, it will poison fish and other aquatic life. Permits from the Wisconsin Department of Natural Resources, Division of Environmental Protection, are required for any chemical spraying operations on a lake. Copper sulfate has been used in the past for algae control on many of the lakes in the watershed.

Cost estimates for algae control are based upon two control operations per lake per year and vary with the size of the lake to be treated and the dosage required to kill the majority of the algae. Cost estimates include the cost of the chemicals, at $1 per acre treated; a boat or barge and spraying apparatus, at an initial cost of $1,250; and operation and maintenance costs of $50 per day. Initial investment costs and annual operation and maintenance costs for algae control are relatively low compared to other plan elements for lake water quality management.

Lake Water Mixing: Provision of pumps or artificial destratification devices to continuously mix a lake and thereby eliminate stratification may improve water quality in a lake. The continuous mixing will provide dissolved oxygen in the deep portions of a lake, which generally contain little or no oxygen during the summer months. By providing oxygen to the deep portions of a lake, anaerobic conditions favorable for bringing nutrients into solution from the bottom muds will be limited. By adding oxygen and lowering surface water temperatures, continuous mixing will also provide an improved and enlarged environment for fish production; and, if operated during the winter, it will reduce or eliminate winter fish kills.

The effects of continuous mixing on algae growth in a lake are not well known. By lowering surface water temperatures and by carrying algae cells out of the zones of photosynthetic activity, mixing may limit algal growths. By circulating nutrient-rich bottom waters throughout the lake volume, however, mixing will bring additional nutrients into the upper waters and may actually cause an increase in the amount of algae being produced and further intensify algal problems.

Cost estimates for providing continuous mixing of a lake are based on the volume of the lake, the number of destratification devices and related facilities required, the power requirements of these devices, and the associated maintenance costs. These estimates have been prepared only for lakes having maximum depths in excess of 20 feet, since only such lakes are stratified. Provision of continuous lake mixing requires a relatively large initial investment for the required equipment, but annual operation and maintenance costs are low.

Other Elements: Several additional methods of lake water quality management were investigated but were eliminated as possible plan elements either because the technology is not currently available to implement them or because the effects of the method are uncertain. These methods are briefly described below, however, since advances in knowledge and technology may make some of them desirable in the future.

Siphons: A siphon could be constructed that would draw water from the deep portions of a lake and discharge it downstream from the lake outlet. Nutrient-rich bottom waters would be discharged from the lake, thereby reducing the amount of nutrients in the lake. This technique would be applicable only in stratified lakes and would be operated only while the lakes are stratified. The effects of this method on algae and weed growth in a lake are not known.

Nutrient Removal: The possibility of removing nitrogen and phosphorus from lake water by chemical and mechanical means was investigated. If part or all of the lake volume could be treated to remove most of the nutrients present, algae and weed growth could be kept under control. There are several methods available for removing nutrients from sewage; but it is not known if these methods can be successfully applied to lake waters, which generally contain less than 1 percent as much nitrogen and phosphorus as municipal sewage. As future knowledge and technology for this solution develop, it may prove to be a very effective, although costly, method for halting, retarding, or even reversing eutrophication of a lake.

Dredging: Since the bottom sediments of a lake contain large quantities of nutrients, some of which may be released to the lake water, dredging to effect a removal of the nutrients was considered. While the technology of dredging is well developed, the results in terms of nutrient removal are uncertain since it is not known how much nutrients are contributed to the lakes from bottom sediments and since the sediments immediately below those removed may be just as rich and contribute just as much nutrients as the sediments removed. Also, the costs of dredging for nutrient removal are very high for the level of uncertainty involved. Dredging may, however, have a significant value as a means of deepening portions of a lake to reduce winter fish kills and to improve recreation potential.

Fish Harvesting: Since fish concentrate nutrients in their body structures, the possibility of removing nutrients by harvesting fish was considered. The total quantity of nutrients that could be removed by this method, however, is very small in relation to the total quantity of nutrients in a lake. If species of algae-eating fish could be cultivated in a lake, the controlled removal of these fish could help to control nuisances caused by excessive algae growths. At present, however, there are no such species of fish in the lakes of the Fox River watershed.

Aquatic biologists in Illinois are experimenting with a species of fish known as tilapias, originally from Africa, that eat weeds and algae and can be used to keep ponds and lakes free of excessive weed and algae growths. They cannot survive at temperatures below 50°F, however, and must be removed to warm waters for the winter. It is possible that in the future, these fish could be raised commercially and stocked in lakes every spring to assist in controlling algae and weeds throughout the growing season.

Algae Harvesting: Removal of algae from a lake by harvesting would have two desirable results. First, the physical removal of algae would reduce or eliminate the nuisances caused by excessive algae growths; and, second, algae removal would result in the removal of large quantities of nutrients contained in the algal cells. Present costs, however, eliminate algae harvesting as an economically feasible method.

Application of Alternative Plan Elements to the Major Lakes in the Watershed

Various water quality management plans were investigated for each of 22 major lakes studied for this purpose in the Fox River watershed and are described in this section. The first table referenced under the discussion of each lake presents a summary of the pertinent characteristics of the lake, including lake surface area, estimated present lake-oriented resident population, major nutrient sources, and existing water quality problems.

The second table referenced under the discussion of each lake indicates alternative plan elements for managing the water quality of the lake, anticipated performance of each plan, and estimated costs for each plan. These alternatives are based on preliminary investigations of each of 22 major lakes within the watershed and indicate the most feasible water quality management plans under the existing state of the art. Cost estimates for the alternative plans are also based on these preliminary investigations. Costs shown in the alternative plan table for each lake include estimated initial capital cost; operation and maintenance costs; total annual cost, including capital recovery; and average annual cost per lake-oriented resident household.[10] The average number of households residing around each lake was determined from existing and anticipated future (1990) population levels around each lake and from the average number of persons per household in the watershed.

Beulah Lake: Beulah Lake consists of a series of five major basins connected by shallow channels. It receives substantial public recreational use. Water quality is generally suitable for all present uses of the lake, although weed growths in bays and connecting channels may interfere with some activities. Nutrient concentrations are about at the average level for lakes within the Fox River watershed. The major nutrient source is spring runoff from manured land, which is estimated to contribute approximately 65 percent of the phosphorus input (see Table 17).

A sanitary district has recently been proposed to serve the area around Beulah Lake. This district, according to the proposal, would provide solid waste collection services, cut and harvest weeds, and take other steps to prevent pollution of the lake.

Two alternative water quality management plan elements were considered for Beulah Lake. The first provides for removal of excessive weed growths that are interfering with recreational activities by weed harvesting (see Table 18).

The second alternative considered may be expected to reduce phosphorus input to the lake by 65 percent through the use of bench terracing to reduce erosion and soil losses from 1,600 acres of agricultural land tributary to the lake. Weed removal would also be provided as in the first alternative.

Because of the generally good water quality conditions of Beulah Lake, the low population density around the lake, and the low proportion of phosphorus estimated to be contributed by septic tank systems located near the lake, a sanitary sewerage system plan element was not considered.

It is recommended that the second alternative water quality management plan for Beulah Lake, including weed harvesting and bench terracing, be included in the recommended watershed plan.

Big Muskego Lake: Big Muskego Lake is a large shallow lake that receives little public use other than for hunting. It is, however, a major waterfowl habitat in southeastern Wisconsin. The lake is covered with extensive weed growths during the summer months. There is evidence of sewage pollution in Bass Bay, probably from the septic tanks serving the homes around the bay (see Table 19).

The only water quality management plan element considered for the lake was weed harvesting and algae control (see Table 20). This plan element could be expected to control nuisance growths of algae and weeds, but the harvesting control and operations should be selective to protect major waterfowl nesting areas and fish spawning areas. No other plan elements were considered because of the limited public use of the lake and the lack of potential to support significant public use due to the very shallow depth of the lake. Investigations should be made in the Bass Bay area to confirm the suspected sources of the sewage pollution in that area, and pollution from these sources should

---

[10] *A lake-oriented resident household was defined as a family residing year-round in a residence located on a land area draining directly to a particular lake and so located as to utilize the recreational and environmental amenities provided by the lake. Lake-oriented households normally would not include families residing in farm dwellings or in residences located a considerable distance away on lands which do not drain directly to the lake.*

a. For the evaluation of prospective sewerage facilities, lake-oriented housholds would include only those households defined above that are not presently served by community sewerage facilities.

b. For the evaluation of other water quality management and improvement measures, lake-oriented households would include both sewered and unsewered households as defined above.

Table 17

SELECTED CHARACTERISTICS OF BEULAH LAKE
WALWORTH COUNTY: 1966

Characteristic	Description
Tributary Drainage Area	12.8 Square Miles
Surface Area.	837 Acres
Shoreline	15.3 Miles
Depth	
Under 3 Feet	13 Percent
Over 20 Feet	34 Percent
Volume.	14,489 Acre-Feet
Lake-Oriented Population.	650
Phosphorus Sources.	Manured land 66%
	Rural runoff 12
	Septic tanks 10
	Other[a] 12
	Total 100%
General Water Quality	Moderate weed growths
	Moderate nutrient concentrations
	Generally good water quality conditions

[a]*Precipitation and ground water.*

Source: Harza Engineering Company and Wisconsin Department of Natural Resources.

be eliminated if the bay is to be used for body-contact recreational activities. It is recommended that the foregoing weed harvesting and algae control water quality plan element be included in the recommended watershed plan.

Bohner Lake: Water quality in Bohner Lake is generally suitable for all present uses of the lake, including swimming, boating, and fishing. High nutrient concentrations, however, give rise to some weed and algae growth that may affect these uses. Major sources of nutrients are individual sewage disposal facilities around the lake, which contribute 40 percent of the phosphorus, and runoff from manured land, which contributes 40 percent of the phosphorus. Chemicals have been used in the past to control weed and algae growths (see Table 21).

The second alternative considered could be expected to reduce phosphorus input to the lake by approximately 40 percent by providing bench terracing for approximately 500 acres of agricultural land tributary to the lake. In addition, nuisances caused by excessive weed and algae growths would be controlled as in the first alternative.

Three alternative water quality management plan elements were considered for Bohner Lake. The first would provide algae control through the use of algicides on the lake and weed control by removing the weeds with mechanical harvesters (see Table 22). This action would alleviate problems caused by excessive weed and algae growths.

The third alternative considered, in addition to providing the facilities of the first two alternatives, would provide a sewerage system and treatment plant to serve all of the developments around the lake (see Figure 20). This installation would eliminate any potential future pollution of the lake from individual sewage disposal systems and, together with bench terracing, could be expected to reduce phosphorus input by 80 percent. A preliminary estimate of the loss of water to the lake resulting from the elimination of septic tank seepage indicates the loss would be equiva-

Table 18

ALTERNATIVE LAKE WATER QUALITY MANAGEMENT PLAN ELEMENTS
BEULAH LAKE, WALWORTH COUNTY

Alternative Plan Element		Estimated Cost							Anticipated Performance
Number Designation	Description	Capital	Annual Operation and Maintenance	Present Worth	Total Annual 1970-1985	Total Annual 1986-2020	Annual Per Capita[a] 1970-1985	Annual Per Capita[a] 1986-2020	
1	Weed harvesting	$ 10,000	$ 1,500	$ 25,000[b]	$ 2,600	$ --	$ 4.0	$ --	Control aquatic nuisance growths
	Total	$ 10,000	$ 1,500	$ 25,000	$ 2,600	$ --	$ 4.0	$ --	
2	Weed harvesting	$ 10,000	$ 1,500	$ 25,000[b]	$ 2,600	$ --	$ 4.0	$ --	Control aquatic nuisance growths
	Bench terraces	98,000	--	98,000	6,200	6,200	9.5	9.5	*Reduce phosphorus input by about 65 percent*
	Total	$ 108,000	$ 1,500	$ 123,000	$ 8,800	$ 6,200	$ 13.5	$ 9.5	

[a]*A population of 650 persons was used for per capita cost calculations.*

[b]*Present worth calculated utilizing a 6 percent rate of interest and a 15-year life. The present worth for all other plan elements calculated utilizing a 6 percent rate of interest and a 50-year life.*

Source: Harza Engineering Company.

Table 19

SELECTED CHARACTERISTICS OF BIG MUSKEGO LAKE WAUKESHA COUNTY: 1966

Characteristic	Description
Tributary Drainage Area	28.0 Square Miles
Surface Area	2,260 Acres
Shoreline	17.7 Miles
Depth	
Under 3 Feet	96 Percent
Over 20 Feet	1 Percent
Volume	6,564 Acre-Feet
Lake-Oriented Population	500
Phosphorus Sources	Manured land 57% Rural runoff 13 Septic tanks 5 Other[a] 25 Total 100%
General Water Quality	Heavy weed growths Winter fish kills Evidence of sewage pollution in Bass Bay

[a]*Precipitation and ground water.*

Source: Harza Engineering Company and Wisconsin Department of Natural Resources.

lent to less than two inches of water over the lake surface annually.

It is recommended that the second alternative water quality management plan for Bohner Lake, including weed harvesting, algae control, and bench terracing, be included in the recommended watershed plan. It is not recommended that the sanitary sewerage system be included in the watershed plan at this time because the cost of the system was deemed to outweigh the water quality benefits, due to the fact that water quality samples indicate a lack of excessive pollution due to inoperative septic tank systems.

Browns Lake: Browns Lake is heavily used for all types of recreational activities by nearby residents and by people staying at the numerous resorts located on the lake. Water quality in the lake is characterized by heavy growths of aquatic weeds and algae, the highest phosphorus concentration of all major lakes in the Fox River watershed, and significant evidence of sewage pollution in the lake. The major nutrient source is drainage from septic tanks, which is estimated to contribute 60 percent of the average phosphorus input to the lake (see Table 23).

About three-fourths of the tributary drainage area lying to the east and south of the lake is overlain with soils that are unsuitable for soil absorption sewage disposal facilities. This area includes much of the residential development around the lake. Soils on the north and west sides of the lake are generally suitable for the use of soil absorption sewage disposal systems.

Four alternative water quality management plan elements were considered for Browns Lake. The first provides for weed harvesting and algae control to alleviate any problems being caused by excessive growths of weeds and algae (see Table 24). The use of chemicals has been necessitated in the past to control nuisance aquatic growths.

The second alternative considered provides for a sewerage system and treatment plant to serve the Cedar Park area on the east side of the lake and the resorts and homes around the remainder of the lake, with the treatment plant discharging to Hoosier Creek (see Figure 21). This installation would eliminate all waste discharges to the lake from individual sewage disposal facilities, would eliminate any public health hazards caused by these discharges, and could be expected to reduce the phosphorus input to the lake by 60 percent. Weed and algae control would be provided as in the first alternative. A preliminary estimate of

Table 20

ALTERNATIVE LAKE WATER QUALITY MANAGEMENT PLAN ELEMENTS BIG MUSKEGO LAKE, WAUKESHA COUNTY

Alternative Plan Element		Estimated Cost							Anticipated Performance
Number Designation	Description	Capital	Annual Operation and Maintenance	Present Worth	Total Annual 1970-1985	Total Annual 1986-2020	Annual Per Capita[a] 1970-1985	Annual Per Capita[a] 1986-2020	
1	Weed harvesting	$ 88,000	$ 13,000	$ 214,000[b]	$ 22,000	$ --	$ 44.0	$ --	Control aquatic nuisance growths
	Algae control	1,250	5,250	52,250[b]	5,400	--	10.8	--	
	Total	$ 89,250	$ 18,250	$ 266,250	$ 27,400	$ --	$ 54.8	$ --	

[a]*A population of 500 persons was used for per capita cost calculations.*

[b]*Present worth calculated utilizing a 6 percent rate of interest and a 15-year life.*

Source: Harza Engineering Company.

Table 21

SELECTED CHARACTERISTICS OF BOHNER LAKE
RACINE COUNTY: 1966

Characteristic	Description
Tributary Drainage Area	3.6 Square Miles
Surface Area	124 Acres
Shoreline	1.8 Miles
Depth	
Under 3 Feet	25 Percent
Over 20 Feet	25 Percent
Volume	1,196 Acre-Feet
Lake-Oriented Population	850
Phosphorus Sources	Manured land 41% Septic tanks 39 Rural runoff 15 Other[a] 5 Total 100%
General Water Quality	Moderate weed and algae growths High nutrient concentrations Water quality generally suitable for most uses

[a] Precipitation.

Source: Harza Engineering Company and Wisconsin Department of Natural Resources.

the loss of water to the lake resulting from the elimination of septic tank seepage indicates that the loss would be less than one inch of water over the lake surface annually.

The third alternative considered provides for a sewerage system and treatment plant to serve only the east side of the lake, with the treatment plant discharging to Hoosier Creek (see Figure 22).

The fourth alternative considered provides for a sewerage system in which sewage collected from both sides of the lake would be carried to the existing treatment plant located south of the City of Burlington, eliminating the need for the construction of a new treatment plant at Browns Lake. This latter alternative would include the costs of increasing the capacity of the existing Burlington plant to handle the additional sewage load (see Figure 23). The third and fourth alternatives would include weed and algae control, as set forth in the first alternative.

Costs for the various alternative plans for Browns Lake are summarized in Table 24. The fourth alternative considered would serve the largest number of persons, since the trunk sewer to the Burlington treatment plant would be capable of serving the presently unsewered area lying east of the Fox River between the City of Burlington and Browns Lake. The diversion of sewage to the Burlington sewage treatment plant, as proposed in the fourth alternative, is considered to be the best way to provide sewer service to Browns Lake,

Table 22

ALTERNATIVE LAKE WATER QUALITY MANAGEMENT PLAN ELEMENTS
BOHNER LAKE, RACINE COUNTY

Alternative Plan Element		Estimated Cost							Anticipated Performance
Number Designation	Description	Capital	Annual Operation and Maintenance	Present Worth	Total Annual 1970-1985	Total Annual 1986-2020	Annual Per Capita[a] 1970-1985	Annual Per Capita[a] 1986-2020	
1	Weed harvesting	$ 4,000	$ 550	$ 9,330[b]	$ 960	$ --	$ 1.1	$ --	Control aquatic nuisance growths
	Algae control	1,250	450	5,620[b]	580	--	0.7	--	
	Total	$ 5,250	$ 1,000	$ 14,950	$ 1,540	$ --	$ 1.8	$ --	
2	Weed harvesting	$ 4,000	$ 550	$ 9,330[b]	$ 960	$ --	$ 1.1	$ --	Control aquatic nuisance growths Reduce phosphorus input by about 40 percent
	Algae control	1,250	450	5,620[b]	580	--	0.7	--	
	Bench terraces	31,000	--	31,000	1,970	1,970	2.3	2.3	
	Total	$ 36,250	$ 1,000	$ 45,950	$ 3,510	$ 1,970	$ 4.1	$ 2.3	
3	Weed harvesting	$ 4,000	$ 550	$ 9,330[b]	$ 960	$ --	$ 1.1	$ --	Control aquatic nuisance growths Reduce phosphorus input by about 80 percent
	Algae control	1,250	450	5,620[b]	580	--	0.7	--	
	Bench terraces	31,000	--	31,000	1,970	1,970	2.3	2.3	
	Sanitary sewerage system (entire lake--850 persons served--secondary treatment plant at lake outlet)[c]	1,484,000	28,000	1,954,300	124,000	124,000	146.0	146.0	
	Total	$ 1,520,250	$ 29,000	$2,000,250	$127,510	$125,970	$ 150.1	$148.3	

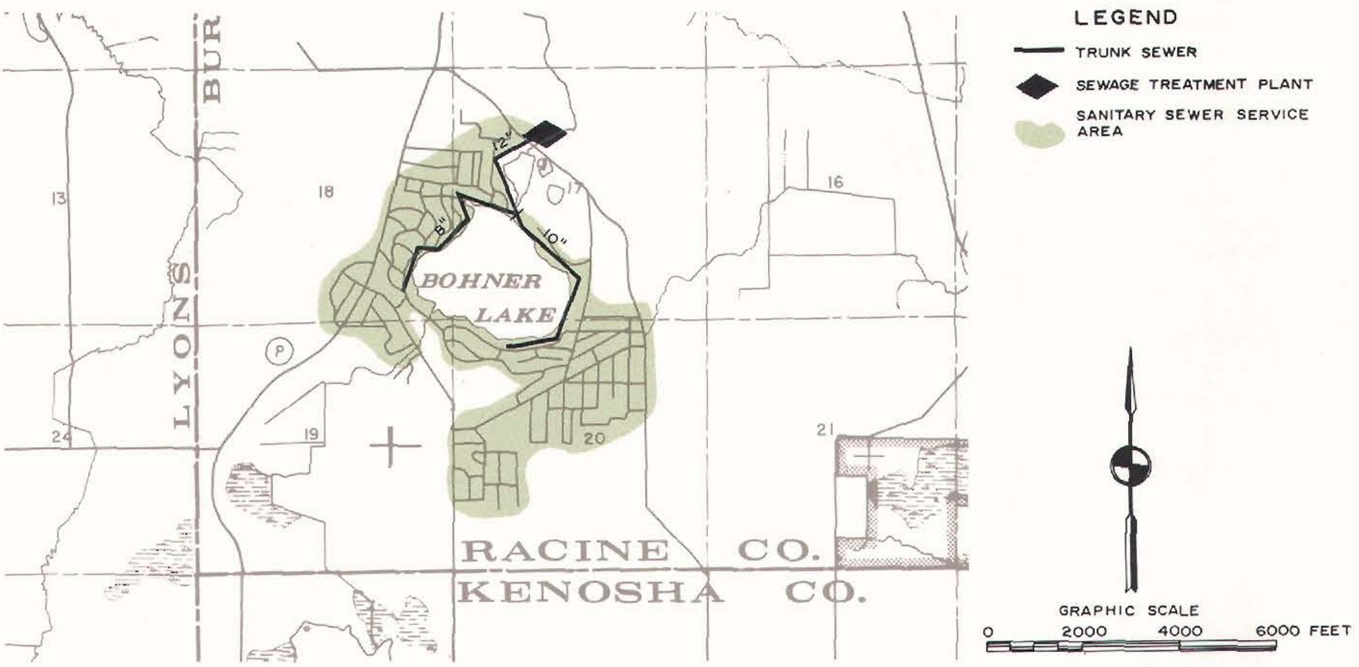
[a] A population of 850 persons was used for per capita cost calculations.

[b] Present worth calculated utilizing a 6 percent rate of interest and a 15-year life. The present worth for all other plan elements calculated utilizing a 6 percent rate of interest and a 50-year life.

[c] The component capital costs of the sanitary sewerage system are: treatment plant (secondary) $184,000; trunk sewers $175,000; lateral and branch sewers $1,125,000.

Source: Harza Engineering Company.

Figure 20
PROPOSED SANITARY SEWERAGE FACILITIES FOR BOHNER LAKE



Almost half of the annual phosphorus inflow to Bohner Lake is contributed by septic tank effluent seepage into the lake. A sanitary sewerage system to serve the lake-oriented resident population of about 850 people would significantly reduce the phosphorus contribution to the lake, thereby reducing the rate of eutrophication. Such a system would also assist in maintaining good lake water quality for recreational uses, eliminating any potential sanitary hazard.

Source: Harza Engineering Company and SEWRPC.

since it not only eliminates the need to construct a separate sewage plant but also allows improved treatment to be supplied to the service area and eliminates any waste discharge from the Browns Lake area to the stream network above Burlington. It is, therefore, recommended that the fourth alternative water quality management plan for Browns Lake, including weed harvesting, algae control, and a sanitary sewerage system with waste treatment at the City of Burlington plant, be included in the recommended watershed plan.

Camp and Center Lakes: Camp and Center Lakes receive moderate use for fishing and as a waterfowl habitat. There are large residential developments on the east side of Camp Lake and around most of Center Lake. Water quality in both lakes is characterized by dense weed and algae growths, average nutrient concentrations, and some evidence of sewage pollution from the homes around the lakes. Approximately 90 percent of the area around the two lakes is overlain with soils that are not suitable for soil absorption sewage disposal systems. Major nutrient sources are drainage from the individual sewage disposal facilities serving homes around the lakes and runoff from manured land (see Table 25).

Four alternative water quality management plan elements were considered for Camp and Center Lakes. The first would provide weed harvesting and algicide applications to eliminate nuisances caused by excessive growths of algae and aquatic weeds in both lakes (see Table 26).

The second alternative considered could be expected to reduce phosphorus input to the lakes by one-half through the construction of bench terraces on 1,200 acres of agricultural land draining to the lakes. Weed and algae control would also be used as in the first alternative.

The third alternative considered provides for the construction of a sanitary sewerage system and

Table 23

SELECTED CHARACTERISTICS OF BROWNS LAKE
RACINE COUNTY: 1966

Characteristic	Description
Tributary Drainage Area	2.2 Square Miles
Surface Area	396 Acres
Shoreline	5.0 Miles
Depth	
Under 3 Feet	12 Percent
Over 20 Feet	2 Percent
Volume	3,135 Acre-Feet
Lake-Oriented Population	1,100
Phosphorus Sources	Septic tanks 60% Manured land 22 Rural runoff 5 Other[a] 13 Total 100%
General Water Quality	Heavy weed and algae growths Evidence of sewage pollution Very high nutrient concentrations

[a]*Precipitation.*

Source: *Harza Engineering Company and Wisconsin Department of Natural Resources.*

treatment facilities to serve the developed areas on the east side of Camp Lake and around all of Center Lake (see Figure 24). This alternative would eliminate all discharge of wastes from these areas to the lakes and thereby serve to eliminate any public health hazards from these discharges. Phosphorus input to the lake would be expected to be reduced by 25 percent. Weed and algae control would also be utilized as in the first alternative.

The fourth alternative considered would provide a sanitary sewerage system and treatment facilities, bench terraces, and weed and algae control. This alternative could be expected to reduce phosphorus input by three-fourths, eliminate most waste discharges to the lake and the related public health hazards, and alleviate problems being caused by the large weed and algae growths. Estimates of the water loss to the lake as a result of the sewerage system indicate that the loss would be negligible. It is recommended that this fourth alternative be included in the recommended watershed plan.

Como Lake: Como Lake is a very shallow lake primarily used for fishing, hunting, and as a waterfowl habitat. Boating and water skiing are minor uses of the lake. Water quality is characterized by extensive growths of weeds and algae in many portions of the lake. Major nutrient inputs to the lake are manured land runoff and drainage from private sewage disposal facilities. Approximately three-fourths of the area around the lake is overlain with soils that are not suitable for soil absorption sewage disposal systems (see Table 27).

Four alternative water quality management plan elements were considered for Como Lake. The first would alleviate nuisance conditions in the lake by removing weeds through the use of weed harvesting machines and by controlling algae growths through the use of algicides (see Table 28).

The second alternative considered could be expected to reduce the phosphorus input to the lake by slightly over one-half through the application of bench terracing on 1,200 acres of agricultural land tributary to the lake and presently subject to substantial erosion and soil loss. Weed and algae control would be provided as in the first alternative.

The third alternative considered would provide a sanitary sewerage system and treatment facilities to serve the large urban development on the north side of the lake (see Figure 25). This would serve to eliminate any sanitary hazards that may be caused by drainage from individual disposal facilities serving residences in this development and could be expected to reduce phosphorus input to the lake by about one-fifth. It would not, however, alleviate any sanitary hazards caused by septic tank discharges from residences located along the south side of the lake. Weed and algae control would also be provided as in the first alternative.

The fourth alternative considered would provide all the elements considered in the first three alternatives. It could be expected to greatly reduce any health hazards caused by malfunctioning private sewage disposal facilities, could be expected to result in a reduction of phosphorus input to the lake by 80 percent, and thereby to alleviate nuisances caused by excessive weed and algae growths in the lake. It is recommended that this fourth alternative be included in the recommended watershed plan.

Eagle Lake: Water quality in Eagle Lake is characterized by large areas of weed and algae growths that interfere with recreational activities, moderately high nutrient concentrations, and some

Table 24

ALTERNATIVE LAKE WATER QUALITY MANAGEMENT PLAN ELEMENTS
BROWNS LAKE, RACINE COUNTY

Alternative Plan Element		Estimated Cost							
Number Designation	Description	Capital	Annual Operation and Maintenance	Present Worth	Total Annual 1970-1985	Total Annual 1986-2020	Annual Per Capita 1970-1985	Annual Per Capita 1986-2020	Anticipated Performance
1	Weed harvesting	$ 5,200	$ 750	$ 7,280[a]	$ 750	$ --	$ 0.5[b]	$ --	Control aquatic nuisance growths
	Algae control	1,250	1,250	12,120[a]	1,250	--	0.8[b]	--	
	Total	$ 6,450	$ 2,000	$ 19,400	$ 2,000	$ --	$ 1.3	$ --	
2	Weed harvesting	$ 5,200	$ 750	$ 7,280[a]	$ 750	$ --	$ 0.5[b]	$ --	Control aquatic nuisance growths
	Algae control	1,250	1,250	12,120[a]	1,250	--	0.8[b]	--	Eliminate public health hazards
	Sanitary sewerage system (entire lake--1,500 persons served--secondary treatment plant at lake outlet)[c] . .	1,331,000	28,000	1,812,600	114,800	114,800	76.5	76.5	Reduce phosphorus input by about 60 percent
	Total	$ 1,337,450	$ 30,000	$ 1,832,000	$ 116,800	$ 114,800	$ 77.8	$ 76.5	
3	Weed harvesting	$ 5,200	$ 750	$ 7,280[a]	$ 750	$ --	$ 0.8[b]	$ --	Control aquatic nuisance growths
	Algae control	1,250	1,250	12,120[a]	1,250	--	1.4[b]	--	Eliminate public health hazards
	Sanitary sewerage system (east side of lake--900 persons served--secondary treatment plant at lake outlet)[d] . .	860,000	20,400	1,201,600	76,000	76,000	84.5	84.5	Reduce phosphorus input by about 60 percent
	Total	$ 866,450	$ 22,400	$ 1,221,000	$ 78,000	$ 76,000	$ 86.7	$ 84.5	
4	Weed harvesting	$ 5,200	$ 750	$ 7,280[a]	$ 750	$ --	$ 0.4[b]	$ —	Control aquatic nuisance growths
	Algae control	1,250	1,250	12,120[a]	1,250	--	0.6[b]	--	Eliminate public health harzards
	Sanitary sewerage system(entire lake--1,950 persons served--advanced waste treatment at Burlington)[e]. . .	1,624,000	21,000	2,005,600	126,800	126,800	65.0	65.0	Reduce phosphorus input by about 60 percent
	Total	$ 1,630,450	$ 23,000	$ 2,025,000	$128,800	$ 126,800	$ 66.0	$ 65.0	

[a]*Present worth calculated utilizing a 6 percent rate of interest and a 15-year life. The present worth for all other plan elements calculated utilizing a 6 percent rate of interest and a 50-year life.*

[b]*A population of 1,500 persons was used for per capita cost calculations.*

[c]*The component capital costs of the sanitary sewerage system are: treatment plant (secondary) $211,000; trunk sewers $260,000; lateral and branch sewers $860,000. An additional capital cost of $102,000 would be needed to provide advanced waste treatment and make alternative 2 strictly comparable to Alternative 4.*

[d]*The component capital costs of the sanitary sewerage system are: treatment plant (secondary) $135,000; trunk sewers $116,000; lateral and branch sewers $609,000. An additional capital cost of $65,000 would be needed to provide advanced waste treatment and make Alternative 3 strictly comparable to Alternative 4.*

[e]*The component capital costs of the sanitary sewerage system are: advanced waste treatment $195,000; trunk sewers $525,000; lateral and branch sewers $904,000.*

Source: Harza Engineering Company.

evidence of sewage pollution. The entire area around the lake is overlain with soils that are unsuitable for soil absorption sewage disposal systems. Major sources of nutrient input to the lake are runoff from manured land, which is estimated to contribute 55 percent of the phosphorus input, and drainage from individual sewage disposal systems, which is estimated to contribute 20 percent of the phosphorus (see Table 29). In addition, the Pure Milk Association plant in Kansasville discharges wastes high in nutrient content to a marsh that drains into Eagle Lake. Adequate waste treatment facilities should be provided at this plant to abate this discharge of nutrients to the lake. The lake is generally treated twice yearly with algicides and herbicides to control luxuriant aquatic growths.

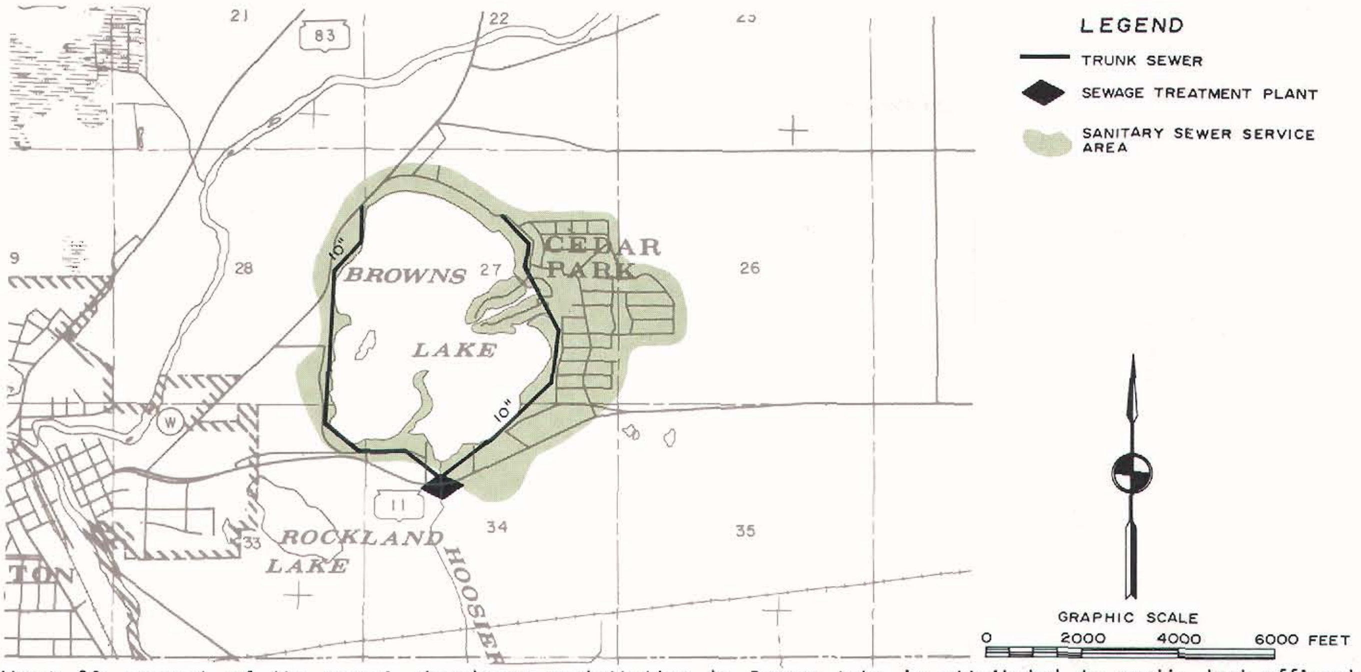
Four alternative water quality management plan elements were considered for Eagle Lake. The first would provide harvesting equipment to remove excessive weed growths and would utilize algicides to control large algal growths (see Table 30). This action would alleviate the problems caused by these growths.

The second alternative considered would, in addition to providing weed and algae control as above, provide bench terracing for 1,000 acres of agricultural land tributary to the lake and may be expected to reduce phosphorus input to the lake by 55 percent.

The third alternative considered would provide a sanitary sewerage system and treatment facilities to serve all of the residences and resorts located around the lake (see Figure 26). This alternative would eliminate any public health hazards being caused by waste discharges to the lake from malfunctioning individual sewage disposal facilities and could be expected to reduce phosphorus input by 20 percent. Weed and algae control would be provided as in the first alternative.

Figure 21

ALTERNATIVE SANITARY SEWERAGE FACILITIES FOR BROWNS LAKE: ENTIRE LAKE WITH TREATMENT PLANT AT LAKE OUTLET



About 60 percent of the annual phosphorus contribution to Browns Lake is attributed to septic tank effluent seepage, seepage which also contributes to the high coliform bacteria counts in the lake. One of the alternative sanitary sewerage systems considered to eliminate these two forms of pollution would have a sewage treatment plant discharging to Hoosier Creek, with tributary sewers serving all of the lake community.

Source: Harza Engineering Company and SEWRPC.

The fourth alternative considered would provide a sanitary sewerage system and treatment facilities, bench terracing, and weed and algae control. This alternative could be expected to reduce phosphorus input to the lake by 75 percent, eliminate waste discharges and sanitary hazards from these discharges to the lake, and control nuisance growths of algae and aquatic weeds.

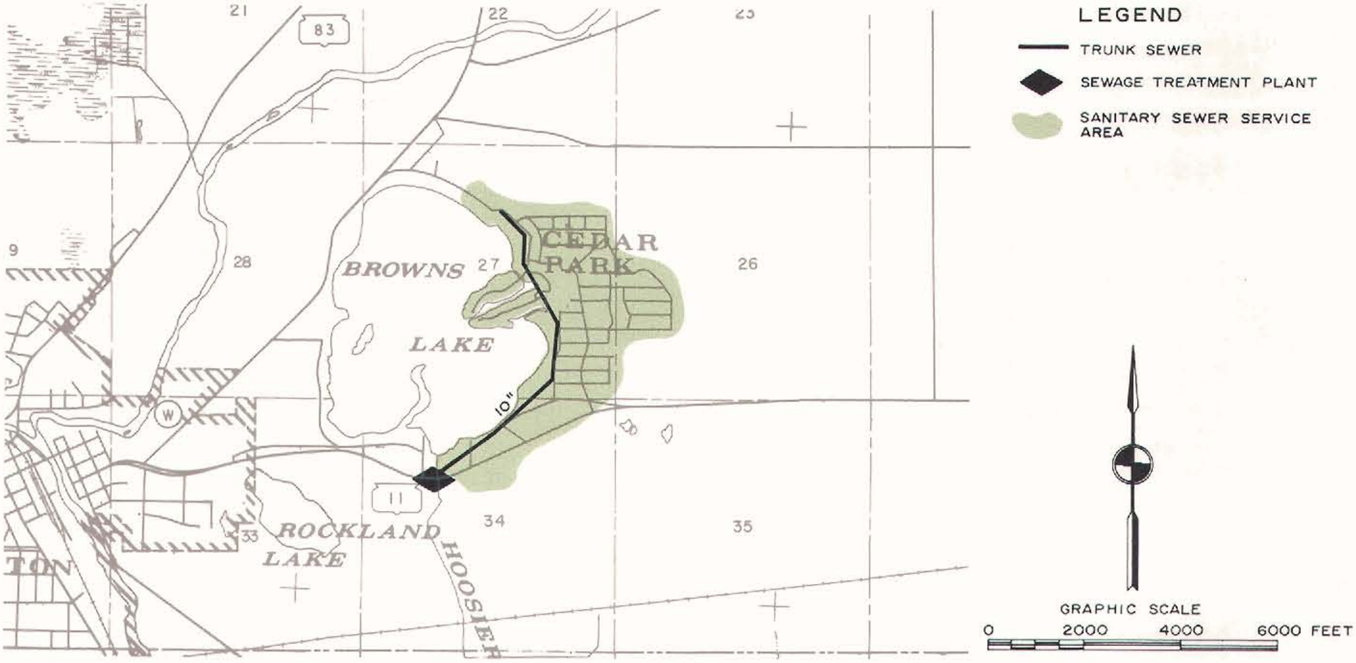
It is recommended that the fourth alternative water quality management plan for Eagle Lake, including weed harvesting, algae control, bench terracing, and a sanitary sewerage system, be included in the recommended watershed plan.

Echo Lake: Echo Lake is a small shallow impoundment of the White River that receives little public use other than aesthetic enjoyment. Water quality in the lake is characterized by moderately high nutrient concentrations, caused mostly by runoff from manured land and upstream waste discharges, and by some bacterial pollution. There is very little weed growth in the lake, probably due to the sand and gravel bottom (see Table 31). No specific water quality management plan elements were considered for Echo Lake because of the little use the lake receives and because improvements in water quality in the White River and Honey Creek, as recommended in the stream water quality management alternative plans, should result in improved quality in Echo Lake. Disinfection of upstream waste discharges should alleviate the bacterial pollution problem, and removal of nutrients from these waste discharges may be expected to reduce phosphorus input to the lake by 25 percent. If additional use is to be made of the lake for recreational activities, it may be desirable to deepen portions of it by dredging.

Elizabeth and Marie Lakes: Elizabeth and Marie Lakes are very intensively used for recreational purposes, including boating, swimming, and fishing. There are many resorts located around the lakes which provide access to the lakes for many people. Water quality is generally suitable for all uses of the lakes, although heavy weed growths interfere with some uses. Major nutrient sources

Figure 22

ALTERNATIVE SANITARY SEWERAGE FACILITIES FOR BROWNS LAKE: EAST SIDE OF LAKE WITH TREATMENT PLANT AT LAKE OUTLET



A second alternative sanitary sewerage plan considered for Browns Lake would provide sewerage service to only those residential areas located along the east side of the lake, with the residences on the west side of the lake to be eventually removed in order to provide restored "natural" lakeshore area. This alternative would also utilize a sewage treatment plant discharging to Hoosier Creek.

Source: Harza Engineering Company and SEWRPC.

are runoff from manured land, runoff from urban and semiurban land, and drainage from individual sewage disposal facilities (see Table 32). Much of the developed area around the lakes is served by a sewerage system and treatment facilities, with effluent disposal away from the lake. The sewerage system should be expanded to serve all of the developed areas around both lakes.

Two alternative water quality management plan elements were considered for Elizabeth and Marie Lakes. The first provides for weed harvesting and removal to eliminate problems being caused by the large growths of aquatic weeds (see Table 33).

The second alternative considered provides for the construction of bench terraces on 1,100 acres of agricultural land draining to the lake, which could be expected to reduce phosphorus input to the lake by 40 percent. Weed control would also be used as in the first alternative. It is recommended that this second alternative be included in the recommended watershed plan.

Geneva Lake: Geneva Lake is the largest lake in the watershed and, as such, is one of the most valuable recreational assets of the entire watershed. It is used for all forms of recreational activities by residents, by people staying at the many resorts surrounding the lake, and by day-use people from the Milwaukee and Chicago metropolitan areas. The major population centers around the lake, including Lake Geneva, Williams Bay, and Fontana, all provide sanitary sewerage service and treatment facilities with effluent disposal away from the lake. Water quality in the lake is generally suitable for all uses, with very low nutrient concentrations and little evidence of nuisance growths of weeds or algae. Dissolved oxygen levels in the bottom waters, however, are generally low; and this may have an adverse effect on the fish life that the lake supports. Major nutrient sources are runoff from manured land and runoff from urban areas (see Table 34).

Two alternative water quality management plan elements were considered for Geneva Lake. The first could be expected to reduce phosphorus input to the lake by 45 percent through the provision of bench terraces on 3,300 acres of agricultural land tributary to the lake and presently subject to excessive erosion and soil loss (see Table 35). Weed and algae control would generally not be necessary, except possibly in isolated areas.

The second alternative considered would provide for artificial destratification of the lake through the use of appropriate mixing devices. This action would provide additional oxygen to the deeper waters of the lake. Additional investigation would be necessary, however, to determine what effect mixing would have on algae and weed growth.

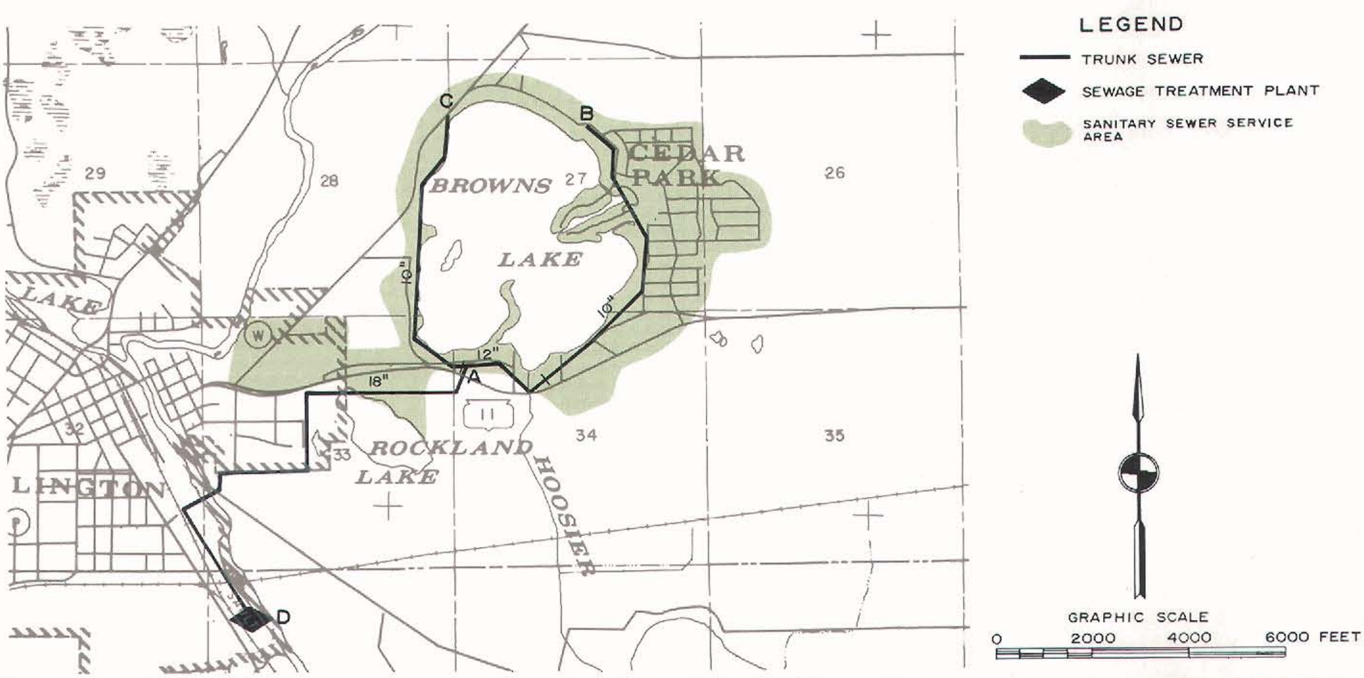
No sanitary sewerage system plan element was considered for Geneva Lake because of the existence of three such systems serving the adjacent City of Lake Geneva and Villages of Fontana and Williams Bay (see Figure 27). It was assured that these existing systems would eventually be to serve all of the urban development around Geneva Lake as the need arises. This assumption was made in view of the antiproliferation policy of the Wisconsin Department of Natural Resources with regard to sewage treatment plants.

It is recommended that the first alternative water quality management plan for Geneva Lake, consisting of bench terracing, be included in the recommended watershed plan. The second alternative, lake mixing, was deemed not warranted based upon existing water quality conditions.

Little Muskego Lake: Little Muskego Lake is used for aesthetic and recreational activities, including fishing, boating, and swimming (see Table 36). Water quality is generally poor, however, in comparison to other lakes in the Fox River watershed. Nuisance growths of weeds and algae are evident in many of the shallow bays, and there is direct evidence of pollution from private sewage disposal systems around the lake. In addition, nutrient concentrations in the lake are among the

Figure 23

RECOMMENDED SANITARY SEWERAGE FACILITIES FOR BROWNS LAKE: ENTIRE LAKE WITH TREATMENT PLANT AT BURLINGTON



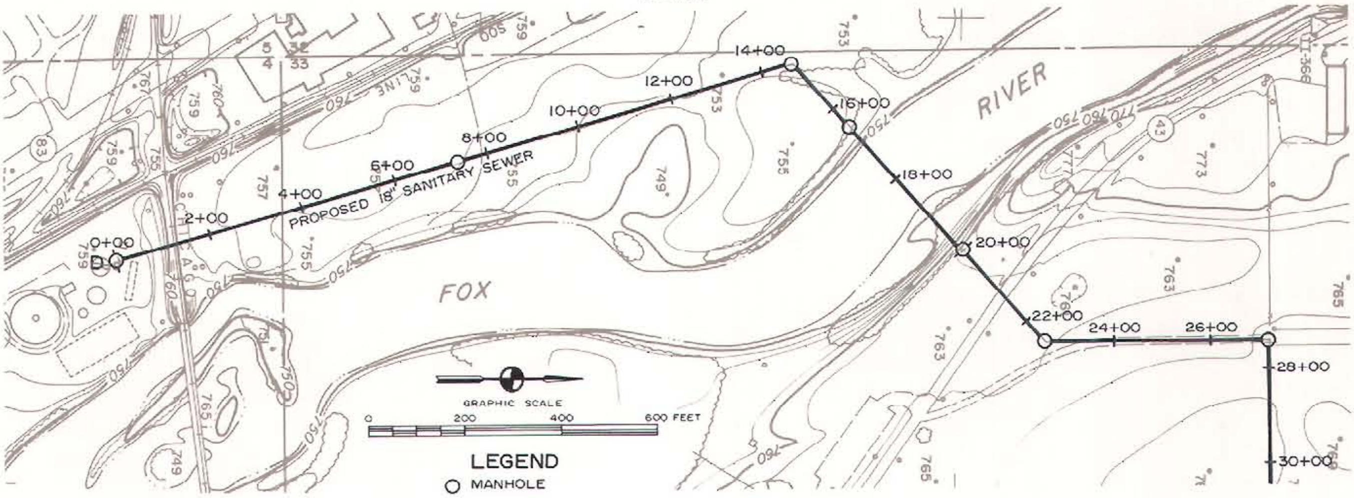
The recommended sanitary sewerage system plan for Browns Lake would provide sewerage service to the entire lake community, as well as to some residences lying in the area between Browns Lake and the City of Burlington. It would also comply with the State of Wisconsin's antiproliferation policy with regard to sewage treatment plants in that the lake community would be connected to an existing sewage treatment plant at Burlington which is recommended to provide advanced waste treatment.

Source: Harza Engineering Company and SEWRPC.

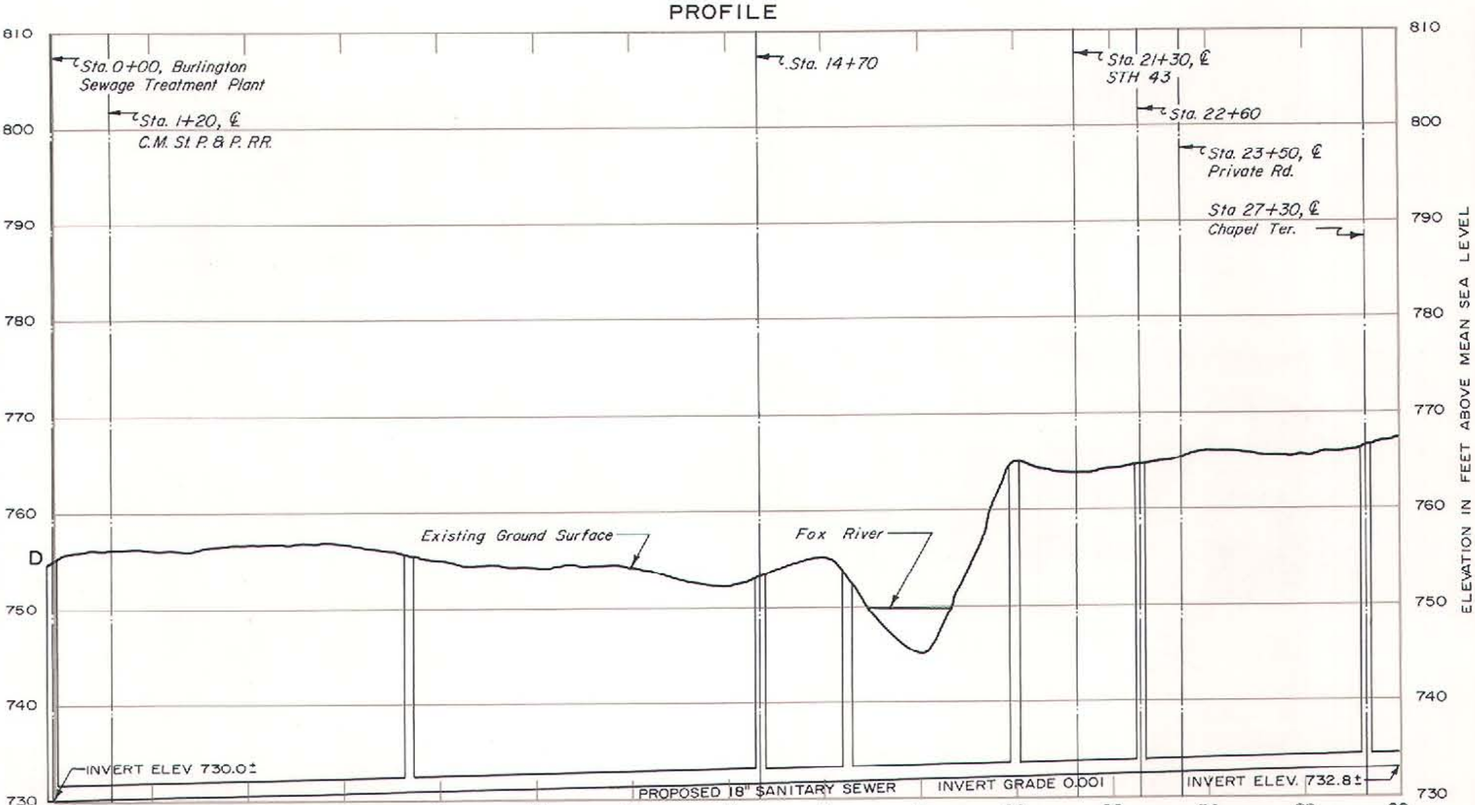
Figure 23 (continued)

RECOMMENDED SANITARY SEWERAGE FACILITIES FOR BROWNS LAKE: ENTIRE LAKE WITH TREATMENT PLANT AT BURLINGTON

PLAN



PROFILE



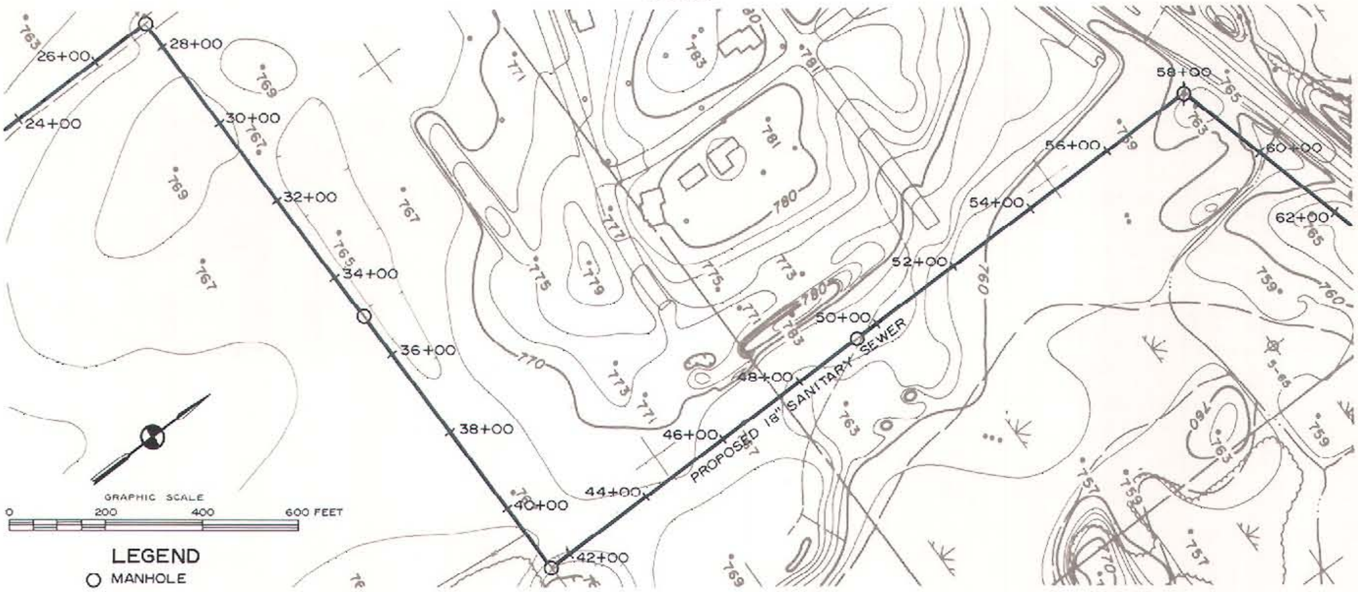
SCALE: HORIZONTAL, 1 INCH = 400 FEET; VERTICAL, 1 INCH = 20 FEET

NOTE: LAKE LEVEL IS TO BE DRAWN DOWN DURING CONSTRUCTION OF SANITARY SEWER

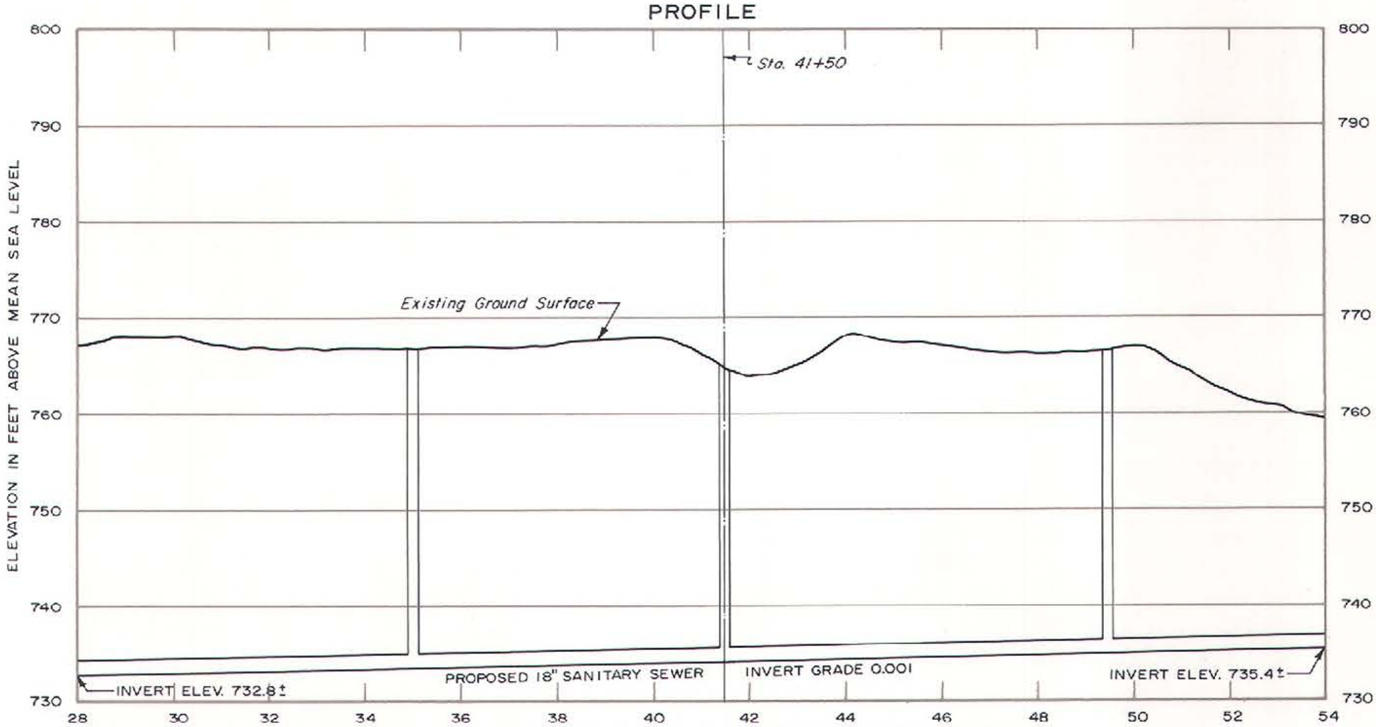
Figure 23 (continued)

RECOMMENDED SANITARY SEWERAGE FACILITIES FOR BROWNS LAKE: ENTIRE LAKE WITH TREATMENT PLANT AT BURLINGTON

PLAN



PROFILE



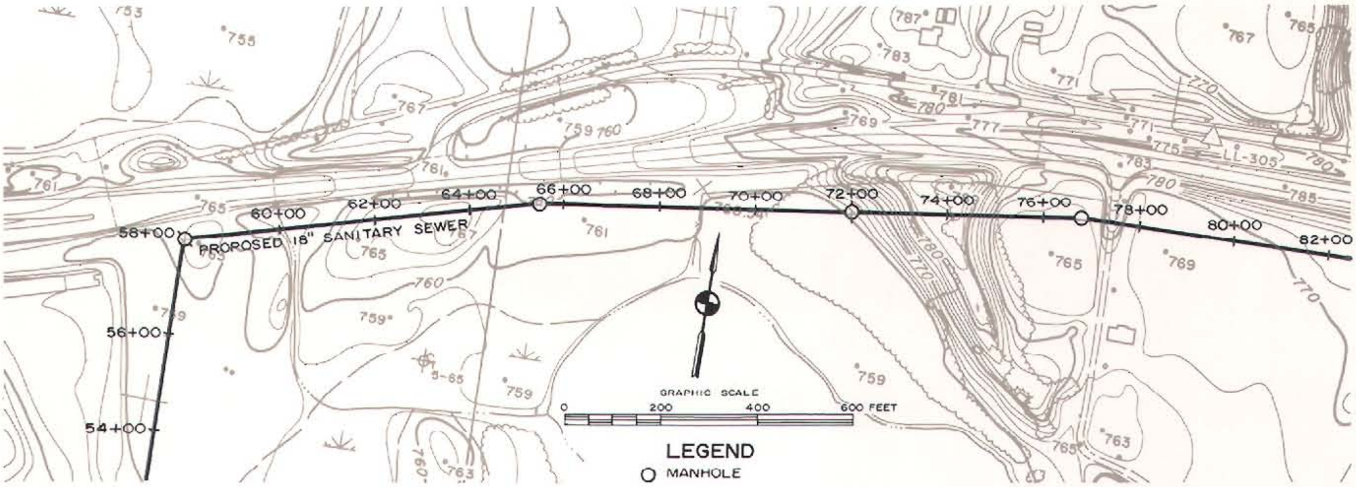
DISTANCE IN HUNDREDS OF FEET FROM BURLINGTON SEWAGE TREATMENT PLANT

SCALE: HORIZONTAL, 1 INCH = 400 FEET ; VERTICAL, 1 INCH = 20 FEET

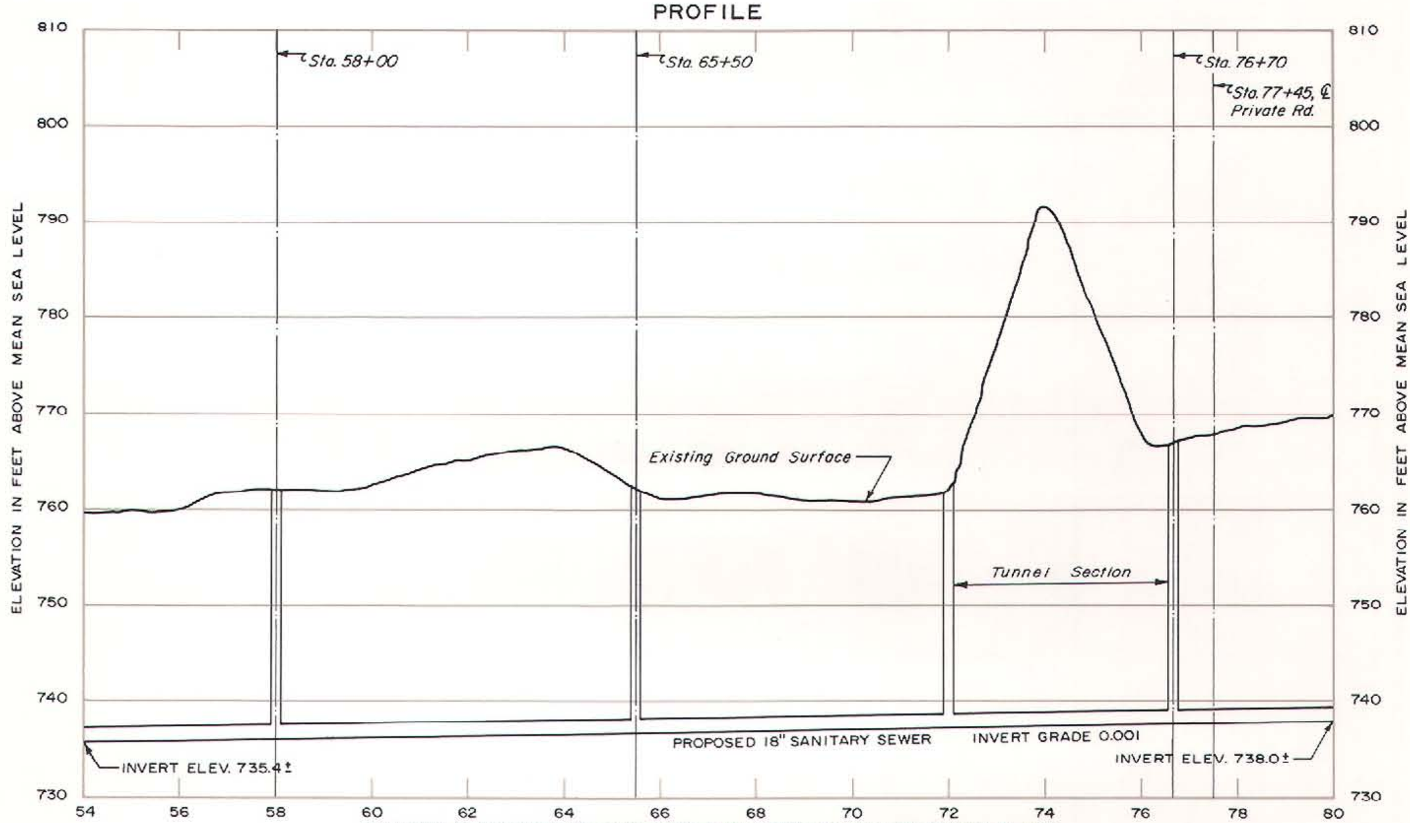
NOTE: LAKE LEVEL IS TO BE DRAWN DOWN DURING CONSTRUCTION OF SANITARY SEWER

Figure 23 (continued)
RECOMMENDED SANITARY SEWERAGE FACILITIES FOR BROWNS LAKE: ENTIRE LAKE WITH TREATMENT PLANT AT BURLINGTON

PLAN



PROFILE



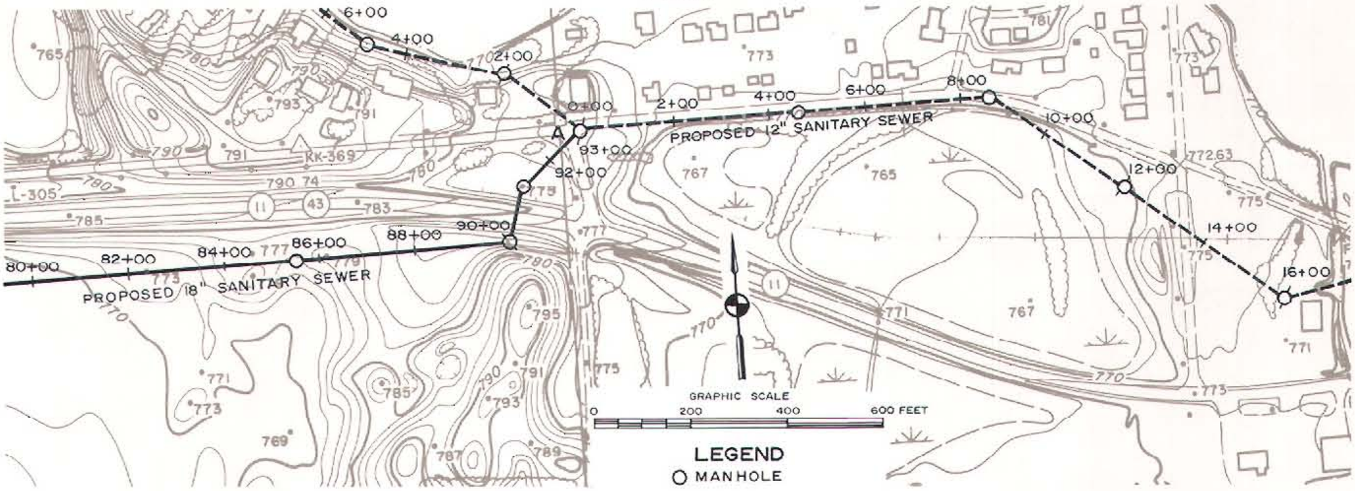
SCALE: HORIZONTAL, 1 INCH = 400 FEET; VERTICAL, 1 INCH = 20 FEET

NOTE: LAKE LEVEL IS TO BE DRAWN DOWN DURING CONSTRUCTION OF SANITARY SEWER

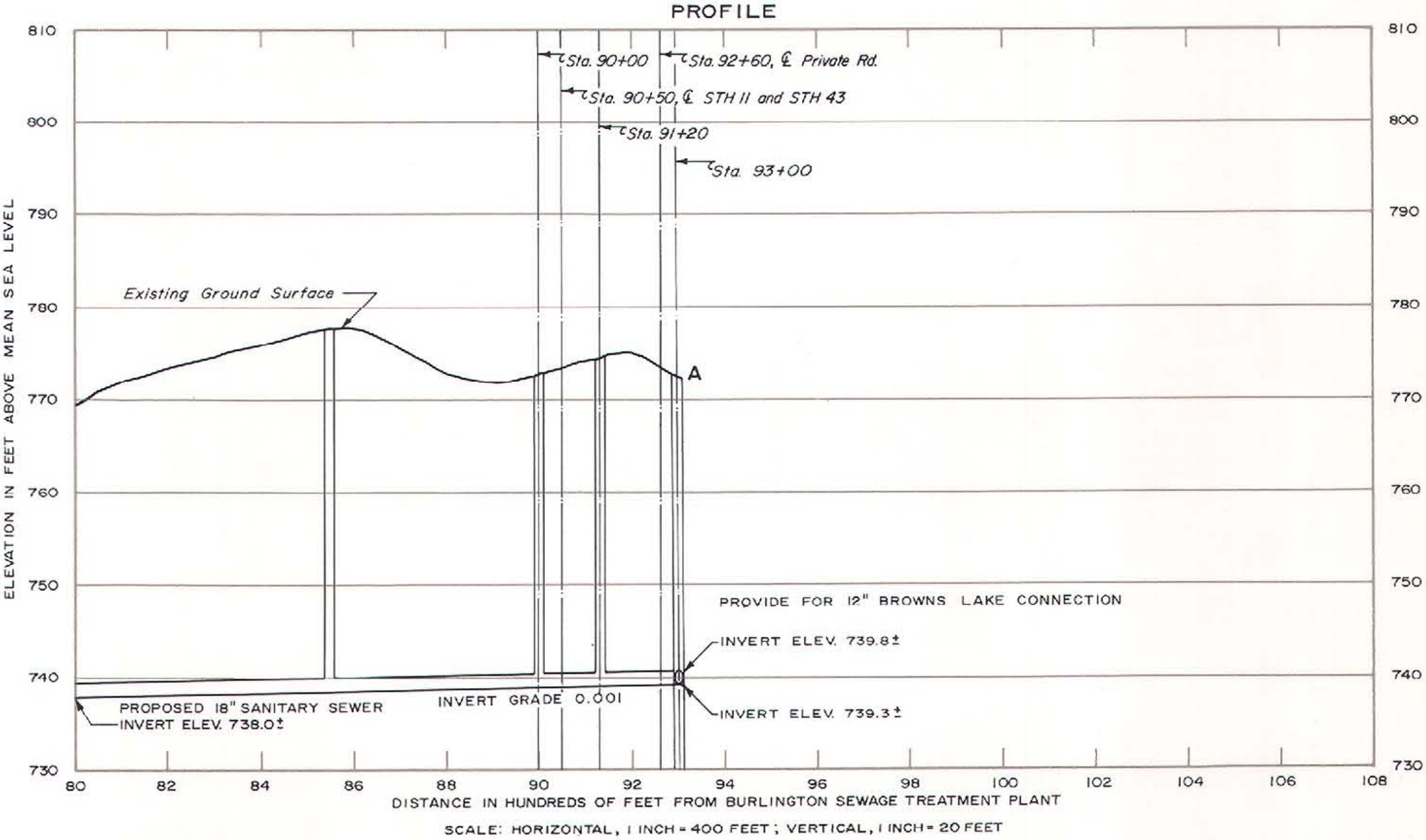
Figure 23 (continued)

RECOMMENDED SANITARY SEWERAGE FACILITIES FOR BROWNS LAKE: ENTIRE LAKE WITH TREATMENT PLANT AT BURLINGTON

PLAN



PROFILE

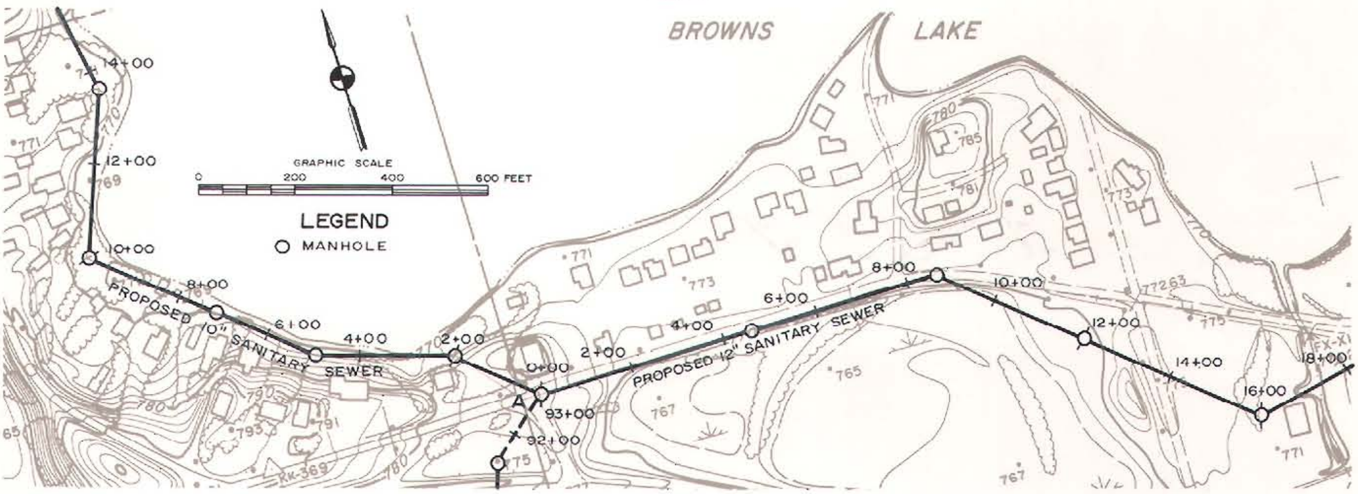


NOTE: LAKE LEVEL IS TO BE DRAWN DOWN DURING CONSTRUCTION OF SANITARY SEWER

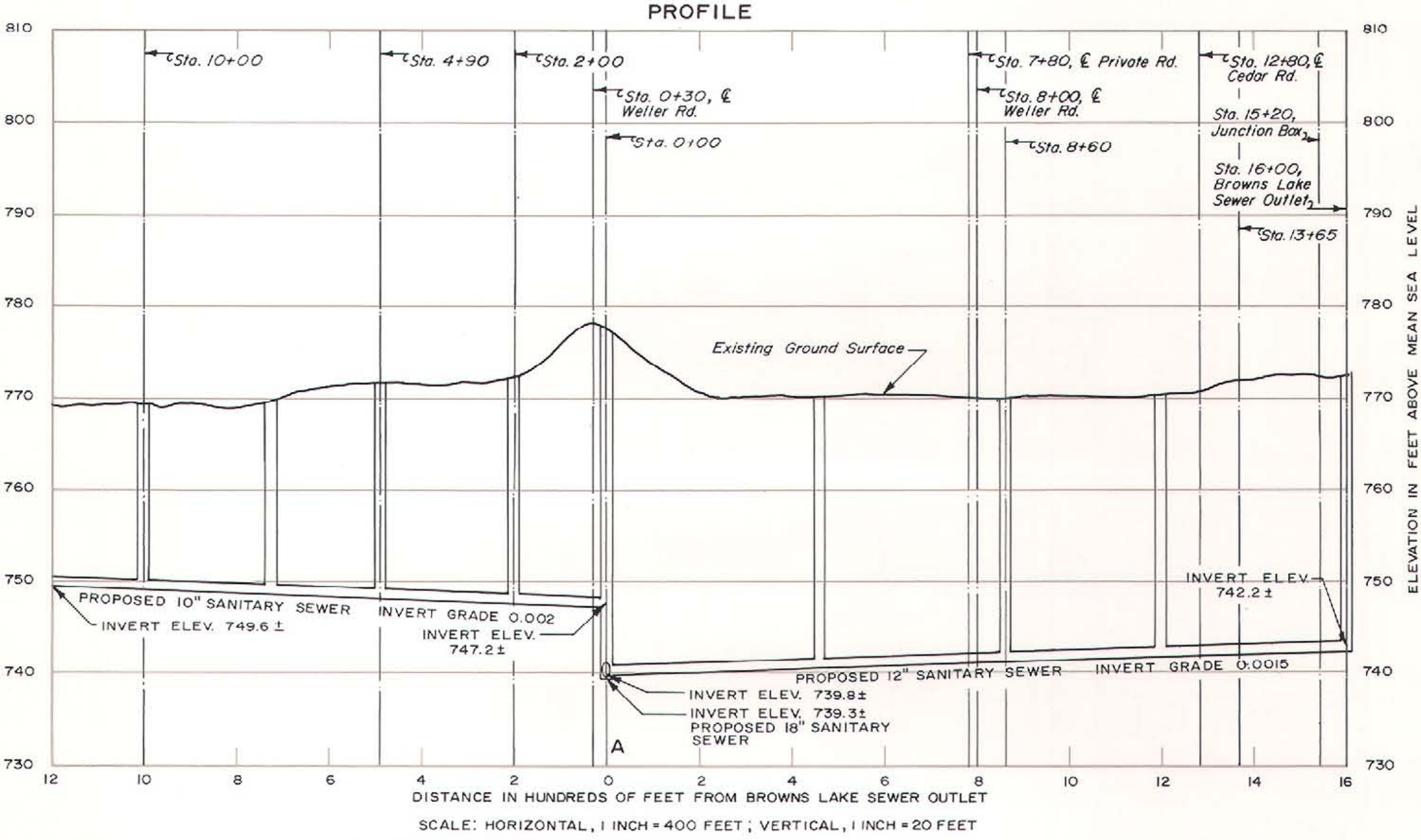
Figure 23 (continued)

RECOMMENDED SANITARY SEWERAGE FACILITIES FOR BROWNS LAKE: ENTIRE LAKE WITH TREATMENT PLANT AT BURLINGTON

PLAN



PROFILE



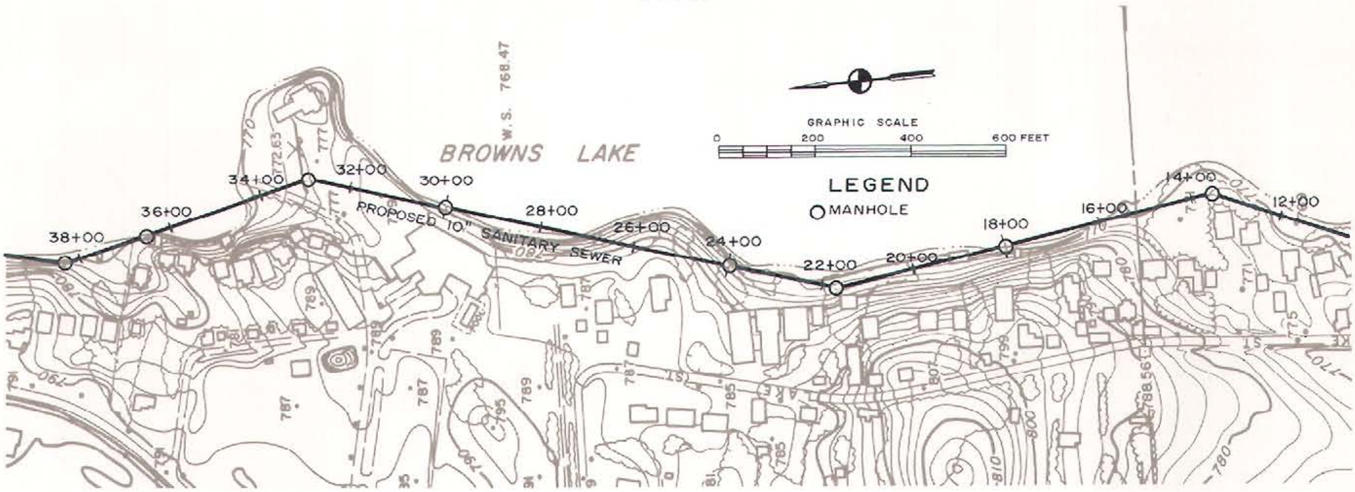
SCALE: HORIZONTAL, 1 INCH = 400 FEET; VERTICAL, 1 INCH = 20 FEET

NOTE: LAKE LEVEL IS TO BE DRAWN DOWN DURING CONSTRUCTION OF SANITARY SEWER

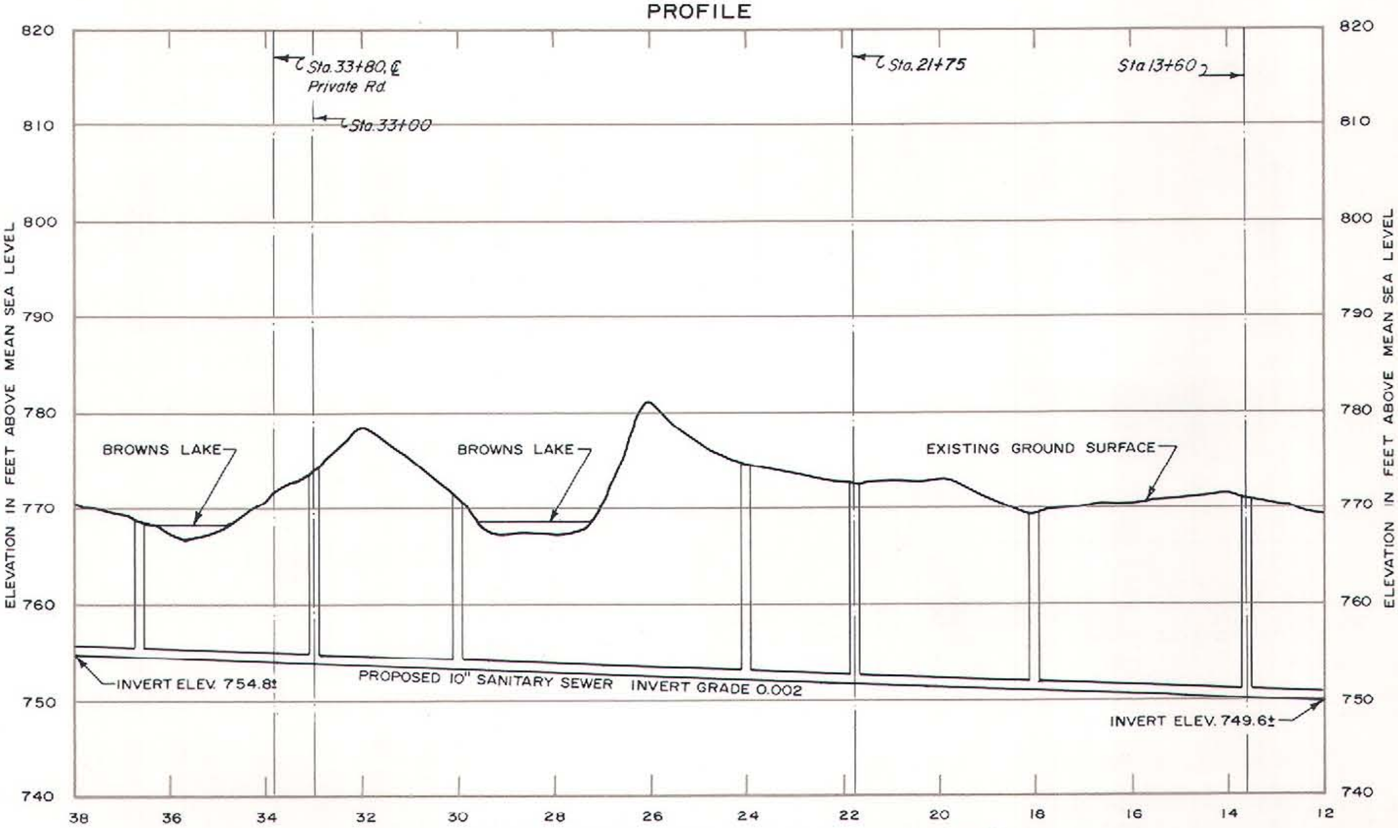
Figure 23 (continued)

RECOMMENDED SANITARY SEWERAGE FACILITIES FOR BROWNS LAKE: ENTIRE LAKE WITH TREATMENT PLANT AT BURLINGTON

PLAN



PROFILE



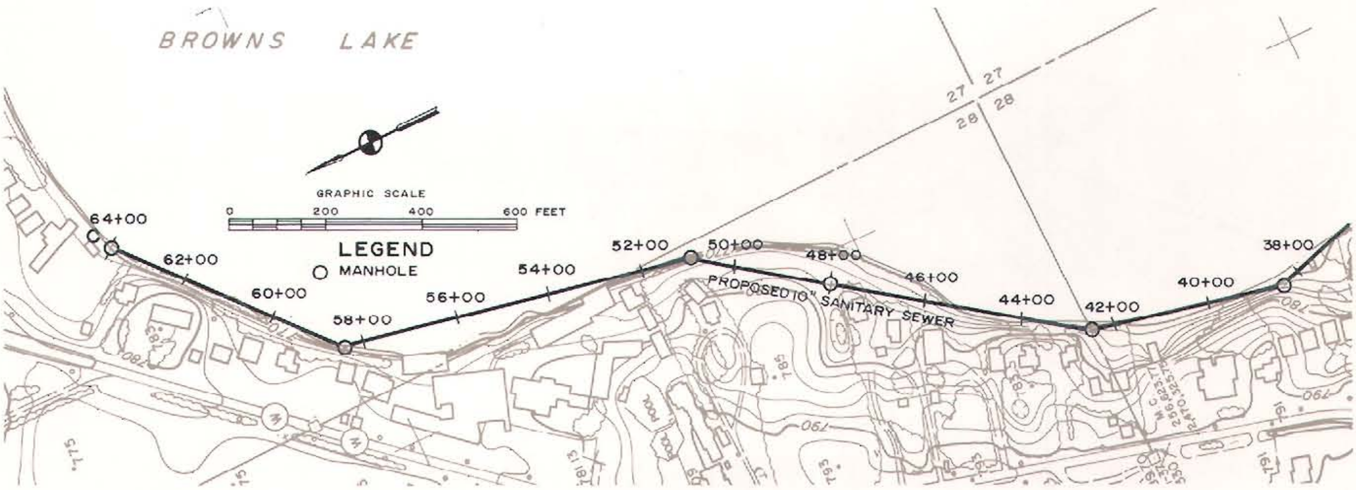
DISTANCE IN HUNDREDS OF FEET FROM BROWNS LAKE SEWER OUTLET

SCALE: HORIZONTAL, 1 INCH = 400 FEET; VERTICAL, 1 INCH = 20 FEET

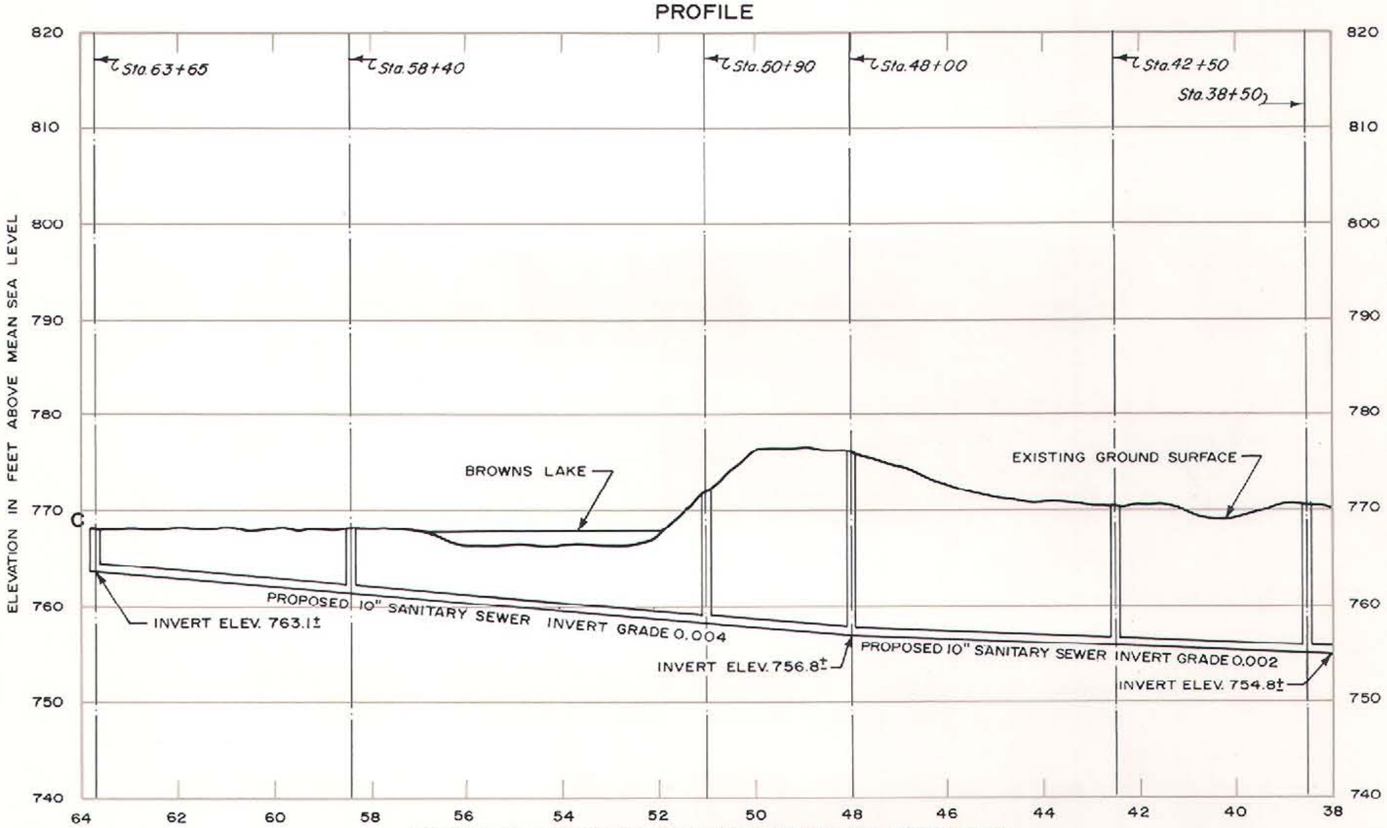
NOTE: LAKE LEVEL IS TO BE DRAWN DURING CONSTRUCTION OF SANITARY SEWER

Figure 23 (continued)
RECOMMENDED SANITARY SEWERAGE FACILITIES FOR BROWNS LAKE: ENTIRE LAKE WITH TREATMENT PLANT AT BURLINGTON

PLAN



PROFILE



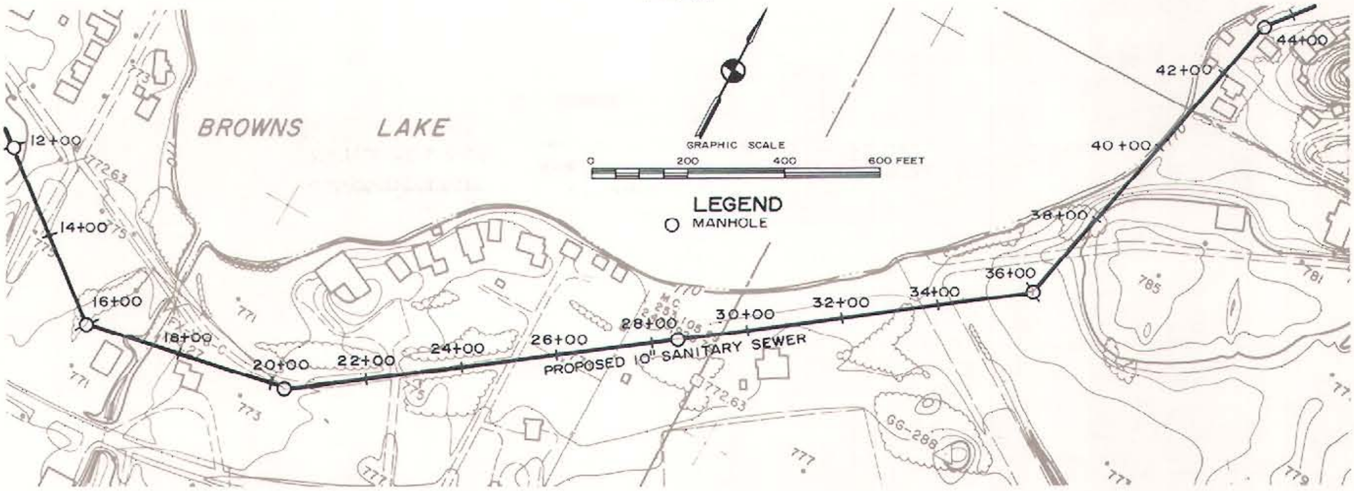
SCALE: HORIZONTAL, 1 INCH = 400 FEET; VERTICAL, 1 INCH = 20 FEET

NOTE: LAKE LEVEL IS TO BE DRAWN DOWN DURING CONSTRUCTION OF SANITARY SEWER

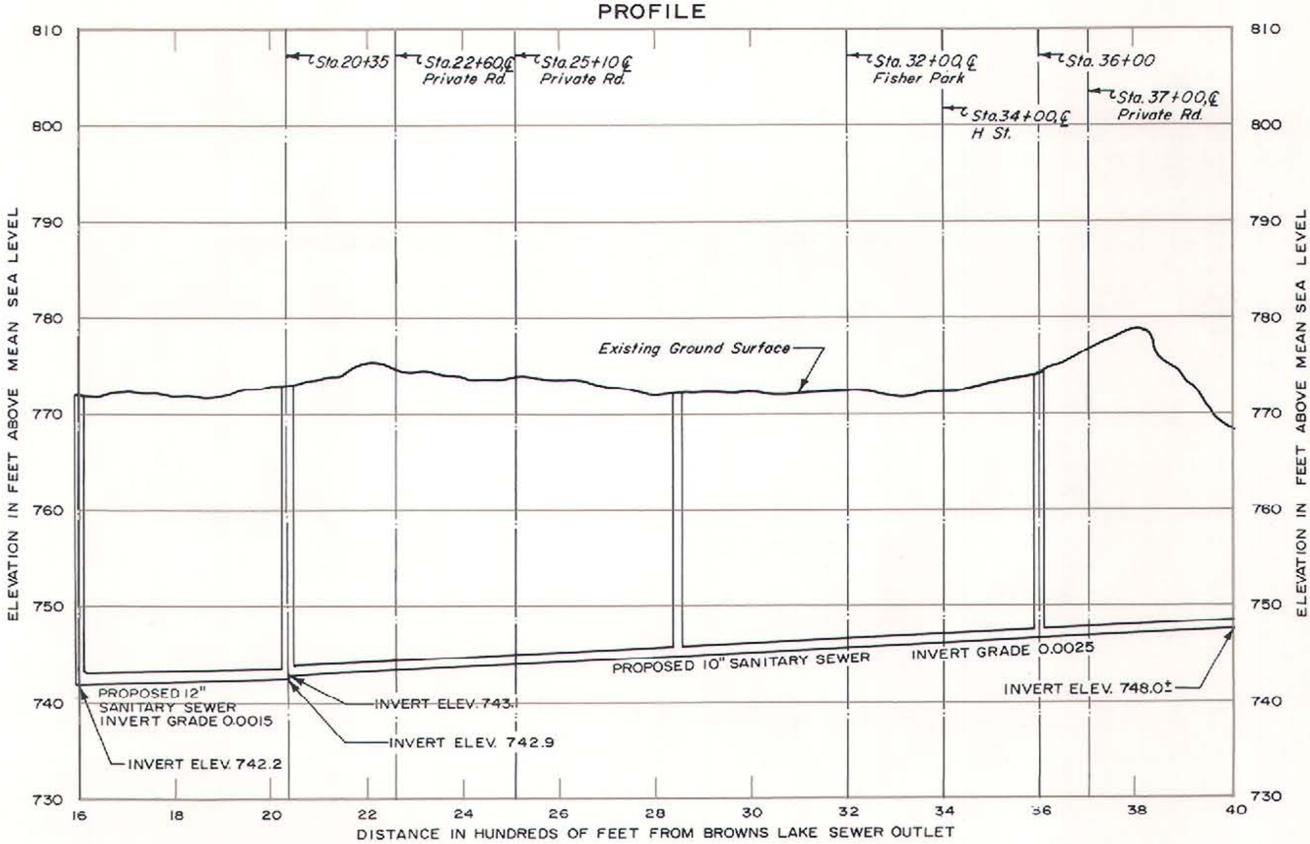
Figure 23 (continued)

RECOMMENDED SANITARY SEWERAGE FACILITIES FOR BROWNS LAKE: ENTIRE LAKE WITH TREATMENT PLANT AT BURLINGTON

PLAN



PROFILE



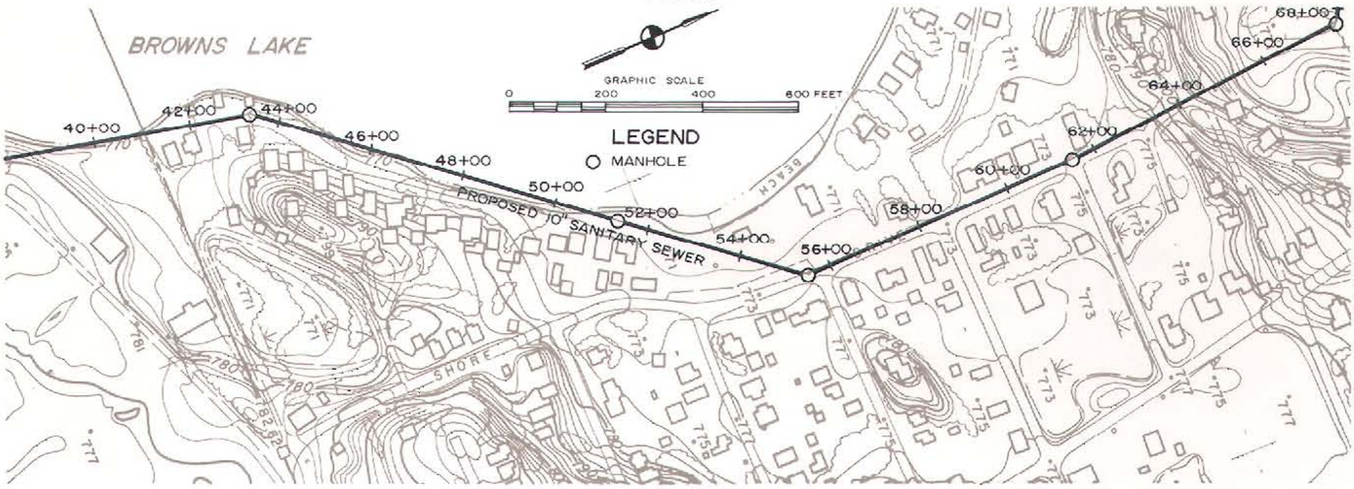
SCALE: HORIZONTAL, 1 INCH = 400 FEET; VERTICAL, 1 INCH = 20 FEET

NOTE: LAKE LEVEL IS TO BE DRAWN DOWN DURING CONSTRUCTION OF SANITARY SEWER

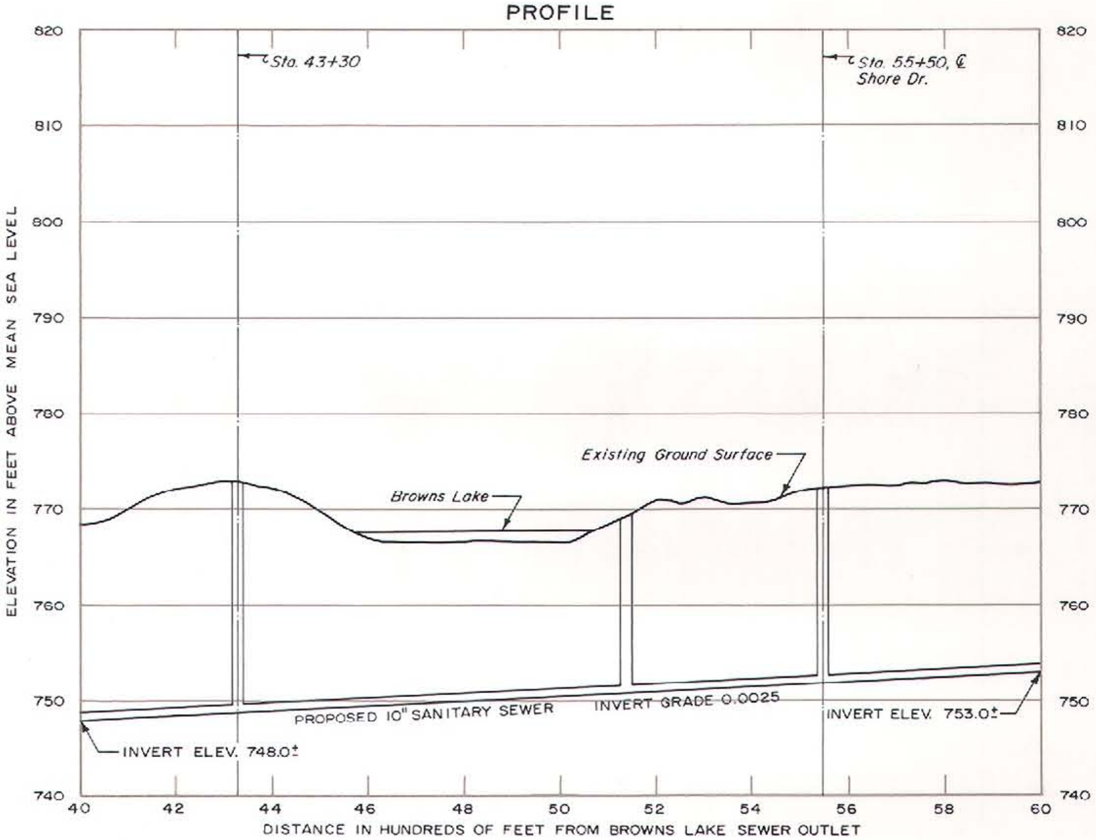
Figure 23 (continued)

RECOMMENDED SANITARY SEWERAGE FACILITIES FOR BROWNS LAKE: ENTIRE LAKE WITH TREATMENT PLANT AT BURLINGTON

PLAN



PROFILE



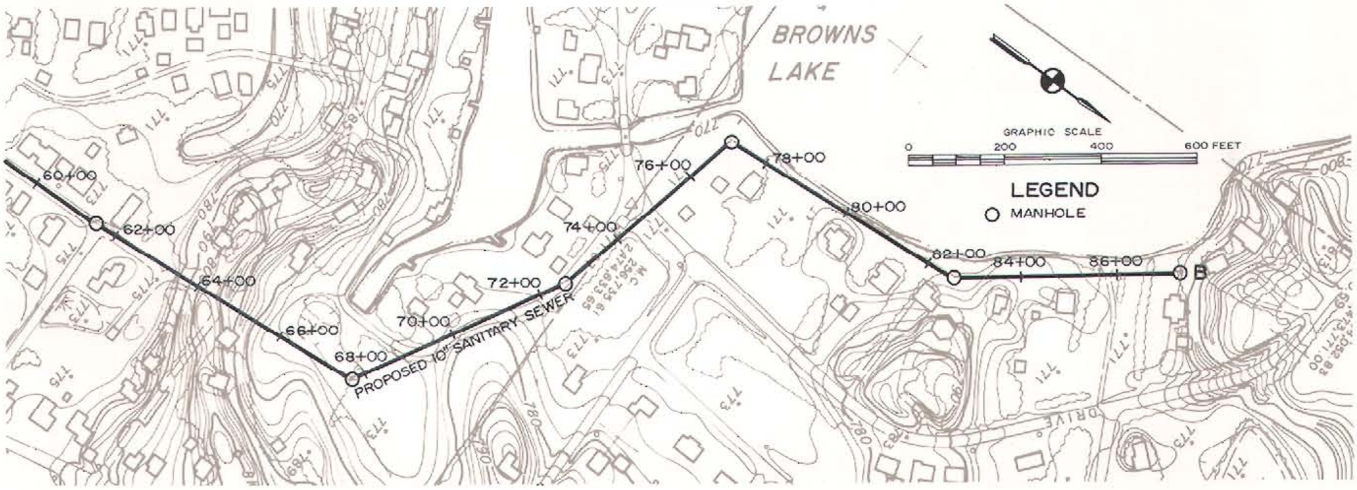
SCALE: HORIZONTAL, 1 INCH = 400 FEET; VERTICAL, 1 INCH = 20 FEET

NOTE: LAKE LEVEL IS TO BE DRAWN DOWN DURING CONSTRUCTION OF SANITARY SEWER

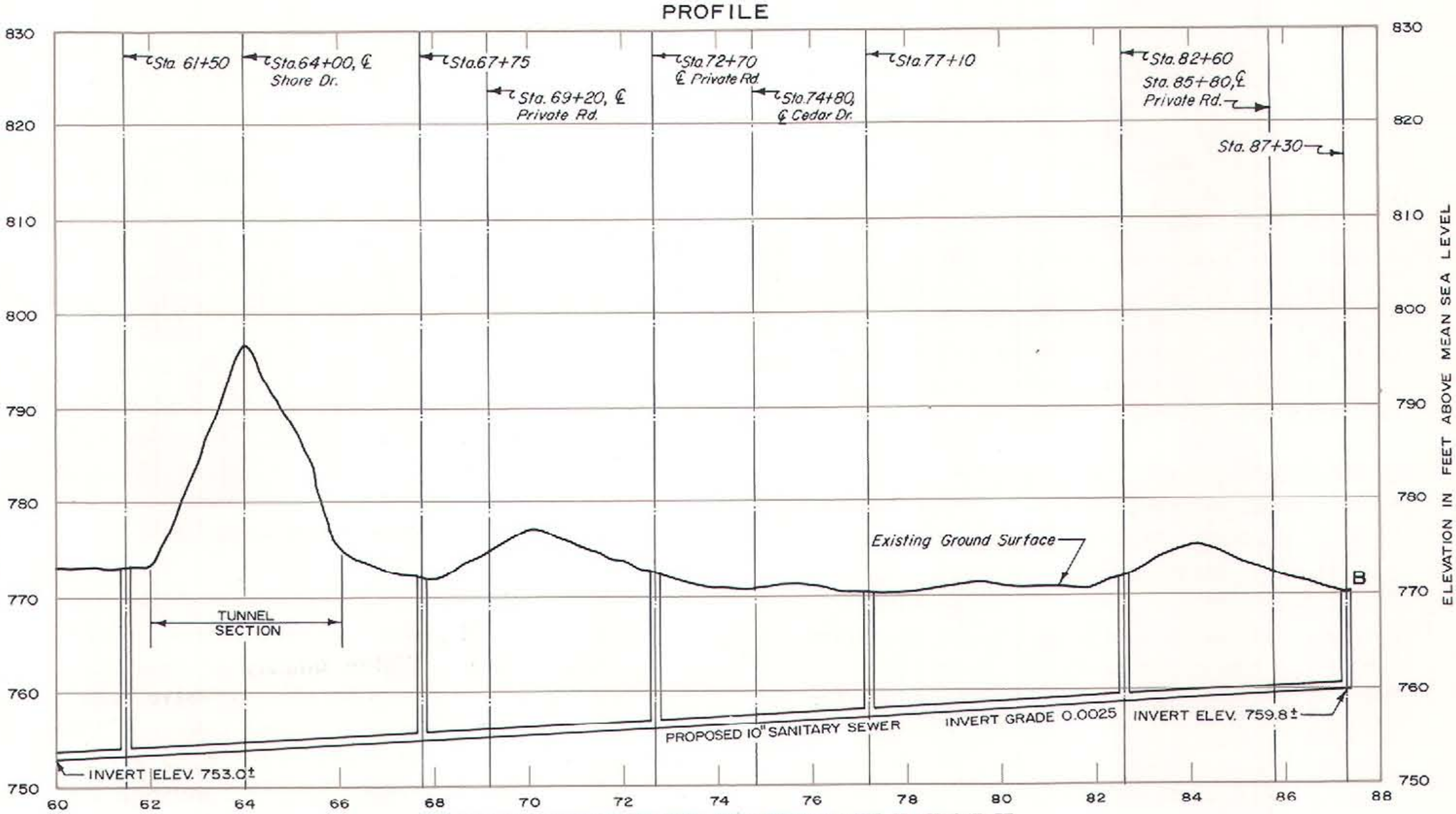
Figure 23 (continued)

RECOMMENDED SANITARY SEWERAGE FACILITIES FOR BROWNS LAKE: ENTIRE LAKE WITH TREATMENT PLANT AT BURLINGTON

PLAN



PROFILE



SCALE: HORIZONTAL, 1 INCH = 400 FEET; VERTICAL, 1 INCH = 20 FEET

NOTE: LAKE LEVEL IS TO BE DRAWN DOWN DURING CONSTRUCTION OF SANITARY SEWER

Table 25

SELECTED CHARACTERISTICS OF CAMP AND CENTER LAKES KENOSHA COUNTY: 1966

Characteristic	Description
Tributary Drainage Area	7.8 Square Miles
Surface Area	590 Acres
Shoreline	11.4 Miles
Depth	
Under 3 Feet	51 Percent
Over 20 Feet	4 Percent
Volume	3,468 Acre-Feet
Lake-Oriented Population	1,200
Phosphorus Sources	Manured land 48% Septic tanks 26 Rural runoff 14 Other[a] 12 Total 100%
General Water Quality	Heavy weed and algae growths Evidence of sewage pollution Moderate nutrient concentrations

[a] *Precipitation and ground water.*

Source: *Harza Engineering Company and Wisconsin Department of Natural Resources.*

highest in the watershed. Major sources of these nutrients have been the malfunctioning private sewage disposal systems and runoff from agricultural land on which manure has been spread during the winter months. The importance of manured land as a nutrient source is diminishing, however, as more and more of the farmland in this area is being developed for residential use. The entire area around Little Muskego Lake, as well as most of the watershed tributary to the lake, is overlain with soils that are unsuitable for soil absorption sewage disposal systems.

A sewerage system is presently under construction to serve primarily the urbanizing area of the City of Muskego, including part of the southern and eastern shoreline of Little Muskego Lake. Preliminary design work is also underway for extension of the system to serve the remainder of the urban and potential urban areas around the lake. Treatment facilities are proposed to consist initially of a series of three stabilization ponds constructed near the north side of Big Muskego Lake. These ponds will be utilized until the tributary sewerage system can be connected to the Milwaukee metropolitan sewerage system.

The City of Muskego is also investigating the possibility of dredging large portions of the lake bottom to remove muck deposits. Tentative approval for the project has been received from the Wisconsin Department of Natural Resources. Removal of the muck would improve the recreational potential of the lake.

Two alternative water quality management plan elements were considered for Little Muskego Lake. The first would seek to control the nuisances caused by excessive weed and algae growths by removing the weeds from the lake through the use of harvesting machines and controlling algal populations by the use of suitable algicides (see Table 37). This action could be expected to remove some of the nutrients from the lake, but it would not correct any public health problems being caused by sewage discharges to the lake.

The second alternative considered provides a sewerage system and treatment facilities to serve all areas around the lake (see Figure 28) and provides control of weeds by harvesting and of algae by the use of algicides, as in the first alternative. This plan element would eliminate all sewage discharges to the lake and would consequently eliminate any possible public health hazards from these discharges. This plan element could also be expected to reduce the input of phosphorus to the lake by about one-half and to reduce algae and weed problems. Under this alternative the existing sewerage system would be expanded to serve the entire area around the lake and, ultimately, to serve the entire watershed area tributary to Little Muskego Lake.

It is recommended that the second alternative water quality management plan for Little Muskego Lake, including weed harvesting, algae control, and an expanded sanitary sewerage system, be included in the recommended watershed plan.

Pell Lake: Pell Lake is a small, shallow lake that receives moderate public use for fishing, swimming, and boating. Water quality is generally suitable for all uses, although excessive weed growths often interfere with some uses. Algae growths have not as yet reached nuisance levels. Individual sewage disposal facilities serving the large development around the lake constitute a pollution hazard, although there is no evidence at present to indicate a deteriorating water quality. Almost all of the residential development around the lake is located on soils that are suitable for soil absorption sewage disposal systems. Only

Table 26

ALTERNATIVE LAKE WATER QUALITY MANAGEMENT PLAN ELEMENTS
CAMP AND CENTER LAKES, KENOSHA COUNTY

Alternative Plan Element		Estimated Cost							Anticipated Performance
Number Designation	Description	Capital	Annual Operation and Maintenance	Present Worth	Total Annual 1970-1985	Total Annual 1986-2020	Annual Per Capita[b] 1970-1985	Annual Per Capita[b] 1986-2020	
1	Weed harvesting	$ 17,500	$ 2,500	$ 41,700[a]	$ 4,300	$ --	$ 3.6	$ --	Control aquatic nuisance growths
	Algae control	1,250	1,400	14,850[a]	1,530	--	1.3	--	
	Total	$ 18,750	$ 3,900	$ 56,550	$ 5,830	$ --	$ 4.9	$ --	
2	Weed harvesting	$ 17,500	$ 2,500	$ 41,700[a]	$ 4,300	$ --	$ 3.6	$ --	Control aquatic nuisance growths Reduce phosphorus input by about 50 percent
	Algae control	1,250	1,400	14,850[a]	1,530	--	1.3	--	
	Bench terraces	73,000	--	73,000	4,700	4,700	3.9	3.9	
	Total	$ 91,750	$ 3,900	$ 129,550	$ 10,530	$ 4,700	$ 8.8	$ 3.9	
3	Weed harvesting	$ 17,500	$ 2,500	$ 41,700[a]	$ 4,300	$ --	$ 3.6	$ --	Control aquatic nuisance growths Eliminate public health hazards Reduce phosphorus input by about 25 percent
	Algae control	1,250	1,400	14,850[a]	1,530	--	1.3	--	
	Sanitary sewerage system (all of Center Lake; east side of Camp Lake--1,200 persons served--secondary treatment plant at lake outlet)[c]	2,274,000	35,000	2,869,000	185,000	185,000	154.0	154.0	
	Total	$ 2,292,750	$ 38,900	$ 2,925,550	$ 190,830	$185,000	$ 158.9	$ 154.0	
4	Weed harvesting	$ 17,500	$ 2,500	$ 41,700[a]	$ 4,300	$ --	$ 3.6	$ --	Control aquatic nuisance growths Eliminate public health hazards Reduce phosphorus input by about 75 percent
	Algae control	1,250	1,400	14,850[a]	1,530	--	1.3	--	
	Bench terraces	73,000	--	73,000	4,700	4,700	3.9	3.9	
	Sanitary sewerage system (all of Center Lake; east side of Camp Lake--1,200 persons served--secondary treatment plant at lake outlet)[c]	2,274,000	35,000	2,869,000	185,000	185,000	154.0	154.0	
	Total	$ 2,365,750	$ 38,900	$ 2,998,550	$ 195,530	$189,700	$ 162.8	$ 157.9	

[a]*Present worth calculated utilizing a 6 percent rate of interest and a 15-year life. The present worth for all other plan elements calculated utilizing a 6 percent rate of interest and a 50-year life.*

[b]*A population of 1,200 persons was used for per capita cost calculations.*

[c]*The component capital costs of the sanitary sewerage system are: treatment plant (secondary) $234,000; trunk sewers $480,000 ; lateral and branch sewers $1,560,000.*

Source: Harza Engineering Company.

10 percent of the tributary drainage area around the lake is covered by soils not suitable for such systems; and, of this 10 percent, most is located in the undeveloped marshy areas near the lake. Major nutrient inputs to the lake are from drainage from the private disposal facilities and runoff from the manured lands (see Table 38).

Three alternative water quality management plan elements were considered for Pell Lake. The first consists of weed harvesting, which would eliminate nuisances being caused by large growths of aquatic weeds (see Table 39). Algae control is not presently needed.

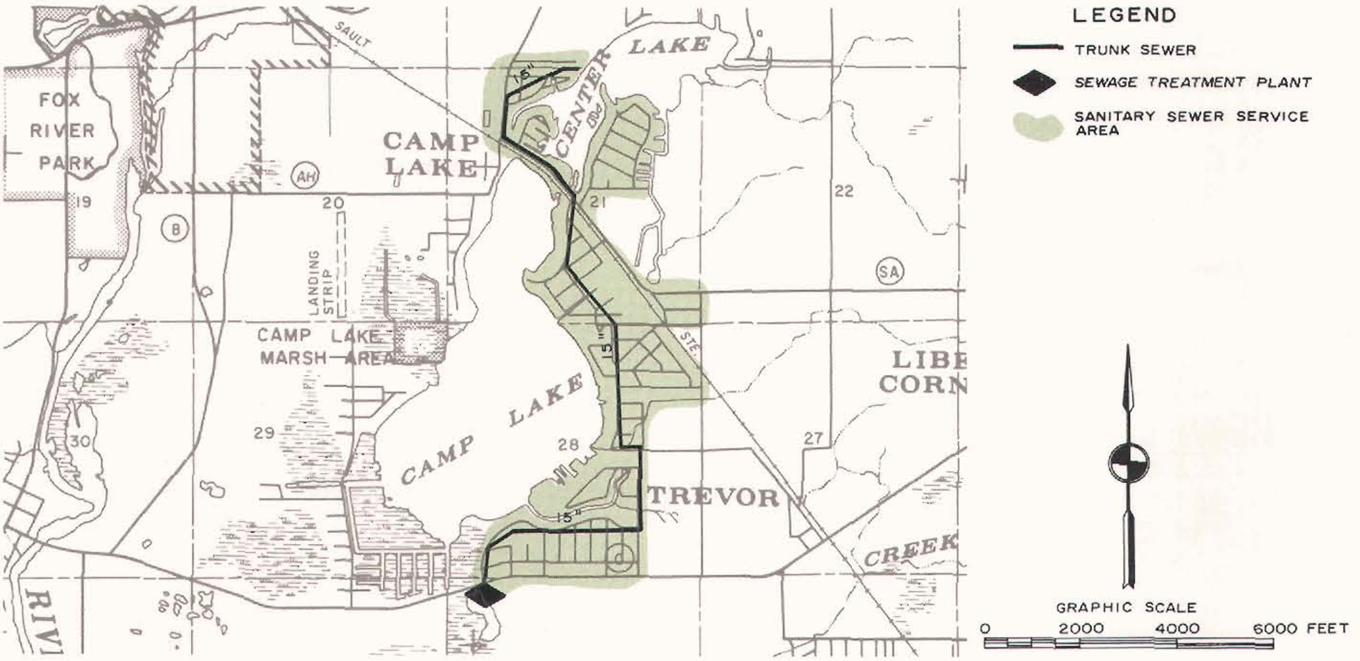
The second alternative considered would provide bench terraces on approximately 200 acres of agricultural land tributary to the lake. The terraces could be expected to reduce phosphorus input to the lake by 30 percent. Weed removal would also be provided as in the first alternative.

The third alternative considered provides for the construction of a sanitary sewerage system and treatment facilities to serve the development around the lake (see Figure 29), bench terraces to control erosion and soil loss, and weed harvesting. This alternative would eliminate any potential waste discharge to the lake from private disposal systems, could be expected to reduce phosphorus input to the lake by 90 percent, and could be expected to alleviate problems caused by excessive weed growths. A preliminary estimate of the loss of water to the lake due to the elimination of septic tank seepage indicates the loss would be equivalent to about 3.5 inches of water over the lake surface annually.

It is recommended that the second alternative water quality management plan for Pell Lake, including weed harvesting and bench terracing, be included in the recommended watershed plan. It is not recommended that the sanitary sewerage system be included in the watershed plan at this time because the cost of the system was deemed to outweigh the water quality benefits, due to the fact that water quality samples indicate a lack of excessive pollution due to inoperative septic tank systems.

Pewaukee Lake: Pewaukee Lake is very intensively used for recreational and aesthetic pur-

Figure 24
RECOMMENDED SANITARY SEWERAGE FACILITIES FOR CAMP AND CENTER LAKES



The sanitary sewerage system proposed for Camp and Center Lakes would eliminate about 25 percent of the present phosphorus contribution to the lakes and would assist in eliminating any public health hazards associated with use of the lakes for swimming, as well as fishing and boating. This particular sewerage system plan would enhance the lake water quality only if complemented by the application of good soil and water conservation practices, such as bench terracing, to the agricultural lands of the lake watershed.

Source: Harza Engineering Company and SEWRPC.

poses. There are extensive weed and algae growths throughout the lake but particularly in the shallow easterly portion of the lake. Nutrient concentrations are very high, and there is some evidence of sewage pollution in the lake. There are over 1,000 homes around the lake dependent upon individual soil absorption sewage disposal facilities, and approximately one-half of the area around the lake is overlain with soils that are unsuitable for soil absorption sewage disposal facilities. Major nutrient contributors to the lake are runoff from lands manured during winter and drainage from septic tank systems. Large quantities of chemicals have been applied annually in recent years to control excessive weed and algae growths (see Table 40).

Four alternative water quality management plan elements were considered for Pewaukee Lake. The first would seek to control the nuisances caused by excessive weed and algae growths through the use of harvesting machines to remove the weeds and of algicides to limit algal growth (see Table 41). The entire lake would be treated for algae control; and those portions of the lake less than seven feet deep, about 20 percent of the lake area, would be harvested to remove weeds.

The second alternative considered would involve bench terracing of approximately 3,200 acres of agricultural land tributary to Pewaukee Lake to reduce erosion and soil loss and thereby reduce nutrient input to the lake. The terraces could be expected to reduce phosphorus input to the lake by 40 percent. Weed and algae control would be utilized, as in the first alternative, to control nuisance growths.

The third alternative considered would provide a sanitary sewerage system around the entire lake (see Figure 30), with waste treatment provided either at the existing Village of Pewaukee sewage treatment plant or at a large consolidated plant serving the entire upper Fox River watershed.

Table 27

SELECTED CHARACTERISTICS OF COMO LAKE
WALWORTH COUNTY: 1966

Characteristic	Description
Tributary Drainage Area	8.1 Square Miles
Surface Area	946 Acres
Shoreline	8.4 Miles
Depth	
Under 3 Feet	18 Percent
Over 20 Feet	-- Percent
Volume	4,033 Acre-Feet
Lake-Oriented Population	1,300
Phosphorus Sources	Manured land 59% Septic tanks 18 Rural runoff 10 Other[a] 13 Total 100%
General Water Quality	Very heavy weed and algae growths Highly eutrophic lake

[a] *Precipitation and ground water.*

Source: Harza Engineering Company and Wisconsin Department of Natural Resources.

Both the need for individual sewage disposal facilities around the lake and the waste discharges to the lake would be eliminated, as would any public health hazards that may presently exist due to such discharges. The phosphorus input to the lake could be expected to be reduced by approximately 20 percent. Algae and weed control would be accomplished as in the first alternative. The costs shown in Table 41 for this and the succeeding alternative are all based on discharging the sewage collected from the areas around the lake into a trunk sewer system serving the entire upper Fox River watershed and providing treatment for this sewage at a large plant located downstream from Waukesha as recommended in the stream water quality management section of this chapter. The incremental cost of providing the necessary sewer and treatment plant capacity for this waste was not included in the cost of stream water quality management plan Alternative Plan 1C, as described in the previous section of this chapter but was included in the costs shown in Table 41. If treatment for the wastes were provided at the Pewaukee sewage treatment plant, as would be necessary if stream water quality management plan Alternative Plan 1A were implemented, the capital costs shown in Table 41 for both this and the succeeding alternative would be increased by approximately $35,000 and the total annual costs shown would increase by approximately $25,000.

The fourth alternative considered consisted of a combination of the first three alternatives and would provide all of the facilities, including a sewerage system, farmland bench terracing, and algae and weed control. This alternative would eliminate waste discharges to the lake and resultant sanitary hazards, could be expected to reduce phosphorus input by 60 percent, and could be expected to alleviate problems caused by excessive growths of weeds and algae. It is recommended that this fourth alternative be included in the recommended watershed plan.

Phantom Lakes: Water quality in the Phantom Lakes is generally suitable for all existing uses of the lakes, which include boating, fishing, and swimming, although there are very heavy growths of aquatic weeds in both lakes, particularly in Lower Phantom Lake. Nutrient concentrations in the lakes are slightly below the average watershed levels, with an estimated 40 percent of the phosphorus being derived from runoff from manured lands (see Table 42).

Two alternative water quality management plan elements were considered for the Phantom Lakes. The first would seek to control the excessive weed and algae growths in the lakes by harvesting the weeds and using algicides to control algal population (see Table 43). The condition of the lakes for recreational and aesthetic uses would be improved by these actions, but excessive nutrient inputs would not be eliminated.

The second alternative considered could be expected to reduce the phosphorus input to the lakes by about 40 percent by providing bench terracing for approximately 1,500 acres of agricultural land within the watershed tributary to the lakes. The terraces could be expected to reduce the amount of phosphorus entering the lakes from commercial fertilizers and manure applied to agricultural land. Weed harvesting and algae control would also be used in this alternative to control nuisance growths.

Algicides and herbicides have frequently been used in the past to control nuisance growths of weeds and algae in both lakes. In 1967 a sanitary district was formed for all of the unincorporated areas around both lakes. Until its dissolution in June 1969, this district provided solid waste collection services for approximately 230 homes; and, during the summer of 1968, it undertook a

Table 28

ALTERNATIVE LAKE WATER QUALITY MANAGEMENT PLAN ELEMENTS

COMO LAKE, WALWORTH COUNTY

Alternative Plan Element		Estimated Cost							Anticipated Performance
Number Designation	Description	Capital	Annual Operation and Maintenance	Present Worth	Total Annual 1970-1985	Total Annual 1986-2020	Annual Per Capita[a] 1970-1985	Annual Per Capita[a] 1986-2020	
1	Weed harvesting	$ 22,800	$ 3,300	$ 54,800[b]	$ 5,600	$ --	$ 4.3	$ --	Control aquatic nuisance growths
	Algae control	1,250	2,200	22,650[b]	2,300	--	1.8	--	
	Total	$ 24,050	$ 5,500	$ 77,450	$ 7,900	$ --	$ 6.1	$ --	
2	Weed harvesting	$ 22,800	$ 3,300	$ 54,800[b]	$ 5,600	$ --	$ 4.3	$ --	Control aquatic nuisance growths Reduce phosphorus input by about 60 percent
	Algae control	1,250	2,200	22,650[b]	2,300	--	1.8	--	
	Bench terraces.	72,000	--	72,000	4,600	4,600	3.5	3.5	
	Total	$ 96,050	$ 5,500	$ 149,450	$ 12,500	$ 4,600	$ 9.6	$ 3.5	
3	Weed harvesting	$ 22,800	$ 3,300	$ 54,800[b]	$ 5,600	$ --	$ 4.3	$ --	Control aquatic nuisance growths Eliminate public health hazards Reduce phosphorus input by about 20 percent
	Algae control	1,250	2,200	22,650[b]	2,300	--	1.8	--	
	Sanitary sewerage system (north side of lake--1,300 persons served--secondary treatment plant at lake outlet)[c] . . .	2,505,000	33,000	3,057,700	193,700	193,700	149.0	149.0	
	Total	$ 2,529,050	$ 38,500	$ 3,135,150	$201,600	$193,700	$ 155.1	$ 149.0	
4	Weed harvesting	$ 22,800	$ 3,300	$ 54,800[b]	$ 5,600	$ --	$ 4.3	$ --	Control aquatic nuisance growths Eliminate public health hazards Reduce phosphorus input by about 80 percent
	Algae control	1,250	2,200	22,650[b]	2,300	--	1.8	--	
	Bench terraces.	72,000	--	72,000	4,600	4,600	3.5	3.5	
	Sanitary sewerage system (north side of lake--1,300 persons served--secondary treatment at lake outlet)[c]	2,505,000	33,000	3,057,700	193,700	193,700	149.0	149.0	
	Total	$ 2,601,050	$ 38,500	$ 3,207,150	$206,200	$198,300	$ 158.6	$ 152.5	

[a] *A population of 1,300 persons was used for per capita cost calculations.*

[b] *Present worth calculated utilizing a 6 percent rate of interest and a 15-year life. The present worth for all other plan elements calculated utilizing a 6 percent rate of interest and a 50-year life.*

[c] *The component capital costs of the sanitary sewerage system are: treatment plant (secondary) $185,000; trunk sewers $300,000; lateral and branch sewers $2,020,000.*

Source: Harza Engineering Company.

weed harvesting and removal operation on Lower Phantom Lake.

No sanitary sewerage system plan element was considered for Phantom Lakes because of the existence of such a system serving the adjacent Village of Mukwonago. It was assumed that this existing system would eventually be expanded to serve all of the urban development around Phantom Lakes as the need arises. This assumption was made in view of the antiproliferation policy of the Wisconsin Department of Natural Resources with regard to sewage treatment plants.

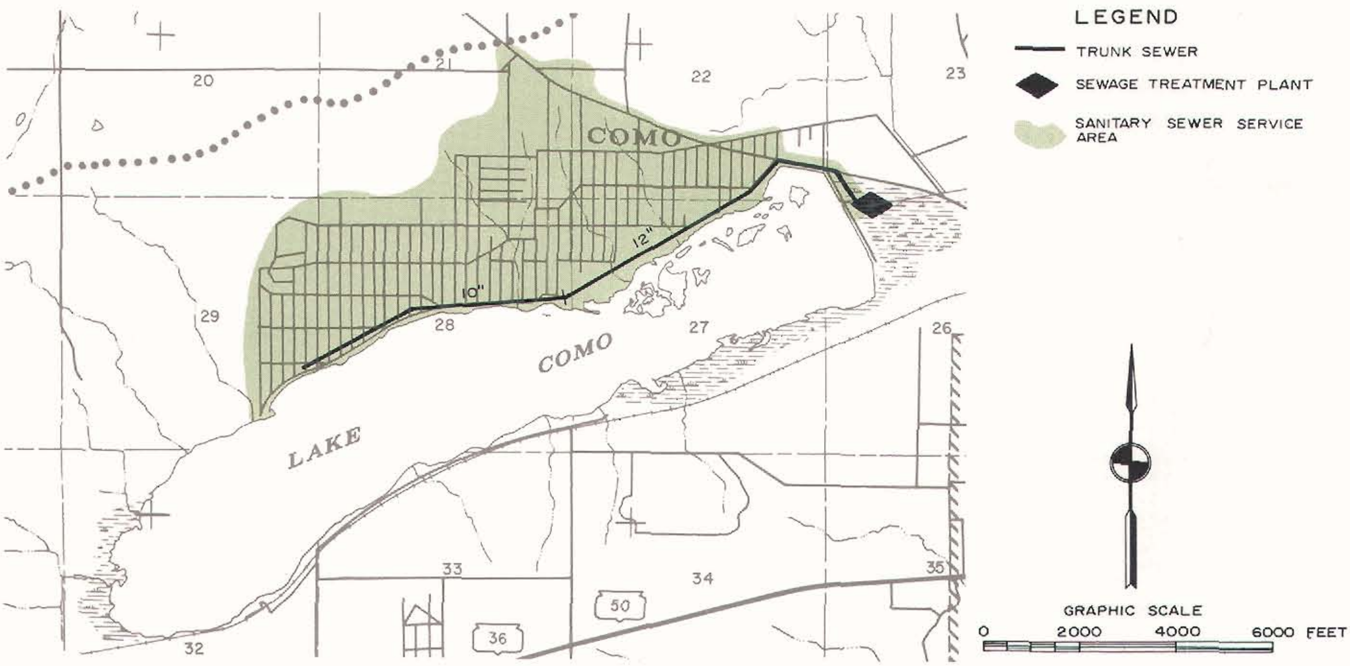
It is recommended that the second alternative water quality management plan for Phantom Lakes, including weed harvesting, algae control, and bench terracing, be included in the recommended watershed plan.

Powers, Tombeau, and Benedict Lakes: Powers, Tombeau, and Benedict Lakes are a series of three lakes used for boating, fishing, and some swimming. Powers Lake is one of the clearest lakes in the watershed. It contains low levels of nutrients, has very few nuisance growths of weeds and algae, and generally exhibits water quality suitable for all uses of the lake. Tombeau and Benedict Lakes have slightly higher nutrient levels and experience some growths of aquatic weeds. With these exceptions, water quality is generally suitable for all desirable uses. Major nutrient sources for the three lakes are runoff from agricultural lands on which manure has been spread while the soil was frozen and from drainage of individual sewage disposal facilities serving homes and resorts around the lakes (see Table 44).

Two alternative water quality management plan elements were considered for Powers, Tombeau, and Benedict Lakes. The first provides for cutting and removal of the weeds to eliminate nuisances caused by large weed growths and to remove the nutrients associated with the weeds (see Table 45).

The second alternative considered provides for the construction of bench terraces on 1,200 acres of agricultural land subject to erosion and soil loss that drains to the lakes. The terraces could be expected to reduce the phosphorus input to the lake by about one-half. Weed control would also

Figure 25
RECOMMENDED SANITARY SEWERAGE FACILITIES FOR COMO LAKE



The sanitary sewerage system proposed for Como Lake would eliminate about 20 percent of the present phosphorus contribution to the lake and would eliminate any public health hazards that might limit the lake community of about 1,300 people from enjoying the use of the lake for all recreational purposes. Lake water quality improvement will, however, be achieved only if good soil and water conservation practices on the agricultural lands tributary to the lake are instituted to accompany the proposed sanitary sewerage system.

Source: Harza Engineering Company and SEWRPC.

be used as needed. It is recommended that this second alternative be included in the recommended watershed plan.

Silver Lake: Silver Lake in Kenosha County is used to a limited extent for boating, fishing, and swimming. Water quality in the lake is characterized by average nutrient concentrations; occasional nuisance growths of algae and weeds; and some evidence of sewage pollution, probably caused by drainage from private sewage facilities serving residences around the lake. Part of the Village of Silver Lake is served by a sewerage system and treatment facilities, and this system should be expanded to serve the entire Village. Major nutrient sources are runoff from manured land and rural runoff (see Table 46).

Two alternative water quality management plan elements were considered for Silver Lake. The first provides for alleviation of the nuisances caused by excessive algae and weed growths through the use of controlled algicide applications and weed harvesting machines (see Table 47).

The second alternative considered could be expected to reduce phosphorus input to the lake by 60 percent through the use of bench terraces on 900 acres of agricultural land presently subject to erosion and consequent nutrient loss into the lake. Weed harvesting and algae control would also be used, as needed, to alleviate problems caused by excessive weed and algae growths. It is recommended that this second alternative be included in the recommended watershed plan.

Tichigan Lake: Tichigan Lake is a natural lake connected by a small channel to the Waterford impoundment on the Fox River. It receives moderate public recreational use, mostly from residents living near the lake. There are heavy weed and algae growths in the lake, very high nutrient concentrations, and some evidence of sewage pollution. The major source of nutrients to the lake is from the Fox River, which contains very high levels of nutrients as a result of upstream waste discharges. Sewage pollution is thought to be due mainly to malfunctioning private sewage disposal facilities serving residences near the lake.

Table 29

SELECTED CHARACTERISTICS OF EAGLE LAKE
RACINE COUNTY: 1966

Characteristic	Description
Tributary Drainage Area	7.2 Square Miles
Surface Area	520 Acres
Shoreline	4.4 Miles
Depth	
Under 3 Feet	21 Percent
Over 20 Feet	-- Percent
Volume	3,669 Acre-Feet
Lake-Oriented Population	550
Phosphorus Sources	Manured land 54% Septic tanks 17 Rural runoff 18 Other[a] 11 Total 100%
General Water Quality	Heavy weed and algae growths Evidence of sewage pollution Moderately high nutrient concentrations

[a] *Precipitation and ground water.*

Source: Harza Engineering Company and Wisconsin Department of Natural Resources.

Approximately 90 percent of the area around the lake is overlain with soils that are unsuitable for use of soil absorption sewage disposal systems (see Table 48).

A significant improvement in lake water quality may be expected to occur with improved water quality conditions in the Fox River, particularly with respect to lower nutrient concentrations. In addition, six alternative water quality management plan elements applicable to the lake itself were also considered.

The first alternative considered would provide control of nuisance growths of aquatic plants and algae by harvesting the plants to remove them from the lake and by using suitable algicides to control algal growth. Chemicals have been used in the past for weed and algae control (see Table 49).

The second alternative considered would eliminate any sewage discharges to the lake from inadequate or malfunctioning private sewage disposal systems by providing a similar sewerage system and treatment facilities to serve all residences around the lake (see Figure 31). This would also serve to eliminate any public health hazards being caused by these waste discharges. Effluent disposal from the treatment facilities should be away from the lake, possibly to a seepage pond or to a site for disposal by land irrigation, since there are no nearby streams suitable for waste disposal use. Weed and algae control would be accomplished as in the first alternative.

Four additional alternative water quality management plan elements were developed for Tichigan Lake. Each of these four alternatives includes weed harvesting, algae control, and a sanitary sewerage system but differs from the second alternative in the sewerage system configuration and location of the sewage treatment plant. The third alternative considered is similar to the second in that a sewage treatment plant is proposed to be located at the north end of the lake. Service would be provided to the entire east side of the lake but only to the Fox Point Park and Tichigan Heights areas on the west side of the lake (see Figure 32). In this alternative the sewage from the west side of the lake would be pumped in a force main across the inlet at the south end of the lake to the trunk sewer serving the east side of the lake. This alternative would not provide sewer service to about 500 persons living on the west side of the lake north of Tichigan Heights. The annual per capita costs are greater for the third alternative than for the second because the total annual cost, which is nearly the same in both alternatives, must be distributed among 500 fewer people.

The fourth alternative considered proposes the construction of two trunk sewers flowing southerly along both the east and west sides of Tichigan Lake to serve the entire lake area. Sewage collected in the west side sewer would be pumped to the east side across the inlet at the south end of the lake. All of the sewage would then be pumped east approximately 8,300 feet to a point where the sewage will flow by gravity to a treatment plant proposed to be located on the Wind Lake Canal near the outlet of Wind Lake (see Figure 33). This alternative has the advantage of increasing the size of the potential service area and of eliminating one small sewage treatment plant, since the proposed Wind Lake Canal plant could serve both Wind Lake and Tichigan Lake. This alternative, however, has several disadvantages, including high construction and operation costs necessitated by pumping operations and the potential for accelerating aquatic weed and algae growth in the Wind Lake Canal because of the increase in waste loading on the Canal, which has a very flat grade and low flow velocity.

Table 30

ALTERNATIVE LAKE WATER QUALITY MANAGEMENT PLAN ELEMENTS
EAGLE LAKE, RACINE COUNTY

Alternative Plan Element		Estimated Cost							
Number Designation	Description	Capital	Annual Operation and Maintenance	Present Worth	Total Annual 1970-1985	Total Annual 1986-2020	Annual Per Capita[a] 1970-1985	Annual Per Capita[a] 1986-2020	Anticipated Performance
1	Weed harvesting	$ 8,250	$ 1,200	$ 19,850[b]	$ 2,040	$ --	$ 3.7	$ --	Control aquatic nuisance growths
	Algae control	1,250	1,250	13,350[b]	1,380	--	2.5	--	
	Total	$ 9,500	$ 2,450	$ 33,200	$ 3,420	$ --	$ 6.2	$ --	
2	Weed harvesting	$ 8,250	$ 1,200	$ 19,850[b]	$ 2,040	$ --	$ 3.7	$ --	Control aquatic nuisance growths
	Algae control	1,250	1,250	13,350[b]	1,380	--	2.5	--	Reduce phosphorus input by about 55 percent
	Bench terraces.	61,000	--	61,000	3,870	3,870	7.0	7.0	
	Total	$ 70,500	$ 2,450	$ 94,200	$ 7,290	$ 3,870	$ 13.2	$ 7.0	
3	Weed harvesting	$ 8,250	$ 1,200	$ 19,850[b]	$ 2,040	$ --	$ 3.7	$ --	Control aquatic nuisance growths
	Algae control	1,250	1,250	13,350[b]	1,380	--	2.5	--	Eliminate public health hazards
	Sanitary sewerage system (entire lake--550 persons served--secondary treatment plant at lake outlet)[c]. . .	1,215,500	21,000	1,576,200	100,000	100,000	182.0	182.0	Reduce phosphorus input by about 20 percent
	Total	$ 1,225,000	$ 23,450	$ 1,609,400	$ 103,420	$ 100,000	$ 188.2	$ 182.0	
4	Weed harvesting	$ 8,250	$ 1,200	$ 19,850[b]	$ 2,040	$ --	$ 3.7	$ --	Control aquatic nuisance growths
	Algae control	1,250	1,250	13,350[b]	1,380	--	2.5	--	Eliminate public health hazards
	Bench terraces.	61,000	--	61,000	3,870	3,870	7.0	7.0	Reduce phosphorus input by about 75 percent
	Sanitary sewerage system (entire lake--550 persons served--secondary treatment plant at lake outlet)[c]	1,215,500	21,000	1,576,200	100,000	100,000	182.0	182.0	
	Total	$ 1,286,000	$ 23,450	$ 1,670,400	$ 107,290	$ 103,870	$ 195.2	$ 189.0	

[a] *A population of 550 persons was used for per capita cost calculations.*

[b] *Present worth calculated utilizing a 6 percent rate of interest and a 15-year life. The present worth for all other plan elements calculated utilizing a 6 percent rate of interest and a 50-year life.*

[c] *The component capital costs of the sanitary sewerage system are: treatment plant (secondary) $135,000; trunk sewers $440,000; lateral and branch sewers $640,000.*

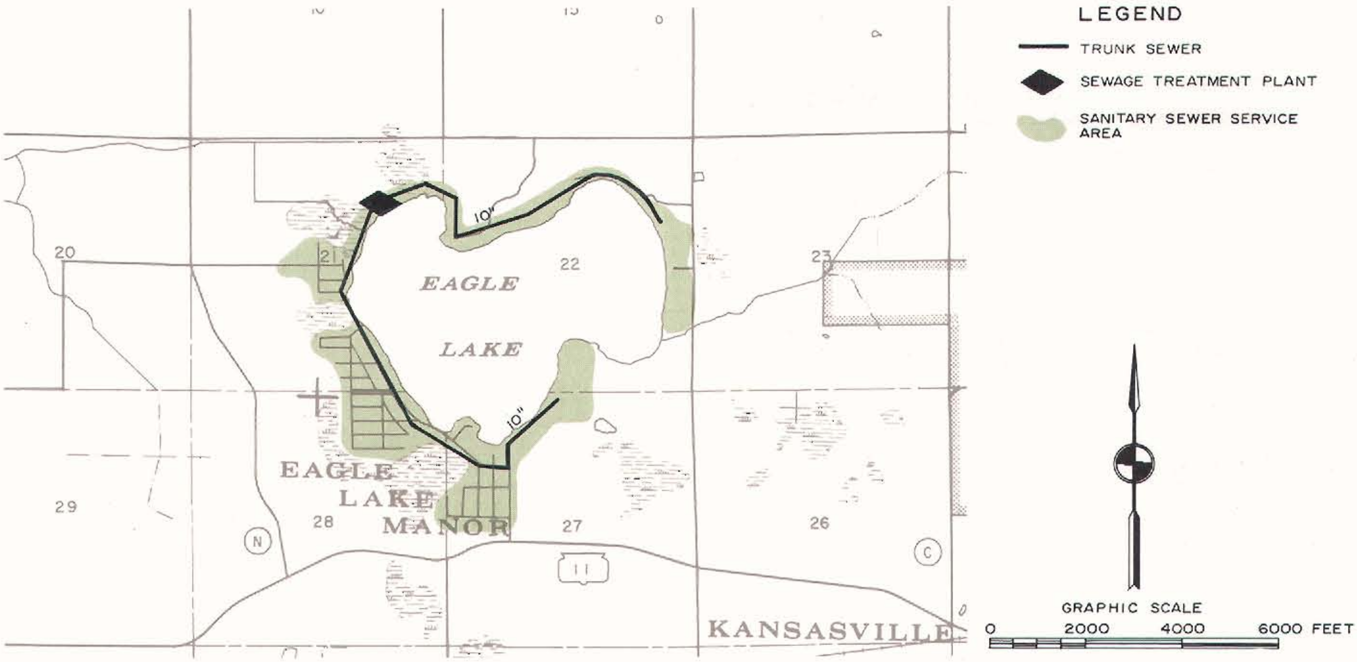
Source: Harza Engineering Company.

The fifth alternative considered is the same as the fourth with respect to the system configuration around Tichigan Lake. Instead of conveying the sewage to the Wind Lake Canal treatment plant, however, the fifth alternative proposes the construction of a gravity sewer south in order to provide treatment at the existing Western Racine County Sewerage District plant near Rochester (see Figure 34). The cost estimates of this alternative include service to the Buena Park area through an additional force main under the Fox River. While existing sewers south from Waterford and treatment capacity at Rochester are available to handle the increased flow from Tichigan Lake and the Buena Park area, it was assumed for cost estimation purposes that a separate sewer and treatment plant would be constructed. As shown in Table 49, the annual per capita costs for the fifth alternative, when apportioned to the residents around Tichigan Lake and Buena Park, are greater than the costs for development of a local system serving only the Tichigan Lake residents. Despite this fact the fifth alternative represents the best ultimate solution for consolidating sewage treatment facilities and maximizing the sewerage service area in this part of the watershed.

The sixth alternative considered provides for sewer service for both sides of Tichigan Lake but locates the sewage treatment plant at the south end of the lake rather than at the north end as proposed in the second and third alternatives. Effluent from this treatment plant would be discharged to the Fox River south of the inlet to Tichigan Lake (see Figure 35). This alternative is compatible with the fifth alternative in that the treatment plant could be eventually abandoned and the sewage pumped into a future gravity main flowing south to the Rochester plant of the Western Racine County Sewerage District.

It is recommended that the sixth alternative water quality management plant for Tichigan Lake, including weed harvesting, algae control, and a sanitary sewerage system with a treatment plant south of the lake inlet and discharging to the Fox River, be included in the recommended watershed plan.

Figure 26
RECOMMENDED SANITARY SEWERAGE FACILITIES FOR EAGLE LAKE



The proposed sanitary sewerage system for Eagle Lake would reduce the phosphorus contribution to Eagle Lake by about 20 percent and would eliminate any public health hazards that might limit the lake community of about 550 persons from enjoying full recreational use of the lake. The proposed sewerage system for this lake would have to be supplemented by improved soil and water conservation practices on the agricultural lands draining to Eagle Lake in order to reduce significantly the rate of eutrophication. The sewerage system could be designed to serve the unincorporated Village of Kansasville and also provide sewage treatment facilities for the Pure Milk Association's plant which now discharges wastes to a lagoon, the effluent from which eventually finds its way through the surface drainage system to Eagle Lake.

Source: Harza Engineering Company and SEWRPC.

Wind Lake: Wind Lake receives a moderate amount of public recreational use, mostly by people living on or near the shoreline. Large weed and algae growths are evident in the lake, particularly along the shoreline; nutrient concentrations are very high; and there is evidence of sewage pollution in the lake, the most likely cause being inadequate or malfunctioning sewage disposal systems serving homes around the lake. The entire area around Wind Lake is overlain with soils that are not suitable for soil absorption sewage disposal systems. Major nutrient inputs to the lake are derived from runoff from frozen agricultural lands on which manure has been spread and from malfunctioning sewage disposal systems (see Table 50).

Five alternative water quality management plan elements were considered for Wind Lake. The first would alleviate problems caused by excessive weed and algae growths by harvesting the weeds and using suitable algicides to control algae (see Table 51).

The second alternative considered could be expected to reduce phosphorus input to the lake by about 45 percent by the use of bench terracing to control soil losses on 1,000 acres of agricultural land tributary to Wind Lake. Algae and weed control would be provided as in the first alternative.

The third alternative considered would provide a sanitary sewerage system and treatment facilities to serve all residences around the lake with a treatment plant discharging to the Wind Lake Canal (see Figure 36). This would eliminate any public health hazards presently being caused by discharges from inadequate individual sewage dis-

Table 31

SELECTED CHARACTERISTICS OF ECHO LAKE
RACINE COUNTY: 1966

Characteristic	Description
Tributary Drainage Area	161.9 Square Miles
Surface Area	71 Acres
Shoreline	2.5 Miles
Depth	
Under 3 Feet	88 Percent
Over 20 Feet	-- Percent
Volume	130 Acre-Feet
Lake-Oriented Population.	6,000
Phosphorus Sources	Manured land 52% Rural runoff 11 Septic tanks 8 Municipal waste water 22 Other[a] 7 Total 100%
General Water Quality	Moderately high nutrient concentrations, but little weed growths Some bacterial pollution

[a]*Urban runoff, precipitation, and ground water.*

Source: Harza Engineering Company and Wisconsin Department of Natural Resources.

posal facilities, and it could be expected to reduce phosphorus input to the lake by 30 percent. Algae and weed control would be accomplished as in the first alternative.

The fourth alternative considered combines all the elements of the first three alternatives, including bench terracing, sewerage system and treatment facilities, and algae and weed control. This would eliminate all major waste discharges to the lake and their consequent health hazards, could be expected to reduce phosphorus input to one-fourth of the present level, and could be expected to control any nuisances caused by excessive weed and algae growths.

The fifth alternative considered provides for the construction of trunk sewers along the west shore and a portion of the east shore, collecting sewage to be treated at a plant discharging to the Wind Lake Canal (see Figure 37). Annual costs per capita in the third and fourth alternatives were computed based on a population to be served of 1,700 people. Annual costs per capita for the fifth alternative were computed based on a population to be served of 1,400 people. The per capita annual cost for this system is slightly higher than the fourth alternative and does not eliminate all septic tank seepage to the lake.

It is recommended that the fourth alternative water quality management plan for Wind Lake, including weed harvesting, algae control, bench terracing, and a sanitary sewerage system serving all residences around the lake with a treatment plant discharging to the Wind Lake Canal, be included in the recommended watershed plan.

SUMMARY

Stream Water Quality Management Plan Elements

A number of alternative stream water quality management plan elements were investigated in the Fox River watershed study, including: the provision of advanced waste treatment for both biochemical oxygen demand and nutrient removal; sewage diversion from the upper reaches of the watershed to the Milwaukee metropolitan sewerage system, combined with the provision of advanced waste treatment for the lower watershed; the disposal of sewage effluent on land; tertiary treatment for biochemical oxygen demand removal, with chemical spraying of the watercourses to control weed and algae growth; low-flow augmentation utilizing Lake Michigan water, combined with chemical spraying of the watercourses to control weed and algae growth; secondary treatment and disinfection of all major waste discharges within the watershed; and secondary treatment and disinfection of all major waste discharges, plus additional biochemical oxygen demand removal, at nine municipal sewage treatment plants within the watershed. The cost performance for each of these alternative stream water quality management plan elements was set forth and analyzed, as was the relative ability of each of the elements to meet the adopted stream water quality objectives and standards.

It is recommended that water quality management, to meet the water use objectives for streams in the Fox River watershed set forth in this study, consist of secondary treatment, disinfection, and advanced waste treatment of all major waste discharges in the watershed for biochemical oxygen demand and nutrient removal. These actions would provide stream water quality levels able to meet the established water use objectives. Such advanced waste treatment is recommended to be provided at one large sewage treatment plant located below Waukesha which, together with a system of trunk sewers, would serve the entire upper Fox River watershed and at six individual sewage treatment plants in the lower Fox River watershed. The initial capital cost of this plan is estimated at $29.6 million,

Table 32

SELECTED CHARACTERISTICS OF ELIZABETH AND MARIE LAKES KENOSHA COUNTY: 1966

Characteristic	Description	
Tributary Drainage Area	9.9	Square Miles
Surface Area	948	Acres
Shoreline	9.5	Miles
Depth		
Under 3 Feet	16	Percent
Over 20 Feet	18	Percent
Volume	9,698	Acre-Feet
Lake-Oriented Population	3,500	
Phosphorus Sources	Manured land	40%
	Urban runoff	23
	Rural runoff	11
	Septic tanks	8
	Other[a]	18
	Total	100%
General Water Quality	Some weed problems Below average nutrient concentrations	

[a]Precipitation and ground water.

Source: *Harza Engineering Company and Wisconsin Department of Natural Resources.*

with annual operation and maintenance costs of 1.6 million. Total annual cost, including capital recovery, operation, and maintenance, is $3.6 million, or $25 per capita per year. These values do not necessarily represent the cost to residents of the watershed, however, since federal and state grants are available to reduce substantially the overall cost to residents of the watershed.

Lake Water Quality Management Plan Elements

A number of alternative lake water quality management plan elements were investigated in the study, including: installation of sanitary sewerage systems, agricultural runoff control, weed harvesting, algae control, and lake water mixing. Utilizing these lake water quality management plan elements, alternative plans for the improvement of lake water quality were prepared for 22 of the major lakes in the Fox River watershed. These plans include some or all of the following elements: a sanitary sewerage system and sewage treatment facilities to serve developed areas around the lake in order to eliminate public health hazards and reduce the nutrient input to the lake due to drainage from individual waste disposal (septic tank) facilities; provision of bench terraces with tile outlets on agricultural lands tributary to the lake that are subject to erosion and loss of soil and nutrients to reduce the nutrient and sediment input; weed harvesting to remove excessive growths of aquatic weeds that interfere with the recreational use of a lake; algae control to reduce algae growths that interfere with recreational and aesthetic uses of the lake; and lake mixing to improve dissolved oxygen levels in the lake.

Based on the cost and anticipated performance of each alternative plan element and on the present condition of each lake, it is recommended that the lake water quality management plans to be included in the recommended comprehensive plan for the Fox River watershed include the following:

Table 33

ALTERNATIVE LAKE WATER QUALITY MANAGEMENT PLAN ELEMENTS ELIZABETH AND MARIE LAKES, KENOSHA COUNTY

Alternative Plan Element		Estimated Cost							Anticipated Performance
Number Designation	Description	Capital	Annual Operation and Maintenance	Present Worth	Total Annual 1970-1985	Total Annual 1986-2020	Annual Per Capita[a] 1970-1985	Annual Per Capita[a] 1986-2020	
1	Weed harvesting	$ 12,400	$ 1,800	$ 29,900[b]	$ 3,100	$ --	$ 0.9	$ --	Control aquatic nuisance growths
1	Total	$ 12,400	$ 1,800	$ 29,900	$ 3,100	$ --	$ 0.9	$ --	
2	Weed harvesting	$ 12,400	$ 1,800	$ 29,900[b]	$ 3,100	$ --	$ 0.9	$ --	Control aquatic nuisance growths
	Bench terraces	67,000	--	67,000	4,200	4,200	1.2	1.2	Reduce phosphorus input by about 40 percent
	Total	$ 79,400	$ 1,800	$ 96,900	$ 7,300	$ 4,200	$ 2.1	$ 1.2	

[a]A population of 3,500 persons was used for per capita cost calculations.

[b]Present worth calculated utilizing a 6 percent rate of interest and a 15-year life. The present worth for all other plan elements calculated utilizing a 6 percent rate of interest and a 50-year life.

Source: *Harza Engineering Company.*

Table 34

SELECTED CHARACTERISTICS OF GENEVA LAKE
WALWORTH COUNTY: 1966

Characteristic	Description
Tributary Drainage Area	28.8 Square Miles
Surface Area	5,262 Acres
Shoreline	20.2 Miles
Depth	
Under 3 Feet	1 Percent
Over 20 Feet	77 Percent
Volume	320,984 Acre-Feet
Lake-Oriented Population	7,100
Phosphorus Sources	Manured land 47%
	Urban runoff 26
	Rural runoff 6
	Septic tanks 7
	Other[a] 14
	Total 100%
General Water Quality	Low nutrient concentrations Generally very good water quality, but low oxygen levels in the bottom waters

[a] *Precipitation and ground water.*

Source: Harza Engineering Company and Wisconsin Department of Natural Resources.

1. Weed harvesting, as required at Beulah; Big Muskego; Bohner; Browns; Camp and Center; Como; Eagle; Elizabeth and Marie; Little Muskego; Pell; Pewaukee; Phantom; Powers, Tombeau, and Benedict; Silver; Tichigan; and Wind Lakes.

2. Algae control, as necessary at Big Muskego, Bohner, Browns, Camp and Center, Como, Eagle, Little Muskego, Pewaukee, Phantom, Silver, Tichigan, and Wind Lakes.

3. A long-term program of soil and water conservation through the construction of bench terraces with tile outlets on agricultural lands within the watersheds of Beulah; Bohner; Camp and Center; Como; Eagle; Elizabeth and Marie; Geneva; Pell; Pewaukee; Phantom; Powers, Tombeau, and Benedict; Silver; and Wind Lakes.

4. Provision of sanitary sewerage systems for Browns, Camp and Center, Como, Eagle, Little Muskego, Pewaukee, Tichigan, and Wind Lakes.

Of the foregoing eight lake sanitary sewerage systems, five—Camp and Center, Como, Eagle, Tichigan, and Wind—would include newly-established separate sewage treatment facilities. Wastes from the other three lake sewerage systems would be conveyed to existing sewage treatment facilities in the watershed in the case of Browns and Pewaukee Lakes and to the Milwaukee metropolitan sewerage system in the case of Little Muskego Lake.

The capital cost of these recommended plan elements for the 22 major lakes in the watershed is approximately $20 million; and the average annual

Table 35

ALTERNATIVE LAKE WATER QUALITY MANAGEMENT PLAN ELEMENTS
GENEVA LAKE, WALWORTH COUNTY

Alternative Plan Element		Estimated Cost							Anticipated Performance
Number Designation	Description	Capital	Annual Operation and Maintenance	Present Worth[a]	Total Annual 1970-1985	Total Annual 1986-2020	Annual Per Capita[b] 1970-1985	Annual Per Capita[b] 1986-2020	
1	Bench terraces	$ 200,000	$ --	$ 200,000	$ 12,700	$ 12,700	$ 1.8	$ 1.8	Reduce phosphorus input by about 45 percent
	Total	$ 200,000	$ --	$ 200,000	$ 12,700	$ 12,700	$ 1.8	$ 1.8	
2	Lake mixing	$ 250,000	$ 24,000	$ 914,000	$ 58,000	$ 58,000	$ 8.2	$ 8.2	Restore oxygen in hypolimnion
	Total	$ 250,000	$ 24,000	$ 914,000	$ 58,000	$ 58,000	$ 8.2	$ 8.2	

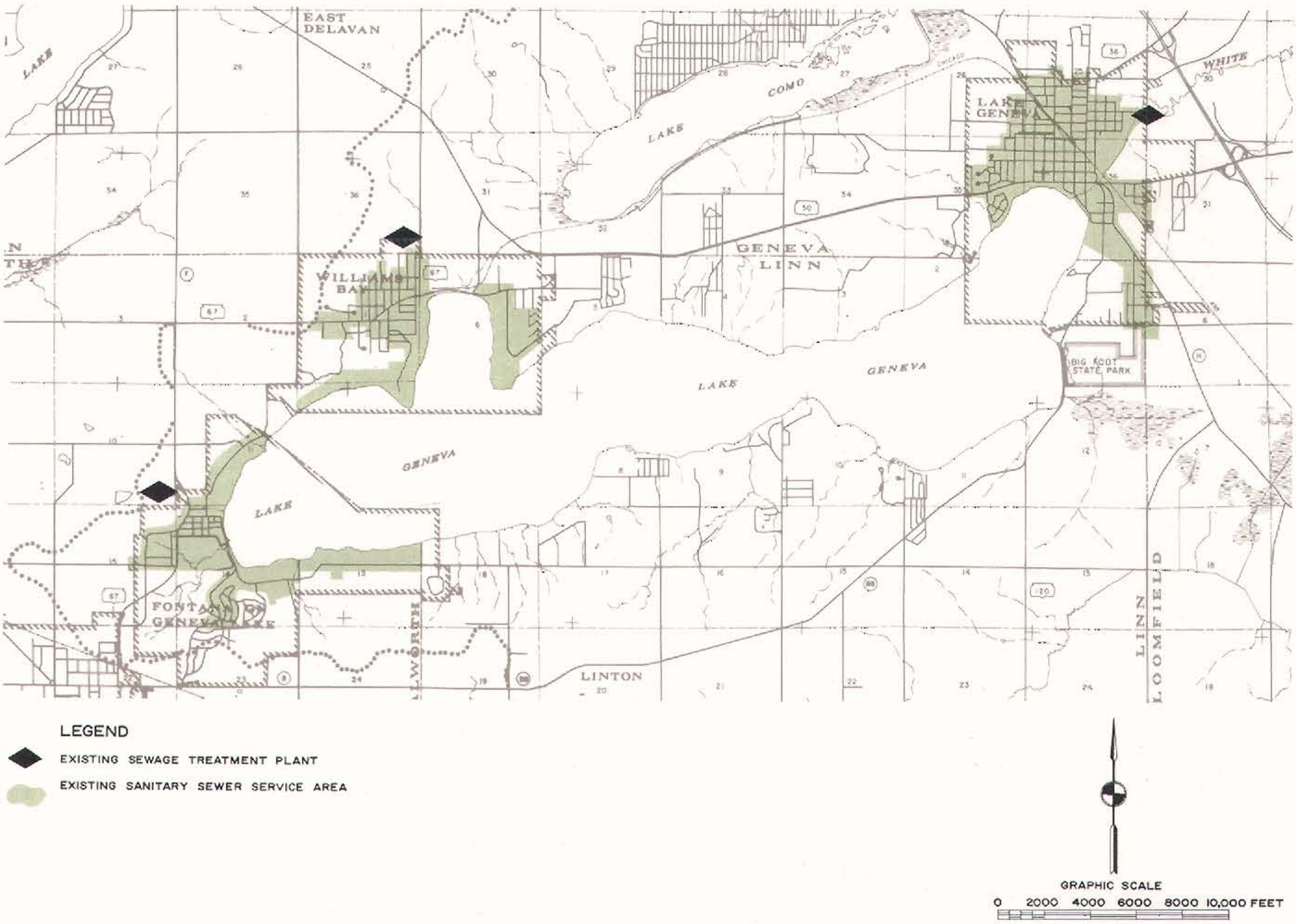
[a] *Present worth calculated utilizing a 6 percent rate of interest and a 50-year life.*

[b] *A population of 7,100 persons was used for per capita cost calculations.*

Source: Harza Engineering Company.

Figure 27

EXISTING SANITARY SEWER SERVICE AREAS AND TREATMENT PLANTS ON GENEVA LAKE



The Geneva Lake area is presently served by three municipal sanitary sewerage systems, and the lake is unique within the Fox River watershed in that no sanitary wastes are presently discharged to the lake. The sewerage service areas of these three existing systems should be extended to all of the urbanized areas around Geneva Lake in order to eliminate all septic tank systems around the lake. Such systems constitute an important source of nutrients and a potential sanitary hazard to the lake.

Source: Harza Engineering Company and SEWRPC.

cost, including capital recovery, operation, and maintenance, is $1,605,600. A summary of the costs of the recommended plan elements for each major lake is presented in Table 52.

Algae control and weed harvesting are recommended to alleviate nuisances caused by excessive aquatic growths present in many lakes in the watershed. The installation of sanitary sewer systems and treatment facilities at the lakes cited is recommended to eliminate the sanitary hazards that may presently exist in these lakes as a result of inadequate or malfunctioning individual on-site soil absorption sewage disposal systems and to reduce the nutrient input to the lakes. Periodic investigations should be made on all lakes in the watershed to assure that there are no wastes entering the lakes that could result in a public health hazard. A long-term program of soil and water conservation through the use of bench terraces on agricultural land is recommended as the

Table 36

SELECTED CHARACTERISTICS OF LITTLE MUSKEGO LAKE WAUKESHA COUNTY: 1966

Characteristic	Description
Tributary Drainage Area	11.4 Square Miles
Surface Area	506 Acres
Shoreline	7.1 Miles
Depth	
Under 3 Feet	27 Percent
Over 20 Feet	26 Percent
Volume	7,170 Acre-Feet
Lake-Oriented Population	4,800
Phosphorus Sources	Septic tanks 47% Manured land 34 Rural runoff 12 Other[a] 7 Total 100%
General Water Quality	Heavy weed and algae growths Evidence of sewage pollution Very high nutrient concentrations

[a]*Precipitation and ground water.*

Source: Harza Engineering Company and Wisconsin Department of Natural Resources.

best means of reducing the nutrient input and sediment load to lakes in the watershed. Runoff and drainage from agricultural lands are the major sources of phosphorus input to the lakes. Terracing of agricultural land with a slope in excess of 2 percent would significantly reduce the phosphorus loss from these lands.

Other plan elements, such as lake mixing, nutrient removal, and algae harvesting, may be appropriate at some lakes in the watershed. In addition, some of the recommended plan elements, such as weed harvesting, algae control, and provision of sanitary sewerage systems, may be appropriate at other lakes in the watershed not studied in detail in the Fox River watershed planning program. Additional intensive study would be needed to determine which elements could serve a given lake and what effects they would have on lake water quality. These investigations could be conducted with the aid of demonstration grants to evaluate the effects of a particular action on the eutrophication problems of a lake.

Table 37

ALTERNATIVE LAKE WATER QUALITY MANAGEMENT PLAN ELEMENTS LITTLE MUSKEGO LAKE, WAUKESHA COUNTY

Alternative Plan Element		Estimated Cost							Anticipated Performance
Number Designation	Description	Capital	Annual Operation and Maintenance	Present Worth	Total Annual 1970-1985	Total Annual 1986-2020	Annual Per Capita[a] 1970-1985	Annual Per Capita[a] 1986-2020	
1	Weed harvesting	$ 11,400	$ 1,650	$ 27,400[b]	$ 2,800	$ --	$ 0.6	$ --	Control aquatic nuisance growths
	Algae control	1,250	1,250	13,350[b]	1,400	--	0.3	--	
	Total	$ 12,650	$ 2,900	$ 40,750	$ 4,200	$ --	$ 0.9	$ --	
2	Weed harvesting	$ 11,400	$ 1,650	$ 27,400[b]	$ 2,800	$ --	$ 0.6	$ --	Control aquatic nuisance growths
	Algae control	1,250	1,250	13,350[b]	1,400	--	0.3	--	Eliminate public health hazards
	Sanitary sewerage system (entire lake)[c]	4,000,000	66,000	5,200,000	329,000	329,000	68.6	68.6	Reduce phosphorus input by about 50 percent
	Total	$ 4,012,650	$ 68,900	$ 5,240,750	$333,200	$329,000	$ 69.5	$ 68.6	

[a]*A population of 4,800 persons was used for per capita cost calculations.*

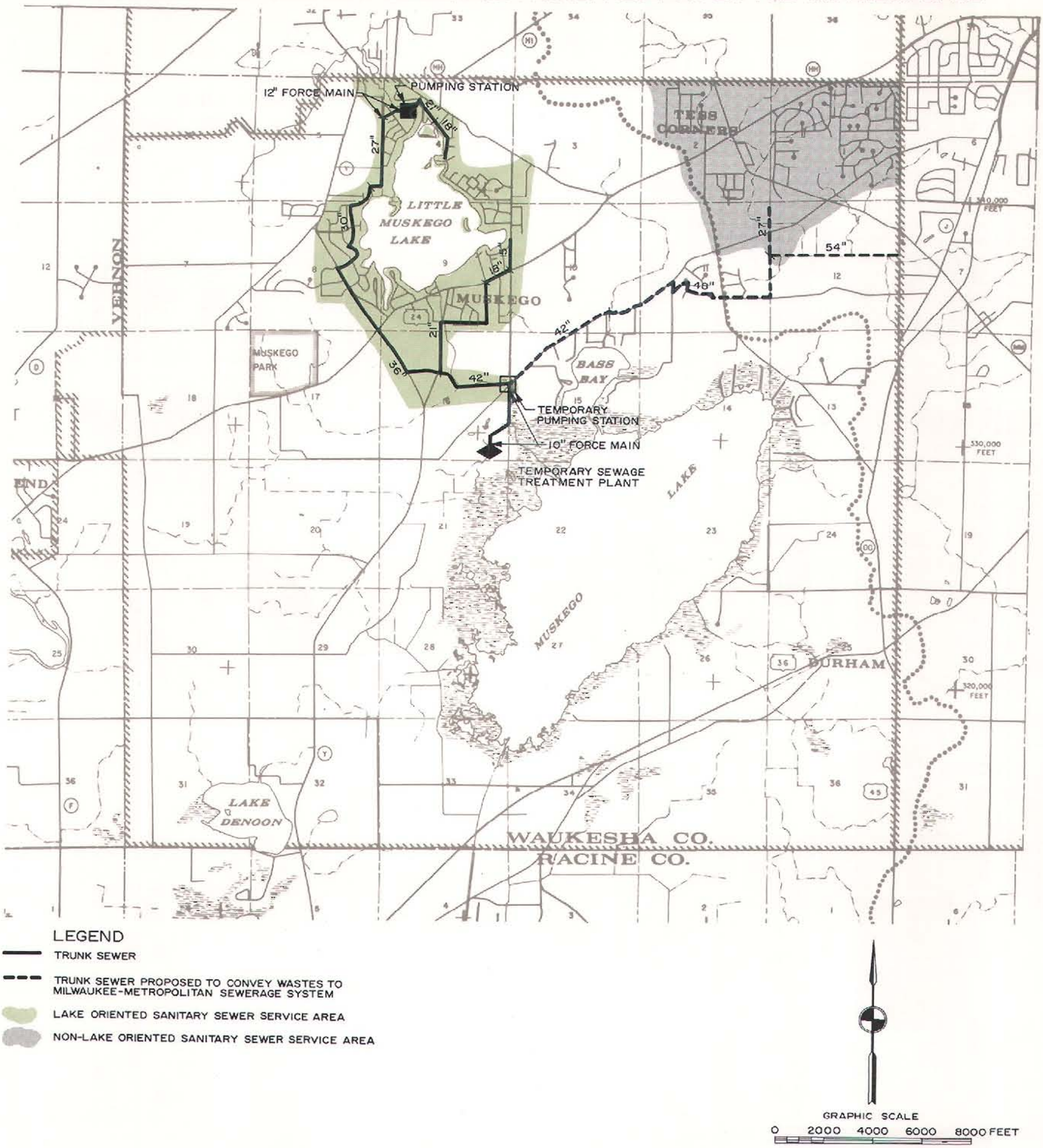
[b]*Present worth calculated utilizing a 6 percent rate of interest and a 15-year life. The present worth for all other plan elements calculated utilizing a 6 percent rate of interest and a 50-year life.*

[c]*The component capital costs of the sanitary sewerage system are: temporary sewage treatment facilities in the City of Muskego $600,000; trunk sewers $1,559,000; lateral and branch sewers $1,841,000.*

Source: Harza Engineering Company, Ruekert and Mielke, Inc., and SEWRPC.

Figure 28

RECOMMENDED SANITARY SEWERAGE FACILITIES FOR LITTLE MUSKEGO LAKE



The proposed sanitary sewerage system for Little Muskego Lake is actually under construction by the City of Muskego as a part of the city sewerage system. Temporarily, the sewage from the lake community will be treated in a two-stage lagoon located on the shores of Big Muskego Lake, with the trunk line sewers eventually being connected to the Milwaukee-Metropolitan Sewerage System, thus exporting the wastes out of the Fox River watershed.

Source: Harza Engineering Company and SEWRPC.

Table 38

SELECTED CHARACTERISTICS OF PELL LAKE WALWORTH COUNTY: 1966

Characteristic	Description
Tributary Drainage Area	1.3 Square Miles
Surface Area	86 Acres
Shoreline	3.6 Miles
Depth	
Under 3 Feet	55 Percent
Over 20 Feet	-- Percent
Volume	314 Acre-Feet
Lake-Oriented Population	1,300
Phosphorus Sources	Septic tanks 58% Manured land 32 Rural runoff 4 Other[a] 6 Total 100%
General Water Quality	Heavy weed growths Below average nutrient concentrations

[a] Precipitation and ground water.

Source: Harza Engineering Company and Wisconsin Department of Natural Resources.

Table 39

ALTERNATIVE LAKE WATER QUALITY MANAGEMENT PLAN ELEMENTS PELL LAKE, WALWORTH COUNTY

Alternative Plan Element		Estimated Cost							
					Total Annual		Annual Per Capita[a]		
Number Designation	Description	Capital	Annual Operation and Maintenance	Present Worth	1970-1985	1986-2020	1970-1985	1986-2020	Anticipated Performance
1	*Weed harvesting*	$ 5,170	$ 650	$ 11,470[b]	$ 1,200	$ --	$ 0.9	$ --	Control aquatic nuisance growths
	Total	$ 5,170	$ 650	$ 11,470	$ 1,200	$ --	$ 0.9	$ --	
2	Weed harvesting	$ 5,170	$ 650	$ 11,470[b]	$ 1,200	$ --	$ 0.9	$ --	Control aquatic nuisance growths
	Bench terraces	14,000	--	14,000	900	900	0.7	0.7	Reduce phosphorus input by about 30 percent
	Total	$ 19,170	$ 650	$ 25,470	$ 2,100	$ 900	$ 1.6	$ 0.7	
3	Weed harvesting	$ 5,170	$ 650	$ 11,470[b]	$ 1,200	$ --	$ 0.9	$ --	Control aquatic nuisance growths
	Bench terraces	14,000	--	14,000	900	900	0.7	0.7	Reduce phosphorus input by about 90 percent
	Sanitary sewerage system (entire lake--1,300 persons served--secondary treatment plant discharging to Nippersink Creek)[c]	2,375,000	33,350	2,934,700	186,400	186,400	143.4	143.4	
	Total	$ 2,394,170	$ 34,000	$ 2,960,170	$ 188,500	$ 187,300	$ 145.0	$ 144.1	

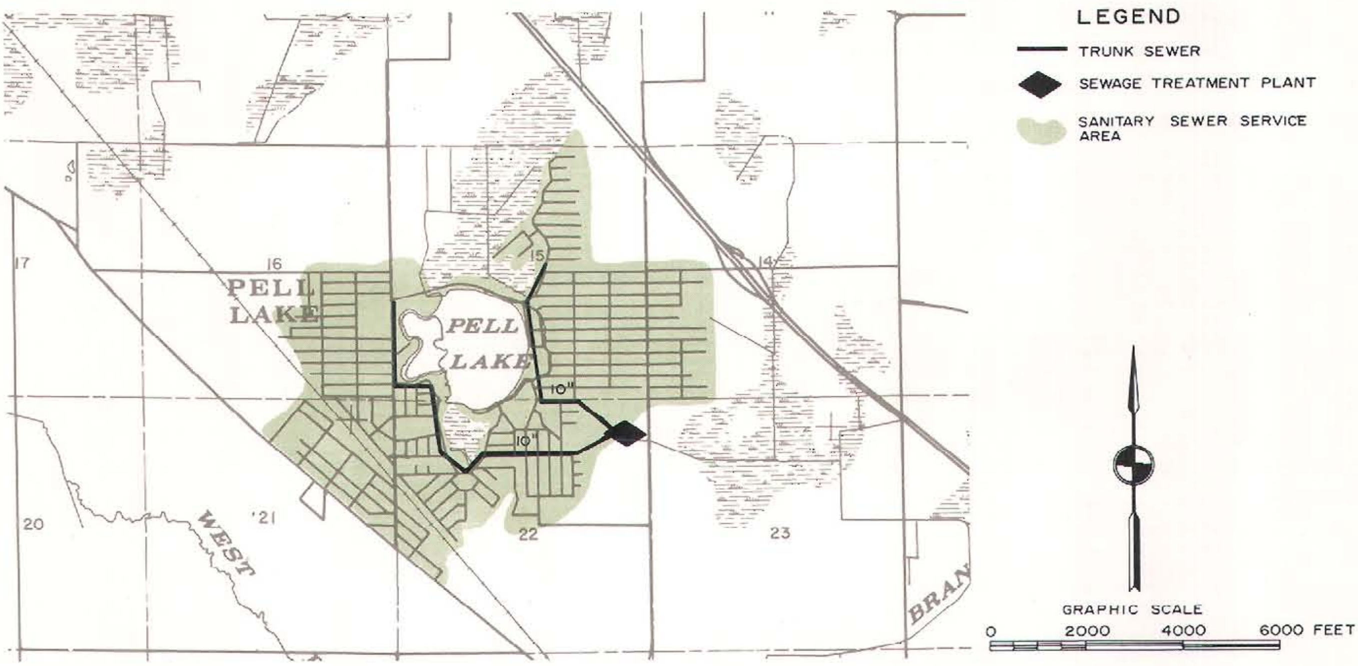
[a] *A population of 1,300 persons was used for per capita cost calculations.*

[b] *Present worth calculated utilizing a 6 percent rate of interest and a 15-year life. The present worth for all other plan elements calculated utilizing a 6 percent rate of interest and a 50-year life.*

[c] *The component capital costs of the sanitary sewerage system are: treatment plant (secondary) $185,000; trunk sewers $250,000; lateral and branch sewers $1,940,000.*

Source: Harza Engineering Company.

Figure 29
PROPOSED SANITARY SEWERAGE FACILITIES FOR PELL LAKE



More than half of the annual phosphorus inflow to Pell Lake is contributed by septic tank effluent seepage into the lake. A sanitary sewerage system to serve the lake-oriented resident population of about 1,300 people would, therefore, serve to reduce significantly the phosphorus contribution to the lake and thereby reduce the rate of eutrophication. Such a system would also assist in maintaining good lake water quality for recreational uses by eliminating any potential sanitary hazard.

Source: Harza Engineering Company and SEWRPC.

Table 40

SELECTED CHARACTERISTICS OF PEWAUKEE LAKE
WAUKESHA COUNTY: 1966

Characteristic	Description
Tributary Drainage Area	27.6 Square Miles
Surface Area.	2,493 Acres
Shoreline	13.7 Miles
Depth	
Under 3 Feet	8 Percent
Over 20 Feet	23 Percent
Volume	36,863 Acre-Feet
Lake-Oriented Population.	6,400
Phosphorus Sources	Manured land 43% Septic tanks 18 Rural runoff 14 Urban runoff 11 Other[a] 14 Total 100%
General Water Quality	Heavy weed and algae growths Evidence of sewage pollution Very high nutrient concentrations

[a]*Precipitation and ground water.*

Source: Harza Engineering Company and Wisconsin Department of Natural Resources.

Table 41

ALTERNATIVE LAKE WATER QUALITY MANAGEMENT PLAN ELEMENTS
PEWAUKEE LAKE, WAUKESHA COUNTY

Alternative Plan Element		Estimated Cost							Anticipated Performance
Number Designation	Description	Capital	Annual Operation and Maintenance	Present Worth	Total Annual 1970-1985	Total Annual 1986-2020	Annual Per Capita[a] 1970-1985	Annual Per Capita[a] 1986-2020	
1	Weed harvesting	$ 24,000	$ 3,500	$ 58,000[b]	$ 6,000	$ --	$ 1.7	$ --	Control aquatic nuisance growths
	Algae control	1,250	5,750	57,050[b]	5,900	--	1.7	--	
	Total	$ 25,250	$ 9,250	$ 115,050	$ 11,900	$ --	$ 3.4	$ --	
2	Weed harvesting	$ 24,000	$ 3,500	$ 58,000[b]	$ 6,000	$ --	$ 1.7	$ --	Control aquatic nuisance growths
	Algae control	1,250	5,750	57,050[b]	5,900	--	1.7	--	Reduce phosphorus input by about
	Bench terraces	195,000	--	195,000	12,400	12,400	3.5	3.5	40 percent
	Total	$ 220,250	$ 9,250	$ 310,050	$ 24,300	$ 12,400	$ 6.9	$ 3.5	
3	Weed harvesting	$ 24,000	$ 3,500	$ 58,000[b]	$ 6,000	$ --	$ 1.7	$ --	Control aquatic nuisance growths
	Algae control	1,250	5,750	57,050[b]	5,900	--	1.7	--	Eliminate public health hazards
	Sanitary sewerage system(entire lake--3,500 persons served)[c]	4,025,000	37,000	4,700,000	298,400	298,400	85.5	85.5	Reduce phosphorus input by about 20 percent
	Total	$ 4,050,250	$ 46,250	$ 4,815,050	$310,300	$298,400	$ 88.7	$ 85.5	
4	Weed harvesting	$ 24,000	$ 3,500	$ 58,000[b]	$ 6,000	$ --	$ 1.7	$ --	Control aquatic nuisance growths
	Algae control	1,250	5,750	57,050[b]	5,900	--	1.7	--	Eliminate public health hazards
	Bench terraces	195,000	--	195,000	12,400	12,400	3.5	3.5	Reduce phosphorus input by about 60 percent
	Sanitary sewerage system (entire lake--3,500 persons served)[c]	4,025,000	37,000	4,700,000	298,400	298,400	85.5	85.5	
	Total	$ 4,245,250	$ 46,250	$ 5,010,050	$322,700	$310,800	$ 92.4	$ 89.0	

[a] *A population of 3,500 persons was used for per capita cost calculations.*

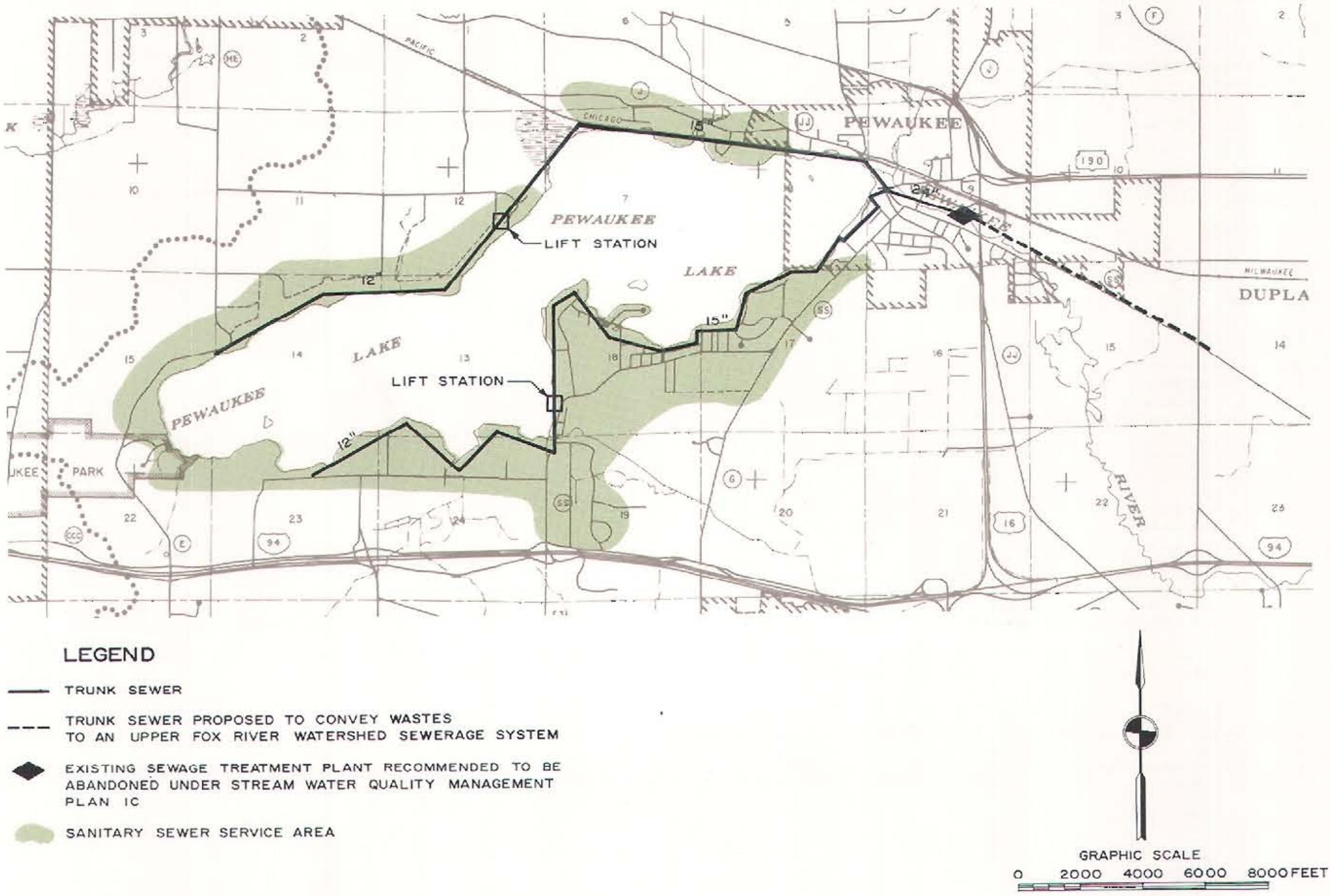
[b] *Present worth calculated utilizing a 6 percent rate of interest and a 15-year life. The present worth for all other plan elements calculated utilizing a 6 percent rate of interest and a 50-year life.*

[c] *The component capital costs of the sanitary sewerage system are: advanced waste treatment at Waukesha $395,000; trunk sewers $1,630,000; lateral and branch sewers $2,000,000.*

Source: Harza Engineering Company.

Figure 30

RECOMMENDED SANITARY SEWERAGE FACILITIES FOR PEWAUKEE LAKE



The extension of the existing Village of Pewaukee sanitary sewerage system to serve all residential areas around Pewaukee Lake would eliminate about 20 percent of the phosphorus contribution to the lake and would assist in eliminating any sanitary hazards associated with use of the lake for recreational purposes, such as swimming, water skiing, fishing, and boating. Substantial lake water quality improvement, however, may be expected to be achieved only if good soil and water conservation practices are also instituted on both the urban and agricultural lands tributary to the lake.

Source: Harza Engineering Company and SEWRPC.

Table 42

SELECTED CHARACTERISTICS OF PHANTOM LAKES WAUKESHA COUNTY: 1966

Characteristics	Description
Tributary Drainage Area	87.4 Square Miles
Surface Area	539 Acres
Shoreline	7.6 Miles
Depth	
Under 3 Feet	65 Percent
Over 20 Feet	2 Percent
Volume	2,710 Acre-Feet
Lake-Oriented Population.	2,500
Phosphorus Sources.	Manured land 39%
	Urban runoff 28
	Rural runoff 11
	Septic tanks 4
	Other[a] 18
	Total 100%
General Water Quality	Heavy weed and algae growths Moderate fertility No evidence of sewage pollution

[a] *Precipitation and ground water.*

Source: *Harza Engineering Company and Wisconsin Department of Natural Resources.*

Table 43

ALTERNATIVE LAKE WATER QUALITY MANAGEMENT PLAN ELEMENTS PHANTOM LAKES, WAUKESHA COUNTY

Alternative Plan Element		Estimated Cost							
Number Designation	Description	Capital	Annual Operation and Maintenance	Present Worth	Total Annual 1970-1985	Total Annual 1986-2020	Annual Per Capita[a] 1970-1985	Annual Per Capita[a] 1986-2020	Anticipated Performance
1	Weed harvesting	$ 23,500	$ 3,450	$ 57,000[b]	$ 5,900	$ --	$ 9.8	$ --	Control aquatic nuisance growths
	Algae control	1,250	1,350	14,350[b]	1,500	--	2.5	--	
	Total	$ 24,750	$ 4,800	$ 71,350	$ 7,400	$ --	$ 12.3	$ --	
2	Weed harvesting	$ 23,500	$ 3,450	$ 57,000[b]	$ 5,900	$ --	$ 9.8	$ --	Control aquatic nuisance growths
	Algae control	1,250	1,350	14,350[b]	1,500	--	2.5	--	Reduce phosphorus input by about 40 percent
	Bench terraces	90,000	--	90,000	5,700	5,700	9.5	9.5	
	Total	$ 114,750	$ 4,800	$ 161,350	$ 13,100	$ 5,700	$ 21.8	$ 9.5	

[a] *A population of 600 persons was used for per capita cost calculations.*

[b] *Present worth calculated utilizing a 6 percent rate of interest and a 15-year life. The present worth for all other plan elements calculated utilizing a 6 percent rate of interest and a 50-year life.*

Source: *Harza Engineering Company.*

Table 44

SELECTED CHARACTERISTICS OF POWERS, TOMBEAU, AND BENEDICT LAKES KENOSHA AND WALWORTH COUNTIES: 1966

Characteristic	Description
Tributary Drainage Area	5.1 Square Miles
Surface Area	590 Acres
Shoreline	9.0 Miles
Depth	
Under 3 Feet	11 Percent
Over 20 Feet	41 Percent
Volume	9,330 Acre-Feet
Lake-Oriented Population	700
Phosphorus Sources	Manured land 54% Rural runoff 17 Septic tanks 17 Other[a] 12 Total 100%
General Water Quality	Some weed growths and average nutrient concentrations in Tombeau and Benedict Lakes Very low nutrient concentrations in Powers Lake Generally very good water quality in Powers Lake

[a]*Precipitation and ground water.*

Source: Harza Engineering Company and Wisconsin Department of Natural Resources.

Table 45

ALTERNATIVE LAKE WATER QUALITY MANAGEMENT PLAN ELEMENTS POWERS, TOMBEAU, AND BENEDICT LAKES, KENOSHA AND WALWORTH COUNTIES

Alternative Plan Element		Estimated Cost							Anticipated Performance
Number Designation	Description	Capital	Annual Operation and Maintenance	Present Worth	Total Annual 1970-1985	Total Annual 1986-2020	Annual Per Capita[a] 1970-1985	Annual Per Capita[a] 1986-2020	
1	Weed harvesting	$ 8,300	$ 1,250	$ 20,400[b]	$ 2,100	$ --	$ 3.0	$ --	Control aquatic nuisance growths
	Total	$ 8,300	$ 1,250	$ 20,400	$ 2,100	$ --	$ 3.0	$ --	
2	Weed harvesting	$ 8,300	$ 1,250	$ 20,400[b]	$ 2,100	$ --	$ 3.0	$ --	Control aquatic nuisance growths
	Bench terraces	75,000	--	75,000	4,700	4,700	6.7	6.7	Reduce phosphorus input by about 55 percent
	Total	$ 83,300	$ 1,250	$ 95,400	$ 6,800	$ 4,700	$ 9.7	$ 6.7	

[a]*A population of 700 persons was used for per capita cost calculations.*

[b]*Present worth calculated utilizing a 6 percent rate of interest and a 15-year life. The present worth for all other plan elements calculated utilizing a 6 percent rate of interest and a 50-year life.*

Source: Harza Engineering Company.

Table 46

SELECTED CHARACTERISTICS OF SILVER LAKE KENOSHA COUNTY: 1966

Characteristic	Description
Tributary Drainage Area	5.9 Square Miles
Surface Area	464 Acres
Shoreline	3.9 Miles
Depth	
Under 3 Feet	26 Percent
Over 20 Feet	20 Percent
Volume	4,820 Acre-Feet
Lake-Oriented Population.	800
Phosphorus Sources.	Manured land 59% Rural runoff 17 Septic tanks 14 Other[a] 10 Total 100%
General Water Quality	Moderate weed and algae growths Evidence of sewage pollution Moderate nutrient concentrations

[a]*Precipitation.*

Source: Harza Engineering Company and Wisconsin Department of Natural Resources.

Table 47

ALTERNATIVE LAKE WATER QUALITY MANAGEMENT PLAN ELEMENTS SILVER LAKE, KENOSHA COUNTY

Alternative Plan Element		Estimated Cost							Anticipated Performance
Number Designation	Description	Capital	Annual Operation and Maintenance	Present Worth	Total Annual		Annual Per Capita[a]		
					1970-1985	1986-2020	1970-1985	1986-2020	
1	Weed harvesting	$ 10,300	$ 1,500	$ 24,850[b]	$ 2,570	$ --	$ 3.2	$ --	Control aquatic nuisance growths
	Algae control	1,250	660	7,650[b]	790	--	1.0	--	
	Total	$ 11,550	$ 2,160	$ 32,500	$ 3,360	$ --	$ 4.2	$ --	
2	Weed harvesting	$ 10,300	$ 1,500	$ 24,850[b]	$ 2,570	$ --	$ 3.2	$ --	Control aquatic nuisance growths
	Algae control	1,250	660	7,650[b]	790	--	1.0	--	Reduce phosphorus input by about 60 percent
	Bench terraces.	53,000	--	53,000	3,360	3,360	4.2	4.2	
	Total	$ 64,550	$ 2,160	$ 85,500	$ 6,620	$ 3,360	$ 8.4	$ 4.2	

[a]*A population of 800 persons was used for per capita cost calculations.*

[b]*Present worth calculated utilizing a 6 percent rate of interest and a 15-year life. The present worth for all other plan elements calculated utilizing a 6 percent rate of interest and a 50-year life.*

Source: Harza Engineering Company.

Table 48

SELECTED CHARACTERISTICS OF TICHIGAN LAKE

RACINE COUNTY: 1966

Characteristic	Description
Tributary Drainage Area	359[a] Square Miles
Surface Area	891 Acres
Shoreline	4.7 Miles
Depth	
Under 3 Feet	5 Percent
Over 20 feet	34 Percent
Volume	6,746 Acre-Feet
Lake-Oriented Population.	600
Phosphorus Sources.	Major source of nutrients is water entering lake from the Fox River
General Water Quality	Heavy weed and algae growths Evidence of sewage pollution Very high nutrient concentrations

[a]*This figure represents the tributary drainage area for the Waterford Dam which backs water into Tichigan Lake.*

Source: *Harza Engineering Company and Wisconsin Department of Natural Resources.*

Table 49

ALTERNATIVE LAKE WATER QUALITY MANAGEMENT PLAN ELEMENTS TICHIGAN LAKE, RACINE COUNTY

Alternative Plan Element		Estimated Cost							
Number Designation	Description	Capital	Annual Operation and Maintenance	Present Worth	Total Annual 1970-1985	Total Annual 1986-2020	Annual Per Capita 1970-1985	Annual Per Capita 1986-2020	Anticipated Performance
1	Weed harvesting	$ 5,200	$ 750	$ 12,470[a]	$ 1,280	$ --	$ 2.1[b]	$ --	Control aquatic nuisance growths
	Algae control	1,250	740	8,430[a]	870	--	1.5[b]	--	
	Total	$ 6,450	$ 1,490	$ 20,900	$ 2,150	$ --	$ 3.6	$ --	
2	Weed harvesting	$ 5,200	$ 750	$ 12,470[a]	$ 1,280	$ --	$ 2.1[b]	$ --	Control aquatic nuisance growths Eliminate public health hazards Reduce phosphorus input by about 40 percent
	Algae control	1,250	740	8,430[a]	870	--	1.5[b]	--	
	Sanitary sewerage system (entire lake--600 persons served--secondary treatment plant at north end of lake)[c] . .	1,014,500	25,000	1,450,000	93,300	93,300	155.0	155.0	
	Total	$ 1,020,950	$ 26,490	$ 1,470,900	$ 95,450	$ 93,300	$ 158.6	$ 155.0	
3	Weed harvesting	$ 5,200	$ 750	$ 12,470[a]	$ 1,280	$ --	$ 2.6[b]	$ --	Control aquatic nuisance growths Eliminate public health hazards Reduce phosphorus input by about 35 percent
	Algae control	1,250	740	8,430[a]	870	--	1.7[b]	--	
	Sanitary sewerage system (east shore, Fox Point Park, and Tichigan Heights only--500 persons served--secondary treatment plant at north end of lake[d]	894,500	25,500	1,349,000	86,800	86,800	173.7	173.7	
	Total	$ 900,950	$ 26,990	$ 1,369,900	$ 88,950	$ 86,800	$ 178.0	$ 173.7	
4	Weed harvesting	$ 5,200	$ 750	$ 12,470[a]	$ 1,280	$ --	$ 2.1	$ --	Control aquatic nuisance growths Eliminate public health hazards Reduce phosphorus input by about 40 percent
	Algae control	1,250	740	8,430[a]	870	--	1.5	--	
	Sanitary sewerage system (entire lake--600 persons served--secondary treatment at proposed Wind Lake Canal treatment plant)[e].	1,483,000	20,840	1,860,000	118,700	118,700	197.7	197.7	
	Total	$ 1,489,450	$ 22,330	$ 1,880,900	$ 120,850	$ 118,700	$ 201.3	$ 197.7	
5	Weed harvesting	$ 5,200	$ 750	$ 12,470[a]	$ 1,280	$ --	$ 0.7	$ --	Control aquatic nuisance growths Eliminate public health hazards Reduce phosphorus input by about 40 percent
	Algae control	1,250	740	8,430[a]	870	--	0.5	--	
	Sanitary sewerage system (entire lake--and Buena Park area--1,800 persons served--advanced waste treatment at Western Racine County Sewerage District treatment plant)[f]	3,396,000	73,510	4,738,000	300,900	300,900	167.2	167.2	
	Total	$ 3,402,450	$ 75,000	$ 4,758,900	$ 303,050	$ 300,900	$ 168.4	$ 167.2	
6	Weed harvesting	$ 5,200	$ 750	$ 12,470[a]	$ 1,280	$ --	$ 2.1	$ --	Control aquatic nuisance growths Eliminate public health hazards Reduce phosphorus input by about 40 percent
	Algae control	1,250	740	8,430[a]	870	--	1.5	--	
	Sanitary sewerage system (entire lake--600 persons served--secondary treatment plant at south end of lake)[g]. . .	1,123,100	26,570	1,413,000	89,670	89,670	149.4	149.4	
	Total	$ 1,129,550	$ 28,060	$ 1,433,900	$ 91,820	$ 89,670	$ 153.0	$ 149.4	

[a] *Present worth calculated utilizing a 6 percent rate of interest and a 15-year life. The present worth for all other plan elements calculated utilizing a 6 percent rate of interest and a 50-year life.*

[b] *A population of 600 persons was used for per capita cost calculations.*

[c] *The component capital costs of the sanitary sewerage system are: treatment plant (secondary) $198,000; trunk sewers $387,500; lateral and branch sewers $429,000. An additional capital cost of $83,000 would be needed to provide advanced waste treatment and make Alternative 2 strictly comparable to Alternative 5.*

[d] *The component capital costs of the sanitary sewerage system are: treatment plant (secondary) $165,000; trunk sewers $300,500; lateral and branch sewers $429,000. An additional capital cost of $65,000 would be needed to provide advanced waste treatment and make Alternative 3 strictly comparable to Alternative 5.*

[e] *The component capital costs of the sanitary sewerage system are: treatment plant (secondary) $161,700; trunk sewers $851,300; lateral and branch sewers $470,000. An additional capital cost of $60,000 would be needed to provide advanced waste treatment and make Alternative 4 strictly comparable to Alternative 5.*

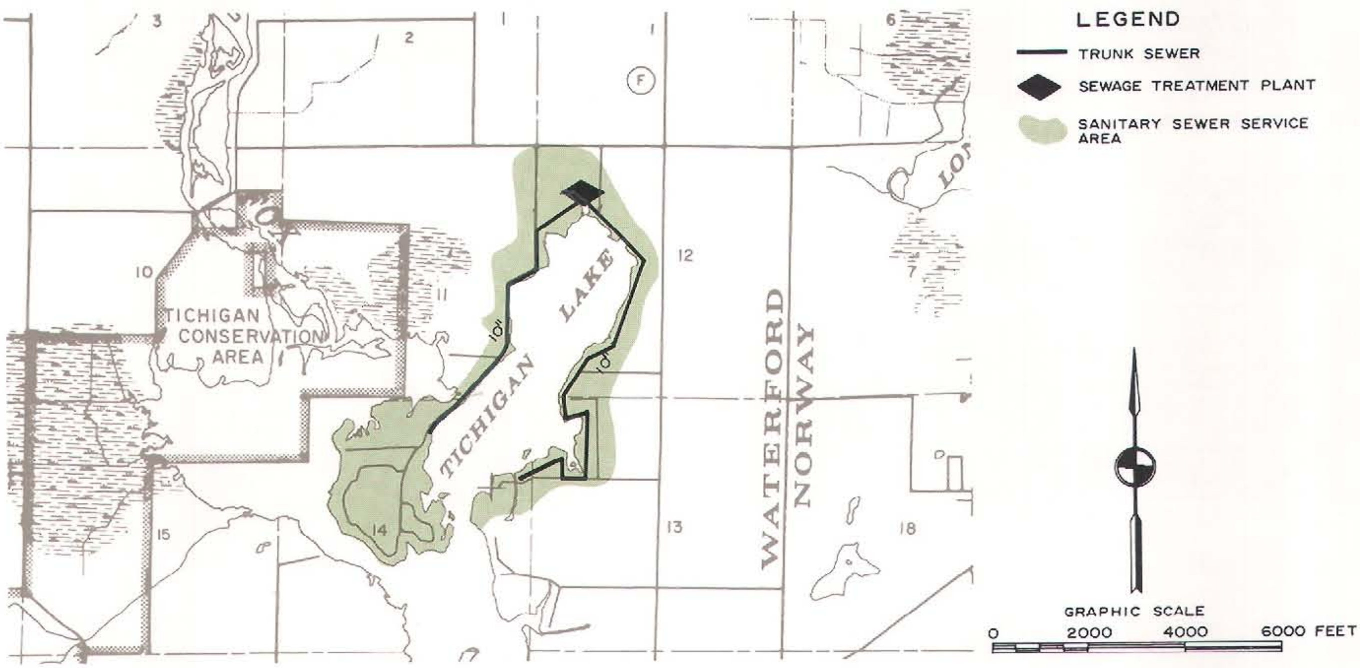
[f] *The component capital costs of the sanitary sewerage system are: advanced waste treatment plant $467,000; trunk sewers $1,608,000; lateral and branch sewers $1,321,000.*

[g] *The component capital costs of the sanitary sewerage system are: treatment plant (secondary) $185,000; trunk sewers $468,100; lateral and branch sewers $470,000. An additional capital cost of $83,000 would be needed to provide advanced waste treatment and make Alternative 6 strictly comparable to Alternative 5.*

Source: Harza Engineering Company.

Figure 31

ALTERNATIVE SANITARY SEWERAGE FACILITIES FOR TICHIGAN LAKE: ENTIRE LAKE WITH TREATMENT PLANT AT NORTH END OF LAKE

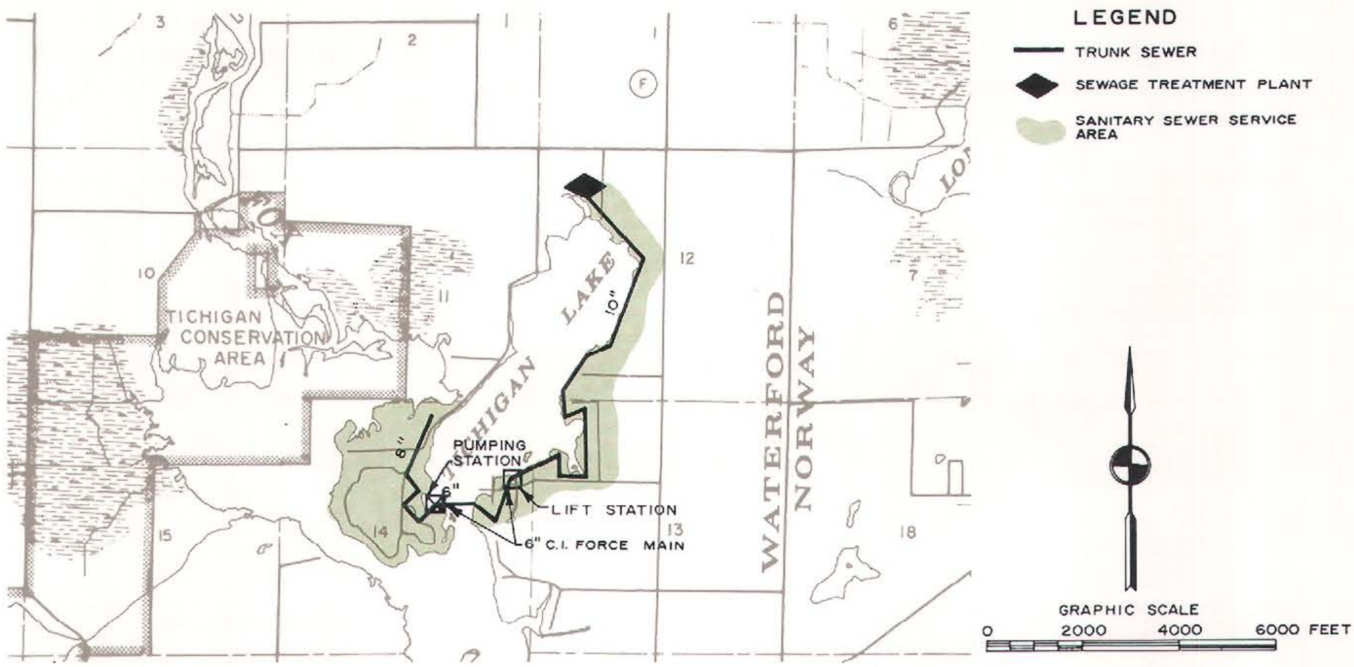


Most of the phosphorus inflow to Tichigan Lake is contributed by the Fox River, which contains very high nutrient levels above the lake. The first of the five alternative sanitary sewerage systems considered to reduce the extremely high coliform counts which are found in Tichigan Lake would locate a sewage treatment plant at the north end of the lake, discharging the treated effluent from the plant to a seepage lagoon. The plant would permit all of the residential areas around the lake to be sewered and thereby would contribute to improvement of the lake water quality. It is important to note, however, that any major improvement of the water quality in the lake will be dependent upon measures to improve water quality in the Fox River.

Source: Harza Engineering Company and SEWRPC.

Figure 32

ALTERNATIVE SANITARY SEWERAGE FACILITIES FOR TICHIGAN LAKE: EAST SIDE AND PORTION OF WEST SIDE OF LAKE WITH TREATMENT PLANT AT NORTH END OF LAKE

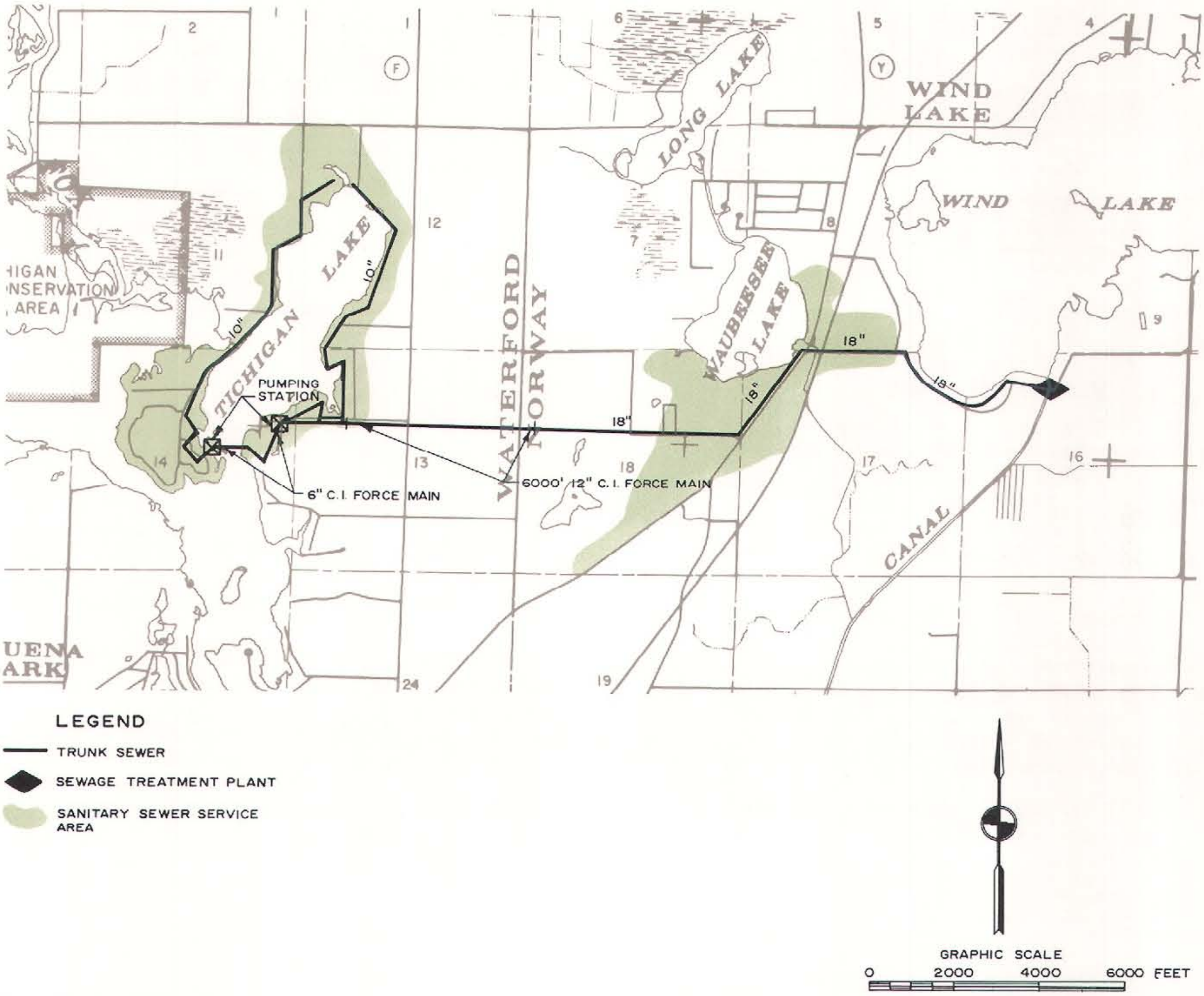


The second of the five alternative sanitary sewerage systems considered for Tichigan Lake would provide sewerage service to all of the residential areas located along the eastern shoreline of the lake but to only a portion of the residential areas located along the western shoreline. The remainder of the residences along the western shoreline would be eventually removed to provide a restored "natural" lakeshore area. This alternative would also utilize a sewage treatment plant located at the north end of the lake, discharging to a seepage lagoon.

Source: Harza Engineering Company and SEWRPC.

Figure 33

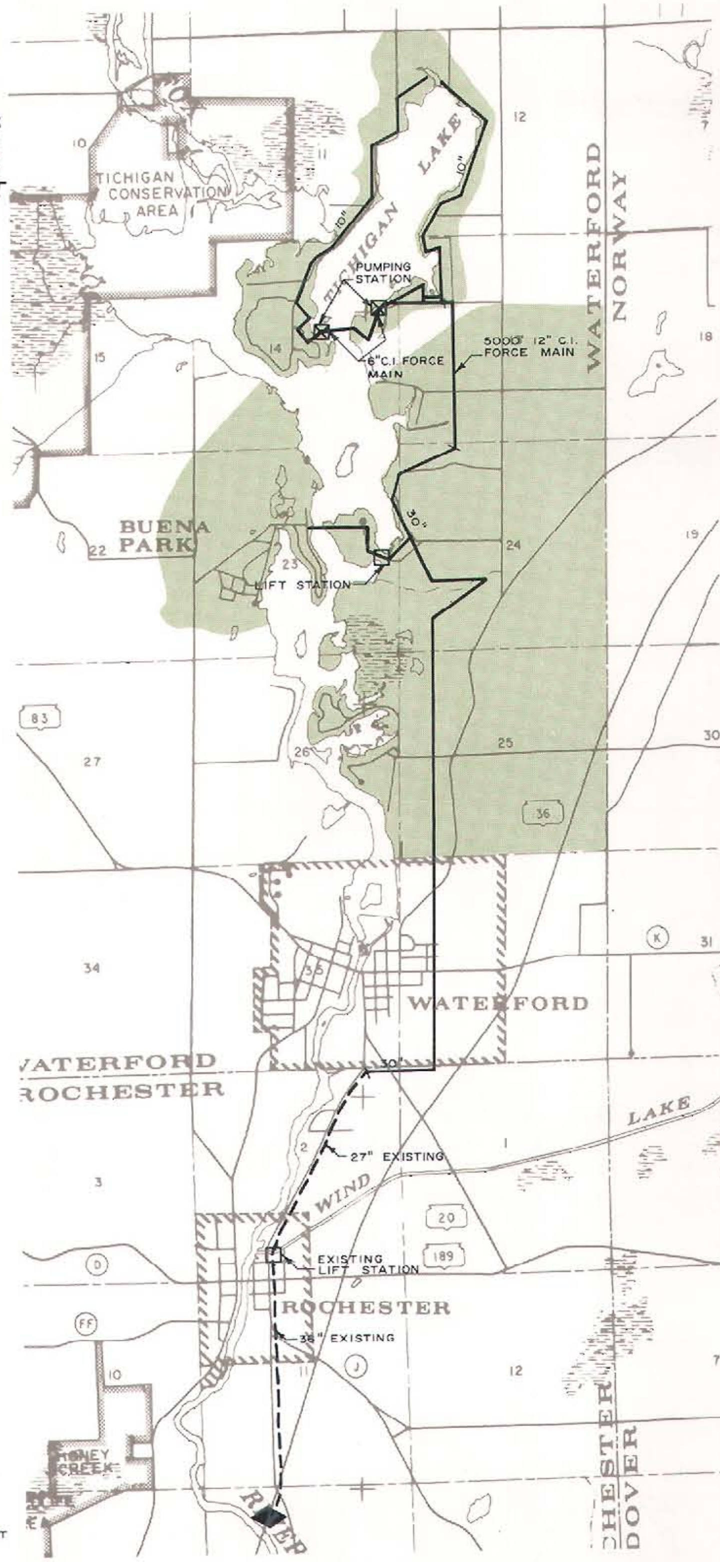
ALTERNATIVE SANITARY SEWERAGE FACILITIES FOR TICHIGAN LAKE: ENTIRE LAKE WITH WASTES CONVEYED TO A WIND LAKE SEWAGE TREATMENT PLANT



The third of the five alternative sanitary sewerage systems considered for Tichigan Lake would provide for the collection of sewage from all of the residential areas located along both the eastern and western shorelines of the lake, with the sewage being carried to a sewage pumping station located at the southern end of the lake. Here the sewage would be pumped through a force main to a point about half way between Tichigan and Wind Lakes, from where it would flow by gravity through a large trunk sewer to a proposed sewage treatment plant located at the outlet of Wind Lake.

Source: Harza Engineering Company and SEWRPC.

Figure 34
ALTERNATIVE SANITARY SEWERAGE FACILITIES FOR TICHIGAN LAKE: ENTIRE LAKE WITH WASTES CONVEYED TO THE WESTERN RACINE COUNTY SEWERAGE DISTRICT TREATMENT PLANT



LEGEND

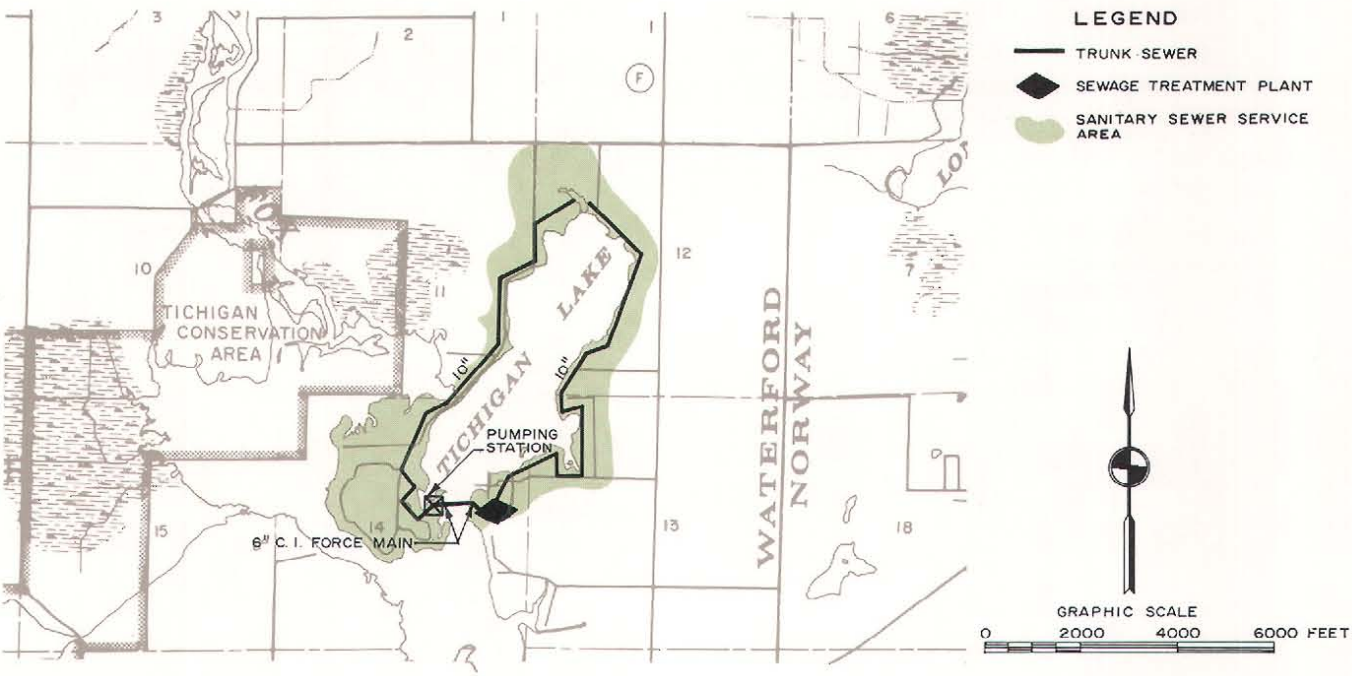
- TRUNK SEWER
- TRUNK SEWER PROPOSED TO CONVEY WASTES TO THE WESTERN RACINE COUNTY SEWERAGE DISTRICT TREATMENT PLANT
- SEWAGE TREATMENT PLANT
- SANITARY SEWER SERVICE AREA

GRAPHIC SCALE
0 2000 4000 6000 FEET

The fourth of the five alternative sanitary sewerage systems considered for Tichigan Lake would provide sewerage service to all of the residential areas located around the entire lakeshore, as well as to some residential development located along the eastern and western shores of the Fox River between Tichigan Lake and the Village of Waterford. The sewage would be conveyed by a trunk sewer along the Fox River to the existing sewage treatment plant of the Western Racine County Sewerage District located south of the Village of Rochester. This particular alternative is the most desirable in terms of long-range development, but the cost is so high as to be financially impractical at this time.

Figure 35

RECOMMENDED SANITARY SEWERAGE FACILITIES FOR TICHIGAN LAKE: ENTIRE LAKE WITH TREATMENT PLANT AT SOUTH END OF LAKE



The sanitary sewerage system recommended for Tichigan Lake would permit all of the residential areas around the lake to be serviced, with eventual connection to the Western Racine County Sewerage District treatment plant at such time as the necessary trunk line could be built along the Fox River. In the interim period, a sewage plant located at the southern end of the lake would provide secondary treatment and disinfection.

Source: Harza Engineering Company and SEWRPC.

Table 50

SELECTED CHARACTERISTICS OF WIND LAKE
RACINE COUNTY: 1966

Characteristic	Description
Tributary Drainage Area	42.6 Square Miles
Surface Area	936 Acres
Shoreline	9.3 Miles
Depth	
Under 3 Feet	32 Percent
Over 20 Feet	15 Percent
Volume.	8,995 Acre-Feet
Lake-Oriented Population.	1,700
Phosphorus Sources.	Manured land 45% Septic tanks 29 Rural runoff 14 Other[a] 12 Total 100%
General Water Quality	Heavy weed and algae growths Evidence of sewage pollution Very high nutrient concentrations

[a] *Precipitation and ground water.*

Source: Harza Engineering Company and Wisconsin Department of Natural Resources.

Table 51

ALTERNATIVE LAKE WATER QUALITY MANAGEMENT PLAN ELEMENTS
WIND LAKE, RACINE COUNTY

Alternative Plan Element		Estimated Cost							
Number Designation	Description	Capital	Annual Operation and Maintenance	Present Worth	Total Annual 1970-1985	Total Annual 1986-2020	Annual Per Capita 1970-1985	Annual Per Capita 1986-2020	Anticipated Performance
1	Weed harvesting	$ 17,500	$ 2,500	$ 41,700[a]	$ 4,300	$ --	$ 2.5[b]	$ --	Control aquatic nuisance growths
	Algae control	1,250	2,250	23,050[a]	2,380	--	1.4[b]	--	
	Total	$ 18,750	$ 4,750	$ 64,750	$ 6,680	$ --	$ 3.9	$ --	
2	Weed harvesting	$ 17,500	$ 2,500	$ 41,700[a]	$ 4,300	$ --	$ 2.5[b]	$ --	Control aquatic nuisance growths
	Algae control	1,250	2,250	23,050[a]	2,380	--	1.4[b]	--	Reduce phosphorus input by
	Bench terraces.	64,000	--	64,000	4,050	4,050	2.4[b]	2.4[b]	about 45 percent
	Total	$ 82,750	$ 4,750	$ 128,750	$ 10,730	$ 4,050	$ 6.3	$ 2.4	
3	Weed harvesting	$ 17,500	$ 2,500	$ 41,700[a]	$ 4,300	$ --	$ 2.5[b]	$ --	Control aquatic nuisance growths
	Algae control	1,250	2,250	23,050[a]	2,380	--	1.4[b]	--	Eliminate public health hazards
	Sanitary sewerage system (entire lake--1,700 persons served--secondary treatment plant at lake outlet)[c] . .	1,413,000	29,000	1,907,400	121,000	121,000	71.3	71.3	Reduce phosphorus input by about 30 percent
	Total	$ 1,431,750	$ 33,750	$ 1,972,150	$ 127,680	$ 121,000	$ 75.7	$ 71.3	
4	Weed harvesting	$ 17,500	$ 2,500	$ 41,700[a]	$ 4,300	$ --	$ 2.5[b]	$ --	Control aquatic nuisance growths
	Algae control	1,250	2,250	23,050[a]	2,380	--	1.4[b]	--	Eliminate public health hazards
	Bench terraces.	64,000	--	64,000	4,050	4,050	2.4[b]	2.4[b]	Reduce phosphorus input by about 75 percent
	Sanitary sewerage system(entire lake--1,700 persons served--secondary treatment plant at lake outlet)[c] . .	1,413,000	29,000	1,907,400	121,000	121,000	71.3	71.3	
	Total	$ 1,495,750	$ 33,750	$ 2,036,150	$ 131,730	$ 125,050	$ 77.6	$ 73.7	
5	Weed harvesting	$ 17,500	$ 2,500	$ 41,700[a]	$ 4,300	$ --	$ 3.1[b]	$ --	Control aquatic nuisance growths
	Algae control	1,250	2,250	23,050[a]	2,380	--	1.7[b]	--	Eliminate public health hazards
	Bench terraces.	64,000	--	64,000	4,050	4,050	2.9[b]	2.9[b]	Reduce phosphorus input by about 75 percent
	Sanitary sewerage system (west shore of lake and portion of east shore only--1,400 persons served--secondary treatment plant at lake outlet)[d] . .	1,200,000	17,000	1,644,600	104,200	104,200	74.3	74.3	
	Total	$ 1,282,750	$ 21,750	$ 1,773,350	$ 114,930	$ 108,250	$ 82.0	$ 77.2	

[a] *Present worth calculated utilizing a 6 percent rate of interest and a 15-year life. The present worth for all other plan elements calculated utilizing a 6 percent rate of interest and a 50-year life.*

[b] *A population of 1,700 persons was used for per capita cost calculations.*

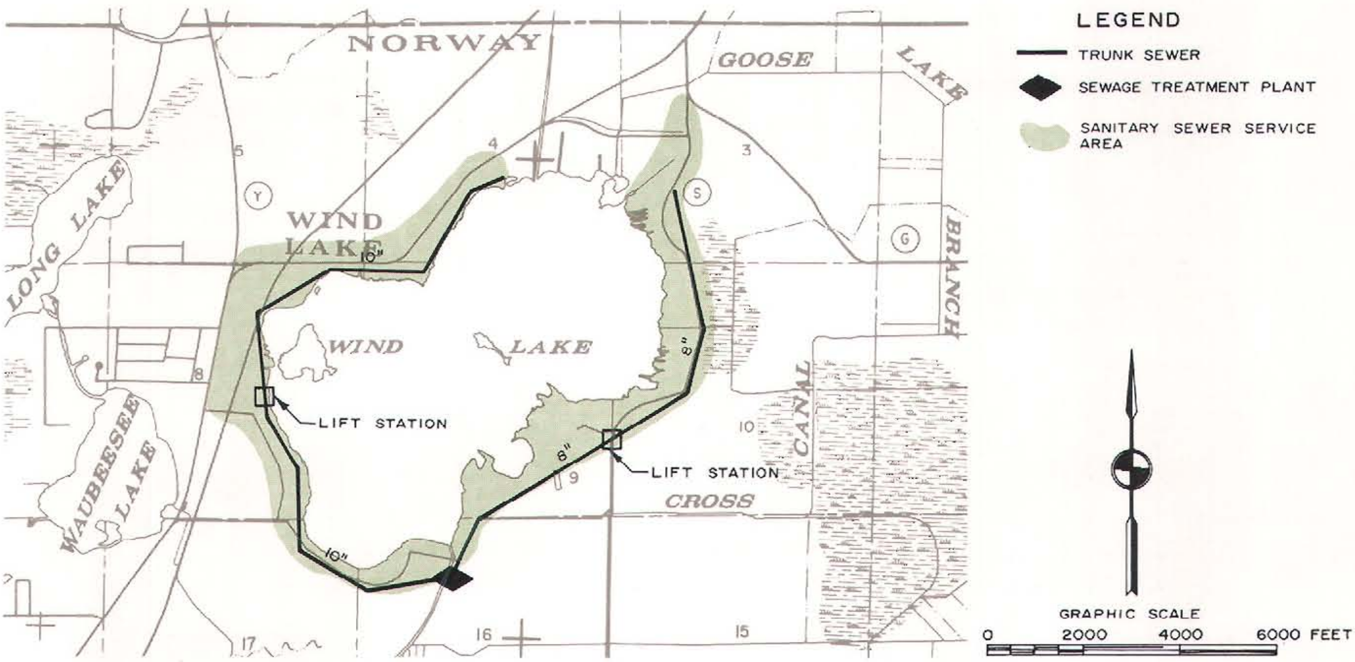
[c] *The component capital costs of the sanitary sewerage system are: treatment plant (secondary) $185,000; trunk sewers $603,000; lateral and branch sewers $625,000.*

[d] *The component capital costs of the sanitary sewerage system are: treatment plant (secondary) $165,000; trunk sewers $448,000; lateral and branch sewers $587,000.*

Source: Harza Engineering Company.

Figure 36

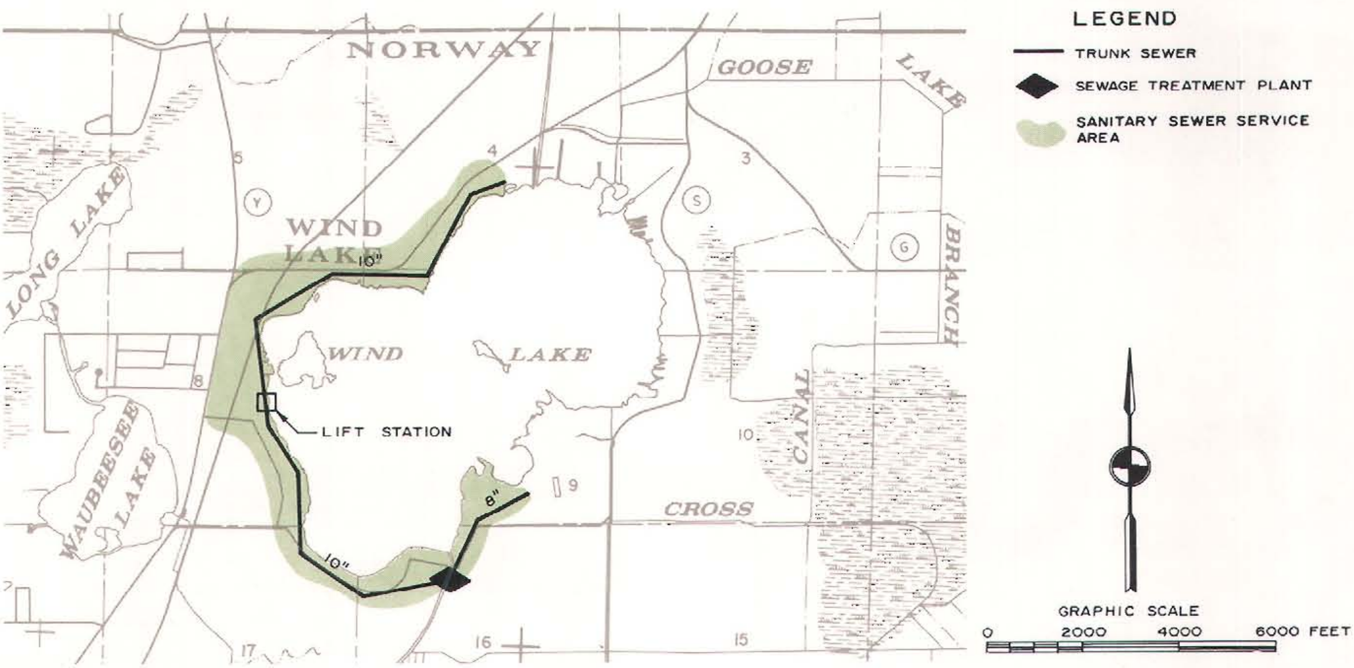
RECOMMENDED SANITARY SEWERAGE FACILITIES FOR WIND LAKE: ENTIRE LAKE WITH TREATMENT PLANT AT LAKE OUTLET



The sanitary sewerage system recommended for Wind Lake would provide sewerage service to the entire lake community and would, in addition, provide such service to existing urban-type subdivisions located to the west and northwest of the lake. The necessary sewage treatment plant would be located at the southern end of the lake, discharging to the Wind Lake Drainage Canal. The sewerage system would serve the 1,700 lake-oriented residents and assist in maintaining good lake water quality for recreational uses.

Source: Harza Engineering Company and SEWRPC.

Figure 37
ALTERNATIVE SANITARY SEWERAGE FACILITIES FOR WIND LAKE: WEST SIDE AND PORTION OF EAST SIDE OF LAKE WITH TREATMENT PLANT AT LAKE OUTLET



An alternative sanitary sewerage system considered for Wind Lake would provide service to only those residential areas located along the southern and western shoreline of the lake. Residential areas along the eastern shoreline would be eventually removed in order to provide a restored "natural" lakeshore area. This alternative would also utilize a sewage treatment plant located near the lake outlet, discharging to the Wind Lake Canal.

Source: Harza Engineering Company and SEWRPC.

Table 52

COST ESTIMATES OF THE RECOMMENDED LAKE WATER QUALITY MANAGEMENT PLAN ELEMENTS FOR THE FOX RIVER WATERSHED

Name of Lake	Recommended Plan Elements	Estimated Cost						
		Capital	Annual Operation and Maintenance	Present Worth[a]	Total Annual		Annual Per Capita[a]	
					1970-1985	1986-2020	1970-1985	1986-2020
Beulah	Weed harvesting	$ 10,000	$ 1,500	$ 25,000	$ 2,600	$ --	$ 4.0	$ --
	Bench terraces	98,000	--	98,000	6,200	6,200	9.5	9.5
	Total	$ 108,000	$ 1,500	$ 123,000	$ 8,800	$ 6,200	$ 13.5	$ 9.5
Big Muskego	Weed harvesting	$ 88,000	$ 13,000	$ 214,000	$ 22,000	$ --	$ 44.0	$ --
	Algae control	1,250	5,250	52,250	5,400	--	10.8	--
	Total	$ 89,250	$ 18,250	$ 266,250	$ 27,400	$ --	$ 54.8	$ --
Bohner	Weed harvesting	$ 4,000	$ 550	$ 9,330	$ 960	$ --	$ 1.1	$ --
	Algae control	1,250	450	5,620	580	--	0.7	--
	Bench terraces	31,000	--	31,000	1,970	1,970	2.3	2.3
	Total	$ 36,250	$ 1,000	$ 45,950	$ 3,510	$ 1,970	$ 4.1	$ 2.3
Browns	Weed harvesting	$ 5,200	$ 750	$ 7,280	$ 750	$ --	$ 0.4	$ --
	Algae control	1,250	1,250	12,120	1,250	--	0.6	--
	Sanitary sewerage system (entire lake--1,950 persons served--advanced waste treatment at Burlington)	1,624,000	21,000	2,005,600	126,800	126,800	65.0	65.0
	Total	$ 1,630,450	$ 23,000	$ 2,025,000	$ 128,800	$ 126,800	$ 66.0	$ 65.0
Camp and Center	Weed harvesting	$ 17,500	$ 2,500	$ 41,700	$ 4,300	$ --	$ 3.6	$ --
	Algae control	1,250	1,400	14,850	1,530	--	1.3	--
	Bench terraces	73,000	--	73,000	4,700	4,700	3.9	3.9
	Sanitary sewerage system (all of Center Lake; east side of Camp Lake--1,200 persons served--secondary treatment plant at lake outlet)	2,274,000	35,000	2,869,000	185,000	185,000	154.0	154.0
	Total	$ 2,365,750	$ 38,900	$ 2,998,550	$ 195,530	$ 189,700	$ 162.8	$ 157.9
Como	Weed harvesting	$ 22,800	$ 3,300	$ 54,800	$ 5,600	$ --	$ 4.3	$ --
	Algae control	1,250	2,200	22,650	2,300	--	1.8	--
	Bench terraces	72,000	--	72,000	4,600	4,600	3.5	3.5
	Sanitary sewerage system (north side of lake--1,300 persons served--secondary treatment at lake outlet)	2,505,000	33,000	3,057,700	193,700	193,700	149.0	149.0
	Total	$ 2,601,050	$ 38,500	$ 3,207,150	$ 206,200	$ 198,300	$ 158.6	$ 152.5

Table 52 (continued)

Name of Lake	Recommended Plan Elements	Estimated Cost						
		Capital	Annual Operation and Maintenance	Present Worth[a]	Total Annual		Annual Per Capita[a]	
					1970-1985	1986-2020	1970-1985	1986-2020
Eagle	Weed harvesting	$ 8,250	$ 1,200	$ 19,850	$ 2,040	$ --	$ 3.7	$ --
	Algae control	1,250	1,250	13,350	1,380	--	2.5	--
	Bench terraces	61,000	--	61,000	3,870	3,870	7.0	7.0
	Sanitary sewerage system (entire lake--550 persons served--secondary treatment plant at lake outlet)	1,215,500	21,000	1,576,200	100,000	100,000	182.0	182.0
	Total	$ 1,286,000	$ 23,450	$ 1,670,400	$ 107,290	$ 103,870	$ 195.2	$ 189.0
Elizabeth and Marie	Weed harvesting	$ 12,400	$ 1,800	$ 29,900	$ 3,100	$ --	$ 0.9	$ --
	Bench terraces	67,000	--	67,000	4,200	4,200	1.2	1.2
	Total	$ 79,400	$ 1,800	$ 96,900	$ 7,300	$ 4,200	$ 2.1	$ 1.2
Geneva	Bench terraces	$ 200,000	$ --	$ 200,000	$ 12,700	$ 12,700	$ 1.8	$ 1.8
	Total	$ 200,000	$ --	$ 200,000	$ 12,700	$ 12,700	$ 1.8	$ 1.8
Little Muskego	Weed harvesting	$ 11,400	$ 1,650	$ 27,400	$ 2,800	$ --	$ 0.6	$ --
	Algae control	1,250	1,250	13,350	1,400	--	0.3	--
	Sanitary sewerage system (entire lake)	4,000,000	66,000	5,200,000	329,000	329,000	68.6	68.8
	Total	$ 4,012,650	$ 68,900	$ 5,240,750	$ 333,200	$ 329,000	$ 69.5	$ 68.6
Pell	Weed harvesting	$ 5,170	$ 650	$ 11,470	$ 1,200	$ --	$ 0.9	$ --
	Bench terraces	14,000	--	14,000	900	900	0.7	0.7
	Total	$ 19,170	$ 650	$ 25,470	$ 2,100	$ 900	$ 1.6	$ 0.7
Pewaukee	Weed harvesting	$ 24,000	$ 3,500	$ 58,000	$ 6,000	$ --	$ 1.7	$ --
	Algae control	1,250	5,750	57,050	5,900	--	1.7	--
	Bench terraces	195,000	--	195,000	12,400	12,400	3.5	3.5
	Sanitary sewerage system (entire lake--3,500 persons served)	4,025,000	37,000	4,700,000	298,400	298,400	85.5	85.5
	Total	$ 4,245,250	$ 46,250	$ 5,010,050	$ 322,700	$ 310,800	$ 92.4	$ 89.0
Phantom	Weed harvesting	$ 23,500	$ 3,450	$ 57,000	$ 5,900	$ --	$ 9.8	$ --
	Algae control	1,250	1,350	14,350	1,500	--	2.5	--
	Bench terraces	90,000	--	90,000	5,700	5,700	9.5	9.5
	Total	$ 114,750	$ 4,800	$ 161,350	$ 13,100	$ 5,700	$ 21.8	$ 9.5

Table 52 (continued)

Name of Lake	Recommended Plan Elements	Estimated Cost: Capital	Annual Operation and Maintenance	Present Worth[a]	Total Annual 1970-1985	Total Annual 1986-2020	Annual Per Capita[a] 1970-1985	Annual Per Capita[a] 1986-2020
Powers, Tombeau, and Benedict	Weed harvesting	$ 8,300	$ 1,250	$ 20,400	$ 2,100	$ --	$ 3.0	$ --
	Bench terraces	75,000	--	75,000	4,700	4,700	6.7	6.7
	Total	$ 83,300	$ 1,250	$ 95,400	$ 6,800	$ 4,700	$ 9.7	$ 6.7
Silver (Kenosha County)	Weed harvesting	$ 10,300	$ 1,500	$ 24,850	$ 2,570	$ --	$ 3.2	$ --
	Algae control	1,250	660	7,650	790	--	1.0	--
	Bench terraces	53,000	--	53,000	3,360	3,360	4.2	4.2
	Total	$ 64,550	$ 2,160	$ 85,500	$ 6,620	$ 3,360	$ 8.4	$ 4.2
Tichigan	Weed harvesting	$ 5,200	$ 750	$ 12,470	$ 1,280	$ --	$ 2.1	$ --
	Algae control	1,250	740	8,430	870	--	1.5	--
	Sanitary sewerage system (entire lake--600 persons served--secondary treatment plant at south end of lake)	1,123,100	26,570	1,413,000	89,670	89,670	149.4	149.4
	Total	$ 1,129,550	$ 28,060	$ 1,433,900	$ 91,820	$ 89,670	$ 153.0	$ 149.4
Wind	Weed harvesting	$ 17,500	$ 2,500	$ 41,700	$ 4,300	$ --	$ 2.5	$ --
	Algae control	1,250	2,250	23,050	2,380	--	1.4	--
	Bench terraces	64,000	--	64,000	4,050	4,050	2.4	2.4
	Sanitary sewerage system (entire lake--1,700 persons served--secondary treatment plant at lake outlet)	1,413,000	29,000	1,907,400	121,000	121,000	71.3	71.3
	Total	$ 1,495,750	$ 33,750	$ 2,036,150	$ 131,730	$ 125,050	$ 77.6	$ 73.7
Total		$19,561,120	$ 332,220	$24,721,770	$1,605,600	$1,512,920	$ --	$ --

[a] *For assumptions underlying the present worth and per capita cost calculations, see the preceding series of tables in this chapter regarding alternative lake water quality management plan elements.*

Source: Harza Engineering Company.

Chapter VI

ALTERNATIVE WATER SUPPLY PLAN ELEMENTS

INTRODUCTION

The two aquifers underlying the Fox River watershed comprise one of the most valuable natural resources of the watershed. These aquifers not only constitute the principal source of water supply within the watershed but, if properly used and managed, also constitute a renewable resource which can serve the watershed for all time to come.

The data and analyses presented in Volume 1 of this report indicated that, if protected from pollution, the natural quality of the ground water from both the shallow and deep aquifers should be adequate to meet all foreseeable domestic, municipal, and industrial water supply needs within the watershed. Local pollution of the shallow aquifer, which constitutes the most important source of water available to meet small highly dispersed demands, such as those generated by residential development not served by public water supply systems, may, in the absence of a sound water resource management program, be expected to become a serious problem within the watershed. Potential sources of pollution of the shallow aquifer include septic tank disposal systems, dumps and improperly located and managed sanitary land fills, and both urban and agricultural runoff. The deep aquifer is less readily subject to pollution and, therefore, may be expected to remain a reliable source of supply of high-quality water throughout the watershed.

The data and analyses presented in Volume 1 of this report also indicated that the quantity of water present in both the shallow and deep aquifers can be expected to be adequate to meet forecast water supply needs within the watershed through the plan design year of 1990, even though total water use within the watershed may be expected to more than double by that year, reaching a total pumping rate of 65 million gallons per average day, or 23.7 billion gallons per year. Because of the relatively high quality of the water and the ready availability of the supply, ground water may be expected to remain the only practical large-scale source of water supply within the watershed through the plan design year.

This chapter describes alternative plans available for meeting future water supply demands within the Fox River watershed from the ground water aquifers. The specific ground water sources available to each existing and probable future major pumping center within the watershed are described and recommendations made concerning the development of the best available source of supply. Because the ground water resources of the watershed can be developed as a source of supply by wells located in, or close to, the areas to be served, the need for extensive transmission mains and pumping stations is minimized. For this reason the alternative water supply plans presented in this report are more general than the alternative plans for pollution abatement or flood control, relating primarily to desirable well field location. Summary data concerning the ground water resources available to local areas of concentrated pumping within the Fox River watershed are given in Table 53. A brief discussion of important factors to be considered in the use of the deep and shallow aquifers underlying the watershed as sources of water supply follows.

DEEP AQUIFER GROUND WATER SUPPLY

The deep sandstone aquifer underlies not only the entire Fox River watershed but extends throughout southeastern Wisconsin and northeastern Illinois. This aquifer constitutes a dependable source of large quantities of high-quality water and can supply all anticipated municipal and industrial water supply needs within the watershed to the plan design year of 1990.

In Volume 1 of this report, it was indicated that in 1966 about 65 percent of the municipal and private utility supply, averaging 8.9 million gallons per day; about 36 percent of the self-supplied commercial and industrial supply, averaging 1.0 million gallons per day; and about 1.3 percent of the self-supplied domestic and agricultural water supply, averaging 0.1 million gallons per day were obtained from the deep aquifer. Total pumpage from this aquifer may be expected to increase from about 10 million gallons per average day in 1966 to 43 million gallons per day by 1990 (see

Table 53

GROUND-WATER RESOURCES AVAILABLE AT EXISTING OR POTENTIAL AREAS OF CONCENTRATED PUMPING IN THE FOX RIVER WATERSHED

	Sand And Gravel Aquifer		Niagara Dolomite Aquifer[a]		Sandstone Aquifer	
Pumping Center	Well Yield Potential	Description	Well Yield Potential	Description	Well Yield Potential	Description
Village of Big Bend	Fair	Up to 50 feet of saturated sand and gravel underlie the area. Well yields are likely to increase toward the Fox River. Diversion of water from large springs located south of the village and protection of the aquifer from surface contamination would be potential problems requiring attention if this source is used.	Poor	The Niagara dolomite aquifer is the principal source for most domestic water supplies in this area. The aquifer lies from 75 to 125 feet below the surface and is 100 to 190 feet thick.	Very Good	The sandstone aquifer lies from 700 to about 2,500 feet below the surface. It is a dependable source of good-quality water. Well yields may be as high as 1 mgd. No well in the village is known to use this aquifer. Use of the sandstone aquifer will not alter flow of springs.
Town and City of Brookfield[b]	Poor	Sand and gravel deposits are found in the drilling of about 60 percent of the wells in this area, but they are seldom used as a source of water supply. These deposits average about 20 feet in thickness. In several wells within a half mile of the Brookfield City Hall, in the NW 1/4 of Section 22, Town 7 North, Range 20 East, however, the sand and gravel deposits are somewhat more than 100 feet thick and may be an important source of water. Recharge to the sand and gravel deposits is relatively small because of the thick cover of clay-rich glacial till soils that occurs in the Brookfield area. No public supply or subdivision water well is known to use this aquifer.	Very Good	The Niagara dolomite aquifer is the principal source of small-to-moderate-sized water supplies in the area. Most of the water used is supplied by privately owned wells that average about 250 feet in depth but may be as deep as 375 feet. At least 20 high-capacity wells tap this aquifer in the area. Most of these wells are used for subdivision supplies; but some are used by industries, commercial establishments, schools, and golf courses. Future high-capacity wells near the watershed boundary are expected to yield up to 350 gpm (0.5 mgd) each. High-capacity wells within a mile of the Fox River are likely to yield up to 500 gpm (0.72 mgd) each. No widespread dewatering of this aquifer is expected by 1990.	Very Good	The sandstone aquifer is a major source of good quality water in this area; but at the end of 1966, it was being used by only three high-capacity wells. These wells are used to supply water for a subdivision, a high school, and a shopping center. The largest of these wells, located in the SE 1/4 of Section 27, Town 7 North, Range 20 East, penetrates 935 feet of sandstone and was tested at 737 gpm (1.1 mgd). Wells of equal, or larger, capacity could be drilled to meet the anticipated 1990 municipal water needs. Future wells may reasonably be expected to yield up to 2 mgd each but should be spaced at sufficient distance from each other to keep pumping interference and pumping costs at a minimum.
City of Burlington	Very Good	Sand and gravel deposits along the north shore of Echo Lake are a potential source of municipal supply in this area and could be used to meet future municipal supply requirements. Wells could be located to induce recharge from the surface water sources. A lesser amount of water is available from sand and gravel deposits located southwest of City Well No. 8 in the NE 1/4 of Section 6, Town 2, North, Range 19 East. Along the White and Fox Rivers, the sand and gravel deposits are thin and offer little water supply potential.	Very Good	The Niagara dolomite aquifer is less than 100 feet below the surface and is about 130 feet thick in this area. Large-diameter wells penetrating the full thickness of the aquifer are usually capable of producing 250 gpm (0.36 mgd). Pollutants may enter wells located near the White River and along the Fox River southeast of the city where the rock crops out.	Very Good	The sandstone aquifer is a dependable source of good-quality water to meet the anticipated 1990 municipal water requirements of this area. The aquifer lies about 620 feet below the land surface and is estimated to be more than 1,800 feet thick. City Well No. 8, located in the NE 1/4 of Section 6, Town 2 North, Range 19 East, tapping 859 feet of the aquifer, may be typical of well yields. The well was tested at 1,300 gpm (1.9 mgd). Some wells pass through large crevices in the Trempealeau Formation and are capable of even greater well yields. The practice of spacing deep wells evenly about the edge of the city should be continued to minimize future well interference.
Village of Eagle	Fair	Sand and gravel deposits located in the southeastern half of the village are a potential source of municipal supply in this area. The well-drained outwash in that area indicates a high recharge rate. The saturated thickness of the glacial deposits is probably between 50 and 75 feet. Test drillings are needed.	Poor	The Niagara dolomite aquifer is not present.	Very Good	The top of the sandstone aquifer is 500 feet below land surface in Village Well No. 1, located in the NW 1/4 of Section 22, Town 5 North, Range 17 East. A well penetrating the full thickness of the aquifer, estimated as 1,100 feet, may be expected to yield 1 mgd. The present village well penetrates 380 feet of the aquifer, and it was tested at 0.37 mgd.
Village of East Troy	Very Good	The sand and gravel aquifer located northwest of the village and along Honey Creek has a water supply potential in excess of the anticipated 1990 needs. Part of the recharge to the aquifer is induced from Honey Creek. Future wells should be drilled at least 500 feet from the stream to reduce the pollution potential. The iron content of water near the base of the aquifer may be objectionable.	Poor	The Niagara dolomite aquifer is not present.	Very Good	The sandstone aquifer begins at a depth of about 600 feet and is at least 1,500 feet thick beneath this area. Dependably high well yields, nearness of recharge area, safety from pollution, and lack of heavy pumpage make this a desirable water source. Water in this aquifer is less mineralized than water from the sand and gravel aquifer.

Table 53 (continued)

Pumping Center	Sand And Gravel Aquifer		Niagara Dolomite Aquifer		Sandstone Aquifer	
	Well Yield Potential	Description	Well Yield Potential	Description	Well Yield Potential	Description
City of Elkhorn	Very Good	A sand and gravel aquifer up to 80 feet thick has been penetrated by several wells in the city. One of the wells, 800 feet north of the water works, was tested at 480 gpm (0.7 mgd). The aquifer is confined beneath a thick cover of glacial till. Increased use of this aquifer would reduce future well construction and pumping costs.	Poor	The Niagara dolomite aquifer, present only in the eastern quarter of the city, has little potential as a municipal water supply source.	Very Good	Good-quality water is available from the sandstone aquifer in amounts surpassing the anticipated 1990 needs of the area. The sandstone aquifer begins at a depth of about 640 feet in city wells and is estimated to reach a total thickness of over 1,300 feet. The aquifer is finer grained and less productive than in most other parts of the Fox River watershed. This is largely offset by the proximity of the recharge area. A 1,500-foot municipal well, drilled in 1962, was tested at 1,001 gpm (1.4 mgd). Well interference is high. Future wells need to be more widely spaced and closer to the recharge area located west of the city.
Village of Fontana	Very Good	A water supply large enough to meet the anticipated 1990 needs is probably vailable from sand and gravel deposits underlying the area. Locating good aquifers in these deposits, which may be as much as 500 feet thick, requires considerable test drilling. Village wells have been tested at 250 gpm (0.36 mgd) and 508 gpm (0.73 mgd), and are between 130 and 138 feet deep. The water is very hard and has a low-iron content.	Poor	The Niagara dolomite aquifer is not present.	Very Good	A large, dependable supply of good-quality water could be developed from the sandstone aquifer, although no well in the area now uses this water source. The sandstone aquifer begins 550 to 750 feet below the surface and is estimated to be 1,300 feet thick. The village is located on the edge of the recharge area.
Village of Genoa City	Very Good	Water supplies large enough to meet the anticipated 1990 needs are available in the sand and gravel deposits. A 96-foot public supply well drilled in 1966 was tested at 530 gpm (0.76 mgd). The aquifer lies in a half-mile wide glacial drainageway that crosses beneath the village from north to south.	Poor	The Niagara dolomite aquifer is only about 40 feet thick in this area and cannot be considered a major source of water.	Very Good	The sandstone aquifer begins about 690 feet beneath the surface and is nearly 2,000 feet thick. Well yields increase as the depths of the wells increase and can exceed 1 mgd. Very little local use is made of the aquifer. Water levels are declining about four feet per year, largely because of pumpage in northeastern Illinois. Saline water may be found in wells over 2,000 feet deep.
City of Lake Geneva	Very Good	Large supplies of water are available from shallow sand and gravel deposits at Lake Geneva because of induced recharge from the White River. City Well No. 3, located 250 feet from the White River, produced 2,300 gpm (3.3 mgd) from a 90-foot thick aquifer. Similar wells can be added to the system as water needs increase. All wells yield very hard water containing iron in excess of the drinking water standards used by the U. S. Public Health Service, 0.3 mg/l.	Poor	The Niagara dolomite aquifer is present under a small area on the northwestern side of the city. It is not used as a source of municipal supply.	Very Good	The top of the sandstone aquifer lies 600 feet beneath the land surface and is estimated to be more than 1,400 feet thick. The quantity of water available from this aquifer exceeds the expected 1990 needs. In 1966 the aquifer received almost no local use. Regional pumpage, however, causes water level declines of about four feet per year.
Village of Lannon	Poor	The sand and gravel aquifer is not suitable for municipal water supply requirements.	Poor	The Niagara dolomite aquifer is the principal source of water in this area for privately owned wells. The aquifer is exposed or is only a few feet below the land surface in most of the village. Because contaminants can move rapidly through this rock, a severe threat exists to public health and welfare from water-borne diseases and noxious chemicals from surface sources. State and county health authorities recommend the use of private wells in the aquifer be discontinued and the establishment of a water utility and construction of a public water supply system. The village is not served by a public sewerage system.	Very Good	The sandstone aquifer is estimated to be about 650 feet in thickness at the center of the village. No well is known to be using this aquifer in the area. Based on nearby wells, however, this aquifer can yield up to 700 gpm (1 mgd) to each well and provide a dependable source of water if a municipal system is established. Deep wells, cased and grouted from the land surface to the Platteville-Galena aquifer, would rarely, if ever, receive contaminants.

Table 53 (continued)

Pumping Center	Sand And Gravel Aquifer		Niagara Dolomite Aquifer		Sandstone Aquifer	
	Well Yield Potential	Description	Well Yield Potential	Description	Well Yield Potential	Description
Village of Menomonee Falls[b]	Poor	Sand and gravel deposits are found in about 40 percent of the wells in the Fox River part of Menomonee Falls, but they are rarely used as a source of water. The deposits average less than 10 feet in thickness, and in no place are they known to be more than 50 feet in thickness. Sand and gravel deposits, therefore, have a low potential for meeting future municipal water requirements at Menomonee Falls.	Fair	The Niagara dolomite aquifer is the principal source of small-to-moderate-sized water supplies in the area. Nearly all of the water is supplied by privately owned wells that average about 160 feet in depth but which may be as deep as 350 feet. The highest-capacity well in this aquifer, located at Menomonee Park, was tested at 125 gpm (0.18 mgd): but a well just beyond the watershed boundary was tested at 320 gpm (0.46 mgd). Contamination is a serious threat in the use of this aquifer, especially in the area west of the Fox River where the rock crops out.	Very Good	The sandstone aquifer could be a major source of water in the area, but it is tapped by only one well, Village Well No. 5. That well, located near the Community Memorial Hospital, in the SW 1/4 of Section 9, Town 8 North, Range 20 East, was drilled to 1,375 feet through 634 feet of the aquifer and was tested at 1,025 gpm (1.5 mgd). The wells must be spaced at sufficient distance to reduce pumping interference; and if this practice is followed, the aquifer should be able to meet municipal water requirements for many years after 1990.
Village of Mukwonago	Very Good	Sand and gravel in the northwestern and southern parts of the village have a high potential for meeting the future water requirements. The best of these deposits fill a buried bedrock valley that crosses beneath the northwestern corner of the village and may be nearly 400 feet in thickness in some places. The water from these deposits reportedly contains up to 3 mg/l iron. This high-iron content requires treatment before use because it causes taste, odor, and staining problems.	Poor	The Niagara dolomite aquifer is thin and only present in a small part of the eastern half of the village. Small-to-moderate well yields are generally available but not enough to dependably meet future municipal requirements at Mukwonago.	Very Good	The sandstone aquifer is the principal source of water supply at Mukwonago. In Unit Well No. 3, located in the SE 1/4 of Section 23, Town 5 North, Range 18 East, the top of the sandstone is at a depth of 650 feet. This well penetrated 850 feet of the aquifer, about half of its full thickness, and was tested at 900 gpm (1.3 mgd). Similar wells can be drilled as municipal water requirements increase. Water levels in the aquifer are falling only one to two feet per year, a relatively low rate in the watershed, because of the nearness of the recharge area and the distance to large pumping centers.
City of Muskego[b]	Very Good	Sand and gravel deposits are found in about 90 percent of the wells in this area. These deposits are estimated to be the source of water for nearly half of the existing wells. The sand and gravel deposits average about 60 feet in thickness but range upward to about 300 feet in the northwestern quarter of the city. Only small water supplies have been developed from sand and gravel located in a deeply buried prehistoric river valley that extends beneath the city from northwest to southeast. The valley, up to four miles wide, is largely filled by clay-rich glacial till. Even though they have a wide range in thickness and may be interbedded with fine-grained material, the sand and gravel deposits have local potential as a source of water supply at rates up to about 500 gpm (0.7 mgd). As these deposits are found in the drilling of new wells, they should be tested for yield.	Very Good	The Niagara dolomite aquifer is a major source of small-to-moderate-sized water supplies in the area. Most of the wells using this aquifer are privately owned. They average about 275 feet in depth but may be as deep as 450 feet. The largest-capacity well in the area tapping the Niagara dolomite aquifer was tested at 134 gpm (0.19 mgd). Wells yielding up to 250 gpm (0.36 mgd) from this source probably could be drilled. The aquifer is missing or only a few feet thick in the buried valley that crosses beneath Muskego from northwest to southeast. The most productive portions of this aquifer probably occur in the area north of STH 24 and in the vicinity of Lake Denoon.	Very Good	The sandstone aquifer is a major potential source of water in this area, but it is being used by fewer than five wells in the city. The largest of these wells is located at Muskego High School. The school well penetrates only 250 feet of the approximately 1,700 feet of sandstone estimated to underlie the site and has been pumped at 200 gpm (0.29 mgd). Wells producing more than 700 gpm (1.0 mgd) of good-quality water could be drilled as the need arises.

Table 53 (continued)

Pumping Center	Sand And Gravel Aquifer		Niagara Dolomite Aquifer		Sandstone Aquifer	
	Well Yield Potential	Description	Well Yield Potential	Description	Well Yield Potential	Description
City of New Berlin[b]	Very Good	Sand and gravel deposits are encountered in the drilling of about 85 percent of the wells in this area, but they are seldom used as a source of water supply. In a sample of the wells, these deposits average about 50 feet in thickness. In the southwestern quarter of the city, the total thickness of sand and gravel is reported to be as much as 185 feet. Of this amount about 130 feet are saturated with water. Even though the sand and gravel deposits have a wide range of thickness and may be interbedded with fine-grained material, they have local potential as a source of water supplies up to about 500 gpm (0.7 mgd). As these deposits are found in the drilling of new wells, they should be tested for yield.	Very Good	The Niagara dolomite aquifer is the principal source of small-to-medium-sized water supplies in the area. Most of the water comes from privately owned wells that average about 160 feet in depth but may be as deep as 400 feet. Only five high-capacity wells tap this aquifer in the area, all to supply subdivisions. One such well, located in Section 14, Town 6 North, Range 20 East, has been pumped at up to 675 gpm (1.0 mgd). The average yield of large wells in this aquifer, however, is generally half of this rate. No widespread dewatering of this aquifer is expected if this aquifer is used as the principal source of water supply by 1990.	Very Good	The sandstone aquifer is a dependable source of water in the area but is tapped by very few wells. The largest of these wells was drilled to a depth of 1,800 feet in 1966 to supply water for the industrial park located in the SE 1/4 of Section 3, Town 6 North, Range 20 East. This municipal well penetrated 1,022 feet of the approximately 1,600 feet of sandstone estimated to underlie the site and has been pumped at 1,000 gpm (1.4 mgd). Wells of equal size and capacity can be drilled in New Berlin as the need increases.
Village of North Prairie	Poor	The sand and gravel aquifer beneath the village is not a dependable source of good quality water for municipal requirements. The aquifer is less than 30 feet thick, interbedded with silt and clay, and subject to frequent contamination from surface sources.	Very Good	The Niagara dolomite aquifer is an important source of water in the area. The amount of water from local recharge and flow from surrounding areas is estimated to be about four times the anticipated water requirements of 1990. The aquifer is 50 to 75 feet beneath the land surface and is about 75 feet thick. A village well, drilled in 1962 in the SE 1/4 of Section 31, Town 6 North, Range 18 East, for fire protection was tested at 602 gpm (0.87 mgd).	Very Good	The sandstone aquifer, located from 580 to about 1,700 feet below the surface, can provide water in quantities far in excess of estimated 1990 needs. Wells can be drilled that yield 1 mgd each of good-quality water. No well in the area is known to be using this aquifer.
Village of Pewaukee	Poor	No major sand and gravel aquifer is present in the village.	Very Good	Maximum well yields averaging about 250 gpm (0.36 mgd) may be expected from the Niagara dolomite aquifer at Pewaukee. The aquifer has limited value as a source of drinking water, however, because of the locally high contamination potential. The rock, which is about 150 feet thick, crops out or is within a few feet of the surface in several parts of the village. Heavily pumping wells near Pewaukee Lake or Pewaukee River would divert water from them.	Very Good	The sandstone aquifer, located 600 to 1,315 feet beneath the land surface near the center of the village, has been the only source of water supply since 1930. Wells are apparently capable of yielding up to 700 gpm (1 mgd) each. Contamination from surface sources is rarely a problem in the use of the sandstone aquifer. Wells tapping the sandstone should, however, be cased and grouted from the surface to the top of the Platteville-Galena aquifer. To reduce interference due to heavy pumping, deep wells should be located at least 2,000 feet apart.
Village of Silver Lake	Very Good	Up to 50 feet of saturated sand and gravel underlie the southern half of the village. Large quantities of water could be obtained from this source using large-diameter vertical wells or collector-type wells. Protection of this water source from contamination would be a major problem because the water table is only a few feet below the land surface and the aquifer underlies the most intensely developed area of the village. A sewerage system recently installed, however, should eliminate much of the contamination potential. Nearby surface water would provide recharge to heavily pumping wells.	Very Good	The Niagara dolomite aquifer is the most common source of private water supplies in the area. The aquifer is about 150 feet below the surface and is about 50 feet thick. No high-capacity wells are known to have been drilled here; but, based on nearby wells, the aquifer should be capable of yielding at least 250 gpm (0.37 mgd) per well. There is little chance of contamination of this water source if well construction and pump installation are according to the state codes.	Very Good	The sandstone aquifer begins 700 feet below the village and is estimated to be about 2,100 feet thick. It is a dependable source of good-quality water that can yield more than 1 mgd per well. No well in the village is presently known to use this aquifer. Water quality is generally adequate for municipal use, but water of inferior quality may be present near the base of the aquifer.

Table 53 (continued)

Pumping Center	Sand And Gravel Aquifer		Niagara Dolomite Aquifer		Sandstone Aquifer	
	Well Yield Potential	Description	Well Yield Potential	Description	Well Yield Potential	Description
Village of Sussex	Poor	No sand and gravel aquifer is available at Sussex to meet possible municipal requirements. A buried bedrock valley in the western half of the village is partly filled by sand and gravel but this deposit is unlikely to supply water to wells at rates greater than 50 gpm (0.07 mgd).	Poor	The Niagara dolomite aquifer is the principal source of water in this area for privately owned wells. The aquifer is exposed or is only a few feet below the land surface in the eastern and southwestern parts of the village. Because contaminants can move very rapidly through this rock, a severe threat exists to public health from water-borne diseases and noxious chemicals from surface sources. State and county health authorities recommend the use of private wells in this aquifer be discontinued and the establishment of a water utility and construction of a public water supply system. The village is served by a public sewerage system.	Very Good	The sandstone aquifer was reached at a depth of 695 feet in a subdivision well located in the SE 1/4 of Section 22, Town 8 North, Range 19 East, and was estimated to be 590 feet thick. This well was tested at 560 gpm (0.8 mgd). Wells of similar construction spaced no closer than 2,000 feet to each other could meet the anticipated 1990 water needs of the village. The piezometric surface is about 325 feet below the land surface and is falling at about three feet per year because of regional pumping of deep wells. Wells cased and grouted from the land surface to the Platteville-Galena aquifer would rarely, if ever, receive contamination from the surface.
Village of Twin Lakes	Very Good	Water in quantities large enough to meet the projected 1990 needs of the village are available from sand and gravel deposits. They make up nearly half of 150 to 250 feet of glacial deposits that underlie Twin Lakes. Beneath the heavily populated area at the north end of Marie Lake, these deposits are about 170 feet thick. Locating an aquifer to supply a high-capacity well will require test drilling because of varying grain size and sorting that are characteristic of these deposits. Hard but otherwise good quality water is present.	Fair	The Niagara dolomite aquifer is a relatively unimportant source of water because it is thin and only present in parts of the village. It is unlikely that more than 100 gpm (0.14 mgd) per well can be obtained from this aquifer.	Very Good	The sandstone aquifer can provide a large and dependable supply of good-quality water for a municipal system. The aquifer begins about 700 feet below the north end of Lake Marie and is estimated to be more than 2,000 feet thick. In 1966 this aquifer received almost no local use. Regional pumpage, however, causes water-level declines of about four feet per year.
Village of Waterford	Poor	No major sand and gravel aquifer is known to occur in the area, and nearly all the wells tap bedrock aquifers. Below the water table the sand and gravel are poorly sorted, generally less than 40 feet thick, and of small areal extent.	Very Good	The Niagara dolomite aquifer lies about 50 feet below the Fox River at Waterford and is about 100 feet thick. Large-diameter wells yield up to 250 gpm (0.36 mgd), depending upon the crevices encountered during drilling. This aquifer was the source of all the municipal water for 50 years until a well in the sandstone aquifer was put into service. The shallow wells were drilled about 30 feet from the river and were in constant danger of contamination. One of these wells is still in use.	Very Good	The sandstone aquifer is 660 feet below the surface at a village well, where it is estimated to reach a total thickness of about 1,800 feet. Village Well No. 2 penetrated 860 feet of the aquifer and had a tested yield of 508 gpm (0.73 mgd) in 1965. Additional wells can be drilled into this dependable source of water as municipal needs increase.
City of Waukesha	Very Good	Sand and gravel deposits along the Fox River south of the city are a potential source of water. Individual well yields may range up to 3 mgd. The chemical quality is expected to be similar to the water presently used from the sandstone aquifer. The adequacy of the supply from this source is largely unproven, however; and test drilling and pumping would be required. The water supply potential of the sand and gravel deposits would be greatly increased if a proposed lake were created in the Vernon Marsh wildlife area southwest of the city.	Fair	The Niagara dolomite aquifer lies between 0 and 275 feet below the surface in the vicinity of Waukesha. Yields up to about 500 gpm (0.72 mgd) are possible but unusual, and many large-diameter wells can be pumped at only a few gallons per minute. The maximum yield of the aquifer per well probably averages about 100 gpm (0.14 mgd). The water is very hard, and objectionable amounts of iron are present in many wells. Pollution is an increasing problem in this aquifer.	Very Good	The sandstone aquifer is a dependable source of good-quality water in this area. Municipal wells range in depth from 1,835 to 2,141 feet and have an average pumpage rate of over 1,000 gpm (1.4 mgd) each. Two wells yield nearly 1,500 gpm (2.1 mgd) each. A new well, located about 2 miles southwest of the city in the SE 1/4 of Section 8, Town 6 North, Range 19 East, is 2,028 feet deep and was tested at 1,300 gpm (1.9 mgd). Similar wells located on the southwestern and western sides of the city could supply the anticipated water needs of this area to 1990.

Table 53 (continued)

Pumping Center	Sand And Gravel Aquifer		Niagara Dolomite Aquifer		Sandstone Aquifer	
	Well Yield Potential	Description	Well Yield Potential	Description	Well Yield Potential	Description
Village of Williams Bay	Very Good	Large quantities of water are available from the sand and gravel deposits, which range from 300 to 400 feet thick. About half of these deposits are sand and gravel. The newest village well, drilled in 1951, was tested at 700 gpm (1.0 mgd). The village treats the water from this source to improve its quality.	Poor	The Niagara dolomite aquifer is not present.	Very Good	The sandstone aquifer is not used in the village, although it contains a large, dependable supply of good-quality water. The aquifer lies 600 to 700 feet beneath the village and is estimated to be about 1,400 feet thick. The recharge area is nearby.
Village of Wind Lake	Fair	The sand and gravel deposits may be a dependable source of supply for a municipal water system; but, because they are interbedded with silt and clay beds, test drilling will be required. Sand and gravel deposits range between 10 and 60 percent of the 160 to 200 feet of glacial deposits beneath the village.	Very Good	The Niagara dolomite aquifer, 160 to 200 feet below the surface, is less than 50 feet thick. The meager information presently available suggests that the rock is highly creviced and well yields up to 300 gpm (0.43 mgd) are likely. Heavy pumping of wells in this aquifer would divert water from Wind Lake.	Very Good	The sandstone aquifer is a large and dependable source of good-quality water in excess of the 1990 needs of the village. The aquifer begins about 780 feet below the land surface and is estimated to be 1,700 feet in thickness. Wells tapping this aquifer can be expected to yield over 1,000 gpm (1.4 mgd). Regional pumping of deep wells, particularly in the Milwaukee area, are causing water level declines of about three feet per year. No well in the village is presently tapping the sandstone aquifer.
Wind Lake Irrigation Area	Poor	The sand and gravel deposits average about 150 feet in thickness beneath this pumping center but include only a few feet of sand and gravel. None of the approximately 20 irrigation wells in use in 1966 obtained its entire supply from these deposits. It is unlikely that the sand and gravel aquifer will yield more than 50 gpm (0.07 mgd) per well in this area.	Very Good	The Niagara dolomite aquifer, located 150 to 300 feet below the general land surface, is the principal source of ground water for irrigation. Wells are located in the recharge area of this aquifer, and some wells are capable of yielding up to 1,500 gpm (2.2 mgd), but the average is approximately 600 gpm (0.9 mgd). The aquifer could sustain greater use because water-level declines have been negligible. A large but undetermined amount of water used for irrigation is pumped from drainage ditches that cross the area and from pits located next to the ditches. Irrigators tend to use wells only during extended dry periods when water needs cannot be met by surface sources.	Very Good	The sandstone aquifer, located about 800 to 2,500 feet below the land surface, could provide more than 1 mgd of good-quality water to each well. Sources of irrigation water closer to the surface would be more desirable than this aquifer, however, because the shallow wells are cheaper. Water for irrigation purposes should be plentiful, of adequate quality, and inexpensive.

[a] *The Platteville-Galena aquifer is not considered in this table because it is inadequate for large water supplies anywhere within the basin.*

[b] *Includes only that part within the Fox River watershed.*

Source: U. S. Geological Survey and SEWRPC.

Table 54), of which 41 million gallons per average day, or 96 percent, could be expected to be required for municipal supply.

The adopted regional land use plan provides a basis for estimating the spatial distribution of this future water supply demand. The land use plan is based, in part, upon the premise that the water resources of the Region can be better managed and future water supply problems avoided if the urban population of the Region is concentrated in areas which can be readily served by public water utilities. Public water utilities in 1966 served 16 areas of the watershed: Brookfield, Burlington, Eagle, East Troy, Elkhorn, Fontana, Genoa City, Hartland, Lake Geneva, Menomonee Falls, Mukwonago, Pewaukee, Walworth, Waterford, Waukesha, and Williams Bay. New public utilities may be expected to be developed by 1990 in 10 areas of the watershed: Big Bend, Lannon, Muskego, New Berlin, North Prairie, Rochester, Silver Lake, Sussex, Twin Lakes, and Wind Lake. Although the deep aquifer can supply water of both an adequate quality and quantity to meet the anticipated total water supply for municipal or public utility use, the premises upon which the regional land use plan was, in part, based will be met only if this aquifer is carefully managed.

Table 54
ESTIMATED WITHDRAWAL OF WATER
IN THE FOX RIVER WATERSHED BY TYPE OF USE: 1990

Use	Principal Source Of Supply	Pumpage In Million Gallons Per Average Day			
		Shallow Aquifer	Deep Aquifer	Surface Water	Total
Public Supply	Ground Water	5.0	41.0	0.0	46.0
Self-Supplied Commerce and Industry	Ground Water	2.0	1.6	0.4	4.0
Domestic and Stock	Ground Water	5.7	0.3	1.0	7.0
Irrigation	Ground Water	6.0	0.0	2.0	8.0
Total		18.7	42.9	3.4	65.0

Source: U.S. Geological Survey and SEWRPC.

Water levels in the deep aquifer have declined by more than 200 feet within parts of the Fox River watershed since the first well was tapped into this aquifer approximately 100 years ago and by more than 300 feet at Milwaukee and 700 feet at Chicago. Present pumpage from this aquifer is causing the water level to continue to decline at the rate of about three to four feet per year in the Racine and Kenosha County portions of the watershed, one to four feet per year in the Waukesha County portion of the watershed, and one to three feet per year in the Walworth County portion of the watershed.

The declines in the water level within this aquifer result from two related causes, regional pumpage located outside the Fox River watershed, primarily in the Chicago and Milwaukee urbanized areas, and local pumpage within the watershed concentrated primarily in Waukesha County. The anticipated declines in the water levels of the deep sandstone aquifer, as shown on Map 13, reflect the effects of both regional and local current and anticipated future pumpage. The greatest declines due to regional pumpage alone are expected to occur along the eastern edges of the watershed. Although these regional declines may be expected to be negligible in central Walworth County, they may be expected to exceed 100 feet by 1990 in central Kenosha County. With the added effects of anticipated local pumpage, total declines in central Kenosha County may be expected to approximate 200 feet.

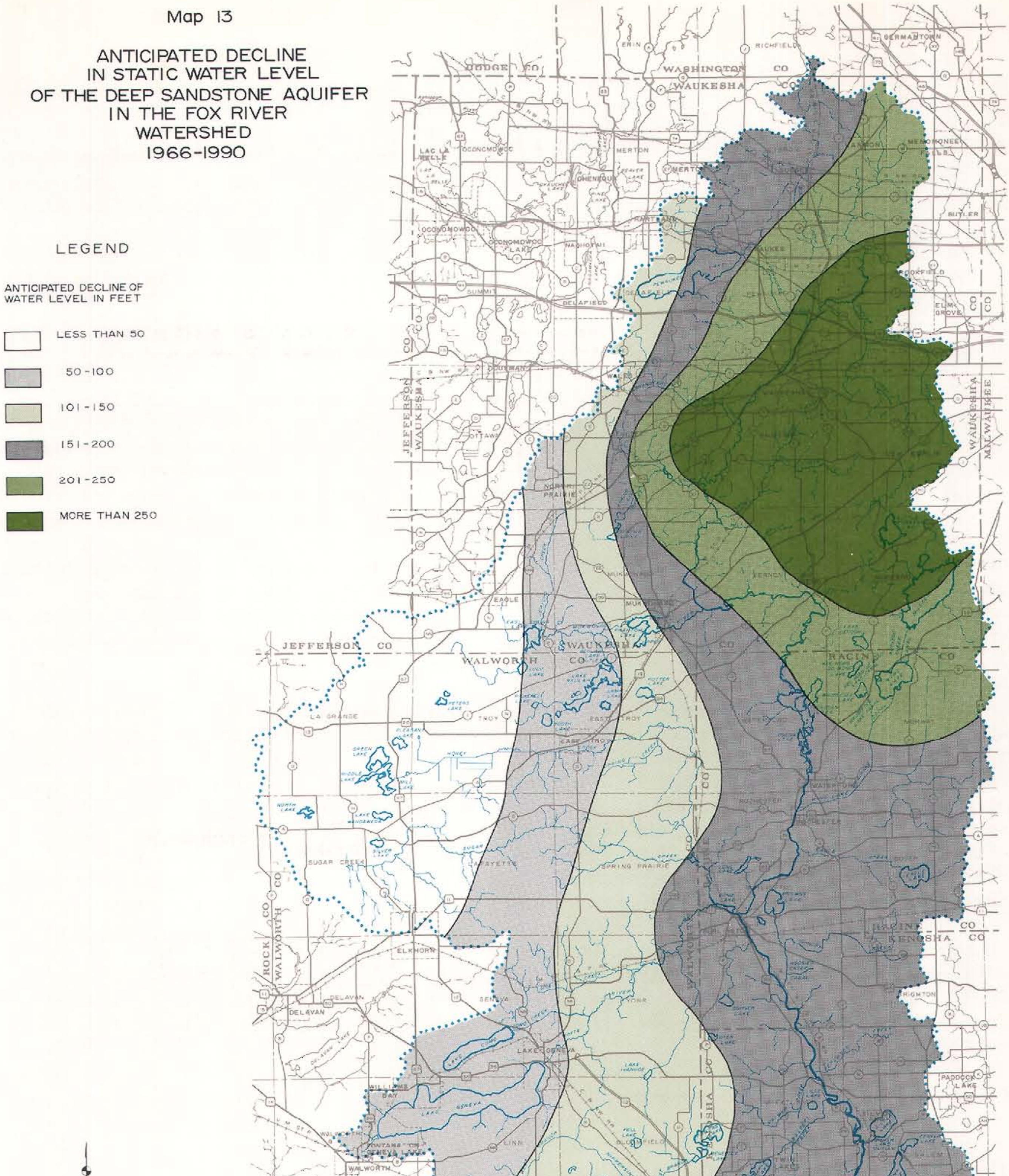
Local pumpage by 1990 may be expected to be heaviest in east central Waukesha County where the greatest declines in water levels may be expected. The effects of the increased demand for, and pumping of water from, the deep aquifer in the Brookfield, Menomonee Falls, Muskego, New Berlin, and Waukesha areas, when added to the effects of the increased regional pumpage, may cause water level declines of more than 250 feet between 1966 and 1990.

This relatively rapid decline in the water level of the deep aquifer provides a warning of the need for a sound water resource management program. Although an adequate supply of ground water is available within the deep aquifer to meet the anticipated needs, the water supply premises, upon which the regional land use plan was in part based, will be met only if this source of supply is carefully managed. In the absence of good water management practices, concentration of population and wells in major pumping centers will result in local water supply problems, an accelerated decline in water levels, and increased pumpage costs. In addition to careful attention to the proper location and spacing of wells tapping the aquifer, contamination of this aquifer will have to be carefully guarded against in any sound management program.

Proper utilization of the deep sandstone aquifer requires that well interference be held to a minimum. Areas of the watershed in which the local municipalities in the Fox River watershed could locate wells for public supply, minimize well interference, and take advantage of anticipated

Map 13

ANTICIPATED DECLINE IN STATIC WATER LEVEL OF THE DEEP SANDSTONE AQUIFER IN THE FOX RIVER WATERSHED 1966-1990



Water levels in the deep sandstone aquifer have declined by more than 200 feet within parts of the Fox River watershed since the first well was tapped into this aquifer about 100 years ago. At the present time, pumpage from this aquifer is causing the water level to decline at rates varying from one to four feet per year throughout the watershed. This map shows the anticipated declines in the water levels of the deep sandstone aquifer by 1990. These anticipated declines reflect the effects of both current and anticipated future pumpage. The greatest declines are expected to occur along the eastern edges of the watershed due primarily to regional pumpage and in east central Waukesha County due to heavy local pumpage. The increased demand for water from the deep aquifer due to increased regional and local pumpage may cause water level declines of more than 250 feet in some areas of the watershed by 1990.

Source: U. S. Geological Survey and SEWRPC.

minimal water level declines are indicated on Map 14.

The Waukesha Pumping Center

The heaviest pumping center in the Fox River watershed is located in the City of Waukesha area. Water use by the City of Waukesha is expected to increase from 6.5 mgd in 1966 to about 19.7 mgd in 1990, almost tripling. The sandstone aquifer, however, is believed capable of meeting this future demand. In 1966 seven wells tapping the sandstone aquifer and ranging in depth from 1,835 to 2,141 feet provided the municipal water supply. At the end of 1967, an eighth well was drilled to a depth of 2,028 feet to serve the city. By 1990 the Waukesha area may need a total of 20 wells of this same type, an increase of 12 over the present number.

In November 1966 pumping wells at Waukesha drew water in the sandstone aquifer from an area of about 260 square miles. Most of the water moved from the recharge area located in western Waukesha County to the pumping wells. A small amount of water moved westward toward Waukesha from the Brookfield and New Berlin areas. The more productive parts of the sandstone aquifer are located to the south and southwest of the city toward the recharge areas in the western portions of the Region. The less productive parts of this aquifer are located west and northwest of the city where a subterrannean area of high crystalline rock restricts the movement of water in the sandstone aquifer. As a consequence, the area south or southwest of the city appears to be the most favorable for the development of new municipal wells. Placement of wells easterly of the areas indicated would increase competition for the available water by increasing well interference and would aggravate problems associated with declining water levels.

Other centers of concentrated pumpage within the remainder of the watershed are not likely to interfere seriously with each other, even though all use the deep sandstone aquifer. The location of new wells for these centers as far westerly as possible would, however, also be advantageous in order to minimize the effects of declining water levels.

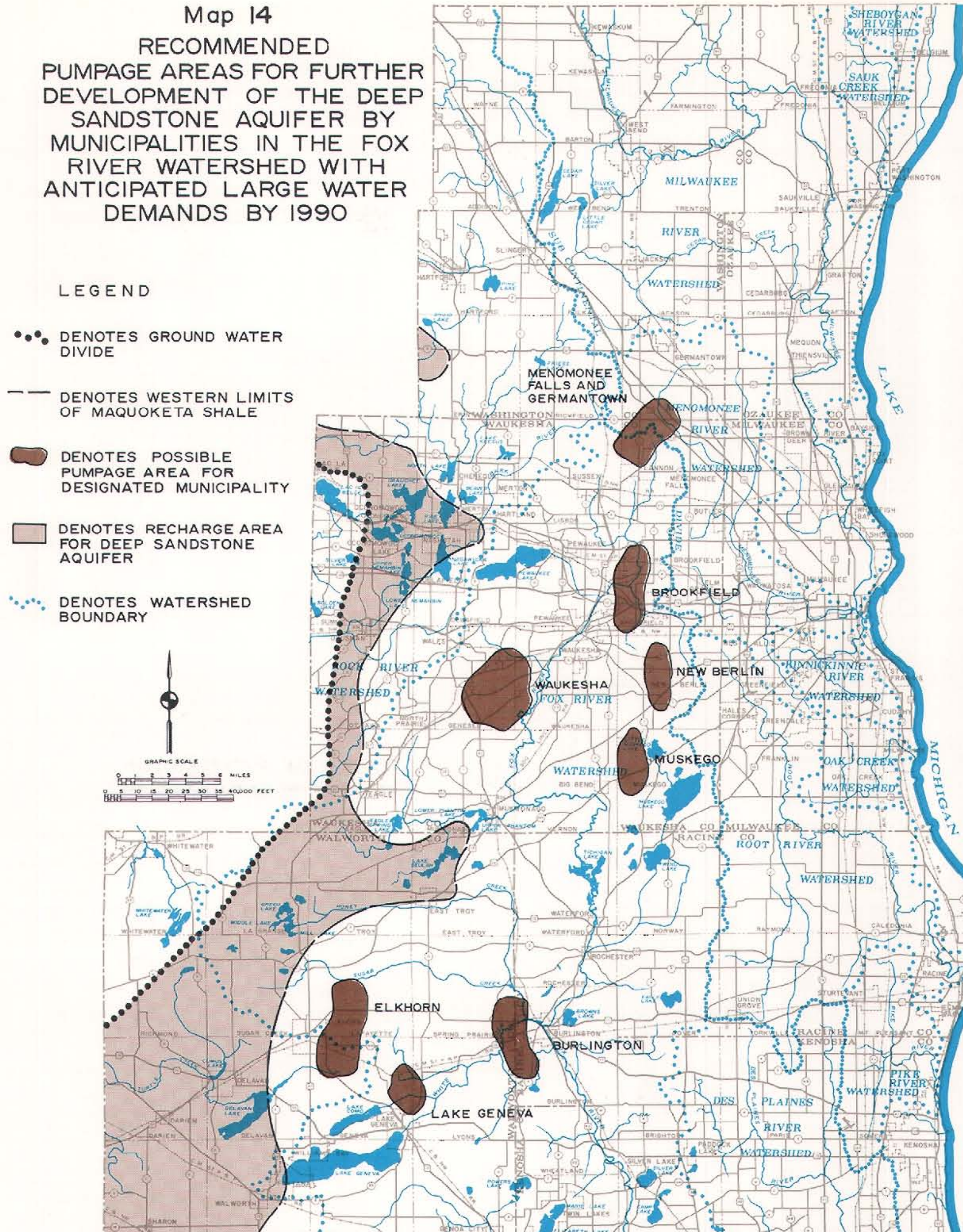
Interference between wells in areas of concentrated pumpage in Waukesha County can be estimated from Figures 38 and 39, which indicate the relation between drawdown and distance from the recharge area of pumped wells. The effects of locating a well either toward or away from the recharge area is also apparent from these figures; greater drawdowns may be expected to occur at greater distances from the recharge area. The upper limb on each curve indicates the drawdown which may be expected along a line from the well directly toward the recharge area, while the lower limb indicates the drawdown to be expected along a line from the well directly away from the recharge area. For example, Figure 38 indicates that, if a well located 10 miles from the recharge area is pumped for a period of five years at an average rate of 1 million gallons per day, the expected drawdown at a distance of one mile from the well in a direction toward the recharge area may be expected to be approximately 19 feet. Figure 39 indicates that the drawdown would be approximately 24 feet at a distance of one-half mile from the well in a direction toward the recharge area. As already noted, increased drawdowns necessitate higher pump lifts and generally increase cost of pumping. Increased drawdowns may also necessitate deeper wells.

SHALLOW AQUIFER GROUND WATER SUPPLY

Unlike the deep sandstone aquifer, which underlies the entire watershed, sand and gravel deposits and the Niagara dolomite bedrock, which together comprise the shallow aquifer, underlie only portions of the watershed and, as indicated in Table 53, range widely in value as a source of water supply. Nevertheless, existing data indicate that the quantity of water present in the shallow aquifer underlying the watershed may also be expected to be adequate to meet the demands upon this aquifer as forecast through the plan design year of 1990. These demands may be expected to be constituted primarily of highly dispersed domestic and stock watering and irrigation needs. The estimated 3.8 inch per year average recharge rate of the shallow aquifer should be adequate to meet all existing and reasonable future uses of that source of supply except irrigation. Increased use of the shallow ground water aquifer for crop irrigation may, in the absence of a sound water resource management plan, result in some local water shortages and water supply conflicts.

The shallow sand and gravel deposits located southwest of the City of Waukesha form a potential water supply for the city, especially along the eastern side of the Fox River, which could be developed as a supplement to the deep aquifer

Map 14
RECOMMENDED PUMPAGE AREAS FOR FURTHER DEVELOPMENT OF THE DEEP SANDSTONE AQUIFER BY MUNICIPALITIES IN THE FOX RIVER WATERSHED WITH ANTICIPATED LARGE WATER DEMANDS BY 1990

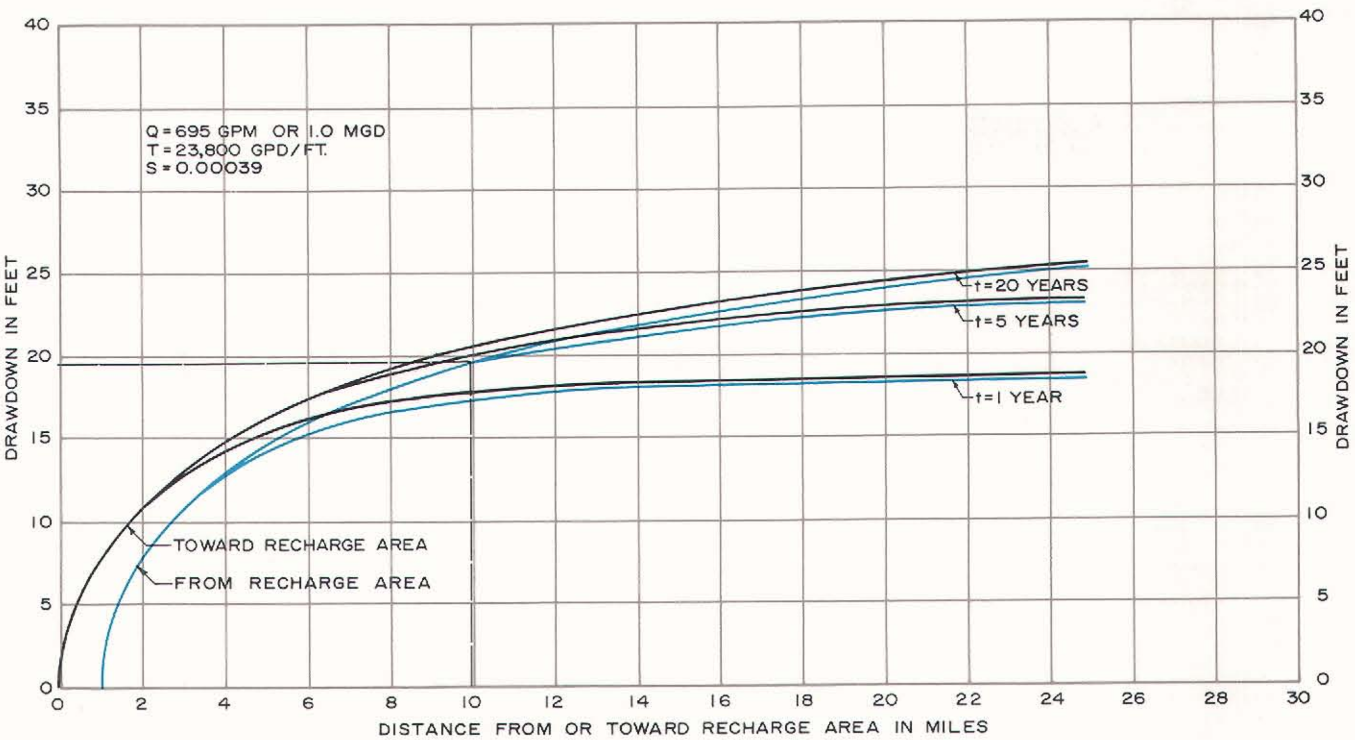


The declining water level of the deep sandstone aquifer provides a warning of the need for a sound ground water resource management program. Without good water management practices, concentration of population and wells in major pumping centers will result in local water supply problems, an accelerated decline of water levels, and in increased water pumpage costs. Careful attention must be paid to the proper location of wells tapping the deep aquifer and to guard against contamination of this aquifer. This map indicates areas of the watershed in which local municipalities could locate future wells for public water supply, minimize well interference, and take advantage of anticipated minimal water level declines.

Source: U. S. Geological Survey and SEWRPC.

Figure 38

RELATION OF DRAWDOWN TO DISTANCE FROM RECHARGE AREA AT ONE MILE DISTANCE FROM PUMPED WELL IN DEEP SANDSTONE AQUIFER, WAUKESHA COUNTY



Source: U. S. Geological Survey.

supply. The water would probably have to be chlorinated to protect against possible biological pollutants. Also, the cost of treating water from the sand and gravel deposits may be higher than treating water from the sandstone aquifer. The cost of drilling wells would be greatly reduced, however, because the wells used would be of shallow construction. Other engineering and economic factors would also need to be considered, including transmission costs. At least 95 percent of the water induced from the Fox River would be returned to the river after use, a small amount being lost to evaporation.

OTHER MINOR SOURCES OF SUPPLY

Surface water resources presently supply few consumptive water needs within the watershed except livestock watering. Small quantities of water are pumped from streams and ponds for irrigation, and an expanded use of surface water for this purpose may occur in the future. The largest lakes within the watershed could be utilized as sources of potable water, although no lakes are so used now. Water could be pumped either directly from the lakes or indirectly through induced recharge of well fields located near the lake shorelines. The advantage of the use of well fields would be that the lake water would be partially filtered when it reached the well. In all cases, however, the lake water would require treatment before delivery to a public water supply system. Any major use of lake water in this manner may be expected to result in serious conflicts with recreational water uses and is, therefore, not recommended.

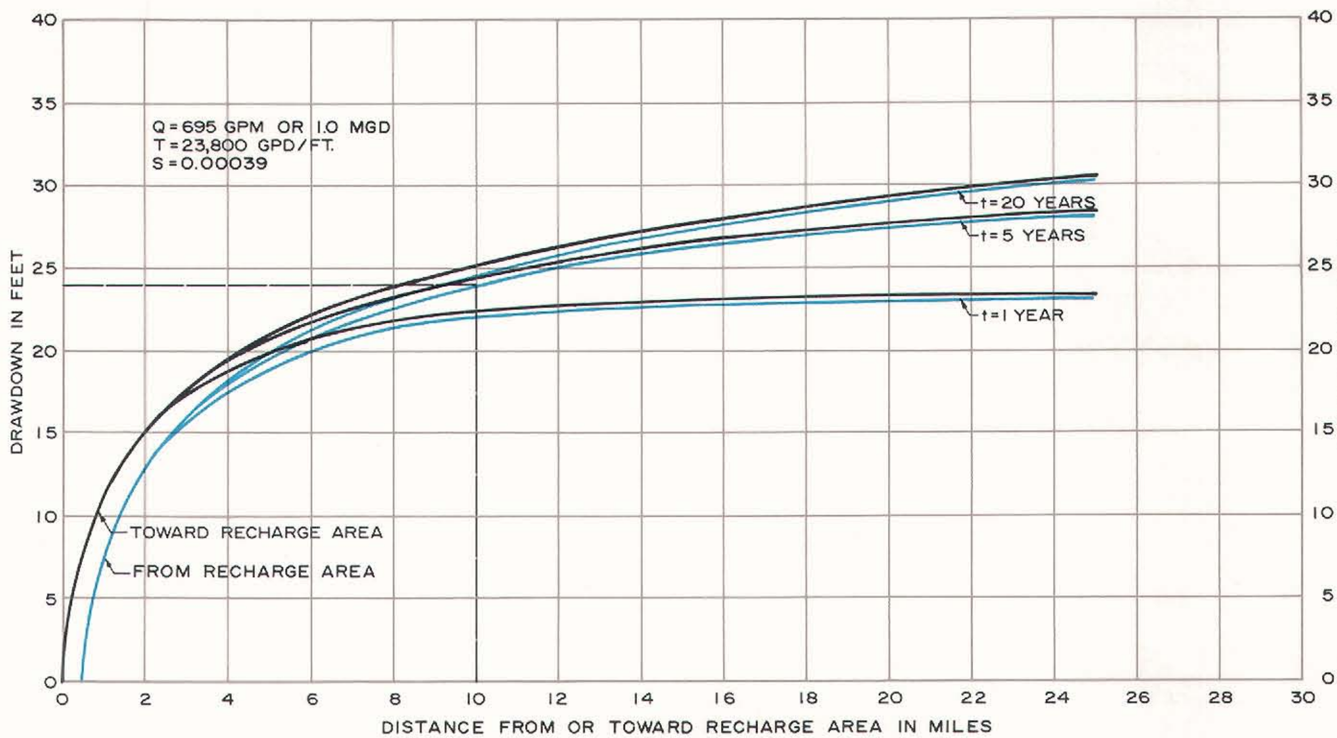
Stream water is presently used only for irrigation and cooling purposes within the watershed. A substantial increase in the amount of water withdrawn from streams for such uses is unlikely because the streams are shallow and the flow is highly variable. Moreover, since most streams within the watershed are also used for waste assimilation, treatment costs for uses other than irrigation and cooling could be expected to be high.

SURFACE WATER RESERVOIR SUPPLY PLAN

A major source of water supply could be created

Figure 39

RELATION OF DRAWDOWN TO DISTANCE FROM RECHARGE AREA AT ONE-HALF MILE DISTANCE FROM PUMPED WELL IN DEEP SANDSTONE AQUIFER, WAUKESHA COUNTY



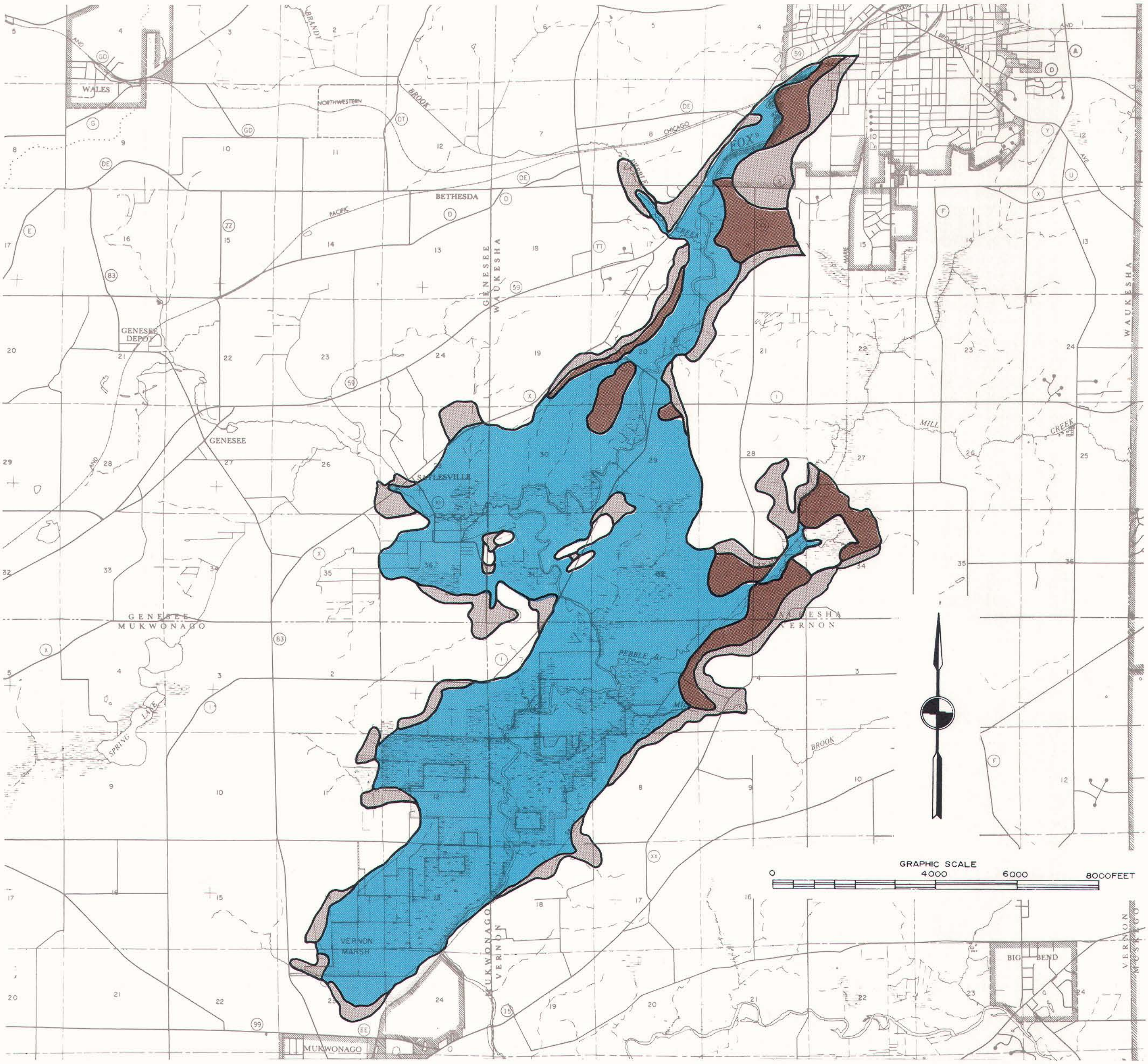
Source: U. S. Geological Survey.

within the watershed by damming the Fox River near the Soo Line Railroad crossing of the river in Section 24, Town 5 North, Range 18 East, in the Town of Mukwonago. The impoundment so created would flood the Vernon Marsh wildlife area, and the headwater pool would extend to the southwesterly limits of the City of Waukesha (see Map 15). The impoundment would be of a multipurpose type, with potential for flood protection, water quality control, and recreation, as well as for water supply utilization. Wells could be installed in areas near the proposed lake to obtain part of the additional municipal water supply needed to serve the growing Waukesha area. Possibly up to one-half of the future water demands of that area could be met by inducing infiltration from the reservoir into the shallow aquifer. Drilling and pumping tests, however, would be needed to determine the specific characteristics of the shallow aquifer and the quality of the water. Areas around the periphery of the proposed reservoir with soil conditions favorable to the installation of wells are indicated on Map 15. Wells installed in these areas to induce infiltration could yield up to 3 million gallons per day, or 2,000 gallons per minute each. The water would require treatment prior to transmission to the users.

A serious problem attendant to this proposal is posed by the discharge of large volumes of treated sewage effluent from the Waukesha sewage treatment plant to the river above the proposed reservoir. This plant in 1966 discharged treated effluent at an average rate of approximately 7 million gallons per day; and in order to protect the quality of the water in the reservoir for municipal use, it would probably be necessary, given the presently used methods of sewage treatment, to outlet this effluent below the proposed impoundment. If advanced waste treatment methods were utilized within the watershed, such "bypassing" of the treated effluent might not be essential on a purely objective basis, although psychological considerations and a historic pride by the City of Waukesha in the quality of its water supply might still politically dictate such a measure. This would require the construction of approximately seven miles of large-diameter

Map 15

POTENTIAL VERNON MARSH AREA WATER SUPPLY RESERVOIR
WAUKESHA COUNTY, WISCONSIN



LEGEND

- (brown) AREAS GENERALLY FAVORABLE FOR DEVELOPMENT OF WELLS YIELDING 500,000 TO 3,000,000 GALLONS OF WATER PER DAY PER WELL FROM SAND AND GRAVEL DEPOSITS. YIELDS WILL NORMALLY INCREASE TOWARD THE PROPOSED IMPOUNDMENT. AREAS ARE LARGELY COMPOSED OF OUTWASH AND DELTA DEPOSITS.
- (grey) AREAS GENERALLY FAVORABLE FOR DEVELOPMENT OF WELLS YIELDING 50,000 TO 500,000 GALLONS OF WATER PER DAY PER WELL FROM SAND AND GRAVEL DEPOSITS. YIELDS ARE INFLUENCED BY THE PERMEABILITY OF THE MATERIAL, THE DISTANCE TO THE PROPOSED LAKE, THE DISTANCE TO LESS PERMEABLE DEPOSITS, AND THE SATURATED THICKNESS. LOCALLY HIGH YIELDS MAY BE OBTAINTED FROM SAND AND GRAVEL LYING BENEATH A COVER OF LESS PERMEABLE SEDIMENTS. AREAS ARE LARGELY COMPOSED OF FINE-GRAINED ICE-CONTACT, OUTWASH, AND LAKE DEPOSITS.
- (white) AREAS WITHIN ONE-HALF MILE OF THE PROPOSED IMPOUNDMENT THAT ARE GENERALLY UNFAVORABLE FOR DEVELOPMENT OF LARGE WATER SUPPLIES IN SAND AND GRAVEL DEPOSITS. SUPPLIES MAY BE SUFFICIENT FOR STOCK AND DOMESTIC USAGE. AREAS CONTAIN TILL OR OTHER FINE-GRAINED SEDIMENTS AT OR NEAR THE SURFACE.
- (blue) PERMANENT POOL OF WATER SUPPLY RESERVOIR

By damming the Fox River near the Soo Line Railroad crossing in the Town of Mukwonago, an impoundment would be created that would flood the Vernon Marsh wildlife area with the headwater pool extending to the southwesterly limits of the City of Waukesha. Such an impoundment could constitute a major source of water supply for the greater Waukesha area. In addition, the impoundment would have potential flood protection, water quality control, and water-based recreation benefits. Although the development of this alternative surface water supply appears uneconomical at this time in terms of capital investment costs alone, the proposal deserves to be reconsidered and reevaluated as urban development continues within the watershed. To retain full flexibility in the future development of the land and water resources of the watershed, therefore, the land required for the reservoir should be maintained in open-space use.

Source: U. S. Geological Survey and SEWRPC.

sewage outfall pipe at an estimated cost of over $2 million. Total capital investment costs required to develop the additional source of supply are estimated at $6.9 million, including the acquisition of 8,000 acres of land for the reservoir at a total estimated cost of $2.4 million; the construction of a water transmission main from the well fields to the City of Waukesha at an estimated cost of $1 million; and the cost of constructing 10 shallow wells estimated at $1.5 million, all in addition to the cost of constructing the sewage outfall.

The capital investment of $6.9 million required to develop the surface supply compares with a total estimated capital investment of approximately $4 million associated with the continued development of the deep sandstone aquifer. The latter capital cost estimate is based upon the construction of 12 new deep wells and includes the cost of well construction, estimated at approximately $200,000 per well; the cost of acquisition of the well sites, estimated at approximately $10,000; and the cost of an average of 6,000 feet of transmission main per well, estimated at a total of $1.5 million.

Although the development of alternative surface water supply within the watershed appears uneconomical at the present time in terms of capital investment cost alone, the proposal deserves reconsideration and reevaluation as development continues within the watershed. The economic feasibility of the proposal may change both with developing technology in water and waste water treatment and with continued urban development within the watershed beyond the plan design year of 1990. If full flexibility is to be retained with respect to the development of alternative sources of water supply within the watershed beyond 1990, the land required for the reservoir must be reserved in open-space use. Extensive urban development within the reservoir area would almost certainly preclude any future provision of the reservoir for water supply purposes.

SUMMARY

The water supply resources of the Fox River watershed are fortunately not only varied as to source but are also renewable. The shallow aquifer underlying the watershed can be developed to meet all foreseeable demand within the watershed for domestic and livestock-watering purposes. Increased use of this aquifer, however, for crop irrigation may result in some local water shortages and water supply conflicts. This aquifer is readily susceptible to pollution; and the quality of the water in this aquifer, therefore, will have to be carefully protected.

The most dependable source of large quantities of high-quality water within the watershed is the deep sandstone aquifer. With the implementation of a good water management program, wells tapping this aquifer may be expected to continue to yield 1 to 2 million gallons per day per well through 1990. Proper well location and spacing, however, will be essential if the full potential of this source of supply is to be realized.

Although the development of an alternative source of water supply in the form of a large multi-purpose reservoir located southwesterly of the City of Waukesha cannot be recommended at the present time for inclusion in a comprehensive watershed plan, the retention of full flexibility for the development of alternative sources of water supply within the watershed to meet the needs of development beyond the plan design year of 1990 indicates that the lands needed for this reservoir should be protected and preserved in essentially open use.

(This page intentionally left blank)

Chapter VII

RECOMMENDED COMPREHENSIVE PLAN FOR THE FOX RIVER WATERSHED

INTRODUCTION

The design of a comprehensive plan for the Fox River watershed required that a selection be made from among the alternatives of each of the four major elements which together were to comprise the comprehensive watershed plan. These four major elements were: 1) a land use base, including the natural resource protection and outdoor recreation elements of such a base; 2) a supporting flood control element; 3) a supporting water pollution abatement element; and 4) a supporting water supply element.

The selection from among the various alternatives must be based upon consideration of many tangible and intangible factors but should focus primarily upon the degree to which the various alternatives meet the established watershed development objectives and upon the accompanying costs. The selection of the plan elements to be included in the final plan must ultimately be made by the responsible elected and appointed public officials concerned and not by the planning technicians, although the latter may properly make recommendations based upon evaluation of engineering, economic, and legal considerations.

The plan selection process utilized, which involved the use of advisory committees and both formal and informal public hearings, has been described in Chapter I of this volume. The alternative land use, flood control, water pollution abatement, and water supply plan elements considered have all been described in previous chapters of this volume. This chapter presents a description of the recommended comprehensive watershed development plan as synthesized from among the various alternative plan elements, along with a presentation of the basis for the synthesis.

BASIS OF PLAN SYNTHESIS

The watershed development objectives selected to be met by the final comprehensive watershed plan, together with the standards for relating these objectives to physical development proposals, thereby facilitating evaluation of the ability of each of the alternative plan proposals to meet the chosen objectives, have been set forth in Chapter II of this volume. In each of the four chapters in which the various alternative land use, flood control, surface water pollution abatement, and water supply plan elements have been set forth, the alternative plan proposals have been evaluated; and recommendations made for inclusion in the comprehensive watershed plan. In this process of plan selection, the various alternative plan elements were evaluated with respect to their engineering, economic, and legal feasibility, as well as with respect to their ability to meet the watershed development objectives and supporting standards. It is clear that no one land use or water control facility plan element can fully satisfy all of the watershed development objectives. Therefore, the recommended comprehensive watershed plan must consist of a combination of individual plan elements, with each plan element contributing toward the satisfaction of the development objectives. It should be noted, too, in this respect, that many of the alternative plan elements were specifically designed to satisfy certain watershed development objectives; and the selection from among such alternatives depends largely upon the attendant costs.

Of the two major land use development alternatives considered, the recommended alternative, described as the watershed plan land use base in Chapter III of this volume, is clearly superior to the unplanned alternative, described in Chapter VIII of this volume, with respect to the attainment of the watershed development objectives. As documented in Chapter VIII of this volume, the unplanned alternative would defeat many of the watershed development objectives and would result in an inefficient spatial distribution of urban development within the watershed which would be more susceptible to future flood damage. The unplanned alternative would be particularly destructive of the natural resource base of the watershed through further intrusion of incompatible urban development into the primary environmental corridor and remaining prime agricultural areas. A continuation of uncontrolled land use development within the watershed could, therefore, be expected to greatly reduce the already inadequate woodland, wetland, wildlife habitat, and prime agricultural areas. The opportunity for the establishment of high-value homesites in the attractive setting of adjacent resource conservation areas would also be lost. On the basis of satisfaction of the watershed development objectives, therefore, the unplanned land use alternative must be rejected.

The recommended land use base element will not, however, in and of itself, fully attain all of the watershed development objectives. This land use base element must, therefore, be supplemented by other plan elements of a resource protection, outdoor recreation, flood control, water pollution abatement, and water supply nature. Careful inspection of Tables 8, 12, 15, and 63, as set forth in other chapters of this volume, will indicate that the recommended resource protection, outdoor recreation, and water control facility plan elements all aid in the attainment of additional watershed development objectives which cannot be met by the recommended land use base element alone. The various recommended plan alternatives, as set forth in Chapters III, IV, V, and VI of this volume, are, in fact, complementary in nature and together provide the composition necessary to fully achieve all of the established watershed development objectives. The land use base and natural resource protection plan elements, for example, by providing a pattern of urban land use development which can be readily served by public sanitary sewerage facilities and by providing for the preservation of environmental corridor lands along the main stem of the Fox River, contribute toward achieving not only the land use development objectives but also the water quality and flood control objectives. Thus, the recommended comprehensive watershed plan represents a synthesis of carefully coordinated individual plan elements, which together will serve to fully satisfy and achieve all of the adopted watershed development objectives.

Because of the extreme difficulty, if not impossibility, of expressing all of the benefits and costs associated with the comprehensive watershed plan in monetary terms, the evaluation of the recommended comprehensive plan has been based primarily on its ability to satisfy the watershed development objectives. The importance of the economic analyses of certain of the individual plan elements, however, as set forth in previous chapters of this volume, cannot be overemphasized, since these economic analyses comprised important inputs to the plan selection process. In some cases, the intangible benefits accruing from a plan element may have been considered of sufficient importance in the plan evaluation process to justify its recommendation for inclusion in the comprehensive watershed plan even though it did not receive a favorable benefit-cost ratio.

PLAN RECOMMENDATIONS

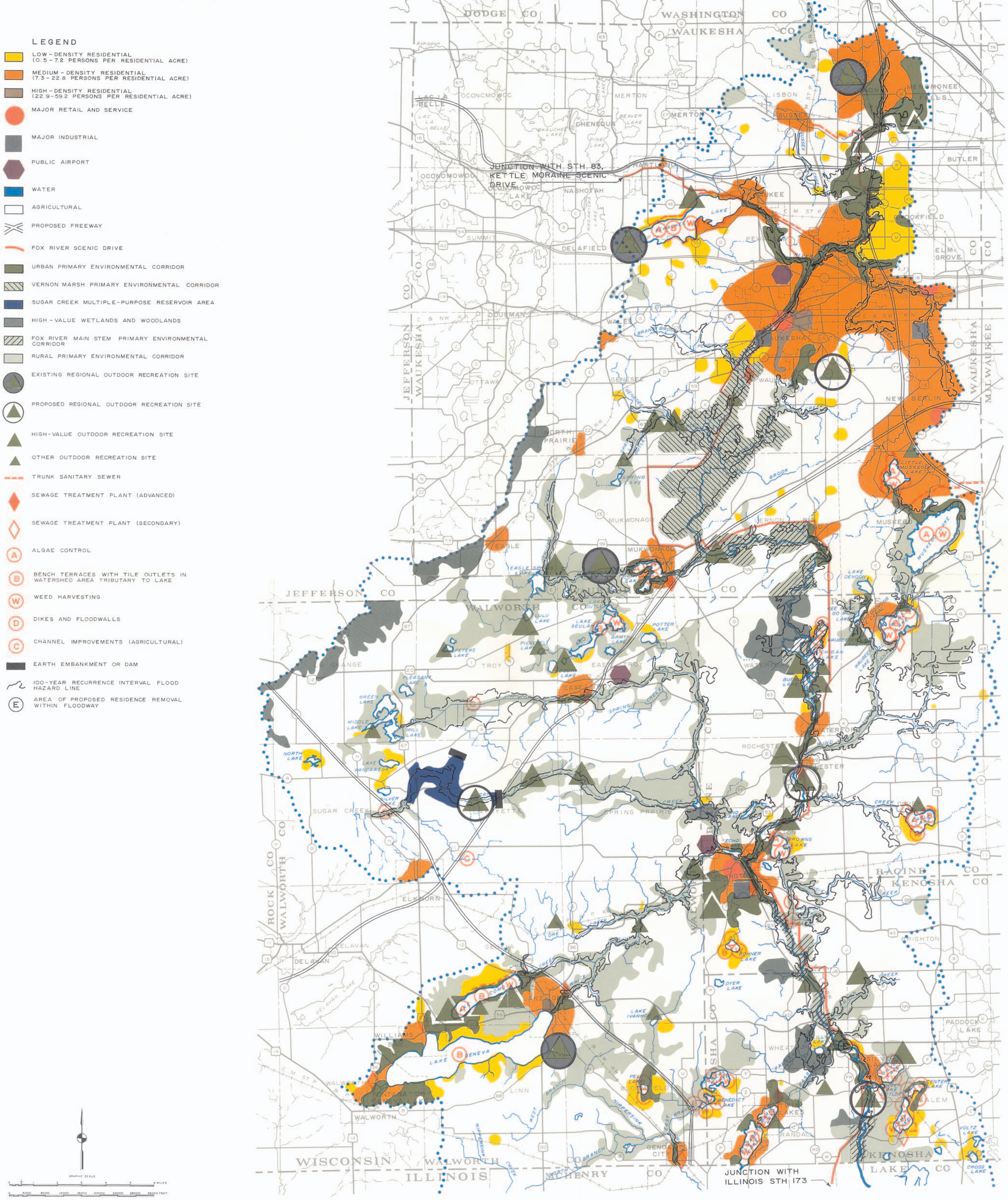
Based upon the analyses of the ability of the various plan elements to satisfy watershed development objectives and related benefit-cost analyses as set forth in previous chapters of this volume, the following plan elements are recommended for inclusion in the comprehensive plan for the Fox River watershed.

Recommended Land Use Base

The controlled existing trend land use plan adopted by the Commission for the Region as a whole is recommended for adoption as the land use base for the Fox River watershed plan. This plan element consists of a mixed program of public acquisition and public regulation of private holdings of land in order to meet future needs for residential, agricultural, conservancy, and park land use within the watershed efficiently and with a minimum destructive effect upon the supporting natural resource base. This plan element places continued emphasis upon the effect of the urban land market in determining the location, intensity, and character of future development within the watershed. It does, however, propose to regulate in the public interest the effect of this market on development in order to provide for a more orderly and economical land use pattern and in order to avoid intensification of watershed developmental and environmental problems. The recommended land use plan element is shown in graphic summary form on Map 16.

Residential Development: Commission forecasts indicate that the population of the Fox River watershed may be expected to reach a level of 359,000 persons by 1990, an increase of approximately 200,000 persons over the 1963 population level, while employment may be expected to reach approximately 97,000 jobs by 1990, an increase of about 63,000 jobs over the 1963 level. The recommended land use plan proposes to accommodate this growth in population and employment through the conversion of approximately 39 square miles of land from rural to urban use over the next two decades. As indicated in Table 3, Chapter III of this volume, the recommended land use plan proposes to add about 44,000 acres to the existing stock of residential land within the watershed in order to meet the housing needs of the anticipated

Map 16
RECOMMENDED COMPREHENSIVE PLAN
FOR THE FOX RIVER WATERSHED
(1990)



Source: SEWRPC.

(This page intentionally left blank)

population increase. The recommended land use plan proposes that about 55 percent of the new residential land be developed at medium densities, that about 43 percent be developed at low densities, and that the remaining 2 percent of the new residential land uses be developed at high densities.

The recommended land use plan proposes that all of the new medium- and high-density residential development be served by public sanitary sewerage and public water supply facilities so that by 1990 82 percent of the total developed urban area within the watershed and 93 percent of the resident population of the watershed would be served by such facilities, as compared to 32 percent and 41 percent, respectively, in 1964. As set forth in Chapter III of this volume, the plan contains similar proposals for the conversion of land to commercial, industrial, governmental and institutional, transportation, communication, and utility land uses as required to meet the gross demand for land generated by the anticipated population and employment within the watershed.

Open Space—Environmental Corridors: The most important elements of the natural resource base of the watershed, including the best remaining woodlands, wetlands, and wildlife habitat; the surface water, together with the associated floodlands and shorelands; and the best remaining potential park sites, have been found to occur within the watershed combined in linear patterns termed primary environmental corridors. These corridors, which encompass about 21 percent of the total area of the watershed, have been described in detail in Chapter IV of Volume 1 and Chapter III of Volume 2 of this report. The preservation and protection of these environmental corridors in accordance with regional and watershed development objectives are essential to the maintenance of a wholesome environment within the watershed and to the preservation of its unique cultural and natural heritage, as well as to the preservation of its natural beauty.

It is recommended that the intermediate alternative natural resource protection plan element, as presented in Chapter III of this volume, be included in the comprehensive plan for the Fox River watershed. This plan element, through a combination of public land acquisition and public regulation of land use, will serve to protect approximately 126,000 acres of land and water contained within the primary environmental corridors of the watershed. Under this plan element, a total of about 46,000 acres, or 36 percent of the primary environmental corridor lands within the watershed and about 8 percent of the total area of the watershed, would eventually be placed in public ownership. Of this total acreage recommended for eventual public ownership, nearly 9,400 acres, or about 20 percent, are already in such public ownership.

The plan recommends public acquisition for all of the primary environmental corridors in those areas of the watershed expected to be in urban use by 1990, totaling about 14,000 acres, or 11 percent of the total corridor area in the watershed. It also recommends public acquisition of the entire primary environmental corridor along the main stem of the Fox River from its headwater area in Waukesha County to the Illinois-Wisconsin State line, totaling about 7,000 acres, or 6 percent of the total corridor area in the watershed. In addition, the plan recommends public acquisition of the Vernon Marsh wildlife conservancy and temporary floodwater storage area in Waukesha County, totaling about 3,000 acres, or 2 percent of the total corridor area in the watershed; the Sugar Creek multiple-purpose reservoir site in Walworth County, totaling about 3,000 acres, or 2 percent of the total corridor area of the watershed; and selected high-value wetland and woodland areas throughout the watershed, totaling about 9,000 acres, or 7 percent of the total corridor area of the watershed. About 11,000 acres of woodlands, or 17 percent of the remaining woodlands and 2 percent of the total watershed area, and about 17,000 acres of wetlands, or 32 percent of the remaining wetlands and 3 percent of the total watershed area, would be permanently protected through public ownership under this plan recommendation. The remaining approximately 80,000 acres of environmental corridor in the watershed would be regulated in the public interest through sound zoning measures, including agricultural, floodland, shoreland, recreational, and low-density residential zoning.

In addition, the plan proposes the establishment of a scenic parkway drive along the main stem of the Fox River from the Illinois-Wisconsin State line to a junction with the Kettle Moraine Scenic Drive just outside of the limits of the watershed. This parkway drive would utilize in its entirety existing state, county, and local streets and highways.

Open Space—Park and Outdoor Recreation Areas: It is recommended that the optimum alternative outdoor recreation-related open-space plan element be included in the comprehensive plan for the Fox River watershed. This plan element would provide approximately an additional 17,600 acres of public outdoor recreation land in the watershed and would bring the total of such land area within the watershed to about 19,600 acres in order to meet fully the forecast demand for outdoor recreation. It should be noted that, of the total of about 17,600 acres of additional recreation land recommended to be acquired, about 9,700 acres, or about 55 percent, would be acquired under the recommended natural resource protection plan element. The recommended park and outdoor recreation plan element provides for a total of eight regional parks within the watershed having a total combined site area of about 3,500 acres. Of these eight parks, four, with a total combined site area of about 900 acres, are existing regional parks—Menomonee, Mukwonago, and Naga-Waukee County Parks, all in Waukesha County, and Big Foot Beach State Park in Walworth County—and four, with a total combined site area of about 2,600 acres, are new regional or expanded local parks—Minooka Park in Waukesha County, Sugar Creek Park in Walworth County, Fox River Park in Kenosha County, and a park site on the Fox River in western Racine County.

Failure to adopt and implement this plan element may be expected to result in overuse and overcrowding of outdoor recreation sites, in serious conflicts of user demands, and in the deterioration and destruction of the recreation-related resource base. It should be noted that, while the recommendation is herein made to fully meet the forecast recreational demand through public acquisition and development, it is recognized that, to the extent that private recreational development occurs to meet this demand, the public acquisition and development of park and related outdoor recreation sites can be reduced. Indeed, it is estimated that up to one-half of the total demand, and, therefore, of the total additional recreation site area, can be expected to be provided through private action.

Open Space—Agricultural Land Use: Under the recommended land use plan, urban expansion within the watershed would by 1990 require the conversion of about 59,000 acres of agricultural land, or 15 percent of the approximately 389,000 acres of land presently devoted to agricultural use within the watershed. About 1,000 acres of this total would constitute prime agricultural land, about 3 percent of the approximately 37,000 acres of prime agricultural land existing within the watershed. The recommended land use plan proposes to preserve the remaining 36,000 acres of the prime agricultural lands in permanent agricultural use. These prime agricultural areas have been delineated on the basis of soils, size and extent of the areas farmed, and the historic capability of the areas to consistently produce better-than-average crop yields.

Flood Control Plan Elements

The basic flood control plan element recommended for inclusion in the comprehensive watershed plan is nonstructural, consisting of the land use development proposals contained in the land use element of the watershed plan, particularly as these land use proposals affect the riverine areas of the watershed. The following structural water control facilities are recommended for inclusion in the comprehensive Fox River watershed plan as a supplement to the basic land use recommendations. A complete description of each of these structural plan elements, together with their associated costs and benefits, has been set forth in Chapter IV of this volume and will not be repeated here.

Levee Construction and Channel Improvements Within the City of Waukesha: This plan element includes the construction of intermittent dikes and floodwalls, designed to contain the 100-year recurrence interval flood flow, along both sides of the Fox River in the City of Waukesha; some channel clearing and shaping to improve the hydraulic capacity of the main stem of the Fox River below the Barstow Street Dam; and the installation of automatic drainage gates on certain storm sewer outlets to prevent storm sewer backup. This plan element would serve to virtually eliminate flood damages within the City of Waukesha. The proposal would not have appreciable effects on flood peaks or flood damages beyond the confines of the City of Waukesha.

Levee Construction and Channel Improvements Within the City of Burlington: This plan element includes the construction of intermittent dikes and floodwalls in the City of Burlington designed to contain the 100-year recurrence interval flood flow along both sides of the Fox River and along portions of both sides of the White River, some clearing and cleaning of the main channel of the

Fox River, and the installation of automatic drainage gates on certain storm sewer outlets to prevent storm sewer backup. This plan element would serve to virtually eliminate flood damages within the City of Burlington. The proposal would not have appreciable effects on flood peaks or flood damages beyond the confines of the City of Burlington.

Channel Improvements on Sugar and Honey Creeks: This plan element includes channel widening and deepening in the upper reaches of Sugar Creek and Honey Creek. It would provide improved agricultural drainage and abate agricultural flood damages.

Channel Improvements on Hoosier Creek: This plan element includes the widening and deepening of a portion of the lower reaches of the main channel of Hoosier Creek and the construction of dikes along selected portions of the Creek designed to contain the 10-year recurrence interval flood. It would provide improved agricultural drainage and abate agricultural flood damages.

Sugar Creek Reservoir: This plan element includes the construction of a multi-purpose reservoir on Sugar Creek in the Town of LaFayette, Walworth County. The reservoir would provide recreation, flood control, and low-flow augmentation benefits, greatly enhancing the development of a regional park recommended in the land use plan for development in the area.

Accessory Structural Flood Control Plan Elements: Accessory structural flood control plan elements include the eventual replacement, when and as required for traffic safety, of 75 highway bridges on the perennial stream system of the Fox River watershed having inadequate waterway openings with new bridges having adequate waterway openings (see Table 13, Chapter IV, Volume 2).

Accessory Nonstructural Flood Control Plan Elements: Accessory nonstructural flood control plan elements include the removal of 160 existing residences in the floodway of the main stem of the Fox River in the Towns of Wheatland and Salem and the Village of Silver Lake, all in Kenosha County. These 160 residences are located within the 10-year recurrence interval flood hazard line in that reach of the Fox River extending from Section 1 in the Town of Wheatland to Section 18 in the Town of Salem and subject to first-floor inundation by a 100-year recurrence interval flood. The lands so vacated are recommended to be converted to public park and parkway use. Gradual acquisition is anticipated, with the existing homes being zoned as nonconforming uses and purchased as they come onto the market.

In addition, it is recommended that all existing homes located in the floodplains of the watershed which are not subject to first-floor level inundation by a 100-year recurrence interval flood be floodproofed as a condition of continued occupance of the floodplains. The cost of this floodproofing shall be assumed by the individual homeowners.

Concluding Remarks—Flood Control Plan Elements: Implementation of the foregoing flood control measures would serve to abate the major flood problems in the Wisconsin portion of the Fox River watershed, virtually eliminating urban flood damages in two of the three major damage reaches and greatly abating agricultural flood damages. Provision of the dikes and floodwalls in the Waukesha and Burlington areas would, moreover, eliminate the need to consider such alternative structural flood control measures as the construction of a floodwater retarding structure near the outlet of the Vernon Marsh, the management of the Waterford impoundment, or the management of the major lakes within the watershed for flood control purposes. Moreover, implementation of the Sugar Creek Reservoir and the recommended nonstructural flood control elements would serve to avoid future intensification of flood problems in the Illinois portion of the Fox River watershed. The naturally well-regulated performance of the Fox River system was documented in Chapter VIII of Volume 1 of this report. The peak discharge of the 100-year recurrence interval flood on the Fox River at Wilmot is only 9,400 cfs, or 10.8 cfs per square mile of tributary drainage area, one-fifth of the comparable unit discharge of some streams in southern Wisconsin. The singularly most important contribution to flood control in both the Illinois and Wisconsin portions of the watershed that can be effected in Wisconsin is to maintain the present well-regulated flow characteristics of the river system by preservation of the existing storage on the floodplains, wetlands, woodlands, and lakes of the watershed.

One of the most important conclusions of the Fox River watershed study is that no major reservoir sites exist within the watershed which could be practically developed to reduce significantly the discharge of a 100-year recurrence interval flood at Wilmot and thereby abate flood problems in the Illinois portion of the watershed. Consequently, if additional flood control benefits for the Illinois portion of the Fox River watershed are to be sought through the Federal Government, it is the recommendation of this study that the following flood control measures be explored:

1. Management of the Waterford impoundment for flood control purposes.

2. Management of the following 10 major lakes for flood control purposes: Pewaukee, Eagle Spring, Beulah, Big Muskego, Eagle, Lauderdale, Como, Geneva, Browns, and Silver (Kenosha County).

3. Construction of a single-purpose flood control reservoir at the outlet of the Vernon Marsh.

Together these three structural flood control elements could provide a storage volume of 56,400 acre-feet and could reduce the peak discharge of a 100-year recurrence interval flood at Wilmot from 9,400 cfs to an estimated 7,500 cfs. It should be stressed that, although these three structural flood control elements were found to have favorable benefit-cost ratios, they are not required to alleviate flood problems within the Wisconsin portion of the Fox River watershed. Moreover, these three structural flood control elements would not eliminate the need to construct the recommended levees in Waukesha or Burlington nor reduce the desirability of the recommended Sugar Creek reservoir. Any or all of these three flood control measures, therefore, would have to be provided in addition to, and not in place of, the structural flood control measures herein recommended as a part of the comprehensive plan for the Fox River watershed. Therefore, the attendant costs should be borne entirely by the benefited areas located entirely outside of the Wisconsin portion of the watershed.

Water Pollution Abatement Plan Elements

The following water pollution abatement facilities and programs are recommended for inclusion in the comprehensive Fox River watershed plan. A description of each of these facilities and programs in the form of plan elements, together with their associated costs and benefits and their relationship to the watershed development objectives and standards, has been set forth in Chapter V of this volume and will not be repeated here.

Stream Water Quality Plan Elements: The following stream water quality programs, one for the upper and one for the lower watershed, are recommended for inclusion in the comprehensive Fox River watershed plan:

1. Abandonment of the existing sewage treatment facilities located at Pewaukee, Brookfield, Poplar Creek, Sussex, and Waukesha and connection of the sanitary sewers tributary to these plants and all other sanitary sewers necessary to support existing and proposed urban development in the headwater area of the Fox River watershed to a single large sewage treatment plant located downstream from Waukesha by a single, integrated trunk sewer system. All of the wastes from the upper watershed would receive advanced waste treatment for nutrient removal and disinfection at the single large treatment plant. The trunk sewer system would extend from the sewage treatment plant site below Waukesha to Lannon, generally along the course of the Fox River, with branches to Pewaukee and Sussex to provide services to these areas (see Map 16). The trunk sewer system would consist of approximately 3.5 miles of 21-inch diameter, 4.9 miles of 24-inch diameter, 0.8 mile of 30-inch diameter, 3.0 miles of 36-inch diameter, 3.2 miles of 48-inch diameter, 6.1 miles of 66-inch diameter, and 1.6 miles of 84-inch diameter gravity flow sanitary sewer laid in open trenches.

   Selection of the foregoing plan recommendations was based upon the variety of reasons set forth in Chapter V of this volume. It should be noted, however, that the remaining two alternative subsystem plan elements, which also included the provision of advanced waste treatment and disinfection, represent acceptable alternatives in terms of satisfying the water quality objectives and the adopted interstate water quality standards as applied to the Fox River watershed.

2. The provision of advanced waste treatment for nutrient removal and disinfection at six of the remaining ten sewage treatment plants in the lower watershed; namely, Mukwonago, Waterford-Rochester, East Troy, Lake Geneva, Burlington, and

Twin Lakes. The two existing sewage treatment plants located at Silver Lake and Genoa City would continue to be operated as secondary treatment plants with the addition of disinfection. The small size of these two plants and the consequently relatively small contribution of biochemical oxygen demand to the receiving stream make it impractical to provide advanced waste treatment at these two plants. Similarly, the two existing sewage treatment plants located at Williams Bay and Fontana would continue to be operated as secondary treatment plants discharging treated effluents to seepage ponds.

3. The connection to public sanitary sewerage systems of 16 of the 19 major industrial waste sources and one of the four major resort waste sources. In addition, the plan recommends that all other industrial and resort waste discharges not connected to centralized public sanitary sewerage systems be given a level of treatment equivalent to secondary treatment and disinfection.

The foregoing water pollution abatement measures, by removing almost all of the organic matter and nutrients from sewage discharged directly into the Fox River, would achieve the established stream water use objectives, as set forth in this report, at the lowest possible cost. Implementation of the first of the two measures would require the establishment of an areawide institutional structure to manage the areawide sewerage system and common treatment plant for the headwater area of the watershed.

If the recommended stream water quality management plan element for the upper Fox River watershed is implemented utilizing the recommended scheme of a single sewage treatment plant and a system of trunk sewers to serve the entire upper watershed (Stream Water Quality Management Plan 1C), it is recognized that additional land in the upper watershed not now lying within a practicable gravity drainage sewer service area would be brought within such a gravity drainage area tributary to the proposed sewage treatment plant below Waukesha. This additional area amounts to approximately 3,200 acres, or 5.1 square miles, as shown on Map 12 in Chapter V. It is important to note that this additional area lies outside the recommended urban development limits, as shown on the adopted regional land use plan and as recommended for adoption as the land use base for the comprehensive Fox River watershed plan. This additional area would also become tributary to a public sanitary sewerage facility if the two-plant alternative sewerage system configuration (Stream Water Quality Management Plan 1B), as set forth in Chapter V, were implemented. If the multiple-plant-alternative system configuration were implemented, (Stream Water Quality Management Plan 1A), this additional area would not lie within a practicable gravity drainage area. If, then, either the one-plant or two-plant alternative sanitary sewerage system configurations are eventually implemented, it will be necessary to adjust the recommended 1990 urban development limits.

Lake Water Quality Management Plan Elements: The following four lake water quality management programs are recommended for inclusion in the comprehensive Fox River watershed plan:

1. The provision of sanitary sewer service at Little Muskego, Pewaukee, Browns, Eagle, Tichigan, Wind, Como, and Camp and Center Lakes. Such service would be provided at five of the eight lakes—Eagle, Tichigan, Wind, Como, and Camp and Center—through the establishment of new sanitary sewerage systems and treatment facilities providing secondary treatment with disinfection. Sewer service at Little Muskego Lake would be provided initially by a temporary treatment facility and ultimately through conveyance of wastes to the Milwaukee Metropolitan Sewerage Commission system, thereby exporting the wastes from the watershed. Sewer service for Pewaukee Lake would be provided as an integral part of the proposed upper Fox River watershed sewerage system discussed above, with eventual advanced treatment of wastes for nutrient removal at the single large sewage treatment plant in the upper watershed. Sewage treatment for wastes from the Browns Lake area would be provided at the Burlington sewage treatment plant, with advanced treatment of wastes for nutrient removal. The recommended treatment plant location and trunk sewer configuration and sizing for each of the eight lakes included in this plan element were described in Chapter V of this volume and will not be repeated here.

2. The provision of chemical control of nuisance algae blooms as necessary at Big Muskego, Little Muskego, Phantom, Eagle, Pewaukee, Bohner, Browns, Wind, Como, Tichigan, Camp and Center, and Silver (Kenosha County) Lakes. This recommendation can serve only to suppress the symptoms of the underlying water problem and, as such, should only be considered a temporary measure to be used until more permanent abatement is achieved through the other recommended plan proposals.

3. Machine harvesting of the aquatic weed growths as necessary at Big Muskego; Little Muskego; Phantom; Eagle; Tichigan; Pewaukee; Bohner; Browns; Wind; Beulah; Como; Pell; Camp and Center; Elizabeth and Marie; Powers, Tombeau, and Benedict; and Silver (Kenosha County) Lakes.

4. The provision of bench terraces with tile outlets on agricultural lands subject to erosion, together with additional appropriate land conservation measures, to control pollution from agricultural runoff on the tributary watersheds of Phantom; Pell; Pewaukee; Bohner; Eagle; Wind; Beulah; Como; Geneva; Camp and Center; Elizabeth and Marie; Powers, Tombeau, and Benedict; and Silver (Kenosha County) Lakes.

The provision of sanitary sewer service to serve existing development around the eight major lakes cited above would eliminate any sanitary hazards which presently exist at these lakes as a result of inadequate or malfunctioning septic tank sewage disposal systems and would assist in reducing the nutrient input to the lakes. The algae control and weed harvesting operations would alleviate nuisance conditions caused by excessive aquatic plant growths. The bench terraces and related agricultural soil and water conservation practices would reduce the nutrient input and sediment loads to the lakes from agricultural areas. These recommended lake pollution abatement measures would serve to meet the established lake water use objectives set forth in this report for the 22 major lakes considered.

Water Supply Plan Elements

The two major aquifers underlying the Fox River watershed constitute the principal source of water supply within the watershed and, if properly used and managed, comprise a renewable resource which can serve the watershed for all time to come. The shallow aquifer can be developed to meet all foreseeable demand within the watershed for domestic and livestock watering purposes, providing that it is carefully protected from pollution through septic tank disposal systems, dumps and improperly located sanitary land fills, and urban and agricultural runoff. Larger yields may be expected where the shallow aquifer has a saturated thickness greater than 100 feet and the sand and gravel and the Niagara dolomite are in contact.

The most dependable source of large quantities of high quality water within the watershed is the deep sandstone aquifer. With proper well location and spacing, this aquifer may be expected to yield an adequate supply of water for municipal and industrial purposes through and beyond the design year of the watershed plan. Recommendations concerning well location and spacing necessary to achieve proper utilization of this aquifer are set forth in Chapter VI of this volume and will not be repeated here.

A major alternative water supply could be created within the watershed by damming the Fox River near the Soo Line Railroad crossing of the Fox River in the Town of Mukwonago. The impoundment so created would flood the Vernon Marsh wildlife area, and the headwater pool would extend to the southwesterly limits of the City of Waukesha. The impoundment would have flood control, water quality control, and recreation, as well as water supply, benefits. Although the development of this alternative surface water supply within the watershed appears uneconomical at the present time in terms of capital investment cost alone, the proposal deserves reconsideration and reevaluation as urban development continues within the watershed. If full flexibility is to be retained with respect to the development of alternative sources of water supply within the watershed beyond the plan design year of 1990, the land required for this reservoir should be maintained in open-space uses. Such reservation would be fully compatible with the land use base element of the comprehensive watershed plan since the proposed reservoir site is located within a primary environmental corridor. Extensive urban development within the reservoir area, if permitted, would almost certainly preclude any future provision of the reservoir for water supply purposes.

COST ANALYSIS

In order to assist the responsible public officials concerned in evaluating the foregoing recommended comprehensive Fox River watershed plan, a preliminary capital improvements program was prepared, which, if followed, would result in total watershed plan implementation by the year 1990. This preliminary capital improvements program includes the staging of the necessary land acquisition and facility construction and the distributing of the attendant costs over a 20-year plan implementation period. This program is presented in summary form for the watershed as a whole in Table 55 and is presented in more detailed form in a series of tables in Chapter IX of this volume. These tables set forth the land acquisition and construction costs and the estimated maintenance and operation costs associated with implementation of each of the recommended plan elements by year and by level of government concerned. The ultimate adoption of capital improvements programs for implementation of the watershed plan will require determination by responsible public officials of not only those plan elements which are to be implemented, and the timing of such implementation, but also of the principal beneficiaries and the available means of financing.

The full capital investment cost of implementing the recommended comprehensive watershed plan for the Fox River watershed is estimated at $120 million over the 20-year plan implementation period. Of this total cost, $66 million, or about 55 percent, is required for implementation of the recommended natural resource base protection and recreation-related land use plan elements and would be used primarily for land acquisition; $29,600,000, or about 25 percent, is required for implementation of the recommended stream water quality management plan elements; $19,561,120, or about 16 percent, is required for the recommended lake water quality management plan elements; and $4,797,600, or about 4 percent, is required for the recommended flood control and agricultural drainage improvement plan elements.

The average annual cost of the total capital investment required for plan implementation would be approximately $6 million per year, or about $24 per capita, the per capita cost being based on a watershed population of 250,000 persons, or somewhat less than the anticipated average resident population of the watershed between the 1963 existing population level of 159,500 persons and the anticipated 1990 population level of 359,000 persons. The average annual capital costs of implementation of the natural resource protection and recreation-related land use plan elements, the stream water quality management plan elements, the lake water quality management plan elements, and the flood control and agricultural drainage improvement plan elements are, respectively, about: $3,326,000; $1,480,000; $978,000; and $240,000.

It is extremely important to note when considering the total cost of plan implementation that, of the total estimated watershed plan implementation cost of $120 million, an estimated $46 million, or about 38 percent, would be incurred in any case by the federal, state, and local units of government concerned simply to provide the facilities necessary to accommodate the forecast population growth and accompanying urbanization as would be manifested in land development within the watershed. For example, of the estimated $66 million required for implementation of the natural resource protection and recreation-related land use plan elements, it is estimated that $12.4 million, or about 19 percent, would be incurred in any case by the state, county, and local units of government for the provision of park and outdoor recreation facilities required to serve the growing watershed population, while, of the $33,336,000 required for implementation of the stream water quality management plan element, an estimated $12 million, or about 40 percent, would be incurred in any case by governmental units in order to provide the increment in sewage collection and treatment facilities required to serve the growing watershed population. Yet, the expenditures of these funds in the absence of a comprehensive watershed plan would not serve to meet the watershed development objectives and standards but could be expected to lead instead to a further deterioration of the overall quality of the environment within the watershed and an intensification of environmental and development problems.

It should be noted that Table 55 recommends that well over two-thirds of the total land acquisition recommended for the preservation of the primary environmental corridors and best remaining park and related open-space sites within the watershed be carried out during the first half of the 20-year plan implementation period. This accelerated land acquisition is recommended in order to acquire

Table 55

SCHEDULE OF CAPITAL AND OPERATION AND MAINTENANCE COSTS
OF THE RECOMMENDED FOX RIVER WATERSHED PLAN BY MAJOR PLAN ELEMENT BY YEAR: 1971-1990[a]

Calendar Year	Project Year	Natural Resource Protection and Recreation-Related Land Use Plan Element			Flood Control Plan Element					Water Pollution Abatement Plan Element				Water Resources Monitoring Program	
					Levee Construction and Reservoir Improvements		Agricultural Drainage Improvements		Floodland Residence Evacuation in the Silver Lake Area[i]	Stream Water Quality Improvements		Lake Water Quality Improvements			
		Land Acquisition[b]	Park and Recreation Facility Construction[c]	Operation and Maintenance[d]	Land Acquisition and Facility Construction[e]	Operation and Maintenance[f]	Land Acquisition and Facility Construction[g]	Operation and Maintenance[h]		Facility Construction[j]	Operation and Maintenance[j]	Facility Construction[k]	Operation and Maintenance[k]	Facility Construction[l]	Operation and Maintenance[m]
1971	1	$ 3,364,920	$ 726,450	$ 23,830	$ 143,400	$ 1,000	$ 84,920	$ 5,190	$ 61,800	$ 2,960,000	$ 1,616,000	$ 1,867,912	$ 332,220	$ 12,000	$ 12,850
1972	2	3,364,920	726,450	47,660	143,400	1,000	84,920	5,190	61,800	2,960,000	1,616,000	1,867,912	332,220	--	12,850
1973	3	3,364,920	726,450	71,490	143,400	1,000	84,920	5,190	61,800	2,960,000	1,616,000	1,867,912	332,220	--	12,850
1974	4	3,364,920	726,450	95,320	143,400	1,000	84,920	5,190	61,800	2,960,000	1,616,000	1,867,912	332,220	--	12,850
1975	5	3,364,920	726,450	119,150	143,400	1,000	84,920	5,190	61,800	2,960,000	1,616,000	1,867,912	332,220	--	12,850
1976	6	3,364,924	1,054,814	160,425	--	1,000	--	5,190	61,800	2,960,000	1,616,000	1,867,912	332,220	--	12,850
1977	7	2,965,454	1,054,814	201,700	484,000	1,900	--	5,190	61,800	2,960,000	1,616,000	1,867,912	332,220	--	12,850
1978	8	2,965,454	1,054,814	242,975	484,000	1,900	--	5,190	61,800	2,960,000	1,616,000	1,867,912	332,220	--	12,850
1979	9	2,965,454	1,054,814	284,250	484,000	1,900	--	5,190	61,800	2,960,000	1,616,000	1,867,912	332,220	--	12,850
1980	10	2,965,454	1,054,814	325,525	484,000	1,900	--	5,190	61,800	2,960,000	1,616,000	1,867,912	332,220	--	12,850
1981	11	2,909,664	1,054,814	366,800	484,000	1,900	--	5,190	61,800	--	1,616,000	--	332,220	--	12,850
1982	12	2,909,670	1,054,814	408,075	--	1,900	--	5,190	61,800	--	1,616,000	--	332,220	--	12,850
1983	13	1,149,190	1,054,814	449,350	--	1,900	--	5,190	61,800	--	1,616,000	--	332,220	--	12,850
1984	14	1,149,190	1,054,814	490,625	--	1,900	--	5,190	61,800	--	1,616,000	--	332,220	--	12,850
1985	15	1,149,190	1,054,814	531,900	--	1,900	--	5,190	61,800	--	1,616,000	--	332,220	--	12,850
1986	16	1,149,190	1,054,814	573,175	--	1,900	--	5,190	61,800	--	1,616,000	--	268,570	--	12,850
1987	17	1,149,190	1,054,814	614,450	--	1,900	--	5,190	61,800	--	1,616,000	--	268,570	--	12,850
1988	18	1,149,190	1,054,814	655,725	--	1,900	--	5,190	61,800	--	1,616,000	--	268,570	--	12,850
1989	19	1,149,190	1,054,814	697,000	--	1,900	--	5,190	61,800	--	1,616,000	--	268,570	--	12,850
1990	20	1,149,190	1,054,854	738,295	--	1,900	--	5,190	61,800	--	1,616,000	--	268,570	--	12,850
Total		$ 47,064,200	$19,454,500	$7,097,180	$ 3,137,000	$ 32,600	$ 424,600	$ 103,800	$1,236,000	$ 29,600,000	$ 32,320,000	$ 18,679,120	$ 6,326,150	$ 12,000	$ 257,000
Annual Average		$ 2,353,210	$ 972,725	$ 354,859	$ 156,850	$ 1,630	$ 21,230	$ 5,190	$ 61,800	$ 1,480,000	$ 1,616,000	$ 933,956	$ 316,308	$ 600	$ 12,850

Table 55 (continued)

[a] *More detailed cost schedules of the major watershed plan elements are set forth in a series of tables in Chapter IX of this volume.*

[b] *Includes the acquisition of 14,472 acres of urban environmental corridor at an estimated average cost of $2,000 per acre; 2,651 acres of Vernon Marsh wildlife conservancy area at an estimated average cost of $200 per acre for 876 acres of wetlands and $700 per acre for 1,775 acres of woodlands and open lands; 3,424 acres of Sugar Creek multiple-purpose reservoir area at an estimated average cost of $700 per acre; 4,549 acres of high-value wetlands at an estimated average cost of $200 per acre; 4,369 acres of high-value woodlands at an estimated average cost of $700 per acre; 7,446 acres of Fox River main stem corridor at an estimated average cost of $700 per acre; 797 acres of regional park lands at an estimated average cost of $700 per acre; 3,944 acres of selected high-value park sites at an estimated average cost of $700 per acre; and 2,581 acres of additional park sites at an estimated average cost of $700 per acre. This schedule calls for the acquisition of all urban environmental corridor lands, Vernon Marsh lands, and regional park lands during the first 12 years of the 20-year plan implementation period.*

[c] *Includes the development of 2,617 acres of regional park lands at an estimated cost of $1,500 per acre plus the development in regional parks of 4 regulation golf courses at an estimated cost of $250,000 per course; 2,383 acres of local park lands at an estimated cost of $3,000 per acre for 536 acres of neighborhood parks and $7,000 per acre for 8,847 acres of community parks. No development costs have been assigned to the additional park sites recommended to be acquired under the optimum alternative outdoor recreation plan element. It was assumed that development of these sites would most likely be deferred until after the initial 20-year plan implementation period.*

[d] *Based upon an estimated average cost of $200 per acre of developed park land. No operation and maintenance costs have been assigned to the undeveloped environmental corridor land.*

[e] *Includes $2,420,000 for land acquisition and construction of the Sugar Creek multiple-purpose reservoir; $367,000 for land acquisition and construction of the dikes and floodwalls in the City of Waukesha; and $350,000 for land acquisition and construction of the dikes and floodwalls in the City of Burlington. If the land scheduled for acquisition in the Sugar Creek environmental corridor under the natural resource protection plan element (see footnote b) is acquired, the estimated cost of $2,420,000 noted above for the Sugar Creek reservoir could be reduced by $1,435,000.*

[f] *Includes an estimated $900 annual operation and maintenance costs for the Sugar Creek reservoir and an estimated $500 annual operation and maintenance costs each for the Burlington and Waukesha dike and floodwall improvements.*

[g] *Includes $183,900 for channel improvements in the Honey-Sugar Creek subwatershed and $240,700 for dikes and channel improvements in the Hoosier Creek subwatershed.*

[h] *Includes an estimated $2,400 annual operation and maintenance costs for the Hoosier Creek improvements and an estimated $2,790 annual operation and maintenance costs for the Honey-Sugar Creek improvements.*

[i] *Assumes an annual average cost of $61,800. Actual timing of expenditures would be determined by the market availability of the 160 residences to be removed.*

[j] *For a detailed breakdown of the component stream water quality management plan element costs, see Appendix F.*

[k] *For a detailed breakdown of the component lake water quality management plan element costs, see Table 52.*

[l] *Includes the construction of two stream gaging stations at an estimated cost of $6,000 each.*

[m] *Includes an estimated $300 annual operation and maintenance costs for each of 29 water quality monitoring stations; an estimated $1,000 annual operation and maintenance costs for each of three stream gaging stations; and an estimated $150 annual operation and maintenance costs for each of four crest gages.*

Source: Harza Engineering Company, U. S. Soil Conservation Service, Wisconsin Department of Natural Resources, and SEWRPC.

the necessary open-space lands while these lands are still in predominantly rural use and before they are preempted by urban development. The average annual capital cost of implementing the natural resource protection and recreation-related land use plan elements is, as noted above, estimated to be $3.3 million, or about $13 per capita, which amount would be expended primarily for land acquisition.

The total land acquisition and construction cost for the recommended flood protection and agricultural drainage improvement works is about $4,797,000, of which $367,000 is required for the construction of dikes and levees in the City of Waukesha, $350,000 for the construction of dikes and levees in the City of Burlington, and $2,420,000 for the construction of the recommended multi-purpose reservoir on Sugar Creek. Channel improvements and other agricultural drainage improvements for the Hoosier Creek and Sugar-Honey Creek drainage districts account for about $425,000 of the total flood control cost, while the floodland residence removal element recommended in the Silver Lake area accounts for the remaining approximately $1,235,000 of the total flood control cost. The average annual capital cost of the total flood control plan element implementation would be $239,580.

Implementation of the stream water quality management plan element would require an average annual capital cost of about $3,326,000, or $25 per capita, the per capita cost being based on the anticipated average watershed population between 1963 and 1990 proposed to be served by the facilities included within the stream water quality management plan element.

Implementation of the recommended lake water quality management plan elements, which would assist in maintaining or improving the level of water quality in 22 of the 45 major lakes of the Fox River watershed and which would include the extension or construction of sanitary sewerage systems around 8 of the 22 lakes, would have an average annual capital cost of $978,056, or $31 per capita, the per capita cost being based on the existing watershed population expected to be served by the lake water quality management plan elements. The per capita cost would vary with each lake community, depending upon the size of the lake community and the complexity of the alternative plan elements, from as little as $1.60 per capita per year for the Pell Lake community to as much as $195 per capita per year for the Eagle Lake community.

The plan also recommends the operation of 5 streamflow gaging stations within the watershed, 3 of which are existing and 2 of which would have to be constructed. It also recommends the operation of 29 water quality monitoring stations and 9 crest gage stations in the watershed. The average annual cost of the water control monitoring stations is estimated at about $12,800, or about $0.06 per capita.

Although the primary beneficiaries of the implementation of the recommended comprehensive watershed plan will be the residents of the Fox River watershed, certain regional, state, interstate, and national benefits would accrue from full plan implementation. This fact should make many of the major plan recommendations eligible for financial assistance from the state and federal levels of government. The possible sources of state and federal financial assistance are described in Chapter IX of this volume. It is estimated that full utilization of these financial resources for watershed plan implementation could serve to reduce the local plan implementation costs by as much as 50 percent.

In order to assess the possible impact of implementation of the watershed plan on the public financial resources of the local units of government within the watershed, an analysis was made of the long-term historic public expenditures by the counties, cities, villages, and towns within the watershed for public park and related purposes and for public sanitary sewerage facilities. The period of study selected was the 21-year period extending from 1948 through 1968, and the data reviewed pertained to those local units of government having 50 percent or more of their geographic area within the boundaries of the watershed itself.[1] As indicated in Table 56, a

[1] *Two exceptions to this criteria were made:*

1. *Because the county level of government within the Region is so important in the provision of major park and outdoor recreation facilities, it was decided to apportion the expenditures of the four major counties in the watershed--Kenosha, Racine, Walworth and Waukesha--on the basis of the proportion of the major county park and outdoor recreation site area within*

the watershed to the total of such land within the county. These proportions were, as of 1963: Kenosha County, 25 percent; Racine County, 0 percent; Walworth County, 100 percent; and Waukesha County, 71 percent. Milwaukee and Washington Counties were not included because only a very small amount of land within these two counties lies within the watershed.

2. *The proportion of the total land areas of the City of Brookfield and the Village of Menomonee Falls lying within the watershed are only slightly under the 50 percent level. Because both of these communities have been experiencing rapid population growth and because this growth is likely to continue in the future and to be concentrated geographically within the watershed portion of the communities, it was decided to include the total receipts and sewer and park expenditures of these two communities, along with the data from the other local units of government within the watershed.*

total of approximately $36.7 million was expended by the local units of government within the watershed for the construction, maintenance, and operation of public sanitary sewerage facilities over the 21-year period. This amounts to an average annual expenditure of about $1.7 million, which, as indicated in the table, is equivalent to 2.4 percent of the average annual public revenues received by the local units of government over the 21-year period. Similarly, approximately $13.6 million was expended by the local units of government within the watershed for the acquisition, development, maintenance, and operation of park and related open spaces over the period. This amounts to an average annual expenditure of $0.6 million, or an average of 0.8 percent, of the average annual revenues received by the local units of government over the 21-year period.

In order to further augment the analysis, three alternative forecasts were prepared to indicate the possible range of future expenditures by local units of government within the watershed for public sanitary sewerage and park purposes under differing assumptions. If it is assumed that the average annual rate of increase in expenditures, which obtained over the 1948 through 1968 period, were to remain constant to the year 1990, approximately $132.0 million would become available for sanitary sewerage purposes and $60.5 million would become available for park purposes. If it is assumed that total annual receipts by the local units of government within the watershed were to increase to the year 1990 at the same average annual rate which obtained over the 1948 through 1968 period, if it is assumed that the monies expended for sanitary sewerage and park purposes will constitute a constant proportion of the total receipts over the forecast period, and if it is further assumed that this constant proportion would be equivalent to the average annual proportion of total receipts which obtained over the 1948 through 1968 period, approximately $117.2 million would become available for sanitary sewerage purposes and $41.4 million would become available for park purposes. If it is assumed that the per capita expenditures, which obtained in 1963 for sanitary sewerage and park purposes,[2] were to remain constant to the year 1990, approximately $71.6 million would become available for sanitary sewerage purposes and $28.7 million would become available for park purposes (see Table 57 and Figure 40).

A review of past expenditure patterns, along with the range of possible future expenditure levels, thus indicates that between $71.6 million and $132.0 million may be expected to be spent by the local units of government within the watershed for sanitary sewerage purposes by 1990 and between $28.7 million and $60.5 million may be expected to be spent for park purposes. These forecast ranges do not represent any major departures from past expenditure levels or patterns and, therefore, may be considered conservative in nature.

The estimated total cost, including capital and operation and maintenance costs, of implementing the water pollution abatement element of the recommended Fox River watershed plan is $87.8 million (see Table 55). This amount can be crudely compared on a gross basis with a possible expenditure of $107 million, the average of the three alternative forecasts of expenditures for sanitary sewerage purposes. While such a comparison would indicate that the plan implementation costs for water pollution abatement are reasonable, it is important to note that the two figures are not strictly comparable. The pollution abatement plan element does not include, for example, the costs of constructing lateral, branch, or minor trunk sewers except in the case of the sanitary sewerage

[2] *Estimated at $10.80 per capita for sewer purposes and $4.30 per capita for park purposes.*

Table 56

EXPENDITURES FOR PUBLIC SANITARY SEWERAGE AND PARK PURPOSES AND TOTAL RECEIPTS REPORTED BY LOCAL UNITS OF GOVERNMENT[a] IN THE FOX RIVER WATERSHED: 1948-1968
(IN MILLIONS OF DOLLARS)

Year	Sanitary Sewerage and Park Expenditures				
	Sanitary Sewer[b]	Percent of Total Receipts	Park[c]	Percent of Total Receipts	Total Receipts[d]
1948	$ 0.3	1.5	$ 0.1	0.5	$ 20.2
1949	0.3	1.4	0.2	0.9	22.2
1950	0.2	0.8	0.1	0.4	25.6
1951	0.3	1.2	0.2	0.8	25.1
1952	0.3	1.0	0.2	0.7	30.1
1953	0.2	0.6	0.2	0.6	33.5
1954	0.5	1.4	0.3	0.8	36.4
1955	1.1	2.7	0.4	1.0	40.2
1956	1.5	3.0	0.3	0.6	50.6
1957	0.8	1.5	0.3	0.6	52.9
1958	0.7	1.2	0.4	0.7	57.2
1959	1.4	2.1	0.4	0.6	67.0
1960	1.2	1.6	0.7	1.0	72.6
1961	1.8	2.0	0.6	0.7	89.1
1962	4.3	4.6	1.0	1.1	93.4
1963	2.0	2.2	0.8	0.9	89.6
1964	2.4	2.3	0.8	0.8	105.6
1965	2.2	1.7	1.5	1.2	126.3
1966	4.0	2.9	1.4	1.0	135.9
1967	5.4	3.5	1.9	1.2	156.0
1968	5.8	3.4	1.8	1.1	168.0
Total	$ 36.7	--	$ 13.6	--	$ 1,497.5
21-Year Average	$ 1.7	2.4	$ 0.6	0.8	$ 71.3

[a] *Includes those local units of government with 50 percent or more of their land area located within the Fox River watershed and, in addition, the City of Brookfield and the Village of Menomonee Falls.*

[b] *Includes expenditures reported on municipal audit reports for such purposes as construction, operation, and maintenance of sanitary sewerage facilities.*

[c] *Includes expenditures reported on municipal audit reports for such purposes as land acquisition and construction, operation, and maintenance of park and related open-space facilities.*

[d] *Includes all receipts recorded on the annual audit reports.*

Source: Wisconsin Department of Administration, Bureau of Municipal Audit, and SEWRPC.

systems recommended for the eight major lake communities. Thus, expenditures can be expected for public sanitary sewerage purposes in addition to those provided for in the recommended plan element. Also, the operation and maintenance costs in the plan do not reflect total operation and maintenance costs but only the incremental operation and maintenance costs attendant to the recommended facilities. At least partially offsetting these facts are four important considerations:

Table 57

ALTERNATIVE FORECASTS OF EXPENDITURES FOR PUBLIC SANITARY SEWERAGE AND PARK PURPOSES BY THE LOCAL UNITS OF GOVERNMENT IN THE FOX RIVER WATERSHED: 1969-1990
(IN MILLIONS OF DOLLARS)

Expenditure Category	Alternative A	Alternative B	Alternative C
Sanitary Sewers	$ 132.0[a]	$ 117.2[b]	$ 71.6[c]
Parks	60.5[a]	41.1[d]	28.7[e]
Total	$ 192.5	$ 158.3	$ 100.3

[a] *Based upon a least squares linear projection of the 1948-1968 expenditures listed in Table 56.*

[b] *Based upon a constant (2.4%) proportion of total forecast annual receipts.*

[c] *Based upon a per capita expenditure of $10.80 per year.*

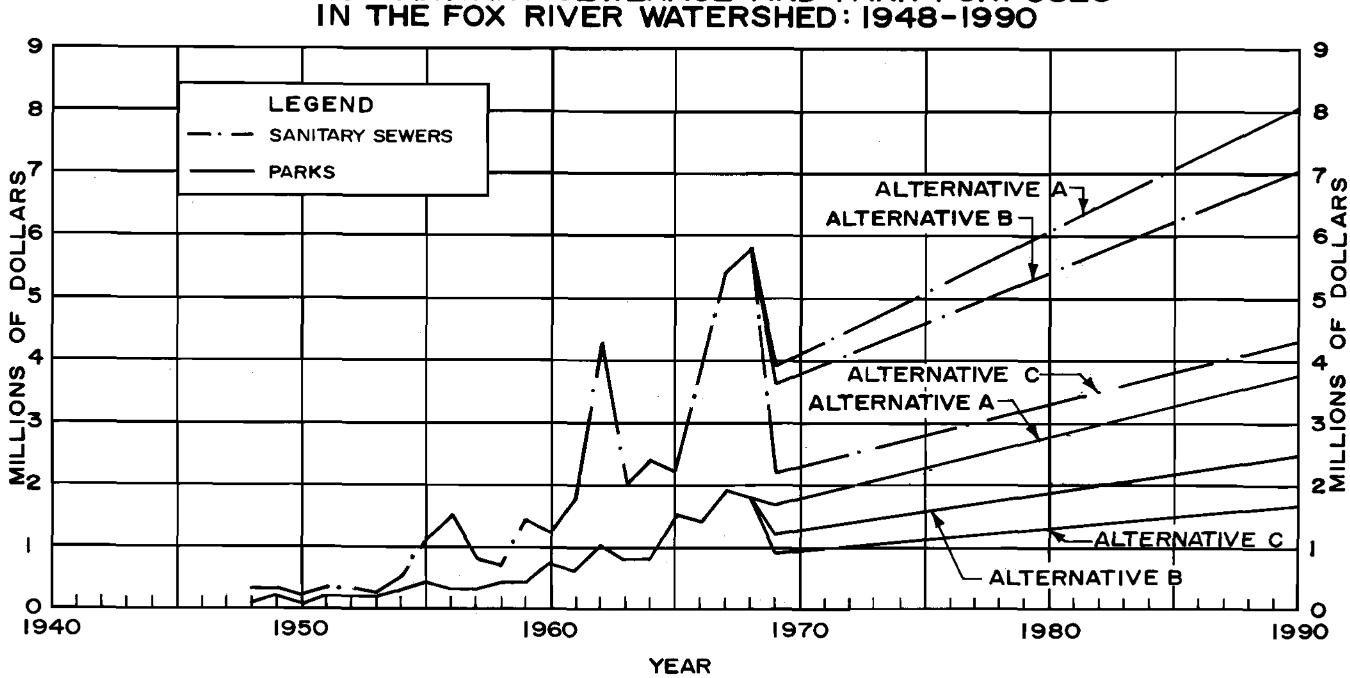
[d] *Based upon a constant (0.8%) proportion of total forecast annual receipts.*

[e] *Based upon a per capita expenditure of $4.30 per year.*

Source: SEWRPC.

Figure 40

PUBLIC EXPENDITURE TRENDS AND ALTERNATIVE FORECASTS FOR PUBLIC SANITARY SEWERAGE AND PARK PURPOSES IN THE FOX RIVER WATERSHED: 1948-1990



Source: Wisconsin Department of Administration, Bureau of Municipal Audit and SEWRPC.

1) the water quality management plan element contains costs for water pollution control measures in addition to sanitary sewerage systems, such as the construction of bench terraces and the conduct of aquatic weed harvesting and algae control programs; 2) implementation of the recommended plan would result in considerably lower expenditures being made by homeowners for the installation and maintenance of private septic tank waste disposal systems; 3) large portions of the costs of installing lateral and branch sewers can be recouped through application of appropriate financing techniques, such as special assessments, and through regulations requiring land developers to install sanitary sewerage facilities as an integral part of the land development process; and 4) it is reasonable to conclude that nonlocal expenditures for sanitary sewerage facilities in the form of state and federal aids will play an increasingly important role in future years.

From the foregoing it is fair to conclude that sufficient monies to implement substantially the recommended water pollution abatement element of the watershed plan should become available without significant shifts in local expenditure patterns. Implementation of the plan would not only meet the state-established water use objectives and supporting standards but would eliminate certain existing public health hazards and avoid the creation of new public health hazards due to malfunctioning septic tank sewage disposal systems located on soils poorly suited for the absorption of sewage effluent and would achieve a land use pattern that can be efficiently and economically provided with municipal sanitary sewerage service.

The estimated total cost, including capital and operation and maintenance costs, of implementing the natural resource protection and recreation-related resource element of the recommended watershed plan is $74 million. This amount can be crudely compared on a gross basis with a possible expenditure of $43 million, the average of the three alternative forecasts of expenditures for park purposes. It is clear that, even if the high alternative forecast of expenditures for park purposes in the watershed is used for comparison with the plan costs, a sizable deficit would remain. Furthermore, the plan implementation costs do not include total operation and maintenance costs but only the incremental operation and maintenance costs attendant to the recommended new outdoor recreation facilities. At least partially offsetting this, however, is the fact that, of $74 million required for plan implementation, about $12 million is recommended to be provided by state agencies. In addition, it is reasonable to assume that greater amounts of state and federal aid for open-space land acquisition will be made available in future years, thus further offsetting the need for additional local expenditures.

In summary, the foregoing analysis demonstrates that the cost of implementing the watershed plan is such as to be reasonably attainable through continuing the current public expenditure patterns for sanitary sewerage purposes and expanding somewhat the expenditures for park purposes. It is clear that, if the adopted water uses are to be met and if the remaining prime elements of the sustaining natural resource base are to be permanently protected and preserved, the level of expenditures needed to implement the recommended watershed plan are necessary and warranted.

SUMMARY

The various plan elements recommended as integral parts of the comprehensive plan for the Fox River watershed have all been described separately and in considerable detail in preceding chapters of this volume. In the comprehensive watershed plan, each plan element was selected so as to complement and strengthen all of the others.

Under the comprehensive watershed plan recommended herein, future urban development within the watershed would be guided through locally exercised land use controls into a more efficient and attractive pattern. Continued encroachment of urban development onto the natural floodplains would be arrested and future intensification of flood problems avoided. Residential development would be concentrated within sanitary sewer and public water supply service areas tributary to existing systems and would be located on soils suited for such use, thus avoiding future sanitation problems. The remaining prime agricultural areas of the watershed would be protected from destruction through urban encroachment. The environmental corridors of riverine woodlands, wetlands, and surface water, together with the associated floodlands, would be preserved, first, by immediate zoning to prohibit inadvisable urban development and gradually by public acquisition for park and parkway purposes. Eventually, the Fox River stream valley system would be transformed into an attractive greenbelt, parkway, recreation, and other open lands serving to attract in urban areas high-value residential development.

The flood damage hazard would be gradually eliminated as new flood-vulnerable development would be prohibited and existing development phases out through purchase and zoning or abated under special conditions by floodproofing. Existing urban development in two locations would be protected by the construction of levees and floodwalls.

The large private investment in homes and in public recreation and conservation lands, which is dependent to a considerable extent upon suitable water quality, would be protected by the recommended water pollution abatement program. Existing waste loadings would be reduced by the provision of advanced treatment for nutrient removal throughout the watershed to produce stream and lake water quality levels capable of meeting the established water use objectives. The water supply resources of the watershed would be protected through proper well location and spacing and through pollution abatement measures.

(This page intentionally left blank)

Chapter VIII

THE UNPLANNED ALTERNATIVE

INTRODUCTION

The recommended land use and water control facility elements of a comprehensive plan for the physical development of the Fox River watershed in southeastern Wisconsin were described in the preceding chapter of this volume. These plan components were selected after careful test and evaluation of the alternatives available and after presentation of these alternatives to the Fox River Watershed Committee, the SEWRPC Technical Advisory Committee on Natural Resources and Environmental Design, the constituent local units of government, and to certain state and federal agencies for further technical and nontechnical review and evaluation. The plan test, evaluation, and review process indicated that implementation of the recommended comprehensive watershed plan would best meet the recommended watershed development objectives formulated as a part of the watershed planning process.

Another alternative is, however, available to the watershed, that of continued existing trend development in the absence of any attempt to guide such development on an areawide basis in the public interest. In order to assess the possible impact of such unplanned development upon the future environment within the watershed and upon the need for water control facilities, this unplanned alternative was explored in some depth. This alternative is not to be construed as a plan but rather as a forecast of one of the many possible end results of unplanned development within the watershed. It is intended to serve not as a recommendation but as a basis of comparison for the evaluation of the potential benefits of the recommended comprehensive watershed development plan; and, in this respect, it serves a particularly important function as a basis for the calculation of flood control benefits attendant to the recommended land use pattern. The flood control benefits associated with the latter were determined by subtracting the residual flood-damage risk associated with the planned alternative from the flood-damage risk projected for the unplanned alternative.

This chapter presents a brief description of the unplanned alternative, a discussion of the implications of this alternative for the water quality control facility systems within the watershed, and a comparison of the unplanned alternative with the recommended plan in terms of attainment of the watershed development objectives.

LAND USE FORECAST METHODOLOGY

The land use pattern chosen to represent the unplanned alternative within the watershed was taken from a similar alternative prepared for the Region as a whole under the regional land use-transportation planning effort. The methodology applied in the development of this land use pattern, including the use of supplemental land use simulation model techniques, is described in SEWRPC Planning Report No. 7, Volume 3, Recommended Regional Land Use and Transportation Plans—1990.

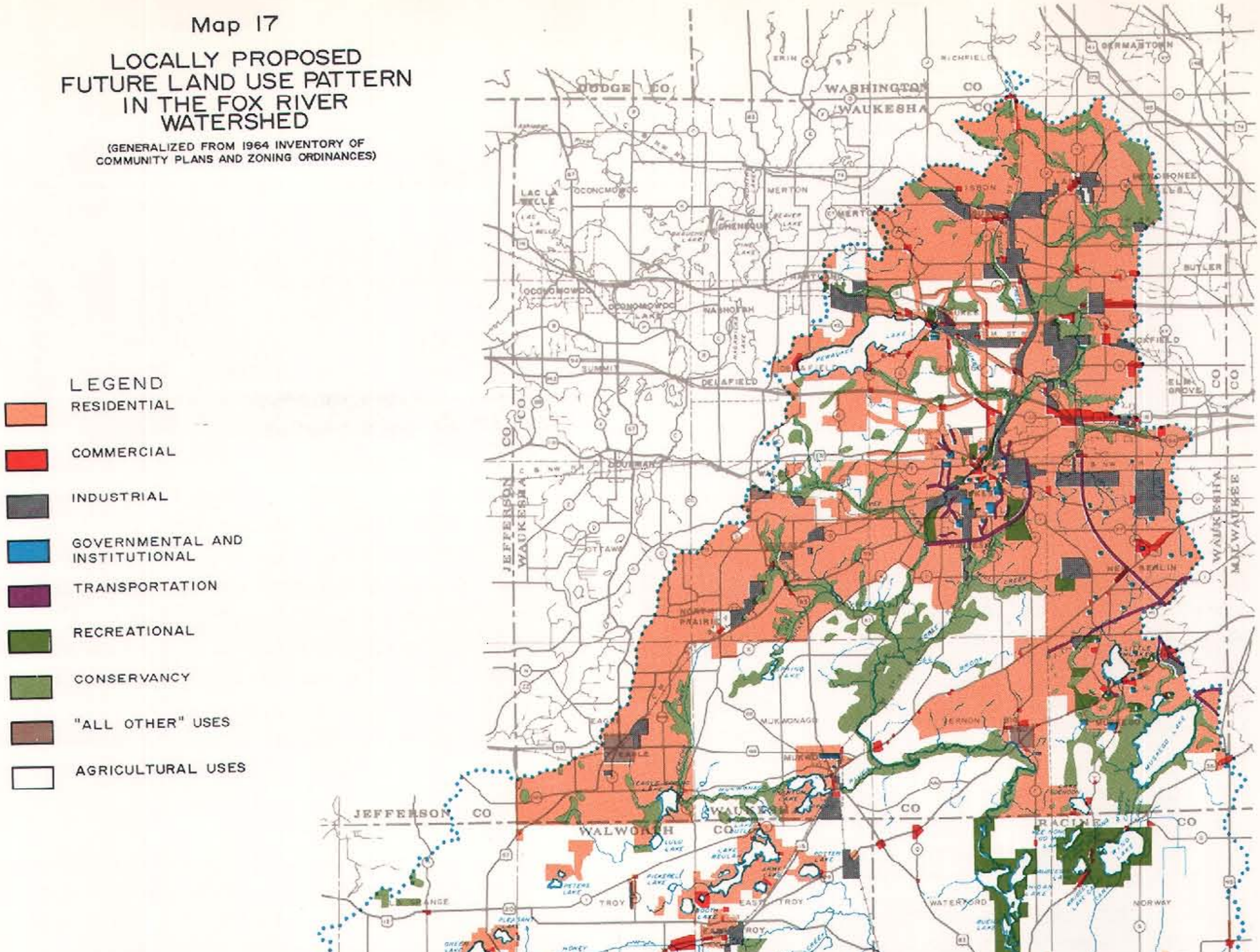
In the assignment of land use activities to subareas of the Region under this methodology, the only major constraint placed on the continuation of historic development trends within the Region and the watershed was that of the probable effect of adopted local plans and plan implementation devices. Land use development was assumed, in the absence of an agreed-upon areawide land use plan, to be guided only by private decisions and the constraints on these decisions imposed by adopted local land use plans and zoning ordinances. Thus, the concept of the unplanned alternative, as used herein, relates to the absence of planning and plan implementation on an areawide, and not on a local, basis. The land use proposals of the local communities comprising the watershed are shown graphically on Map 17 and are quantitatively compared to the proposals advanced in the recommended watershed plan in Tables 58 and 59.

The spatial distribution of the various land uses resulting from the unplanned alternative, as projected for the Region as a whole, was modified somewhat for the watershed by giving special attention to the probable location of future urban development in the riverine areas of the watershed. Development in the riverine areas was projected on the basis of observed existing trends and in consideration of the effect of existing and

Map 17

LOCALLY PROPOSED FUTURE LAND USE PATTERN IN THE FOX RIVER WATERSHED

(GENERALIZED FROM 1964 INVENTORY OF COMMUNITY PLANS AND ZONING ORDINANCES)



The land use proposals of the county and local units of government in the Fox River watershed, when mapped together, present a composite picture of how the Fox River watershed would develop in accord with local development objectives. It is apparent from the above map that the recent pattern of areawide urban development, including largely uncontrolled spread of relatively low-density residential and related development in areas noncontiguous to already developed areas, may be expected to continue under the local land use proposals. Furthermore, the local land use proposals do not adequately provide for effective regulation of land use development in floodlands and shorelands; do not recognize in most instances the need to protect and preserve the primary environmental corridors and related high value elements of the natural resource base; and often result in the zoning of land for urban development far in excess of the actual demand for such land over a rational planning period.

Source: SEWRPC.

Table 58

URBAN AND RURAL LAND USE IN THE FOX RIVER WATERSHED: 1963, 1990 RECOMMENDED LAND USE PLAN, AND AS PROPOSED IN COMMUNITY PLANS AND ZONING ORDINANCES[a]

Land Use Category	Existing (1963)		1990 Recommended Plan		Locally Proposed	
	Acres	Percent	Acres	Percent	Acres	Percent
Urban Land Use						
Residential.	30,664	5.1	44,132	7.3	145,709	24.2
Low-Density	*24,675[b]*	*4.1*	*26,253*	*4.3*	*111,856*	*18.6*
Medium-Density	*5,749[b]*	*0.9*	*17,602*	*2.9*	*31,980*	*5.3*
High-Density	*249[b]*	*0.1*	*277*	*0.1*	*1,873*	*0.3*
Commercial	1,324[c]	0.2	2,039	0.3	5,805	1.0
Industrial	1,297[d]	0.2	2,335	0.4	15,685	2.6
Mining	2,909	0.5	2,909	0.5	--	--
Transportation	22,793[e]	3.9	28,673	4.8	--	--
Governmental	2,204[f]	0.4	3,671	0.6	746	0.1
Recreational	6,446[g]	1.1	8,764	1.5	12,452	2.1
Total Urban Land Use.	67,637	11.4	92,523	15.4	180,398	30.0
Rural Land Use						
Agricultural	388,847	64.7	367,694	61.2	347,626	57.9
Water, Woodlands, Wetlands	144,295	23.9	140,562	23.4	72,756[h]	12.1
Total Rural Land Use	533,142	88.6	508,256	84.6	420,382	70.0
Total	600,779	100.0	600,779	100.0	600,779	100.0

[a] *Community plans and zoning ordinance inventory dated 1964.*

[b] *Estimated from 1963 land use inventory data.*

[c] *Includes 242 acres of on-site parking.*

[d] *Includes 121 acres of on-site parking.*

[e] *Includes utilities; excludes 484 acres of off-street parking.*

[f] *Includes institutional uses and 121 acres of on-site parking.*

[g] *Includes only the intensively used portions of recreation areas, such as ball diamonds and tennis courts.*

[h] *Includes land unplanned and unzoned, as well as land zoned in an unrestricted manner.*

Source: SEWRPC.

Table 59

CHANGES IN LAND USE IN THE FOX RIVER WATERSHED: 1990 RECOMMENDED LAND USE PLAN AND AS PROPOSED IN COMMUNITY PLANS AND ZONING ORDINANCES [a]

Land Use Category	1990 Recommended Plan Change		Locally Proposed Change	
	Acres	Percent	Acres	Percent
Residential	13,468	43.9	115,045	375.2
Low-Density.	*1,578*	*6.3*	*87,181*	*353.3*
Medium-Density	*11,862*	*206.6*	*26,240*	*457.1*
High-Density	*28*	*11.2*	*1,624*	*652.2*
Commercial.	715	54.0	4,481	338.4
Industrial.	1,038	80.0	14,388	1,109.3
Transportation.	5,880	25.8	0	0.0
Governmental.	1,467	66.6	- 1,458	-66.2
Recreational.	2,318[b]	36.0	6,006	93.2
Agricultural.	-21,153	- 5.4	- 41,221	-10.6
Other Open Land[c].	- 3,733	- 2.6	- 97,241	-57.2

[a] *Community plans and zoning ordinance inventory dated 1964.*

[b] *Includes only the intensively used portions of recreation areas, such as ball diamonds and tennis courts.*

[c] *Includes water, wetlands, and woodlands.*

Source: SEWRPC.

committed utility and transportation system service areas. Stage discharge and damage frequency curves relating to uncontrolled floodland development were then prepared for the resulting projected future floodland development pattern, as described in Chapter VII, Volume 1, of this report.

THE UNPLANNED ALTERNATIVE—LAND USE

The spatial distribution of the various land uses which could be expected to result from the unplanned alternative is shown graphically on Map 18 and quantitatively compared to the proposals advanced in the recommended watershed plan in Table 60.

Residential Development

The land use pattern which would result from the unplanned alternative would accommodate the expected watershed population increase of 199,500 persons by 1990, primarily through a continued outward expansion of existing urban areas; and leapfrog residential development in outlying rural areas of the watershed. Highly dispersed residential development could be expected to continue in the absence of any enforcement of rural development standards in the rural areas of the watershed and through continued heavy reliance upon very low residential development densities and on-site soil absorption sewage disposal systems. As indicated in Table 60, more than 68,600 acres of new residential development would be added to the existing stock of residential land within the watershed under the unplanned alternative, five times as much as under the recommended land use plan. Nearly 92 percent of this additional residential acreage would be developed at low densities, with net lot sizes ranging from one-half to five acres per dwelling unit and gross population densities ranging from 350 to 3,499 persons per square mile. This is in sharp contrast to the recommended land use plan wherein nearly 90 percent of the additional residential acreage would be developed at medium densities, with net lot sizes ranging from 6,300 to 19,800 square feet per dwelling unit and gross population densities ranging from 3,500 to 9,999 persons per square

Table 60

URBAN AND RURAL LAND USE IN THE FOX RIVER WATERSHED: 1963, 1990 RECOMMENDED LAND USE PLAN, AND 1990 UNPLANNED ALTERNATIVE

Land Use Category	Existing (1963)		Change 1963-1990				Total 1990			
			Planned		Unplanned		Planned		Unplanned	
	Acres	Percent of Major Category	Acres	Percent Change	Acres	Percent Change	Acres	Percent of Total	Acres	Percent of Total
Urban Land Use										
Residential	30,664	45.4	13,468	43.9	68,609	223.7	44,132	47.7	99,273	57.2
Low-Density	*24,675*[a]	*36.5*	*1,578*	*6.3*	*62,787*	*255.9*	*26,253*	*28.4*	*87,462*	*50.4*
Medium-Density	*5,740*[a]	*8.5*	*11,862*	*206.6*	*5,657*	*102.5*	*17,602*	*19.0*	*11,397*	*6.6*
High-Density	*249*[a]	*0.4*	*28*	*11.2*	*165*	*26.9*	*277*	*0.3*	*414*	*0.2*
Commercial	1,324[b]	2.0	715	54.0	1,940	146.5	2,039	2.2	3,264	1.9
Industrial	1,297[c]	1.9	1,038	80.0	1,460	112.6	2,335	2.5	2,757	1.6
Mining	2,909	4.3	0	0.0	0	0.0	2,909	3.1	2,909	2.7
Transportation	22,793[d]	33.7	5,880	25.8	27,845	122.2	28,673	31.0	50,638	29.2
Governmental	2,204[e]	3.3	1,467	66.6	3,363	152.6	3,671	4.0	5,567	3.2
Recreational	6,446[f]	9.5	2,318	36.0	2,563	39.8	8,764	9.5	9,009	5.2
Total Urban Land Use	67,637	100.0	24,886	36.8	105,780	156.4	92,523	100.0	173,417	100.0
Rural Land Use										
Agricultural	388,847	72.9	-21,153	-5.4	- 94,603	-24.3	367,694	72.3	294,244	68.9
Water, Woodlands, Wetlands	144,295	27.0	- 3,733	-2.6	- 11,177	- 7.7	140,562	27.7	133,118	31.1
Total Rural Land Use	533,142	100.0	-24,886	-4.7	-105,780	-19.8	508,256	100.0	427,362	100.0
Total	600,779	--	--	--	--	--	600,779	--	600,779	--

[a] *Estimated from 1963 land use inventory data.*

[b] *Includes 242 acres of on-site parking.*

[c] *Includes 121 acres of on-site parking.*

[d] *Includes utilities; excludes 484 acres of off-street parking.*

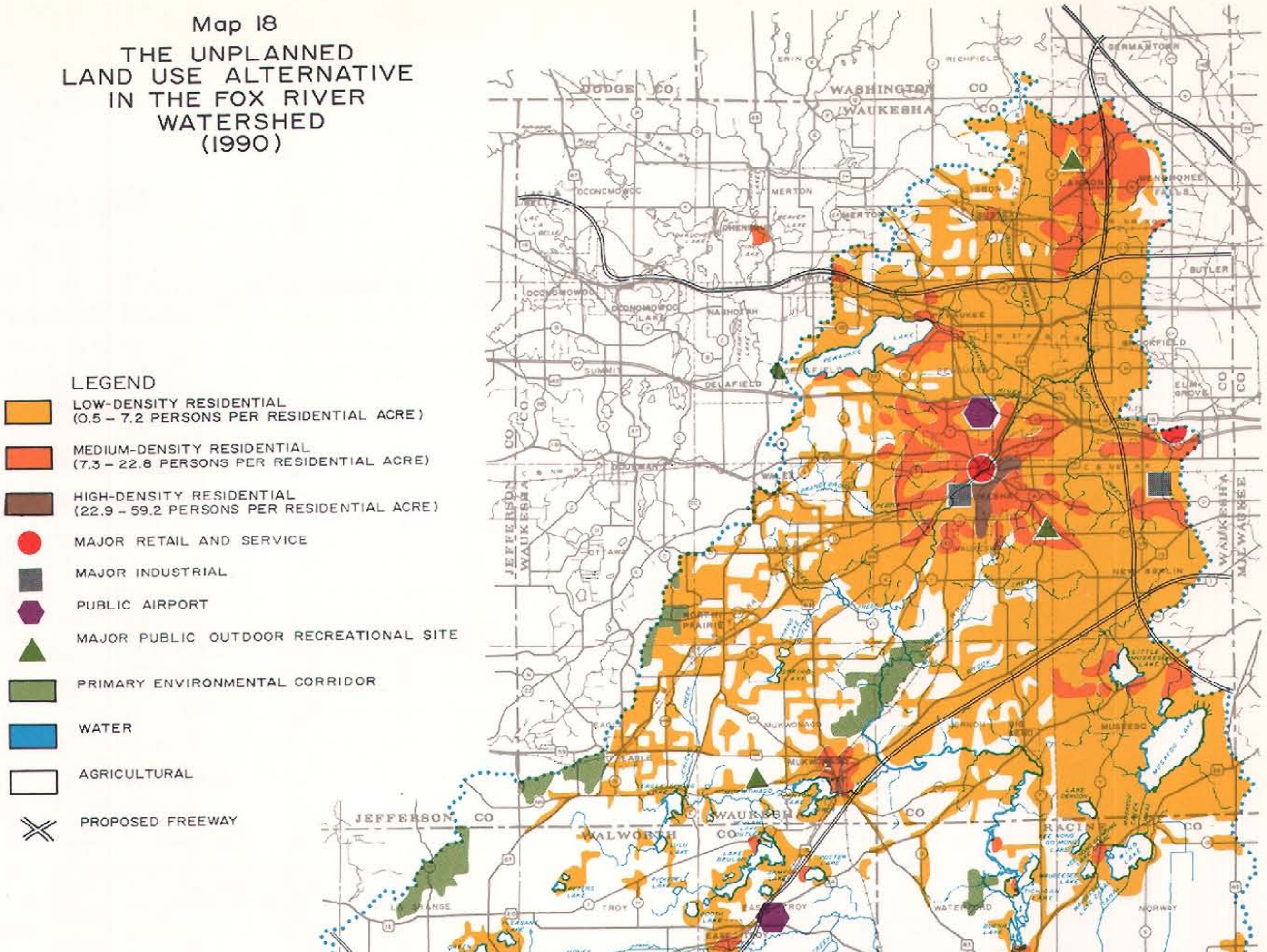
[e] *Includes institutional uses and 121 acres of on-site parking.*

[f] *Includes only the intensively used portions of recreation areas, such as ball diamonds and tennis courts.*

Source: SEWRPC.

Map 18

THE UNPLANNED LAND USE ALTERNATIVE IN THE FOX RIVER WATERSHED (1990)



One of the many possible land use patterns which could evolve within the watershed in the absence of any efforts to guide development on an areawide basis in the public interest is depicted in the above map. The development through 1990 of the watershed in the above manner would require the conversion of 165 square miles of rural land to urban use in a highly dispersed low-density pattern which would make the provision of basic municipal services, such as sewerage and water supply, difficult and costly. The above pattern is in contrast to the recommended watershed land use plan, which would require the conversion of only 39 square miles of rural land to urban use, all of which could be readily served by public water supply and sanitary sewerage facilities. Development of the watershed in the manner indicated on this map could be expected to result in increasing problems in flooding and water pollution, destruction of much of the remaining woodlands and wetlands, and in a continued deterioration and destruction of the underlying and sustaining natural resource base.

Source: SEWRPC.

mile. In the unplanned alternative, medium-density residential lands would increase by only 5,657 acres.

The recommended land use plan seeks to provide an overall urban population density of about 3,020 persons per square mile within the watershed by 1990. Under the unplanned alternative, urban population densities within the watershed could be expected to continue to decrease from the 1963 level of approximately 2,412 persons per square mile to a 1990 density of about 1,385 persons per square mile (see Table 61). Failure to accomplish a reversal in this trend of lower urban development densities within the watershed, as proposed in the recommended land use plan, will continue to present the local units of government within the watershed with all of the problems attendant to highly dispersed low-density residential development, including incomplete neighborhoods requiring extensive urban services, services which can only be provided inefficiently and at a high cost. Failure to accomplish this reversal will also result in the continued breakup of economic farm units, leaving a residual of scattered underdeveloped and undeveloped areas of land which lack potential for either good rural or urban development. Finally, failure to accomplish this reversal will greatly intensify environmental problems in the watershed and will result in continued deterioration and destruction of such elements of the resource base as the woodlands and wetlands.

Sewer and Water Services

The unplanned alternative would require the conversion of nearly 165 square miles of land within the watershed from rural to urban use by 1990. It would increase the urban land use of the watershed by more than 156 percent as contrasted to the conversion of 38.9 square miles of land, an increase of only 37 percent, under the recommended plan. The need to restrict intensive urban development to those areas within the watershed having both soils suitable for such development and gravity drainage sanitary sewer service readily available would not be recognized under the unplanned alternative as it would by implementation of the recommended land use plan. Under the unplanned alternative, only 22 percent of the total developed area of the watershed could be readily provided in 1990 with public sanitary sewer facilities tributary to existing and locally proposed systems (see Table 62); and only 22 percent of the total developed area of the watershed could be readily provided with public water supply facilities. Thus, the unplanned alternative would result in a continued emphasis upon not only low-density residential development but also the concomitant widespread utilization of private wells and domestic septic tank sewage disposal systems rather than upon municipal water supply and sewerage facilities.

Table 61

DEVELOPED AREA AND POPULATION DENSITY IN THE FOX RIVER WATERSHED: 1963, 1990 RECOMMENDED LAND USE PLAN, AND 1990 UNPLANNED ALTERNATIVE

	Existing (1963)	Increment 1963-1990 Planned		Increment 1963-1990 Unplanned		Total 1990	
		Number	Percent	Number	Percent	Planned	Unplanned
Square Miles of Developed Area[a]	57	55	96.5	274	480.7	112	331
Urban Population	137,500	200,700	146.0	321,000	233.5	338,200	458,500
Population Per Square Mile of Developed Area	2,412	3,649	151.3	1,172	48.6	3,019	1,385

[a] *Determined by measuring the extent of uninterrupted urban development (see SEWRPC Planning Report No. 7, Volume 1, Chapter V, footnote 1).*

Source: SEWRPC.

Table 62

DEVELOPED URBAN AREA AND POPULATION SERVED BY PUBLIC SANITARY SEWER AND PUBLIC WATER SUPPLY FACILITIES IN THE FOX RIVER WATERSHED: 1963, 1990 RECOMMENDED

Extent of Service	Existing (1963)		Increment 1963-1990				Total 1990			
			Planned		Unplanned		Planned		Unplanned	
	Public Sewer	Public Water Supply	Public Sewer	Public Water Supply	Public Sewer	Public Water Supply	Public Sewer	Public Water Supply	Public Sewer	Public Water Supply
Developed Urban Area:										
Total Square Miles . .	57	57	55	55	274	274	112	112	331	331
Square Miles Served in Watershed	16.0	18.9	59.8[a]	56.9[a]	36.2	33.3	75.8	75.8	52.2	52.2
Square Miles Served from Outside Watershed[b]	2.2	0.5	13.3	15.0	17.7	19.4	15.5	15.5	19.9	19.9
Square Miles Served. .	18.2	19.4	73.1	71.9	53.9	52.7	91.3	91.3	72.1	72.1
Percent of Total Served	32	34	--	--	--	--	82	82	22	22
Population:										
Total Population . . .	137,500	137,500	200,700	200,700	321,000	321,000	338,200	338,200	458,500	458,500
Population Served in Watershed. . . .	50,200	60,000	204,600[a]	194,800	67,400	58,000	254,800	254,800	127,400	127,400
Population Served from Outside Watershed[b].	6,200	1,900	53,200	57,500	42,200	46,600	59,400	59,400	48,500	48,500
Population Served . .	56,400	61,900	257,700	252,200	119,500	114,000	314,100	314,100	175,900	175,900
Percent of Total Served	41	45	--	--	--	--	93	93	38	38

[a] *The increment in square miles and population served by public sewer and public water supply facilities within the watershed is larger than the increment of the total developed area because public sewer and water supply services, under the planned alternative, would be extended to include not only the increment of developed area but also some existing urban areas now served by these two public utilities.*

[b] *The sewage from those portions of the Cities of Delafield and Elkhorn and the Village of Hartland within the watershed, as well as those portions of the Cities of Brookfield, New Berlin, and Muskego and the Village of Menomonee Falls within the watershed served by the Metropolitan Sewerage Commission of Milwaukee County, is transported to sewage treatment plants which discharge their treated effluent to watercourses outside the Fox River watershed.*

Source: SEWRPC.

The impact of such development upon surface water quality is extremely difficult to forecast because, unlike sewage treatment plant effluent, septic tank effluent is usually discharged to streams and lakes only indirectly after percolation through the soil and dilution by both surface and ground water. Other environmental problems attendant to the widespread utilization of on-site septic tank facilities and private wells, however, would probably far outweigh any consideration of the effects of the use of such facilities on surface water quality. Continued widespread use of septic tank sewage disposal systems could be expected to subject the shallow ground water aquifer to pollution in more numerous locations involving larger and larger areas with serious attendant public health problems. Odor and drainage problems could be expected to continue to develop where residential development is located on soils poorly suited for septic tank filter fields, as could attendant public health hazards. As noted in Chapter IV, Volume 1, of this report, such soils are widespread, covering over 56 percent of the total area of the watershed.

Under the unplanned alternative, 221.3 square miles, or 77 percent of all new development within the watershed, would probably have to rely on private shallow wells as a source of water supply; and over 220.1 square miles, or 77 percent of the new development, would have to rely upon on-site sewage disposal systems. Consequently, by 1990 only about 38 percent of the total watershed population could be expected to be served by public sanitary sewerage and water supply facilities. In 1963 about 18.2 square miles, or 32 percent, of the developed area of the watershed and 41 percent of the total population were served by public sanitary sewerage facilities, while about 20.0 square miles, or 34 percent, of the developed area and 45 percent of the 1963 population were served by public water supply facilities. In sharp contrast to the unplanned alternative, the recommended land use plan would make possible the provision of public sewerage and water supply facilities to all new residential development within the watershed and would by 1990 facilitate the provision of public sewer and water service to 82 percent of the total developed area of the watershed and 93 percent of the total population.

Local Park Land Use

The recommended watershed land use plan calls for the acquisition and eventual development of 536 acres of local park land in the form of neighborhood parks to serve the additional residential development anticipated to occur within the watershed by the year 1990. In addition, the recommended watershed land use plan calls for the ultimate development of an additional 1,847 acres of local park land in the form of community parks within the acquired urban environmental corridors in order to fully meet the recommended standard of 10 acres of local park land per thousand resident population. Thus, the recommended watershed land use plan provides for a total of 2,383 acres of additional local park land. Under the unplanned alternative, the amount of land needed for neighborhood and community parks totals 2,563 acres or about 180 acres more than the local park land proposed in the recommended watershed land use plan. This additional local park land would be necessary in order to serve the large increase in low-density residential land use which would occur under the unplanned alternative. It should also be noted that the unplanned alternative would not be nearly as effective in protecting the natural resource base of the watershed because of the large amount of residential development which would be likely to occur within the environmental corridors. While some of the neighborhood and community parks which would be established under the unplanned alternative might be located within the environmental corridors, it is likely that the uncontrolled residential development would usurp most of the high-value natural resource areas, with the local and community parks then relegated to the remaining low-value resource areas. Thus, while the recommended watershed land use plan proposes to develop slightly fewer acres for local park use than would be developed under the unplanned alternative, the recommended plan, because of the proposed acquisition and preservation of the primary environmental corridors, would be far more effective in protecting the natural resource base of the watershed.

Agricultural Land Use

Under the unplanned alternative, the expansion of urban activities in the presently rural areas of the watershed could result in the conversion of 105,780 acres of rural land uses to urban uses between 1963 and 1990. This would be an equivalent annual rate of conversion of about 3,900 acres, or 6.1 square miles. As indicated in Table 60, much of the urban expansion of 105,780 acres would take place on land that is now in agricultural use and would result in a decrease of about 24.3 percent of the existing stock of agricultural land within the watershed. The recommended land use plan would require the conversion of only 58,893 acres, or 15.1 percent of the existing stock of such land by 1990. Moreover, the unplanned alternative would result in a conversion of 24,443 acres, or 19.0 percent, of the remaining prime agricultural lands, while the recommended plan would require the conversion of only 982 acres, or less than 1 percent of these lands.

THE UNPLANNED ALTERNATIVE—FLOOD DAMAGES AND WATER QUALITY MANAGEMENT

Implications for Flood Control

The floodlands of the Fox River watershed, as delineated by the 100-year recurrence interval flood hazard lines, encompass a total of 71.4 square miles of land, or 7.5 percent of the total watershed area. By 1963, 2.8 square miles, or about 4 percent of this total floodland area, had been converted to urban use; and the average annual flood-damage risk totaled $77,000, with a major flood, such as the 1960 flood, causing total damages of almost one-half million dollars, and a 100-year recurrence interval flood having a damage potential of $857,000.

Under the unplanned alternative, an additional 22.7 square miles of floodlands could be expected to be converted from rural to urban use within the watershed by 1990, resulting in an increase in the annual risk of flood damage from $77,000 to $112,000 and an increase in the risk of damage from a 100-year recurrence interval flood from $857,000 to $1.5 million.

At the present time, the amount of water temporarily stored on the floodlands of the Fox River watershed during the peak of a 100-year recurrence interval flood is about 110,000 acre-feet. This existing storage is equivalent to 2.3 inches of runoff over the total area of the watershed, or a flow of 55,000 cubic feet per second for a period of one day at the Wilmot Dam in Kenosha County. This storage results in a significant reduction of peak flood flows within the watershed as compared to those which would occur if this floodland storage were eliminated through urban development. Under the unplanned alternative, an additional 22.7 square miles, or 32 percent, of the floodland area could be expected to be converted from rural to urban use; and, as a direct consequence, significant amounts of the presently available floodland storage could be expected to be lost to urban development. Additional channel improvements would then be necessary to accommodate this urban development in the floodlands, which could be expected to increase further downstream peak flood discharges. Effects of these increased discharges would be particularly significant in the upper reaches of the main stem of the Fox River from the headwaters to the City of Burlington.

The increase in flood damage and in peak flood discharges accompanying the unplanned land use alternative could be expected to increase the need and demand for structural flood control measures beyond those proposed in the recommended comprehensive watershed plan. These might include channel improvements of an indeterminate extent, together with the construction of far more extensive systems of dikes and floodwalls than proposed in the recommended watershed plan.

Of the alternative structural flood control plan elements described in Chapter IV of this volume, levee construction and channel improvements within the Cities of Waukesha and Burlington; a floodwater retarding structure near the outlet of the Vernon Marsh; reconstruction of the existing dam at Waterford and management of its impoundment for flood control; and management of the major lakes within the watershed for flood control would all be physically compatible with the unplanned alternative.

Implications for Water Quality Management

Although certain alternative water pollution abatement measures, such as the provision of secondary treatment with disinfection of the effluent and the provision for nutrient removal, would be applicable to any sewage treatment plant configuration serving the unplanned land use alternative, the problems associated with the economical extension of centralized sanitary sewer service under the unplanned alternative would make these pollution abatement measures less effective. More importantly, the proliferation of small sewage treatment plants serving highly dispersed, relatively small enclaves of urban development within the watershed would make the attainment of advanced sewage treatment extremely difficult if not impossible. The probable effects of the lack of such advanced treatment on future stream water quality within the watershed have been described in Chapter V of this volume. The unplanned land use alternative would also make the attainment of a centralized sanitary sewerage system for those reaches of the Fox River above the City of Waukesha more difficult. Consequently, the Fox River above Waukesha could be expected to become unsuited for any use except waste assimilation and transmission. Lake eutrophication could be expected to continue at a rapid rate, with the lakes becoming increasingly undesirable for not only recreational activities but for aesthetic values as well. The foregoing may be expected to be accompanied by decreasing property valuations in the lake-oriented communities of the watershed.

BENEFITS OF THE UNPLANNED ALTERNATIVE

One advantage that can be advanced for the unplanned alternative is that decision-making as to land use would continue to be decentralized in individual landowners and developers. This is an extremely intangible benefit, however; and any monetary benefits are and would continue to be derived by relatively few persons. In a free enterprise economy, each landowner and developer should be subject to a minimum of constraints in selecting the utilization of his land that, to him, appears to offer the greatest profit; and each consumer should be free to choose the opportunity that, to him, appears to offer the greatest value. Theoretically, in a free enterprise economy, the individual is in the best position to evaluate his own particular set of circumstances and then to choose the opportunity that appears most profitable to him. For example, a land developer and home builder are free to choose whether or not to locate on the floodland; and in theory would carefully weigh the attendant benefits and costs and before actually locating on the floodland would have concluded that the risk of flood damage is outweighed by other benefits of the floodland location, fully realizing that future owners should not expect nor obtain any governmental aid through publicly funded flood protection or drainage programs.

For this theory to apply in practice, however, it would be necessary for each individual decision-maker, in making his decision, to have full knowledge of the existence and magnitude of the flood risk and to be willing to act responsibly upon that knowledge. This is seldom the case in the Fox River watershed, and it is highly unlikely that an individual deciding whether or not to buy an existing building in the floodland would do so if all of the flood risk facts were made available to him to help him in determining his home or business location. The costs attendant to water pollution are not recognized at all in such decisions.

COSTS OF THE UNPLANNED ALTERNATIVE

Both heavy direct and spillover costs would be incurred under the unplanned alternative, with the latter costs being defined as those costs which the community as a whole must bear as a result of private development decisions. Direct costs would result from recurring flood damages which would be incurred by residents of the floodlands and by the watershed communities, and the magnitude of these costs has been discussed in a previous section of this chapter. Major areas in which spillover costs would be incurred include the loss to the community of prime park and related open-space lands; loss in recreational value of the streams and lakes of the watershed due to water pollution; and the increased cost of providing community services to a highly dispersed land use pattern, including, in addition to sanitary sewer and water supply services, school services and police and fire protection. Although these spillover costs have real monetary values, such costs are virtually impossible to calculate and must, therefore, be considered as intangibles.

A benefit-cost analysis was not made for the unplanned alternative because the only recognized benefit would be the maximization of individual decision-making, to which a monetary value cannot be assigned. Presumably, this alternative would be acceptable only if the benefit-cost ratios of all other alternative plans, including allowances for intangible considerations, were found to be less than 1. A comparative evaluation of the recommended comprehensive watershed plan with the unplanned alternative was made on the basis of the relative ability to meet established watershed development objectives and standards. This evaluation is presented in summary form in Table 63.

SUMMARY

This chapter has presented a description, comparison, and evaluation of the recommended comprehensive Fox River watershed plan with the unplanned alternative. The recommended comprehensive watershed plan was designed specifically to meet established watershed development objectives, whereas the unplanned alternative was prepared to reflect one possible consequence of a continuation of existing development trends within the watershed in the absence of any attempt to guide such development on an areawide basis in the public interest. The recommended watershed plan best meets the adopted watershed development objectives and standards; and its implementation could be expected to provide a safer, more healthful, and more pleasant, as well as a more orderly and efficient, environment within the watershed. Implementation of the recommended watershed plan would abate many of the existing areawide development problems, would avoid the creation of new developmental problems, and would do much to protect and enhance the underlying and sustaining natural resource base.

The unplanned alternative would require the least amount of areawide effort toward regulation of development in the public interest and would require few restraints on the operation of the urban land market in determining the future character, intensity, and spatial distribution of land use development within the watershed. The unplanned alternative, however, could be expected to lead to a continued intensification of existing environmental problems within the watershed, including flooding and water pollution; could be expected to result in the almost total destruction of the natural resource base; and could be expected to result in a land use pattern which would be as disorderly and inefficient as it would be ugly. The need to protect the floodways and floodplains of the perennial stream system, the best remaining woodlands and wetlands, the best remaining wildlife habitat, and the best remaining agricultural areas would be ignored as would the value of developing an integrated system of park and open-space areas centered on the primary environmental corridors of the Region. Failure to recognize these needs and values has, indeed, been the case within the watershed in the past as attested to by growing environmental problems. Continuation of these past practices can only lead to the further deterioration and destruction of the natural resource base of the watershed, increasing costs for governmental facilities and services, and a decline in the overall quality of life within the watershed.

Table 63

COMPARISON OF THE RELATIVE ABILITY OF THE RECOMMENDED FOX RIVER WATERSHED PLAN AND THE UNPLANNED ALTERNATIVE TO MEET ADOPTED DEVELOPMENT STANDARDS

Land Use Objective	Recommended Watershed Land Use Plan	Unplanned Alternative
Objective No. 1		
Standard		
1. Residential Land Allocation		
a. Low-density--250 acres/1,000 persons	Met[a]	240 acres/1,000
b. Medium-density--70 acres/1,000 persons	Met[a]	70 acres/1,000
c. High-density--25 acres/1,000 persons	Met[a]	25 acres/1,000
2. Governmental and Institutional Land Allocation		
a. Local--6 acres/1,000 added population	Met[a]	Not met
b. Regional--3 acres/1,000 added population	Met[a]	Not met
3. Park and Recreation Land Allocation		
a. Local--1.0 acre/100 added population	0.34 acre/100[a]	0.32 acre/100
b. Regional--0.4 acre/100 added population	0.53 acre/100[a]	0.26 acre/100
c. Swimming--0.45 acre/100 participants	Met[a]	Partially met
d. Picnicking--12.5 acres/100 participants	Met[a]	Partially met
e. Golfing--32.8 acres/100 participants	Met[a]	Not met
f. Camping--133.3 acres/100 participants	Met[a]	Not met
g. Skiing--3.7 scres/100 participants	Met[a]	Met
4. Commercial Land Allocation		
a. 5 acres/100 added employees	3.32 acres/100	3.91 acres/100
5. Industrial Land Allocation		
a. 7 acres/100 added employees	6.56 acres/100	6.16 acres/100
Objective No. 2		
Standard		
1. Residential planning units	Could be met[b]	Difficult to meet
2. Regional commercial land location	Met[a]	Met
3. Major industrial land location	Met[a]	Met
Objective No. 3		
Standard		
1. Soils		
a. Urban uses	Met[a]	Largely unmet
b. Rural uses	Met[a]	Largely unmet
c. Sanitary sewer service areas	Met[a]	Largely unmet
2. Inland Lakes and Streams		
a. Large inland lakes over 50 acres		
1. 25% of shore in natural state	Met for 45 lakes	Met for 9 of 45 lakes
2. 10% of shore in public use	Met for 6 of 45 lakes[c]	Met for 3 of 45 lakes
3. 50% of shore in nonurban uses	Met for 16 of 45 lakes[c]	Met for 3 of 45 lakes
b. Small inland lakes under 50 acres		
1. 25% of shore in natural state	Could be met[b]	Not met
c. Perennial streams		
1. 25% of shore in natural state	Met for 25 of 30 streams	Met for 8 of 30 streams
2. 50% of shore in nonurban uses	Met for 25 of 30 streams	Met for 7 of 30 streams
3. Restrict urban uses in floodplains	Met[a]	Not met
4. Restrict development in channels and floodways	Met[a]	Not met

Table 63 (continued)

Land Use Objective	Recommended Watershed Land Use Plan	Unplanned Alternative
3. Wetlands		
a. Protect wetlands over 50 acres and those with high resource value	Met[a]	Not met
4. Woodlands		
a. 10% of watershed	Partially met	Not met
b. 40 acres each of 4 forest types.	Could be met[b]	Could be met
c. 5 acres/1,000 regional population[d]	10 acres/1,000	Unknown
5. Wildlife[e]		
a. Maintain a wholesome habitat	Met	Not met
Objective No. 4		
Standard		
1. Major transportation routes penetrating residential planning units	Could be met	Difficult to meet
2. Major transportation routes penetrating resource areas	Partially met	Unknown
3. Transportation service to appropriate areas	Could be met[b]	Difficult to meet
4. Transportation terminal areas.	Could be met[b]	Could be met
5. Sewer service to residential areas	82% served	22% served
6. Water supply to residential areas.	93% served	22% served
7. Maximize use of existing transportation and utility facilities	Met[a]	Not met
Objective No. 5		
Standard		
1. Physical self-containment of residential planning units.	Could be met[b]	Difficult to meet
2. Appropriate land uses within residential planning units.	Could be met[b]	Difficult to meet
3. Variety of housing within residential planning units	Could be met[b]	Difficult to meet
Objective No. 6		
Standard		
1. Major industrial site requirements	Met[c]	Met
2. Local commercial site requirements	Could be met[b]	Unknown
3. Major commercial site requirements	Met[b]	Not met
Objective No. 7		
Standard		
1. Local park spatial location.	Could be met	Difficult to meet
2. Regional park spatial location	Met[a]	Not met
Objective No. 8		
Standard		
1. Preserve prime agricultural areas.	99% preserved	81% preserved
2. Preserve other appropriate agricultural areas. . .	85% preserved	76% preserved

Table 63 (continued)

Water Control Objective	Recommended Watershed Water Control Facilities Plan	Unplanned Alternative
Objective No. 1		
Standard		
1. Existing bridges and culverts		
a. Minor streets--pass the 10-year flood.	Met[a]	Could be met
b. Arterial streets and highways--pass the 50-year flood	Met[a]	Difficult to meet
c. Freeways--pass the 100-year flood	Met[a]	Met
d. Railroads--pass the 100-year flood	Met	Met
2. New bridges and culverts shall meet the foregoing applicable standards. Maximum headloss shall not exceed 0.5 foot.	Met	Could be met
3. Structure design shall maximize passage of ice flows and debris	Met	Met
4. Channel improvements should be restricted to the absolute minimum necessary	Met[a]	Not met
5. All other water control facilities, such as dams or diversion channels, shall accommodate the 100-year flood	Met[a]	Could be met
6. Public land acquisitions to eliminate water control facilities shall encompass the entire 100-year floodplain	Could be met	Not met
Objective No. 2		
Standard		
1. Stream reach water quality levels shall meet State Water Quality Standards for all reaches . .	Met[a]	Difficult to meet
2. All stream reaches shall meet State Minimum Standards.	Met	Unknown
3. Residential lots less than 5 acres on poor soils shall be served by public sanitary sewers. . . .	Partially met	Not met
Objective No. 3		
Standard		
1. All lake water uses shall be compatible with recreation, fishing, and aesthetic uses.	Met[a]	Difficult to meet
2. Lake water uses not allowed.	Met[a]	Unknown
3. Lake water quality standards shall meet State Water Quality Standards.	Met[a]	Difficult to meet
4. Algae and weeds shall not create a nuisance. . . .	Met[a]	Not met

Table 63 (continued)

[a] *This standard has been met under the recommended land use plan because it served as an input to the plan design process.*

[b] *This standard could be met only by local community action.*

[c] *If the recommendations contained in the series of lake use reports prepared under the Fox River watershed study are carried out, 39 of the 45 major lakes would meet the standard of 10 percent of shore in public use and 27 of the 45 major lakes would meet the standard of 50 percent of shore in nonurban use.*

[d] *Only that woodland cover contained within the primary environmental corridors was assumed to be preserved.*

[e] *This standard has been met under the recommended watershed land use plan because all of the environmental corridors are proposed to be protected and preserved.*

Note: These objectives are listed in the same order as in Chapter II, Volume 2, of this report.

Source: SEWRPC.

Chapter IX

PLAN IMPLEMENTATION

INTRODUCTION

The recommended comprehensive plan for the Fox River watershed described in the foregoing chapter of this report provides a design for the attainment of the specific watershed development objectives formulated under the Fox River watershed study in cooperation with the local, state, and federal units and agencies of government concerned. The final watershed plan emphasizes six main elements: the regulation, in the public interest, not only of the use of land lying in areas subject to periodic flooding but also the use of land and water throughout the entire watershed; the acquisition of certain riverine areas and other lands for the protection and preservation of the underlying and sustaining natural resource base of the watershed; the provision of adequate park and related open-space sites to meet the growing demand within the watershed for outdoor recreation; the construction of certain flood control facilities; the construction of certain water pollution abatement facilities; and the application of sound water supply development and management practices to the ground water aquifers which must serve as the principal source of municipal and industrial supply within the watershed in the foreseeable future. In a practical sense, the recommended watershed plan is not complete, however, until the steps required to implement the plan, that is, to convert the plan into action policies and programs, are specified.

This chapter is, therefore, presented as a guide for use in the implementation of the recommended watershed plan. Basically, it outlines the actions which must be taken by the various levels and agencies of government concerned if the recommended comprehensive watershed plan is to be fully carried out. Those units and agencies of government which have plan adoption and plan implementation powers applicable to the Fox River watershed plan are identified; necessary or desirable formal plan adoption actions are specified; and specific implementation actions are recommended with respect to the recommended land use, recreation and natural resource protection, flood control, water pollution abatement, and water supply plan elements to each of the units and agencies of government concerned. In addition, financial and technical assistance programs available to such units and agencies of government in implementation of the watershed plan are discussed.

The plan implementation recommendations contained in this chapter are, to the maximum extent possible, based upon, and related to, existing governmental programs and are predicated upon existing enabling legislation. Because of the ever-present possibility of unforeseen changes in economic conditions, state and federal legislation, case law decisions, governmental organization, and tax and fiscal policies, it is not possible to declare once and for all time exactly how a process as complex as watershed plan implementation should be administered and financed. In the continuing planning process for southeastern Wisconsin, it will, therefore, be necessary to periodically update not only the watershed plan elements and the data and forecasts on which these plan elements are based but also the recommendations contained herein for implementation.

BASIC CONCEPTS AND PRINCIPLES

It is important to recognize that plan implementation measures must grow out of adopted plans. Thus, action policies and programs must not only be preceded by plan adoption but also must emphasize the most important and essential elements of the comprehensive watershed plan and those areas of action which will have the greatest impact on guiding and shaping development in accordance with the recommended plan. Of particular importance in this regard are those plan implementation efforts which are directly related to achieving the watershed development objectives, especially those objectives dealing with protection of the underlying and sustaining natural resource base, with flood control, and with water pollution abatement.

With respect to natural resource protection and the provision of adequate facilities for outdoor recreation, watershed plan implementation will be largely achieved if future residential development within the watershed approximates the density and spatial distribution patterns recommended in the land use base element of the watershed plan; if all of the primary environmental corridor lands lying within the existing and probable future urban areas of the watershed and along the main stem of the Fox River are publicly acquired for conservancy and related open-space purposes; if certain additional high-value wetlands and woodlands within the corridors are publicly acquired for conservancy purposes; and if the proposed regional and local park sites are acquired for public recreational use.

With respect to flood control, watershed plan implementation will be largely achieved if the delineated floodways and floodplains are kept in substantially open use throughout the watershed, either through public acquisition of floodlands, as recommended in all existing and probable future urban areas and along the entire main stem of the Fox River, or through effective floodland zoning in rural areas; if levee construction and channel improvements are made in the Cities of Burlington and Waukesha; if channel improvements are made on Honey, Hoosier, and Sugar Creeks; if the multi-purpose Sugar Creek reservoir is constructed; and if existing residences in the floodlands in Kenosha County are gradually removed. The importance to the entire watershed plan of maintaining in permanent open use the primary environmental corridors and associated floodways and floodplains of the Fox River system cannot be overemphasized. Elimination of the existing natural valley storage and encroachment in the form of dumping, filling, and structure placement in the floodways and floodplains will inevitably destroy the present naturally well-regulated flow characteristics of the Fox River system and will result in increased flooding and concomitant flood damages within the watershed and in public demands for the construction of expensive flood control facilities.

With respect to water pollution abatement and water quality control, watershed plan implementation will be largely achieved if advanced waste treatment is provided at all major municipal sewage treatment plants within the watershed and if sanitary sewerage systems are provided at Browns, Camp and Center, Como, Eagle, Little Muskego, Pewaukee, Tichigan, and Wind Lakes. With respect to the upper watershed, the plan indicates that the required advanced waste treatment could best be provided through the construction of an areawide trunk sewer system conveying all wastes to a single large treatment plant located below the City of Waukesha. The water use objectives and supporting water quality standards incorporated in the plan, however, could also be achieved by any one of the other two alternative sanitary sewerage system configurations considered for the upper watershed, should it prove impractical to create the institutional structure required to build and maintain an areawide sewerage system within a reasonable period of time following plan adoption. Thus, with respect to the upper watershed, plan implementation will be largely achieved if advanced waste treatment is provided, regardless of the system configuration utilized to provide such treatment. With respect to the lower watershed, plan implementation will be largely achieved if advanced waste treatment is provided at the sewage treatment plants serving the Cities of Burlington and Lake Geneva, the Villages of East Troy, Mukwonago, and Twin Lakes, and the western Racine County sewerage district; if sanitary sewerage service is provided for the Browns Lake community through the City of Burlington sewage treatment plant; if sanitary sewerage service is provided for the Little Muskego Lake community through the Milwaukee-Metropolitan sewerage system; and if sanitary sewerage systems are established at Camp and Center, Como, Eagle, Tichigan, and Wind Lakes.

With respect to water supply, watershed plan implementation will be largely achieved if the plan recommendations concerning well location and spacing for proper development of the deep aquifer underlying the watershed are followed and if the land for a potential surface water supply reservoir in the Vernon Marsh area of Waukesha County is publicly acquired.

Primary emphasis in plan implementation, then, should be placed upon the following four aspects of watershed development: 1) the preservation in open uses, through land acquisition and zoning, of the primary environmental corridors and associated floodways and floodplains of the entire river system; 2) the preservation, through land acquisition, of designated high-value park lands and high-value woodland and wetland areas; 3) the provision of advanced waste treatment facilities at all sewage treatment plants recommended to be in operation within the watershed through the plan design year of 1990; and 4) the construction of certain flood control structures and designated channel improvements.

There are three main ways through which the necessary watershed plan implementation may be achieved; and these parallel the three functions of the Regional Planning Commission: inventory, or the collection, analysis, and dissemination of basic planning data on a uniform, areawide basis; plan design, or the preparation of a framework of long-range plans for the physical development of the Region; and plan implementation, or the provision of a center for the coordination of planning and plan implementation activities. All require at least a receptive attitude and preferably active planning and plan implementation programs at the local, county, and state levels of government.

A great deal can be achieved with respect to guiding watershed development along better lines through the simple task of collecting, analyzing, and disseminating basic planning and engineering data on a continuing and uniform basis. Experience within the Region to date has shown that, if this important inventory function is properly carried out, the resulting information will be used and acted upon both by local and state agencies of government and by private investors. Since such data were used as a primary input to the preparation of the Fox River watershed plan, the utilization of these data in arriving at public and private development decisions on a day-to-day basis will tend to contribute substantially toward implementation of the comprehensive watershed plan.

With respect to the function of plan preparation or design, it is essential that some of the watershed plan elements be carried into greater depth and detail for sound implementation. Specifically, the plan recommendations dealing with the flood control and pollution abatement facilities must be carried through preliminary engineering to the final design stages. Further study must be given to the actual geographic limits of the public land acquisitions and land use controls necessary to protect adequately the primary environmental corridors and high-value wetlands and woodlands. The preparation of such detailed plans will require the continuing development of very close working relationships between the Commission, the four county boards concerned, the local units of government concerned, and certain special-purpose units or agencies of government and state agencies, and in particular the Wisconsin Department of Natural Resources.

It will be highly desirable, although not absolutely essential, to achieve a high degree of watershed plan implementation through the Commission's objective of serving as a center for the coordination of local, areawide, state, and federal planning and plan implementation activities within the watershed. The Commission's community assistance program, which actively assists the local municipalities in the preparation of plans and plan implementation devices, is an important factor in this respect and will make possible the integration of watershed and local plans adjusting the details of the latter to the broader framework of the former.

Under the provisions of recently enacted federal legislation and subsequent federal administrative determinations,[1] applications by state and local units of government for federal grants in partial support of the planning, acquisition of land for, and the construction of such public facilities as sewerage and water supply systems, parks, waste treatment facilities, and land conservation projects must, in metropolitan regions, be submitted to an officially designated areawide planning agency for review, comment, and recommendation before consideration by an administering federal agency. The comments and recommendations of the areawide planning agency must include information concerning the extent to which the proposed project is consistent with the comprehensive planning program for the region, including, in southeastern Wisconsin, the Fox River watershed planning program, and the extent to which such project contributes to the fulfillment of such planning programs. The review comments and recommendations by the areawide planning agency are entirely advisory to the local, state, and federal agencies of government concerned and are intended to provide a basis for achieving the necessary coordination of public development programs in urbanizing regions of the United States. If used properly such review can be of material assistance in achieving implementation of the recommended Fox River watershed plan.

PLAN IMPLEMENTATION ORGANIZATIONS

Although the Regional Planning Commission can promote and encourage watershed plan implementation in various ways, as discussed above, the completely advisory role of the Commission

---

[1] *Section 204 of the Demonstration Cities and Metropolitan Development Act of 1966; Title IV of the Intergovernmental Cooperation Act of 1968; and U.S. Bureau of the Budget Circular No. A-95, dated July 24, 1968.*

requires that actual implementation of the recommended Fox River watershed plan be entirely dependent upon action by certain local, areawide, state, and federal agencies of government. Examination of the various agencies that are available under existing enabling legislation to implement the recommended watershed plan reveals an array of departments, commissions, committees, boards, and districts at all levels of government. These agencies range from general-purpose local units of government, such as common councils and village boards, to special-purpose districts, such as metropolitan sewerage commissions and soil and water conservation and drainage districts; to state regulatory bodies, such as the Wisconsin Department of Natural Resources; and to federal agencies that provide financial and technical assistance for plan implementation, such as the U. S. Soil Conservation Service and the U. S. Army Corps of Engineers.

Because of the many and varied agencies in existence, it becomes exceedingly important to identify those agencies having the legal authority and financial capability to most effectively implement the recommended watershed plan elements. Accordingly, those agencies whose action will have significant effect either directly or indirectly upon the successful implementation of the recommended comprehensive watershed plan and whose full cooperation in plan implementation will be essential are listed and discussed below.[2] The agencies are, for convenience, discussed by level of government; however, the interdependence between the various levels, as well as between agencies, of government and the need for close intergovernmental cooperation cannot be overemphasized. Most of the agencies needed for watershed plan implementation are already in existence within the watershed. The creation of new agencies for watershed plan implementation should, therefore, be considered only if such agencies are absolutely essential, and, if essential, the creation of the new agencies should be in such form as to complement and supplement most effectively the plan implementation activities of the agencies already in existence.

Watershed Committee

Since planning at its best is a continuing function, a public body should remain on the scene to coordinate and advise on the execution of the watershed plan and to undertake plan updating or renovation as necessitated by changing events. Although the Commission is charged with and will perform this continuing areawide planning function, it cannot do so properly without the active participation and support of local governmental officials through an appropriate advisory committee structure. It is, therefore, recommended that the Fox River Watershed Committee be reconstituted as a continuing intergovernmental advisory committee to provide a focus for the coordination of all levels of government in the execution of the Fox River watershed plan. The Fox River Watershed Committee would thus continue to be a creature of the Southeastern Wisconsin Regional Planning Commission, pursuant to Section 66.945(7) of the Wisconsin Statutes, and would report directly to the Commission.

The Committee membership should be readjusted so that each municipality which is likely to be substantially affected by the final watershed plan is represented on the standing committee. This would include at least the following local units of government: Waukesha County, including the County Park and Planning Commission and the County Health Department; Racine County, including the County Highway and Park Committee and the County Planning Committee; Walworth County, including the County Park and Planning Commission; Kenosha County, including the County Park Commission; the Cities of Brookfield, Burlington, Muskego, and Waukesha; the Villages of Menomonee Falls, Pewaukee, and Silver Lake; the Western Racine County Sewerage District; the Soil and Water Conservation Districts of Kenosha, Racine, Walworth, and Waukesha Counties; the University of Wisconsin–Extension Service; the Wisconsin Department of Natural Resources, Division of Environmental Protection and Service (Planning and Research); as well as the Commission itself.

Local Level Agencies

Statutory provisions exist for the creation at the county and municipal level of the following agencies having planning and plan implementation

[2] *A more detailed discussion of the duties and functions of local, areawide, and state agencies as they relate to plan implementation may be found in SEWRPC Technical Report No. 2, Water Law in Southeastern Wisconsin, 1966; SEWRPC Technical Report No. 6, Planning Law in Southeastern Wisconsin, 1966; and SEWRPC Planning Guide No. 4, Organization of Planning Agencies, 1964.*

powers important to comprehensive watershed plan implementation, including police, acquisition, condemnation (eminent domain), and construction (tax appropriation) powers.

County Park and Planning Commissions: These commissions have the obligation to prepare a county park system plan and a county street and highway system plan. In addition, these commissions may be used to prepare and administer county shoreland, floodland, and comprehensive land use zoning ordinances and to administer county subdivision plat review. The commissions are empowered to acquire, develop, and operate county parks and other open-space lands. The existence of a county park and planning commission in each county in the watershed is, therefore, highly desirable for proper implementation of the recommended watershed plan, especially with respect to the resource protection, recreation, and general land use plan recommendations.

All four of the counties comprising the Fox River watershed have established some form of county park agency. Waukesha County created a county park and planning commission in 1954 and assigned to it all county zoning, subdivision plat review, and park functions. Similarly, Walworth County created a county park and planning commission in 1967, with full zoning, subdivision plat review, and park functions. Responsibility for park and parkway acquisition and development in Racine County is currently assigned to the Racine County Highway and Parks Committee, which has recently established a separate staff with sole responsibility for park and parkway acquisition, development, operation, and maintenance. The zoning and subdivision plat review functions in Racine County are assigned to the office of the County Planning Director under the supervision of the County Planning Committee. Kenosha County established a Park Commission in 1925, which Commission has full responsibility for park and parkway acquisition, development, operation, and maintenance. The zoning and subdivision plat review functions in Kenosha County are assigned to the office of the Zoning Administrator under the supervision of the County Zoning Committee.

It is recommended that the Kenosha County Board consider the recreation and reconstitution of its park commission as a county park and planning commission, pursuant to Section 27.02 of the Wisconsin Statutes, assigning to it all duties relating to planning, zoning, subdivision plat review, and modified official mapping, as well as county park acquisition and development. Alternatively, it is recommended that the Kenosha County Board create and staff a county planning department, leaving the park function with the present County Park Commission. Such a Kenosha County Park and Planning Commission or Planning Department would have, along with the existing park and planning agencies in Racine, Walworth, and Waukesha Counties, primary responsibility for implementation of the land use, recreation, and natural resource protection plan elements of the comprehensive Fox River watershed plan. A model ordinance creating a county park and planning commission may be found in SEWRPC Planning Guide No. 4, Organization of Local Planning Agencies, Appendix E. Sections 27.03(2), 27.06, and 59.97 of the Wisconsin Statutes provide for the staffing and financing of such commissions.

Municipal Planning Agencies: These agencies include city, village, and town park boards or plan commissions created pursuant to Sections 27.08, 27.13, 62.23(1), 61.35, and 60.18(12) of the Wisconsin Statutes. Such agencies may be used to supplement the actions of the county park and planning commissions in implementation of the various elements of the proposed watershed plan. An extended discussion of the extent and limitations of the power of these agencies may be found in SEWRPC Planning Guide No. 4, Organization of Local Planning Agencies, 1964.

It is recommended that those cities, villages, and towns in the Fox River watershed without plan commissions duly created in accordance with Section 62.23 of the Wisconsin Statutes create such commissions. These included, as of July 1967: the Village of Rochester and the Towns of Brighton, Randall, Salem, Wheatland, Dover, Norway, Raymond, Rochester, Bloomfield, Delavan, East Troy, Geneva, LaGrange, LaFayette, Linn, Lyons, Richmond, Spring Prairie, Sugar Creek, Troy, Walworth, Whitewater, and Vernon. A model ordinance and resolution creating such commissions and giving towns power to create such commissions is provided in the above cited SEWRPC local planning guide, Appendices D and F.

It is also suggested that cities and villages in the watershed whose corporate limits abut unincorporated areas consider, as necessary and as circumstances dictate, the creation of joint extraterritorial zoning committees with the adjacent towns, pursuant to Section 62.23(7)(a) of the Wisconsin Statutes, for the purpose of cooperative and joint land use planning and zoning in areas of mutual interest.

Municipal Utility and Sanitary Districts: These districts may be created by towns, villages, and cities, pursuant to Sections 66.072, 60.30, 61.36, 62.18, and 198.22 of the Wisconsin Statutes, and are authorized to plan, design, construct, operate, and maintain various public sanitary sewer and water supply systems. Such districts have an important plan implementation function to perform with respect to the water pollution abatement elements of the Fox River watershed plan.

As of January 1, 1970, there were established the following 15 utility and sanitary districts in the watershed: Browns Lake Sanitary District, Town of Burlington; Sanitary District No. 1, Town of Norway; North Cape Sanitary District, Towns of Norway and Raymond; and Utility District No. 1, Town of Rochester, all in Racine County; Sanitary District No. 1, Town of East Troy; Linn Sanitary District, Town of Linn; Golf Hills Sanitary District No. 1, Town of Lyons; Town of Lyons Sanitary District No. 2, Town of Lyons; and Sanitary District No. 1, Town of Troy, all in Walworth County; Greenfield Heights Sanitary District, Town of Brookfield; Hidden Woods Estates Sanitary District, Town of Brookfield; Westbrooke Sanitary District, Town of Brookfield; Westchester Sanitary District, Town of Brookfield; Lake Pewaukee Sanitary District, Town of Delafield; Eagle Springs Lake Sanitary District, Town of Eagle; and Sanitary District No. 1, Town of Pewaukee, all in Waukesha County.

Soil and Water Conservation Districts: The importance of proper soil and water conservation and management practices to the full implementation of the land use, resource protection, and water quality control elements of the watershed plan cannot be overemphasized. Lack of such practices will have a critical adverse effect upon land use, flood control works, pollution abatement, and recreational facilities. Soil and water conservation districts, as authorized under Section 92.05 of the Wisconsin Statutes, have the authority to develop plans for the conservation of soil and water resources, prevention of soil erosion, and prevention of floods and the authority to adopt special land use regulations that would implement such plans in unincorporated areas. Such adoption, however, must follow a referendum at which two-thirds of the land occupiers approve the regulations. Soil and water conservation districts have the authority to acquire through eminent domain any property or rights therein for watershed protection; soil and water conservation; flood prevention works; and fish, wildlife, and recreational works, all of which may be constructed under federal Public Law 83-566, as amended, as part of a watershed plan implementation program.

Soil and water conservation districts are by law in Wisconsin made coterminous with counties, and all of the four counties in the Fox River watershed concerned with implementation of the Fox River watershed plan have created such districts. All of these districts have entered into basic and supplemental memoranda of understanding with the U. S. Department of Agriculture, Soil Conservation Service, for technical assistance. Thus, there exist within the watershed the duly constituted bodies required to represent the counties of the watershed in those agricultural, conservation, and management programs which are administered by state and federal agencies.

Areawide Agencies

Except as noted below, statutory provisions exist for the creation of the following multi-county or other areawide agencies having both general and specific planning and plan implementation powers important to the implementation of the Fox River watershed plan.

Metropolitan Sewerage Commissions: Until recently the Wisconsin Statutes provided for the creation of two types of metropolitan sewerage commissions generally empowered to plan sanitary sewerage and strom water drainage systems and to construct such systems over large areas which may include many local units of government. One type of commission is provided for in counties having a population of 500,000 or more and containing a city of the first class and is by definition at the present time applicable only to Milwaukee County. The other type of commission may be formed by cities, villages, and towns in all other parts of Wisconsin. While these two types of commissions differ with respect to organization and method of financing, their basic powers are very similar. The Metropolitan Sewerage Commission of the County of Milwaukee, created pursuant to Section 59.96 of the Wisconsin Statutes, has jurisdiction over all of Milwaukee County, working in close cooperation with the Sewerage Commission of the City of Milwaukee, and is empowered to contract for the transmission, treatment, and disposal of sewage with cities, villages, towns, town sanitary districts, or other metropolitan districts lying within the same drainage area as that of the Commission itself. The Commission is also authorized to construct, operate, and maintain drainage and flood control works on all streams and watercourses within Milwaukee County and outside Milwaukee County where a watercourse flows from within the County to a point outside the County.

As noted in Chapter XIV of Volume 1 of this report, it appears that the current enabling legislation would prevent any direct involvement of the Metropolitan Sewerage Commission of the County of Milwaukee in the abatement of water pollution or flood problems in the Fox River, other than serving certain relatively small areas of the watershed within the Cities of Brookfield, Muskego, and New Berlin and the Village of Menomonee Falls, since the Fox River watershed lies west of the subcontinental divide traversing the Southeastern Wisconsin Region and since the Metropolitan Sewerage Commission of the County of Milwaukee must, by law, confine its operations to certain areas of the Region lying east of the subcontinental divide. The extensive experience and high level of technical expertise developed over many years by the Metropolitan Sewerage Commission of the County of Milwaukee, however, represent a substantial public investment that should not be disregarded with alternative organizational arrangements for water pollution abatement in other portions of the watershed are considered.

The second type of metropolitan sewerage district authorized by the Wisconsin Statutes under Sections 66.20 through 66.209 also has broad powers to plan, construct, and maintain interceptor and main sanitary sewers, storm sewers, and sewage treatment plants similar to those granted to the Metropolitan Sewerage Commission of the County of Milwaukee. One such district, the Western Racine County Sewerage District, currently exists within the Fox River watershed. The future role of such metropolitan sewerage districts in watershed plan implementation, however, became clouded early in 1969 when the Wisconsin Supreme Court ruled that the Wisconsin Legislature, in providing for the creation of such metropolitan sewerage districts by county courts, had unconstitutionally delegated legislative authority to the judiciary.[3] Subsequent to this action by the Wisconsin Supreme Court, the Wisconsin Legislature provided curative legislation validating the existence of the three metropolitan sewerage districts established to date under Sections 66.20 through 66.209 of the Statutes within the State of Wisconsin.[4] The Legislature, however, has not as yet provided any mechanism to make it possible to create new metropolitan sewerage districts or expand the districts now in existence, such as the Western Racine County Sewerage District in the Fox River watershed.

<u>County Drainage Boards and Districts:</u> Chapter 88 of the Wisconsin Statutes authorizes landowners to petition the county court to create a drainage district under the control of a county drainage board. Such districts are intended to provide for the execution of specific areawide drainage improvements. A drainage district may lie in more than one municipality and in more than one county. The cost of any drainage improvements is assessed against the lands that are specifically benefited.

<u>Flood Control Boards:</u> Chapter 87 of the Wisconsin Statutes provides that property owners living in a single drainage area, which may involve more than a single governmental unit, may petition for a formation of a flood control board. Application for the creation of such a board must be made through the Wisconsin Department of Natural Resources. The flood control boards are empowered to straighten, widen, deepen, and otherwise alter watercourses and build flood control works, all activities being subject to review by, and approval of, the Wisconsin Department of Natural Resources.

The flood control facility plan elements recommended in the Fox River watershed plan can be accomplished by existing agencies, such as soil and water conservation districts, metropolitan sewerage districts or commissions, drainage districts, or park commissions. The creation of a special flood control board under Chapter 87 of the Wisconsin Statutes, therefore, should be con-

[3] *In re: <u>Petition for Fond du Lac Metropolitan Sewerage District</u>, 42 Wis, 2nd 323 (1969).*

[4] *Chapter 132, <u>Laws of Wisconsin</u>, 1969. These three districts are the Madison Metropolitan Sewerage District, the Green Bay Metropolitan Sewerage District, and the Western Racine County Sewerage District.*

sidered only if the existing agencies fail to act to implement, in a timely and proper manner, the flood control recommendation contained in the Fox River watershed plan. Should the lake level management flood control alternative plan element discussed in Chapter IV of this volume ever become a recommended plan element, a special flood control board would become a virtual necessity.

Cooperative Contract Commissions: Section 66.30 of the Wisconsin Statutes provides that municipalities[5] may contract with each other to form cooperative service commissions for the joint provision of any services or joint exercise of any powers that such municipality may be authorized to exercise separately; and such commissions have been given bonding powers for the purposes of acquiring, developing, and equipping land, buildings, and facilities for regional projects. Significant economies can often be affected through providing governmental services and facilities on a cooperative, areawide basis. Moreover, the nature of certain developmental and environmental problems often requires that solutions be approached on an areawide basis. Such an approach may be efficiently and economically provided through the use of a cooperative contract commission.

Intergovernmental cooperation under such commissions may range from the sharing of expensive public works equipment through the construction, operation, and maintenance of major public works facilities on an areawide basis. A cooperative contract commission may be created for the purpose of watershed plan implementation and may be utilized in lieu of any of the aforementioned organizations for such implementation. A model agreement creating a cooperative contract commission is provided in SEWRPC Technical Report No. 6, Planning Law in Southeastern Wisconsin, Appendix A.

Regional Planning Commission: Although not a plan implementation agency, one other areawide agency warrants comment: the Regional Planning Commission itself. As already noted, the Commission has no statutory plan implementation powers. However, in its role as a coordinating agency for planning and development activities within the seven-county Southeastern Wisconsin Region, the Commission may, through community planning assistance services and through the review of federal and state grants-in-aid, play an important role in ultimate plan implementation. In addition, the Commission provides a basis for the creation and functioning of the Fox River Watershed Committee, which should remain as an important continuing public planning organization in the watershed.

State Level Agencies

There exist at the state level the following agencies that either have general or specific planning authority and certain plan implementation powers important to the adoption and implementation of the comprehensive Fox River watershed plan.

Wisconsin Department of Natural Resources: This Department has broad authority and responsibility in the areas of park development, natural resources protection, water quality control, and water regulation. As such, it combines the park and land-based natural resource protection functions of the former State Conservation Commission and the water regulatory functions formerly assigned to the State Public Service Commission. The Department has the obligation to prepare a comprehensive statewide plan for outdoor recreation, to develop long-range, statewide conservation and water plans, and the authority to designate such sites as necessary to protect, develop, and regulate the use of state parks, forests, fish, game, lakes, streams, plant life, and other outdoor resources; authority to acquire conservation and scenic easements; and the authority to administer the federal grant program known as the Land and Water Conservation Fund within the state, as well as the park and open-space grant funds available under the State Outdoor Recreation Program (ORAP). The Department also has the obligation to establish water quality standards and to establish standards for floodplain and shoreland zoning; authority to adopt, in the absence of local action, shoreland and floodplain zoning ordinances; and the authority to prohibit the installation or use of on-site soil absorption sewage disposal systems and to approve the regulation of such systems as that regulation may be promulgated by the Wisconsin Division of Health. In addition, the Department has authority to regulate water diversions, shoreland grading, dredging, encroachments, and deposits in navigable waters; authority to regulate construction of neighboring ponds, lagoons, and waterways, stream improve-

[5] *The term municipality under this section of the Statutes is defined to include the state, any agency thereof, cities, villages, towns, counties, school districts, and regional planning commissions.*

ments, and pierhead and bulkhead lines; authority to regulate the construction, maintenance, and abandonment of dams; authority to regulate water levels of navigable lakes and streams, stream improvement, and removal of certain lake bed materials; and the authority to require abatement of water pollution, to administer state financial aid programs for water resource protection, to assign priority for federal aid applications for sewage treatment plants, to review and approve water supply and sewerage systems, and to license well drillers and issue permits for high capacity wells. With such broad authority for the protection of the natural resources of the state and the Region, this Department will be extremely important to implementation of nearly all of the major elements of the comprehensive Fox River watershed plan.

Wisconsin Department of Local Affairs and Development: This Department has the authority to review subdivision plats, proposed municipal incorporations, consolidations, and annexations, and to provide technical assistance to local units of government in planning and planning-related matters.

Wisconsin Department of Transportation: This Department is broadly empowered to provide the state with an integrated transportation system. Within the Wisconsin Department of Transportation, the State Highway Commission is charged with the responsibility for administering all state and federal aid for highway improvement; for the planning, design, construction, and maintenance of all state highways; and for planning, laying out, revising, constructing, reconstructing, and maintaining the national system of interstate and defense highway system, the federal aid primary system, the federal aid secondary system, and the forest highway systems, all subject to federal regulation and control. The State Highway Commission is also responsible for reviewing all county trunk highway systems. As such, the State Highway Commission, along with the respective County Highway Committees of the County Boards of Supervisors concerned, can play a role in full implementation of the Fox River watershed plan with respect to the construction and reconstruction of bridges and other highway facilities within the watershed and the designation and marking of a scenic parkway drive along the main stem of the Fox River.

Wisconsin Division of Health: This Division has the authority to review subdivision plats not served by public sanitary sewerage systems and to regulate private on-site soil absorption sewage disposal systems.

Wisconsin Soil Conservation Board: This Board has the obligation to review and to coordinate the programs of the County Soil and Water Conservation District; to apportion certain state and federal fund allotments; to administer federal watershed projects authorized under P. L. 566, as amended; and to approve federal participation in projects relating to the program responsibilities of county drainage boards, as set forth in Chapter 88 of the Wisconsin Statutes.

Federal Level Agencies

There exist at the federal level the following agencies which administer federal aid and assistance programs that can have important effects upon the implementation of the recommended Fox River watershed plan because of the potential impact on the financing of both actual land acquisition and construction of specific facilities.

U. S. Department of Housing and Urban Development: This agency administers urban planning, flood insurance, urban beautification, park and open-space acquisition and development, and sewer and water facility construction grants. The park and open-space and sewer and water facility construction grant programs can be particularly important to implementation of the land use, recreation, and water quality control elements of the Fox River watershed plan.

U. S. Department of the Interior, Federal Water Pollution Control Administration: This agency administers sanitary sewage treatment plant and pollution control facility construction grants, which grants can be particularly important to implementation of the water quality control element of the Fox River watershed plan. In addition, this agency is responsible for the ultimate enforcement of water quality standards on interstate rivers, should the state not adequately enforce such standards.

U. S. Department of the Interior, Bureau of Outdoor Recreation: This agency administers park and open-space acquisition and development grants through the Federal Land and Water Conservation Fund program. The program is administered in

Wisconsin through the State Department of Natural Resources. Grants under this program can be particularly important to implementation of the recreation and resource protection elements of the Fox River watershed plan.

U. S. Department of the Interior, Geological Survey: This agency conducts continuing programs with respect to water resource appraisal and monitoring. The programs of the U. S. Geological Survey are particularly important to the implementation of the continuous stream gaging program recommended in the Fox River watershed plan.

U. S. Department of Agriculture, Farmers Home Administration: This agency administers water and waste disposal construction grants and loans for rural areas, as well as resource conservation grants and loans. Such grants can be important to implementation of the water pollution control element of the Fox River watershed plan.

U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service: This agency administers park and recreation acquisition grants related to the conversion of land in agricultural use called GREENSPAN. In addition, this agency administers the Federal Agricultural Conservation Program (ACP), which provides grants to rural landowners in partial support in carrying out approved soil, water, woodland, and wildlife conservation practices. These grants can be important to implementation of the water pollution control element of the Fox River watershed plan.

U. S. Department of Agriculture, Soil Conservation Service: This agency administers resource conservation and development projects and watershed projects under federal P. L. 566 and provides technical and financial assistance through county soil and water conservation districts to landowners in the planning and construction of measures for land treatment, agricultural water management, and flood prevention; and for public fish, wildlife, and recreational development. This agency also conducts detailed soil surveys and provides interpretations as a guide to utilizing soil survey data in local planning and development. Certain programs administered by this agency can be of particular importance to implementation of certain of the flood control, agricultural drainage improvement, and agricultural land planning and treatment measures, such as the construction of bench terraces with tile outlets, as recommended in the Fox River watershed plan.

U. S. Department of the Army, Corps of Engineers: This agency has broad authority subject to U. S. Congressional approval to construct flood control facilities and as such could have a particularly important role in implementation of certain of the flood control recommendations contained in the Fox River watershed plan.

PLAN ADOPTION AND INTEGRATION

Upon adoption of the Fox River watershed plan by formal resolution of the Southeastern Wisconsin Regional Planning Commission in accordance with Section 66.945(10) of the Wisconsin Statutes, the Commission will transmit a certified copy of the resolution adopting the watershed plan, together with the plan itself, to all local legislative bodies within the Fox River watershed and to all of the aforesaid existing state, local, areawide, and federal agencies that have potential plan implementation functions.

Adoption, endorsement, or formal acknowledgement of the comprehensive watershed plan by the local legislative bodies and the existing local, areawide, state, and federal level agencies concerned is highly desirable not only to assure a common understanding between the several governmental levels and to enable their staffs to program the necessary implementation work but is, in some cases, required by the Wisconsin Statutes before certain planning actions can proceed, as in the case of city, village, and town plan commissions created pursuant to Section 62.23 of the Wisconsin Statutes. In addition, formal plan adoption may also be required for state and federal financial aid eligibility.

It is extremely important to understand that adoption of the recommended Fox River watershed plan by any unit or agency of government pertains only to the statutory duties and functions of the adopting agencies, and such adoption does not and cannot in any way preempt or commit action by another unit or agency of government acting within its own area of functional and geographic jurisdiction. Thus, adoption of the Fox River watershed plan by a county would make the plan applicable as a guide, for example, to county park system development but not to any municipal park development within the county. To make the plan applicable as a guide to municipal park development would require its adoption by the municipality concerned.

Upon adoption or endorsement of the plan by a unit or agency of government, it is recommended that the policy-making body of the unit or agency direct its staff to review in detail the plan elements of the comprehensive watershed plan. Once such review is completed, the staff can propose to the policy-making body for its consideration and approval the steps necessary to fully integrate the watershed plan elements into the plans and programs of the unit or agency of government.

Local Level Agencies

1. It is recommended that the Kenosha County Board formally adopt the comprehensive Fox River watershed plan, including the land use elements, the park and parkway elements, and the floodland evacuation elements, by ordinance pursuant to Sections 27.04(2) and 66.945(12) of the Wisconsin Statutes after a report and recommendation by the County Park Commission and the County Zoning Committee.

2. It is recommended that the Racine County Board formally adopt the comprehensive Fox River watershed plan, including the land use elements, the park and parkway elements, and streamflow recordation element, by ordinance pursuant to Sections 27.04(2) and 66.945(12) of the Wisconsin Statutes after a report and recommendation by the County Highway and Parks Committee and the County Planning Committee.

3. It is recommended that the Walworth County Board formally adopt the comprehensive Fox River watershed plan, including the land use elements, the park and parkway elements, and the Sugar Creek Reservoir element, by ordinance pursuant to Sections 27.04(2) and 66.945(12) of the Wisconsin Statutes after a report and recommendation by the County Park and Planning Commission.

4. It is recommended that the Waukesha County Board formally adopt the comprehensive Fox River watershed plan, including the land use elements, the park and parkway elements, the Vernon Marsh preservation element, and streamflow recordation element, by ordinance pursuant to Sections 27.04(2) and 66.945(12) of the Wisconsin Statutes after a report and recommendation by the County Park and Planning Commission.

5. It is recommended that the plan commissions of all cities, villages, and towns in the watershed adopt the recommended Fox River watershed plan, as it affects them, by resolution pursuant to Section 62.23(3)(b) and certify such adoption to their respective governing body.

6. It is recommended that the governing bodies of all municipal water and sanitary districts and utilities formally acknowledge the land use and resource protection elements of the comprehensive Fox River watershed plan and determine their utility service areas in accordance with such plan.

7. It is recommended that the County Soil and Water Conservation Districts of Kenosha, Racine, Walworth, and Waukesha Counties adopt those portions of the recommended Fox River watershed plan affecting them, including the land use elements, the channel improvement elements, and the land treatment measures, such as bench terraces with tile outlets, so as to establish a broad, well-designed basis for the development of comprehensive conservation plans under Section 92.08(4) of the Wisconsin Statutes and to assist in establishing eligibility for tax relief and technical and financial assistance.

Areawide Agencies

1. It is recommended that the Western Racine County Sewerage District and any other metropolitan sewerage district or commission created within the watershed subsequent to the publication of this report formally acknowledge the recommended Fox River watershed plan, particularly the land use elements in the determination of their service areas and the water pollution abatement elements in the determination of the location of future sewage treatment plants and of future levels of sewage treatment.

2. It is recommended that the Racine and Walworth County Drainage Boards, as well

as any other county drainage board or drainage district created within the watershed subsequent to the publication of this report, formally acknowledge the recommended Fox River watershed plan, especially with respect to the flood control and drainage elements.

3. It is recommended that any cooperative contract agency or commission created within the watershed subsequent to the publication of this report formally acknowledge the recommended Fox River watershed plan in regard to the exercise of their specific powers and duties.

State Level Agencies

1. It is recommended that the Wisconsin Natural Resources Board endorse the comprehensive Fox River watershed plan and direct its staff in the Wisconsin Department of Natural Resources to integrate the recommended watershed plan elements into its broad range of agency responsibilities, as well as to assist in coordinating plan implementation activities over the next 20 years. In particular, it is recommended that the Natural Resources Board endorse the recommended environmental corridor and regional recreational sites, including the Sugar Creek multipurpose reservoir and recreational site, and direct its staff to integrate these plan elements into the long-range conservation and comprehensive outdoor recreation plans authorized by Section 23.09(7) of the Wisconsin Statutes and required by the Federal Land and Water Conservation Fund Act. It is further recommended that the Board, through its staff, coordinate the recommended Fox River watershed plan with its activities relating to floodland and shoreland zoning. It is also recommended that the Board and its staff consider and give due weight to the recommended Fox River watershed plan in the exercise of their various water regulatory powers. It is further recommended that the Board adopt the detailed soils data and analyses prepared by the U. S. Soil Conservation Service as a guide in regulating soil absorption sewage disposal systems. Finally, it is recommended that the Board endorse the water pollution control plan recommendations of the Fox River watershed plan and direct its staff to integrate these plan recommendations into its water quality control activities.

2. It is recommended that the Wisconsin Department of Local Affairs and Development endorse the recommended Fox River watershed plan and integrate the plan into its activities with respect to the provision of technical assistance to local units of government, with respect to reviewing subdivision plats, and with respect to administering federal urban planning grants.

3. It is recommended that the State Highway Commission of the Wisconsin Department of Transportation consider and give weight to the recommended Fox River watershed plan in the exercise of its various responsibilities governing the construction and reconstruction of highway facilities.

4. It is recommended that the Wisconsin Board of Health and Social Services endorse the land use elements of the Fox River watershed plan and direct its staff to follow the plan recommendations in the exercise of their subdivision plat review and approval powers created pursuant to Section 236.13(2)(m) of the Wisconsin Statutes. It is further recommended that the Board direct its staff to utilize the detailed soil survey prepared by the U. S. Department of Agriculture, Soil Conservation Service, as a guide in reviewing and objecting to subdivision plats, in accordance with Section 236.12 of the Wisconsin Statutes. It is further recommended that the Board adopt the detailed soils data and analyses as a guide in regulating soil absorption sewage disposal systems.

5. It is recommended that the Wisconsin Soil Conservation Board endorse the recommended Fox River watershed plan, particularly the agricultural land use, environmental corridor, and other natural resource protection plan elements, so as to coordinate the County Soil and Water Conservation District Program and projects as required in Section 92.04(4)(c) of the Wisconsin Statutes.

Federal Level Agencies

1. It is recommended that the U. S. Department of Housing and Urban Development formally acknowledge the Fox River watershed plan and utilize such plan in its administration and granting of federal aids for urban beautification, open-space land, park development, and sewer and water facilities and in the administration of its flood insurance program.

2. It is recommended that the U. S. Department of Interior, Federal Water Pollution Control Administration, formally acknowledge the recommended Fox River watershed plan and utilize the plan recommendations in the administration and granting of federal aids for sewage treatment plants and related facilities.

3. It is recommended that the U. S. Department of Interior, Bureau of Outdoor Recreation, formally acknowledge the Fox River watershed plan and utilize the plan recommendations in its administration and granting of federal aids under the Land and Water Conservation Act.

4. It is recommended that the U. S. Department of Interior, Geological Survey, acknowledge and consider the Fox River watershed plan and continue, in cooperation with the various counties concerned, its entire water resources investigation program, including the maintenance and expansion of its stream gaging program within the watershed.

5. It is recommended that the U. S. Department of Agriculture, Farmers Home Administration, formally acknowledge the Fox River watershed plan and utilize the plan recommendations in its administration and granting of loans and grants-in-aid for rural water and waste disposal facilities and for watershed development programs.

6. It is recommended that the U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service, formally acknowledge the Fox River watershed plan and utilize the plan recommendations in its administration of the Cropland Adjustment Program and the Agricultural Conservation Program, with particular respect to the various natural resource conservation practices.

7. It is recommended that the U. S. Department of Agriculture, Soil Conservation Service, formally acknowledge the Fox River watershed plan and utilize the plan recommendations in its administration and granting of federal aids for resource conservation and development and multiple-purpose watershed projects and in its provision of technical assistance to landowners and operators for land and water conservation practices.

8. It is recommended that the U. S. Department of Army, Corps of Engineers, formally acknowledge the Fox River watershed plan and resume its suspended flood control study of the Fox River watershed, giving due consideration and weight in the completion of that study to implementation of the following flood control recommendations contained in the comprehensive plan for the Fox River watershed: the construction of levees and channel improvements in the City of Waukesha, the construction of levees and channel improvements in the City of Burlington, and the construction of a multiple-purpose reservoir on Sugar Creek. It is further recommended that the Corps of Engineers continue to cooperate with any local or state units and agencies of government in their requests for assistance in the construction of the aforementioned projects.

SUBSEQUENT ADJUSTMENT OF THE PLAN

No plan can be permanent in all of its aspects or precise in all of its elements. The very definition and characteristics of areawide planning suggest that an areawide plan, such as a watershed plan, to be viable and of use to local, state, and federal units and agencies of government, be continually adjusted through formal amendments, extensions, additions, and refinements to reflect changing conditions. The Wisconsin Legislature clearly foresaw this when it gave to regional planning commissions the power to "amend, extend, or add to the master plan or carry any part or subject matter into greater detail" in Section 66.945(9) of the Wisconsin Statutes.

Amendments, extensions, and additions to the Fox River watershed plan will be forthcoming not only from the work of the Commission under the continuing regional planning programs but also from state agencies as they adjust and refine statewide plans and from federal agencies as national policies are established or modified or as new programs are created or existing programs are expanded or curtailed. Adjustments must also come from local planning programs, which, of necessity, must be prepared in greater detail and result in greater refinement of the watershed plans. This is particularly true with respect to the land use and natural resource protection elements of the watershed plan. Areawide adjustments may come from subsequent regional or state planning programs, which may include additional comprehensive or special-purpose planning efforts, such as the preparation of regional sanitary sewerage service plans, regional water supply plans, and regional or county park and open-space plans.

All of these adjustments and refinements will require the utmost cooperation by the local, areawide, state, and federal agencies of government, as well as coordination by the Southeastern Wisconsin Regional Planning Commission, which has been empowered under Section 66.945(8) of the Wisconsin Statutes to act as a coordinating agency for programs and activities of the local units of government.

To achieve this coordination between local, state, and federal programs most effectively and efficiently and, therefore, to assure the timely adjustments of the watershed plan, it is recommended that all of the aforesaid state, areawide, and local agencies having various plan and plan implementation powers advise and transmit all subsequent planning studies, plan proposals and amendments, and plan implementation devices to the Southeastern Wisconsin Regional Planning Commission for consideration as to integration into, and adjustment to, the watershed plan. Of particular importance in this respect will be the continuing role of the Fox River Watershed Committee in intergovernmental coordination.

LAND USE, NATURAL RESOURCE, AND RECREATION PLAN ELEMENT IMPLEMENTATION

Introduction

The implementation of the land use, natural resource, and recreation elements of the comprehensive Fox River watershed plan is of central importance to the realization of the overall watershed plan. These elements, moreover, require the most intricate implementation actions and the utmost cooperation between the local units of government and the areawide, state, and federal agencies concerned if the watershed development objectives are to be fully achieved. This is true not only because the land use, natural resource, and recreation-related resource plan elements are closely interrelated in nature and support and complement one another but also because these elements are closely related to the flood control and pollution abatement elements of the plan. If, for example, urban residential, commercial, and industrial growth is properly located within the watershed and is not allowed to preempt the natural floodland areas nor destroy the remaining wetlands and woodlands, a great deal will be achieved with respect to flood control, as well as natural resource protection. Similarly, if the recommended environmental corridor and other high-value natural resource areas are acquired for natural resource protection and conservancy purposes, this will in turn assure acquisition of many of the best park sites remaining within the watershed. Although all of the plan implementation recommendations are closely interrelated, this section has been divided, for convenience in presentation and use, into the following major subject areas: zoning; land acquisition for natural resource protection; land acquisition for park and outdoor recreation; and woodland and wetland management.

Zoning Ordinances

Of all the land use plan implementation devices, the most readily available, most important, and most versatile, is the application of the local police power to the control of land use development through the adoption of appropriate zoning ordinances, including zoning district regulations and zoning district delineations. The following zoning ordinances or amendments to existing zoning ordinances should be adopted by the appropriate county and local units of government within the watershed so as to provide a clear indication of the intent to implement the Fox River watershed plan and thereby to provide a framework for other planning and plan implementation efforts.

1. It is recommended that the county zoning agencies of the four counties within the watershed, in cooperation with the town plan commissions and town zoning com-

mittees, formulate and recommend to their respective county board appropriate amendments to the county zoning ordinances, pursuant to Section 59.97(3) of the Wisconsin Statutes, to provide district regulations, including exclusive use districts and shoreland and floodland regulations similar to those provided in the SEWRPC Model Zoning Ordinance, together with changes to the zoning district maps to implement the recommended watershed land use pattern.[6]

2. It is recommended that the four county boards adopt appropriate amendments and changes to the zoning district maps, pursuant to Section 59.97(3) of the Wisconsin Statutes, to provide district delineations, including floodway and floodplain regulatory areas, to implement the recommended watershed land use pattern. It is further recommended that the boards of all towns which have filed approval of the County Zoning Ordinance or which subsequently approve such County Zoning Ordinance file a certified copy of the approval of such amendments and changes to the zoning map, pursuant to Section 59.97(2) and 59.97(3)(g) of the Wisconsin Statutes.

3. It is recommended that the plan commissions of all cities, villages, and those towns which have not filed approval of the County Zoning Ordinance formulate and recommend to their respective governing bodies new zoning ordinances or amendments to existing zoning ordinances in accordance with Section 60.74 or 62.23(7) of the Wisconsin Statutes so as to provide district regulations, including exclusive use districts and shoreland and floodland regulations similar to those provided in the SEWRPC Model Zoning Ordinance, together with appropriate zoning district map changes, to reflect the recommended watershed land uses.

4. It is recommended that the respective municipal governing bodies, then, adopt such zoning ordinances or amendments thereto, including such zoning district maps or changes thereto, pursuant to Section 60.74 or 62.23(7) of the Wisconsin Statutes. The zoning of lands in certain unincorporated areas should, as needs dictate, be supplemented jointly by the exercise of the extraterritorial zoning powers of the cities and villages with the towns, pursuant to Section 62.23(7)(a) of the Wisconsin Statutes.

The task of delineating zoning district boundaries to reflect the land use plan recommendations in the comprehensive watershed plan is as difficult as it is important. Proper delineation of the boundaries of the various zoning districts to achieve the land use pattern recommended in the watershed plan will require careful study and a thorough understanding of not only the local community plan recommendations by the local zoning agencies but also the watershed plan recommendations and their relationships to the local plans. In this process the primary environmental corridors must be broken down into several zoning districts as necessitated by the various types of natural resources found in such corridors. Moreover, the delineation of zoning districts to reflect immediately the recommended watershed land use plan would result initially in overzoning, which may, in turn, result in mixed and uneconomical future land use patterns. Therefore, the use of holding zones, such as exclusive agricultural districts and large estate-type residential districts, will be necessary to regulate community growth in both time and space in an orderly and economical manner.

The following recommendations are made to all zoning agencies within the watershed to assist them in the task of zoning ordinance preparation, including zoning district delineation.

Residential Areas: Not all of the areas shown as devoted to residential use in the recommended watershed land use plan should be initially placed in residential use districts. Only existing and

---

[6] *All four counties in the watershed have already begun to implement this recommendation. The Racine County Planning Committee has prepared, and the Racine County Board adopted on December 2, 1969, a revised county zoning ordinance containing many of the recommended exclusive use districts and all of the recommended floodland and shoreland regulations. The preparation of revised zoning district maps for each of the towns in Racine County is now underway. The Kenosha County Zoning Committee and the Walworth and Waukesha County Park and Planning Commissions are at various stages in programs designed to revise and update their respective county zoning ordinances.*

platted, but not yet fully developed, residential areas and those areas that have immediate development potential and can be economically served by municipal utilities and facilities, such as sanitary sewer, public water supply, and schools, should be placed in exclusive residential districts related to the development densities indicated on the recommended watershed land use plan. The balance of the proposed future residential land use areas should be placed in exclusive agricultural districts or large estate-type residential districts so as to act as a holding zone for future development. The use of such holding districts is discussed in SEWRPC Planning Guide No. 3, Zoning Guide. Such holding districts should be rezoned into the appropriate residential zoning district or supporting land use district, such as business, neighborhood, or park districts, only when the community can economically and efficiently accommodate the proposed development.

Agricultural Areas: Areas shown as devoted primarily to agricultural use on the recommended watershed land use plan should usually be placed in an exclusive agricultural use district which essentially permits only agricultural uses. In such areas dwellings should be permitted only as accessory to the basic agricultural uses. Wetlands, woodlands, floodlands, and wildlife habitat areas that lie outside the delineated primary environmental corridor but within the agricultural use areas on the recommended watershed land use plan should be placed in conservancy districts.

Environmental Corridors: The environmental corridors shown on the recommended watershed land use plan should be placed immediately into one of several zoning districts as dictated by consideration of existing development; the character of the specific resource values to be protected within the corridor; and the attainment of the outdoor recreation, open-space preservation, and resource conservation objectives of the watershed plan. Prime wildlife habitat areas, wetlands, woodlands, and floodways and floodplains lying in the corridors should be placed in conservancy districts. Existing and potential park sites lying in the corridors should be placed in park districts which permit the development of appropriate private and public recreational facilities. The remaining area lying in the corridors may then be placed in exclusive agricultural use districts or in large estate-type residential use districts, depending upon the limitations of the soils for utilization of on-site sewage disposal systems.

Other Outdoor Recreation Sites: The remaining outdoor recreation sites shown on the recommended watershed land use plan located outside of the environmental corridors should be placed in exclusive agricultural, conservancy, or park districts so as to ensure preservation and availability for eventual public acquisition. It should be noted, however, that such zoning cannot be used in attempts to lower the land values of the parcels involved. Rather, such zoning should be used in an attempt to preserve the open character of the land, with public acquisition at the determined fair market value within a reasonable period of time.

Floodlands: It is recommended that all counties, cities, villages, and towns within the watershed amend, as appropriate, their zoning ordinances to include special floodland regulations similar to those set forth in Appendix I of SEWRPC Planning Guide No. 5, Floodland and Shoreland Development Guide. Such regulations, if properly adopted and enforced, will ensure the substantial maintenance in open uses of all floodways and floodplains in the watershed. It should also be noted that such floodland regulations are required in addition to any basic zoning district regulations, such as estate-type residential districts, park districts, and conservancy districts. Each county, city, and village in the watershed must, pursuant to Section 87.30 of the Wisconsin Statutes, formulate and adopt an effective and reasonable floodland zoning ordinance as soon as the necessary flood hazard data, such as that provided by the Fox River watershed study, become available. Failing to do so may result in the Wisconsin Department of Natural Resources acting to exercise state floodplain zoning powers, pursuant to Section 87.30 of the Wisconsin Statutes.

Shorelands: It is recommended that the four counties in the watershed formulate and adopt, under Section 59.971 of the Wisconsin Statutes, special shoreland zoning regulations which would apply in unincorporated areas to all land lying within 1,000 feet of a lake, pond, or flowage and 300 feet from the bank of a river or stream or to the landward side of the floodplain, whichever is greater. A model of such special shoreland regulations has been set forth in Appendix I of SEWRPC Planning Guide No. 5 and seeks to regulate development in shoreland areas for the primary purpose of improving water quality. In this respect it should be noted that specific land use recommendations with respect to shoreland areas are available for all 45 major lakes in the Fox River watershed in the series of lake use reports published under the Fox River watershed planning program.[7] It should be noted further that all four counties in the watershed must adopt, pursuant to the State Water Resources Act of 1965, such special shoreland regulations.

Property Tax Policies: One of the valid criticisms often leveled against the use of exclusive agricultural and conservancy districts, as well as of restrictive floodland regulations, is that in an urbanizing area the assessed valuation of the restrictively zoned land may be so high as to reasonably preclude the maintenance of the land in predominantly rural uses. In addition, the mill rate applied to the assessed valuation is often rapidly rising in developing communities, due to increased demands for urban services and, in particular, for school services. This is particularly true where communities have allowed substantially unregulated land development to occur, resulting in extensive urban sprawl. It is this kind of development that would be avoided if the regional land use plan is implemented.

Section 70.32 of the Wisconsin Statutes directs local assessors to assess real estate at the full market value which could ordinarily be obtained at a private sale. Where such open lands are adjacent to, or within, a rapidly urbanizing area and particularly so where poor land use regulations have permitted highly dispersed urban development, property tax assessments may reflect the public's exaggerated estimate of development potential. Under present Wisconsin constitutional and statutory law, the most satisfactory way to relieve the owner of lands zoned for exclusive agricultural or conservancy use or for floodland use from unrealistically high property assessment and resultant taxation is to remove the development potential. This may be accomplished in one of three ways:

1. The property owner may voluntarily grant an easement to a governmental unit, which easement would prohibit development for a period of at least 20 years;

2. The property owner may voluntarily place restrictive covenants upon the lands, which covenants would prohibit development and would be enforceable by a governmental unit in perpetuity or for some substantial time; or

3. A governmental unit may purchase the development rights.

All of these private or governmental actions will serve to permit the local assessor to assess lands at their fair market value for agricultural, conservancy, and floodland uses, rather than for potential urban uses. It is recommended that all cities, villages, and towns within the Fox River watershed instruct their assessors that such potential tax relief exists for individual property owners upon their voluntary sale or relinquishment of potential development rights. It is further recommended that the Wisconsin Department of Revenue develop guidelines as to the extent to which assessments should be reduced if development potential is effectively removed.

It is recognized that all of the three above methods of removing the immediate development potential represent techniques largely untried in the Southeastern Wisconsin Region, if not in the entire nation. At the present time, however, they represent the only satisfactory ways in which the inconsistencies between the Wisconsin taxing, land development, and open-space reservation policies can at least partially be overcome.[8] It is clear that the entire problem represented by premature land development and the effects of property taxation needs extensive study within Wisconsin. It is, therefore, recommended that the Wisconsin Department of Local Affairs and Development take the lead in initiating a legislative study designed to probe the inconsistencies now existing between property taxation and land development policies in Wisconsin and recommend changes to the State Legislature. Such a study should be conducted in cooperation with the Wisconsin Departments of Revenue, Administration, and Natural Resources, as well as local and county governments and concerned citizen groups, such as the Wisconsin Taxpayers Alliance. The study should review efforts by other states to overcome this property tax-land development problem and, in particular, the efforts being made in the States of New Jersey and California.

---

[7] *A sample lake use report has been reproduced in full in Appendix D of Volume 1 of this report. Copies of all 45 lake use reports are available from the Commission Offices at a cost of $1.00 each.*

[8] *For further discussion of this problem, see Chapter VI of SEWRPC Technical Report No. 6, Planning Law in Southeastern Wisconsin, 1966.*

Greenway Tax Law Proposal: The problems relating to the deterioration and destruction of woodlands within the watershed were discussed in Chapter XII of Volume 1 of this report. Nearly 90 percent of the significant remaining woodland areas in the watershed, which woodland areas cover 11 percent of the watershed area, are in private ownership. In order to encourage private owners of woodlands to manage their stands on a balanced use and sustained yield basis and to provide an incentive for not changing the basic land use, it is recommended that the Wisconsin Department of Natural Resources take the lead in seeking the necessary state legislation to establish a new tax law program designed to provide for reduced property taxes on woodlands that are managed principally for aesthetic and scenic values, for wildlife conservancy, for limited production of forest products, and for watershed protection purposes.

This property tax law, which could be termed a "Greenway Tax Law," could be patterned after the existing Woodland Tax Law program. The principal feature of the proposed law would be to reduce the property tax rate on woodlands placed under the program in return for the property owners agreeing to undertake a sound woodland management program. Technical assistance in establishing the necessary management program could be provided by the Department of Natural Resources. The proposed law could also include a payment by the state to the local governments to help offset the reduced taxes. The law should also include a penalty clause for withdrawal of woodlands from the program.

Land Acquisition for Natural Resource Protection

The recommended Fox River watershed plan places great emphasis upon the preservation, protection, and balanced use of the natural resource base, including the soils, surface and ground water, wetlands, woodlands, and wildlife habitat. Included in the plan are several recommendations for land acquisition to protect the natural resource base. These include the acquisition of all primary environmental corridors in those areas of the watershed designated in the plan to be developed for urban land uses by 1990; the acquisition of all other primary environmental corridors along the main stem of the Fox River; the acquisition of the Vernon Marsh wildlife conservancy and temporary floodwater storage area; the acquisition of the Sugar Creek corridor and reservoir area; and the acquisition of selected high-value wetlands and woodlands adjacent to publicly owned or leased forest and wildlife areas. A schedule of land acquisition costs for implementation of the natural resource protection plan element is set forth in Table 64. It should again be stressed that important relationships exist between these land acquisition recommendations, which are intended primarily for natural resource protection purposes, and the park and outdoor recreation, flood control, pollution abatement, and water supply plan elements.

Urban Environmental Corridors: It is recommended that Kenosha, Racine, Walworth and Waukesha Counties acquire, either through outright purchase of fee simple interests or through the purchase of development rights, all lands designated as primary environmental corridors which lie within areas of the watershed expected to become urban by 1990. In Kenosha County it is recommended that the County Park Commission acquire those urban corridors located in the Towns of Salem and Wheatland along the Fox River and adjacent to Center Lake and those corridors located in and adjacent to the Village of Twin Lakes. The urban corridor lands recommended to be acquired within Kenosha County total 2,014 acres, with the total acquisition cost estimated at $4,028,000. In Racine County it is recommended that the County Highway and Parks Committee acquire those urban corridors located in the City of Burlington; the Villages of Rochester and Waterford; and the Towns of Burlington, Norway, Rochester, and Waterford. The urban corridor lands to be acquired within Racine County total 2,832 acres, with the total acquisition cost estimated at $5,664,000. It is recommended that the Walworth County Park and Planning Commission acquire those urban environmental corridors in the City of Lake Geneva; Villages of East Troy, Fontana, Genoa City, and Williams Bay; and the Towns of Bloomfield, East Troy, Geneva, Linn, and Walworth. The urban corridor lands to be acquired within Walworth County total 3,447 acres, with the total acquisition cost estimated at $6,894,000. It is recommended that the Waukesha County Park and Planning Commission acquire those urban environmental corridors in the Cities of Brookfield, Muskego, and Waukesha; the Villages of Big Bend, Lannon, Menomonee Falls, and Pewaukee; and the Towns of Brookfield, Mukwonago, Pewaukee, Vernon, and Waukesha. The urban corridor lands to be acquired within Waukesha County total 6,179 acres, with the total

Table 64

SCHEDULE OF CAPITAL COSTS OF THE RECOMMENDED NATURAL RESOURCE PROTECTION PLAN ELEMENT OF THE FOX RIVER WATERSHED PLAN BY COUNTY BY YEAR: 1971-1990

Calendar Year	Project Year	Kenosha County				Racine County			
		Urban Environmental Corridor[a] (County)	High-Value Wetlands[b] (State)	Fox Main Stem Environmental Corridor[c] (County)	Total	Urban Environmental Corridor[a] (County)	High-Value Wetlands[b] (State)	Fox Main Stem Environmental Corridor[c] (County)	Total
1971	1	$ 335,666	$ 12,090	$ --	$ 347,756	$ 472,000	$ 31,930	$ --	$ 503,930
1972	2	335,666	12,090	--	347,756	472,000	31,930	--	503,930
1973	3	335,666	12,090	--	347,756	472,000	31,930	--	503,930
1974	4	335,666	12,090	--	347,756	472,000	31,930	--	503,930
1975	5	335,666	12,090	--	347,756	472,000	31,930	--	503,930
1976	6	335,666	12,090	--	347,756	472,000	31,930	--	503,930
1977	7	335,666	12,090	--	347,756	472,000	31,930	--	503,930
1978	8	335,666	12,090	--	347,756	472,000	31,930	--	503,930
1979	9	335,666	12,090	--	347,756	472,000	31,930	--	503,930
1980	10	335,666	12,090	--	347,756	472,000	31,930	--	503,930
1981	11	335,666	12,090	--	347,756	472,000	31,930	--	503,930
1982	12	335,674	12,090	--	347,764	472,000	31,930	--	503,930
1983	13	--	12,090	108,850	120,940	--	31,930	189,525	221,455
1984	14	--	12,090	108,850	120,940	--	31,930	189,525	221,455
1985	15	--	12,090	108,850	120,940	--	31,930	189,525	221,455
1986	16	--	12,090	108,850	120,940	--	31,930	189,525	221,455
1987	17	--	12,090	108,850	120,940	--	31,930	189,525	221,455
1988	18	--	12,090	108,850	120,940	--	31,930	189,525	221,455
1989	19	--	12,090	108,850	120,940	--	31,930	189,525	221,455
1990	20	--	12,090	108,850	120,940	--	31,930	189,525	221,455
Total		$ 4,028,000	$ 241,800	$ 870,800	$ 5,140,600	$ 5,664,000	$ 638,600	$ 1,516,200	$ 7,818,800
Annual Average		$ 201,400	$ 12,090	$ 43,540	$ 287,255	$ 283,200	$ 31,930	$ 75,810	$ 390,940

Calendar Year	Project Year	Walworth County					Waukesha County				
		Urban Environmental Corridor[a] (County)	Sugar Creek Multiple-Purpose Reservoir Area[d] (State)	High-Value Wetlands[b] (State)	High-Value Woodlands[e] (State)	Total	Urban Environmental Corridor[a] (County)	Vernon Marsh Wildlife Conservancy Area[f] (State)	High-Value Woodlands[e] (State)	Fox Main Stem Environmental Corridor[c] (County)	Total
1971	1	$ 574,500	$ 399,466	$ 1,470	$ 103,845	$ 1,079,281	$ 1,029,833	$ 70,885	$ 49,070	$ --	$ 1,149,788
1972	2	574,500	399,466	1,470	103,845	1,079,281	1,029,833	70,885	49,070	--	1,149,788
1973	3	574,500	399,466	1,470	103,845	1,079,281	1,029,833	70,885	49,070	--	1,149,788
1974	4	574,500	399,466	1,470	103,845	1,079,281	1,029,833	70,885	49,070	--	1,149,788
1975	5	574,500	399,466	1,470	103,845	1,079,281	1,029,833	70,885	49,070	--	1,149,788
1976	6	574,500	399,470	1,470	103,845	1,079,285	1,029,833	70,885	49,070	--	1,149,788
1977	7	574,500	--	1,470	103,845	679,815	1,029,833	70,885	49,070	--	1,149,788
1978	8	574,500	--	1,470	103,845	679,815	1,029,833	70,885	49,070	--	1,149,788
1979	9	574,500	--	1,470	103,845	679,815	1,029,833	70,885	49,070	--	1,149,788
1980	10	574,500	--	1,470	103,845	679,815	1,029,833	70,885	49,070	--	1,149,788
1981	11	574,500	--	1,470	103,845	679,815	1,029,833	70,885	49,070	--	1,149,788
1982	12	574,500	--	1,470	103,845	679,815	1,029,837	70,885	49,070	--	1,149,792
1983	13	--	--	1,470	103,845	105,315	--	70,885	49,070	353,150	473,105
1984	14	--	--	1,470	103,845	105,315	--	70,885	49,070	353,150	473,105
1985	15	--	--	1,470	103,845	105,315	--	70,885	49,070	353,150	473,105
1986	16	--	--	1,470	103,845	105,315	--	70,885	49,070	353,150	473,105
1987	17	--	--	1,470	103,845	105,315	--	70,885	49,070	353,150	473,105
1988	18	--	--	1,470	103,845	105,315	--	70,885	49,070	353,150	473,105
1989	19	--	--	1,470	103,845	105,315	--	70,885	49,070	353,150	473,105
1990	20	--	--	1,470	103,845	105,315	--	70,885	49,070	353,150	473,105
Total		$ 6,894,000	$ 2,396,800	$ 29,400	$ 2,076,900	$ 11,397,100	$12,358,000	$1,417,700	$ 981,400	$2,825,200	$ 17,582,296
Annual Average		$ 344,700	$ 399,470	$ 1,470	$ 103,845	$ 568,535	$ 617,900	$ 70,885	$ 49,070	$ 141,260	$ 879,115

[a]*Includes the acquisition in Kenosha County of 2,014 acres; in Racine County of 2,832 acres; in Walworth County of 3,447 acres; and in Waukesha County of 6,179 acres, all at an estimated average cost of $2,000 per acre.*

[b]*Includes the acquisition in Kenosha County of 1,209 acres; in Racine County of 3,193 acres; and in Walworth County of 147 acres, all at an estimated average cost of $200 per acre.*

[c]*Includes the acquisition in Kenosha County of 1,244 acres; in Racine County of 2,166 acres; and in Waukesha County of 4,036 acres, all at an estimated average cost of $700 per acre.*

[d]*Includes the acquisition of 3,424 acres at an estimated average cost of $700 per acre.*

[e]*Includes the acquisition in Walworth County of 2,967 acres and in Waukesha County of 1,402 acres at an estimated average cost of $700 per acre.*

[f]*Includes the acquisition of 2,651 acres at an estimated average cost of $200 per acre for 876 acres of wetlands and $700 per acre for 1,775 acres of woodlands and open lands.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

acquisition cost estimated at $12,358,000. It is further recommended that the cities, villages, and towns wherein urban environmental corridor land is located cooperate with the various county park agencies in the acquisition of such corridors through preservation in open use by appropriate zoning and official mapping, and, where feasible, through acquisition by subdivision dedication.

It is recommended that, because of the possible loss of such corridors to various forms of urban development, the above designated urban corridors be reserved and acquired during the first 12 years of the 20-year plan implementation period. In this connection purchase of less-than-fee interest of such corridor lands would be considerably cheaper and would result in more rapid preservation in proper use of the designated riverine areas. Such acquisition of less-than-fee interest may be in the form of scenic easements; conveyances of development rights to assure continuance of very low-density residential, private park and related open-space uses; and grants of various public uses and development rights for construction and use of park and outdoor recreation facilities. These devices, however, should be used only when acquisition of the entire fee interest is too costly or for other reasons is not available. First priority in land acquisition, as recommended in the Fox River watershed plan, should be given to the designated urban corridors.

Fox River Main Stem Corridors: It is recommended that Kenosha, Racine, and Waukesha Counties acquire those remaining primary environmental corridors outside of the urban corridors lying along the main stem of the Fox River. In Kenosha County it is recommended that the Kenosha County Park Commission acquire those remaining main stem corridors in the Towns of Salem and Wheatland. The remaining main stem corridor lands to be acquired within Kenosha County total 1,244 acres, with the total acquisition cost estimated at $870,800. It is recommended that the Racine County Highway and Parks Committee acquire those remaining main stem corridors located in the Towns of Burlington, Rochester, and Waterford. The remaining main stem corridor lands to be acquired within Racine County total 2,166 acres, with the total acquisition cost estimated at $1,516,200. It is recommended that the Waukesha County Park and Planning Commission acquire those remaining main stem corridors in the Towns of Mukwonago and Vernon. The remaining main stem corridor lands to be acquired within Waukesha County total 4,036 acres, with the total acquisition cost estimated at $2,825,200. The purchase for public use of these remaining main stem corridors, together with the purchase of the urban corridors, will result in eventual public ownership of the entire floodlands of the main stem of the Fox River in Wisconsin.

Vernon Marsh Wildlife Conservancy and Temporary Floodwater Storage Area: It is recommended that the Wisconsin Department of Natural Resources expand its existing Vernon Marsh ownership limits to include all that area indicated in the Fox River watershed plan as constituting the Vernon Marsh primary environmental corridor for wildlife conservancy and temporary floodwater storage purposes. This would require the acquisition of a total of 2,651 acres of land in addition to the 3,896 acres presently under the control of the Department of Natural Resources. Total acquisition cost is estimated at $1,417,700. Acquisition of this additional area by the Department will ensure that the entire valuable wetland and floodplain area known as the Vernon Marsh will be permanently preserved and protected. It was noted in Chapter VI of this volume that, although this area has potential as a future water supply reservoir, such use would not be required at least to the plan design year. Should it ever become necessary to develop this area as a surface water supply reservoir, it is recognized that an agency other than the Department of Natural Resources would have to acquire the needed land from the Department and construct the necessary reservoir.

Sugar Creek Corridor and Reservoir Area: It is recommended that the Wisconsin Department of Natural Resources acquire all the lands needed for the development of a multiple-purpose reservoir on Sugar Creek in the Towns of LaFayette and Sugar Creek in Walworth County. The total area needed for this project is 3,424 acres, including land adjacent to the reservoir for park use; and the acquisition cost is estimated at $2,396,800. It is further recommended that the Department of Natural Resources develop, in conjunction with the reservoir, a multiple-purpose state park. Development cost of such a park is estimated to be $2,980,000.

High-Value Wetlands: It is recommended that the Wisconsin Department of Natural Resources acquire those high-value wetlands identified for public acquisition in the Fox River watershed plan. Such acquisition, totaling 4,549 acres, would include expansion of the existing Tichigan wildlife area in Racine County, Honey Creek wildlife area in Racine and Walworth Counties, the Karcher wildlife area in Kenosha and Racine Counties, the New Munster wildlife area in Kenosha County, and scattered wetland parcels throughout the watershed. Total acquisition cost for these high-value wetlands is estimated at $909,800.

High-Value Woodlands: It is recommended that the Wisconsin Department of Natural Resources acquire those high-value woodlands identified for public acquisition in the Fox River watershed plan. Such acquisition, totaling 4,369 acres, would include expansion of the existing Kettle Moraine State Forest area in Walworth and Waukesha Counties. Total acquisition cost for high-value woodlands is estimated at $3,058,300.

Land Acquisition and Development for Park and Outdoor Recreation

The recommended Fox River watershed plan, in addition to the above natural resource protection proposals, includes recommendations for regional park development and the public acquisition and development of certain high-value and park sites. It should be noted that many of the recommended park and outdoor recreation sites lie within the environmental corridors recommended for acquisition under the natural resource protection plan element. Acquisition of these corridors, therefore, will ordinarily result in certain lands being acquired and therefore available for ultimate park development. In addition to the Sugar Creek site discussed above, three major regional park sites are recommended for immediate public acquisition and full development within the 20-year plan implementation period. Each of these is discussed below. A schedule of capital costs by county for implementing the outdoor recreation element of the Fox River watershed plan is set forth in Table 65.

Minooka Park Site: It is recommended that the Waukesha County Park and Planning Commission fully develop the Minooka Park site in the Town of Waukesha as a multiple-purpose regional park. This park presently has a total area of 297 acres, adequate for its intended purpose. Development costs of this park site are estimated at $695,500.[9]

[9] *This park site has already been acquired by the Waukesha County Park and Planning Commission.*

Western Racine County Park Site: It is recommended that the Racine County Highway and Parks Committee acquire and develop as a multiple-purpose county park the Western Racine County Park site along the Fox River in the Town of Rochester. This park site would have an area of 250 acres and would cost an estimated $175,000 to acquire. Development costs of this park are estimated at $625,000.

Fox River Park Site: It is recommended that the Kenosha County Park Commission expand the existing Fox River County Park in the Town of Salem. Such expansion will require the acquisition of 250 acres of land in addition to the 120 acres of land in public ownership. Estimated costs of acquiring and developing the expanded park are $175,000 and $625,000, respectively.

Selected Additional High-Value Park Sites: It is recommended that the four county park agencies acquire and develop, as the demand dictates, additional high-value outdoor recreation sites for county parks, as indicated in the Fox River watershed plan. Acquisition of these additional high-value park sites as county park facilities would total 7,227 acres and is estimated to cost $2,760,800. Four of these park sites, totaling 834 acres, are located in Kenosha County and are estimated to cost $351,400 to acquire. Seven of these park sites, totaling 1,927 acres, are located in Racine County and are estimated to cost $763,000 to acquire. Seven of these park sites, totaling 3,065 acres, are located in Walworth County and are estimated to cost $326,200 to acquire. Five of these park sites, totaling 1,401 acres, are located in Waukesha County and are estimated to cost $199,500 to acquire. Of the total 23 recommended additional high-value outdoor recreation sites, 12 are located in the primary environmental corridors recommended for acquisition in the natural resource protection plan element and would be acquired if that plan element were fully implemented.[10] These 12 sites should be given priority in any county park land acquisitions, over and above the three regional park sites discussed above.

[10] *The estimated land acquisition costs set forth in this section do not include the 12 sites located in the primary environmental corridors recommended to be acquired in the natural resource protection plan element.*

Table 65

SCHEDULE OF CAPITAL AND OPERATION AND MAINTENANCE COSTS OF THE RECOMMENDED OUTDOOR RECREATION PLAN ELEMENT OF THE FOX RIVER WATERSHED PLAN BY COUNTY BY YEAR: 1971-1990

Calendar Year	Project Year	Kenosha County				Racine County			
		Land Acquisition[a] (County-Local)	Park and Recreation Facility Construction[b] (County-Local)	Operation and Maintenance[c] (County-Local)	Total	Land Acquisition[a] (County-Local)	Park and Recreation Facility Construction[b] (County-Local)	Operation and Maintenance[c] (County-Local)	Total
1971	1	$ 33,495	$ 27,500	$ 900	$ 61,895	$ 53,865	$ 75,050	$ 2,450	$ 131,065
1972	2	33,495	27,500	1,800	62,795	53,865	75,050	4,900	133,515
1973	3	33,495	27,500	2,700	63,695	53,865	75,050	7,350	135,965
1974	4	33,495	27,500	3,600	64,595	53,865	75,050	9,800	138,415
1975	5	33,495	27,500	4,500	65,495	53,865	75,050	12,250	140,865
1976	6	33,495	69,166	7,066	109,727	53,865	116,716	16,366	186,647
1977	7	33,495	69,166	9,632	112,293	53,865	116,716	20,482	190,763
1978	8	33,495	69,166	12,198	114,859	53,865	116,716	24,598	194,879
1979	9	33,495	69,166	14,764	117,425	53,865	116,716	28,714	198,995
1980	10	33,495	69,166	17,330	119,991	53,865	116,716	32,830	203,111
1981	11	15,995	69,166	19,896	105,057	36,365	116,716	36,946	189,727
1982	12	15,995	69,166	22,462	107,623	36,365	116,716	41,062	193,843
1983	13	15,995	69,166	25,028	110,189	36,365	116,716	45,178	197,959
1984	14	15,995	69,166	27,594	112,755	36,365	116,716	49,294	202,075
1985	15	15,995	69,166	30,160	115,321	36,365	116,716	53,410	206,191
1986	16	15,995	69,166	32,726	117,887	36,365	116,716	57,526	210,307
1987	17	15,995	69,166	35,292	120,453	36,365	116,716	61,642	214,423
1988	18	15,995	69,166	37,858	123,019	36,365	116,716	65,758	218,539
1989	19	15,995	69,166	40,424	125,585	36,365	116,716	69,874	222,655
1990	20	15,995	69,176	43,000	128,171	36,365	116,726	74,000	226,791
Total		$ 494,900	$ 1,175,000	$ 388,930	$ 2,058,830	$ 902,300	$ 2,126,000	$ 713,890	$ 3,736,730
Annual Average		$ 24,745	$ 58,750	$ 19,447	$ 102,942	$ 45,115	$ 106,300	$ 35,722	$ 186,837

Calendar Year	Project Year	Walworth County				Waukesha County			
		Land Acquisition[a] (County-Local)	Park and Recreation Facility Construction[b] (State)	Operation and Maintenance[c] (State)	Total	Land Acquisition[a] (County-Local)	Park and Recreation Facility Construction[b] (County-Local)	Operation and Maintenance[c] (County-Local)	Total
1971	1	$ 129,570	$ --	$ --	$ 129,570	$ 67,235	$ 623,900	$ 20,480	$ 712,315
1972	2	129,570	--	--	129,570	67,235	623,900	40,960	732,795
1973	3	129,570	--	--	129,570	67,235	623,900	61,440	753,275
1974	4	129,570	--	--	129,570	67,235	623,900	81,920	773,755
1975	5	129,570	--	--	129,570	67,235	623,900	102,400	794,235
1976	6	129,570	198,666	12,133	340,369	67,235	670,266	124,860	863,061
1977	7	129,570	198,666	24,266	352,502	67,235	670,266	147,320	885,521
1978	8	129,570	198,666	36,399	364,365	67,235	670,266	169,780	907,981
1979	9	129,570	198,666	48,532	376,498	67,235	670,266	192,240	930,441
1980	10	129,570	198,666	60,665	388,631	67,235	670,266	214,700	952,901
1981	11	129,570	198,666	72,798	400,764	46,445	670,266	237,160	954,571
1982	12	129,570	198,666	84,931	412,897	46,445	670,266	259,620	977,031
1983	13	129,570	198,666	97,064	425,030	46,445	670,266	282,080	999,491
1984	14	129,570	198,666	109,197	437,163	46,445	670,266	304,540	1,021,951
1985	15	129,570	198,666	121,330	449,296	46,445	670,266	327,000	1,044,411
1986	16	129,570	198,666	133,463	461,429	46,445	670,266	349,460	1,066,871
1987	17	129,570	198,666	145,596	473,562	46,445	670,266	371,920	1,089,331
1988	18	129,570	198,666	157,729	485,695	46,445	670,266	394,380	1,111,791
1989	19	129,570	198,666	169,862	497,828	46,445	670,266	416,840	1,134,251
1990	20	129,570	198,676	181,995	509,961	46,445	670,276	439,300	1,156,711
Total		$ 2,591,400	$2,980,000	$1,455,960	$ 7,023,840	$ 1,136,800	$ 13,173,500	$ 4,538,400	$ 18,862,690
Annual Average		$ 129,570	$ 149,000	$ 72,798	$ 351,192	$ 56,840	$ 658,675	$ 231,950	$ 943,135

[a] *Includes the acquisition in Kenosha County of 250 acres of regional park land and 457 acres of additional high-value park land; in Racine County of 250 acres of regional park land and 1,039 acres of additional high-value park land; in Walworth County of 3,702 acres of additional high-value park land; and in Waukesha County of 297 acres of regional park land and 1,327 acres of additional high-value park land, all at an estimated average cost of $700 per acre.*

[b] *Includes the development in Kenosha County of 250 acres of regional park land; in Racine County of 250 acres of regional park land; in Walworth County of 1,820 acres of regional park land; and in Waukesha County of 297 acres of regional park land, all at an estimated cost of $1,500 per acre; the development in regional parks of 4 regulation golf courses at an estimated cost of $250,000 per course; and the development in Kenosha County of 20 acres of neighborhood parks and 70 acres of community parks; in Racine County of 57 acres of neighborhood parks and 190 acres of community parks; and in Waukesha County of 461 acres of neighborhood parks and 1,585 acres of community parks, all at estimated average costs of $3,000 per acre and $7,000 per acre, respectively. No development costs have been assigned to the additional high-value park sites recommended to be acquired under the optimum alternative outdoor recreation plan element. It was assumed that development of these sites would most likely be deferred until after the initial 20-year plan implementation period.*

[c] *Based on estimated average costs of $100 per acre of developed regional park land and $200 per acre of developed neighborhood and community park land.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Other Additional High-Value Outdoor Recreation Sites: It is recommended that the four county park agencies or the cities, villages, and towns concerned acquire and develop, as the demand dictates, the 16 additional recommended local potential park sites in the watershed. Of these 16 sites, four would be acquired if the recommended environmental corridor acquisition under the natural resource plan element of the watershed plan is fully carried out; and these four sites should be given priority in any local park land acquisitions. In some cases these additional potential outdoor recreation sites would make logical additions to existing county park systems; in other cases these sites would more appropriately make additions to existing city, village, or town park systems. The local units of government involved in the acquisition of these other potential outdoor recreation sites are: the Villages of Menomonee Falls and Twin Lakes and the Towns of Dover, Geneva, LaGrange, Lyons, Mukwonago, Norway, Randall, Troy, Waterford, and Waukesha. Acquisition of these other outdoor recreation sites would total 2,115 acres, and the land acquisition costs are estimated at $1,200,500.[11]

Private Park Development: The foregoing outdoor recreation land acquisition and development recommendations provide for meeting the entire anticipated outdoor recreation demand through public action. It is, however, fully recognized that private recreational development has been and will continue to play an important role in meeting outdoor recreation demand within the Fox River watershed. The future extent of such private outdoor recreation development cannot, however, be reliably forecast. It is known that at the present time about one-half of the developed recreation land in the watershed devoted to the five major outdoor recreational activities upon which the 1990 forecast demand is based is in private ownership and operation. This level of private activity may continue in the future. To the extent that it does, it will reduce the need to publicly acquire and develop the park and related open-space lands.

[11] *The estimated land acquisition costs set forth in this section do not include the four sites located in the primary environmental corridor recommended to be acquired in the natural resource protection plan element.*

Park Land Preservation: It is not economically desirable or financially feasible to acquire all of the aforementioned recommended park lands and natural resource corridor lands immediately. Therefore, certain police powers that are available to local units of government should be used to protect from development those areas recommended for eventual public acquisition. In addition to preserving those natural resource areas and park lands recommended to be eventually acquired by the use of exclusive agricultural, conservancy, and park districts under zoning ordinances and by sound floodland zoning regulations, the official mapping powers possessed by local units of government should also be utilized for this purpose. Such powers, as well as recommended mapping survey procedures, are shown in Planning Guide No. 2, Official Mapping Guide, 1964.

It is, therefore, recommended that all affected cities, villages, and towns in the watershed prepare and adopt, pursuant to Section 62.23(6) of the Wisconsin Statutes, official maps showing thereon as park sites all park sites and as parkways all corridors recommended for acquisition in the Fox River watershed plan. Such official maps should be prepared for both the area encompassed within the corporate limits of the municipalities and the area within the extraterritorial subdivision plat approval jurisdictional area and should be adopted by an ordinance similar to that set forth in Appendix A of SEWRPC Planning Guide No. 2, Official Mapping Guide.

Fox River Scenic Parkway Drive

It is recommended that the Wisconsin Department of Transportation coordinate, through the county highway committees of Kenosha, Racine, and Waukesha Counties, the establishment, over existing state, county, and local streets and highways, of the recommended Fox River scenic parkway drive. It is anticipated that the establishment of this scenic parkway drive will consist primarily of the design, preparation, and placement of appropriate signs identifying the parkway route along its 63 mile length, an effort similar in nature to the making of the existing Kettle Moraine scenic drive.

Woodland and Wetland Management

The comprehensive Fox River watershed plan also includes recommendations for the institution on a large scale of sound woodland and wetland management practices in an effort to conserve and improve these important resources. Implementation of this plan element will largely depend on actions by private landowners of woodland and wetland areas. Technical and financial assistance is available to private landowners in such efforts. The Wisconsin Department of Natural Resources, Division of Forestry and Recreation, and Division of Fish, Game, and Enforcement, and the University Extension Service will provide to all landowners, upon request and at no cost, technical advice on woodland and wetland management. A number of woodland and wetland management techniques and measures, such as tree planting, timber stand improvement, streambank protection, and establishment of wildlife cover are eligible for cost-sharing through the Agricultural Conservation Program conducted by the U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service, in cooperation with the U. S. Soil Conservation Service, the Wisconsin Department of Natural Resources, and the University Extension Service. Maximum use of such technical and financial assistance is essential to the implementation of this plan element.

FLOOD CONTROL PLAN ELEMENT IMPLEMENTATION

The major flood abatement recommendation contained in the Fox River watershed plan is the institution of sound floodland zoning regulations throughout the watershed and the acquisition for public park and parkway use of all of the floodlands of the main stem of the Fox River. These land use recommendations are supported by certain structural flood control elements. A schedule of capital costs by county for implementing the flood control element of the Fox River watershed plan is set forth in Table 66.

Levee Construction and Channel Improvements—City of Waukesha

It is recommended that the City of Waukesha undertake the responsibility for the construction of dikes and floodwalls within the City as recommended in the Fox River watershed plan. The construction of such dikes and floodwalls is estimated to cost $367,000, including the cost of acquisition of all necessary lands, easements, and rights-of-way. Actual construction of these dikes and floodwalls could possibly be accomplished as a general works project by the U. S. Army Corps of Engineers. Under such a project, the Corps of Engineers, after appropriate detailed engineering studies and hearings and upon U. S. Congressional approval, would construct the dikes and floodwalls, given local assurance that the City would provide all the lands, easements, and rights-of-way necessary for the construction of the project; that the Federal Government would be held free from all damages due to the construction of the works; and that the City would properly maintain all the works after completion in accordance with prescribed regulations. Thus, the proposed dike and floodwall construction could be accomplished by the City of Waukesha, with the local cost being only that necessary to acquire the needed land and other easements. In the alternative it is recommended that the City of Waukesha seek assistance in the construction of the recommended dikes and floodwalls under the watershed assistance program administered by the U. S. Department of Agriculture, Soil Conservation Service.

It is further recommended that the City of Waukesha, through the Corps of Engineers or Soil Conservation Service, undertake the necessary channel clearing and shaping recommended to be accomplished below the Barstow Street Dam to improve the characteristics of the river. It is also recommended that the City undertake the installation of automatic drainage gates as recommended on 17 storm sewer outlets discharging to the Fox River in order to prevent storm sewer backup. Finally, it is recommended that the City of Waukesha construct a storm sewer from St. Paul Avenue to the Fox River as a flood alleviation device in the location shown on Map 8.

Levee Construction and Channel Improvements—City of Burlington

It is recommended that the City of Burlington undertake the responsibility for constructing dikes and floodwalls within the City as recommended in the Fox River watershed plan. The construction of such dikes and floodwalls is estimated to cost $350,000, including the cost of acquisition of all necessary lands, easements, and rights-of-way. The actual construction of these recommended dikes and floodwalls could be accomplished by the U. S. Army Corps of Engineers or the U. S. Department of Agriculture, Soil Conservation Service, in the same manner as outlined above in the discussion of levee construction for the City of Waukesha. It is further recommended that the City of Burlington undertake the minor channel clearing and installation of automatic drainage gates on 22 storm sewer outlets discharging to the Fox River as proposed in the plan.

Channel Improvements—Sugar and Honey Creeks

Certain channel improvements are recommended in the Fox River watershed plan to provide better

Table 66

SCHEDULE OF CAPITAL AND OPERATION AND MAINTENANCE COSTS OF THE RECOMMENDED FLOOD CONTROL PLAN ELEMENT OF THE FOX RIVER WATERSHED PLAN BY COUNTY BY YEAR: 1971-1990

Calendar Year	Project Year	Kenosha County	Racine County					
		Floodland Residence Evacuation in the Silver Lake Area[a]	Levee Construction in the City of Burlington		Agricultural Drainage Improvements on Hoosier Creek		Total	
			Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance
1971	1	$ 61,800	$ 70,000	$ 500	$ 48,140	$ 2,790	$ 118,140	$ 3,290
1972	2	61,800	70,000	500	48,140	2,790	118,140	3,290
1973	3	61,800	70,000	500	48,140	2,790	118,140	3,290
1974	4	61,800	70,000	500	48,140	2,790	118,140	3,290
1975	5	61,800	70,000	500	48,140	2,790	118,140	3,290
1976	6	61,800	--	500	--	2,790	--	3,290
1977	7	61,800	--	500	--	2,790	--	3,290
1978	8	61,800	--	500	--	2,790	--	3,290
1979	9	61,800	--	500	--	2,790	--	3,290
1980	10	61,800	--	500	--	2,790	--	3,290
1981	11	61,800	--	500	--	2,790	--	3,290
1982	12	61,800	--	500	--	2,790	--	3,290
1983	13	61,800	--	500	--	2,790	--	3,290
1984	14	61,800	--	500	--	2,790	--	3,290
1985	15	61,800	--	500	--	2,790	--	3,290
1986	16	61,800	--	500	--	2,790	--	3,290
1987	17	61,800	--	500	--	2,790	--	3,290
1988	18	61,800	--	500	--	2,790	--	3,290
1989	19	61,800	--	500	--	2,790	--	3,290
1990	20	61,800	--	500	--	2,790	--	3,290
Total		$ 1,236,000	$ 350,000	$ 10,000	$ 240,700	$ 55,800	$ 590,700	$ 65,800
Annual Average		$ 61,800	$ 17,500	$ 500	$ 12,305	$ 2,790	$ 31,089	$ 3,290

Calendar Year	Project Year	Walworth County						Waukesha County	
		Construction of a Multiple-Purpose Reservoir on Sugar Creek		Agricultural Drainage Improvements on Sugar and Honey Creeks		Total		Levee Construction in the City of Waukesha	
		Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance
1971	1	$ --	$ --	$ 36,780	$ 2,400	$ 36,780	$ 2,400	$ 73,400	$ 500
1972	2	--	--	36,780	2,400	36,780	2,400	73,400	500
1973	3	--	--	36,780	2,400	36,780	2,400	73,400	500
1974	4	--	--	36,780	2,400	36,780	2,400	73,400	500
1975	5	--	--	36,780	2,400	36,780	2,400	73,400	500
1976	6	--	--	--	2,400	--	2,400	--	500
1977	7	484,000	900	--	2,400	484,000	3,300	--	500
1978	8	484,000	900	--	2,400	484,000	3,300	--	500
1979	9	484,000	900	--	2,400	484,000	3,300	--	500
1980	10	484,000	900	--	2,400	484,000	3,300	--	500
1981	11	484,000	900	--	2,400	484,000	3,300	--	500
1982	12	--	900	--	2,400	--	3,300	--	500
1983	13	--	900	--	2,400	--	3,300	--	500
1984	14	--	900	--	2,400	--	3,300	--	500
1985	15	--	900	--	2,400	--	3,300	--	500
1986	16	--	900	--	2,400	--	3,300	--	500
1987	17	--	900	--	2,400	--	3,300	--	500
1988	18	--	900	--	2,400	--	3,300	--	500
1989	19	--	900	--	2,400	--	3,300	--	500
1990	20	--	900	--	2,400	--	3,300	--	500
Total		$ 2,420,000	$ 13,500	$ 183,900	$ 48,000	$ 2,603,900	$ 60,600	$ 367,000	$ 10,000
Annual Average		$ 121,000	$ 675	$ 9,195	$ 2,400	$ 130,195	$ 3,030	$ 18,350	$ 500

[a] *Assumes an annual average cost of $61,800. Actual timing of expenditures would be determined by the market availability of the 160 residences to be removed.*

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

agricultural drainage in the upper reaches of Sugar Creek and Honey Creek. No active farm drainage districts are known to exist along either of these two tributaries of the Fox River. It is, therefore, recommended that farm drainage districts be organized for the area to be served by the recommended improvements along Sugar and Honey Creeks, pursuant to the provisions of Chapter 88 of the Wisconsin Statutes. Such districts would be formed under the control of the Walworth County Drainage Board and would have the powers necessary to undertake all types of channel improvements, as well as channel maintenance. In lieu of the creation of such drainage districts, the necessary channel improvement work could be accomplished by a cooperative contract commission created under Section 66.30 of the Wisconsin Statutes. The total estimated cost of the recommended agricultural drainage improvements on Sugar and Honey Creeks is $183,900. It is recommended that technical and financial aid in the carrying out of this plan recommendation be sought from the U. S. Soil Conservation Service under the federal P. L. 566 watershed program.

Channel Improvements—Hoosier Creek

It is recommended that the Hoosier Creek Drainage District undertake the channel improvements and earth dike construction recommended for Hoosier Creek and the Hoosier Branch Canal in order to provide agricultural flood damage protection and improved drainage. The total estimated cost of the recommended agricultural drainage improvements on Hoosier Creek is $240,700. It is recommended that technical and financial aid in the carrying out of this plan recommendation be sought from the U. S. Soil Conservation Service under the federal P. L. 566 watershed program.

Sugar Creek Reservoir

It is recommended that the Wisconsin Department of Natural Resources sponsor the construction, operation, and maintenance of all lands, waters, and facilities associated with the proposed Sugar Creek Reservoir. As already noted, such reservoir should form the basis for a multiple-purpose state park facility. The total estimated cost of the recommended reservoir is $2,420,000. This figure does not include cost estimates for land acquisition and development of the proposed major outdoor recreation facility. It is recommended that the Department of Natural Resources explore the possibility of cooperation and financial participation in the proposed reservoir construction with the U. S. Army Corps of Engineers and the U. S. Department of Agriculture, Soil Conservation Service, as appropriate.

Bridge Construction

It is recommended that any public or private body constructing or financing new bridges or replacing existing bridges under the perennial stream channel system of the Fox River watershed design and construct such bridge in accordance with the water control facility development objectives and standards set forth in Chapter II of this report and with the accompanying design methodology and criteria. The cost of bridge replacement and construction is not included in the recommended watershed plan since it is assumed that any structures requiring replacement have served their useful life and will, in any case, require replacement for traffic safety and transportation system construction, operation, and maintenance purposes.

Floodland Structure Removal

It is recommended that the Kenosha County Park Commission, in conjunction with the acquisition of land along the main stem of the Fox River, acquire and remove 160 residences located within the floodway in the Towns of Salem and Wheatland as these residences come onto the real estate market. The total estimated cost of this plan element is $1,235,115.

Floodland Land Use Controls

In addition to the zoning of floodlands, as recommended under implementation of the land use element of the Fox River watershed plan, it is recommended that other land use control and related measures be undertaken within the Fox River watershed. These include corrective measures dealing with obstructions in the channels and floodways to regulations requiring floodproofing of existing structures.

It is recommended that Kenosha, Racine, Walworth, and Waukesha Counties formally request the Wisconsin Department of Natural Resources to survey periodically the bed of the Fox River and to institute appropriate legal action to cause the removal of materials or structures, pursuant to Sections 30.11, 30.12, and 30.13 of the Wisconsin Statutes. It is further recommended that any local unit of government lying along the Fox River and its tributary streams reports to the Department of Natural Resources, in writing, every violation which has or may occur relative to structures or deposits in navigable waters and to extension beyond duly-established pierhead lines, pursuant to Section 30.14(1) of the Wisconsin Statutes.

It is recommended that all cities, villages, and towns in the Fox River watershed direct their local municipal engineers and building or housing inspectors to inspect periodically and determine whether any structure lying in the floodway or floodplain is in need of extensive repair or is so old or so dangerous, unsafe, unsanitary, or otherwise so unfit for human habitation as to be beyond repair. Upon such findings municipalities may cause the razing of such structure, pursuant to Section 66.05 of the Wisconsin Statutes, or institute action pursuant to Chapter 280 of the Wisconsin Statutes.

It is recommended that all counties, cities, villages, and towns in the watershed undertake to include in their zoning, building, housing, subdivision, and sanitary ordinances, as appropriate, regulations dealing with the control of seepage, sewer backup relief, and protection from overland flood flow for dwellings located in the floodlands. Such floodproofing regulations should supplement sound floodway and floodplain regulations in the zoning ordinance to prohibit further urban development of floodlands.

It is recommended that other supplemental preventive measures be taken, including, as appropriate, the posting of flood warning signs along the 100-year recurrence interval flood boundary and the design and installation of municipal utilities and facilities in such a way as to discourage the development of floodlands.

Streamflow Recordation

It is recommended that Waukesha County continue to finance 50 percent of the operation and maintenance of the existing, continuous, recording stream gage in the City of Waukesha under the interagency cooperative agreement executed between Waukesha County, the Southeastern Wisconsin Regional Planning Commission, and the U. S. Geological Survey. It is further recommended that the U. S. Geological Survey continue to operate the recording stream gage at Wilmot and that two additional, continuous, flow-recording stream gages be established within the watershed, one on the Mukwonago River near the confluence with the Fox River in the Town of Mukwonago, Waukesha County, and another on the White River in the Town of Burlington, Racine County. It is recommended that 50 percent of the cost of these two additional gaging stations be financed by the Waukesha and Racine County Boards, respectively, under an interagency agreement to be executed between Waukesha and Racine Counties, the Southeastern Wisconsin Regional Planning Commission, and the U. S. Geological Survey.

WATER POLLUTION ABATEMENT PLAN ELEMENT IMPLEMENTATION

The pollution abatement facility plan elements of the recommended comprehensive Fox River watershed plan include the provision of advanced waste treatment for additional biochemical oxygen demand and nutrient removal at all major waste discharges in the watershed. Within the upper Fox River watershed, the plan recommends the establishment of an integrated sanitary sewerage system, with a system of trunk sewers conveying all liquid wastes to a single large sewage treatment plant located below Waukesha. The plan also recommends the provision of advanced waste treatment at six of the ten existing sanitary sewage treatment plants in the lower watershed, the establishment of new sewerage systems at five major lakes in the watershed, and the provision of sanitary sewerage service to three additional major lakes in the watershed through connection to existing sewerage systems. Finally, the plan recommends the institution of algae control operations as necessary at 13 major lakes in the watershed; the institution of weed harvesting operations as necessary at 20 major lakes in the watershed; the institution of improved soil and water conservation practices in the tributary drainage area of 17 major lakes in the watershed, including the construction of bench terraces; the regulation of the installation of on-site soil absorption sewage disposal systems; the conduct of stream basin surveys on a regular basis; and a continuing water quality monitoring program. Schedules of capital costs for implementing the water pollution abatement plan element of the Fox River watershed plan are set forth by county in Tables 67, 68, 69, and 70.

Upper Fox River Watershed Sewerage System

The provision of advanced waste treatment at municipal sewage treatment plants in the upper watershed is essential to the abatement of the most severe stream water pollution problems existing within the watershed. In order to provide the necessary advanced waste treatment, the comprehensive Fox River watershed plan recommends the establishment of a trunk sewer system to collect all liquid wastes generated in the upper

Table 67

SCHEDULE OF CAPITAL AND OPERATION AND MAINTENANCE COSTS OF THE RECOMMENDED WATER POLLUTION ABATEMENT PLAN ELEMENT OF THE FOX RIVER WATERSHED PLAN FOR KENOSHA COUNTY: 1971-1990

Calendar Year	Project Year	Stream Water Quality Improvements		Lake Water Quality Improvements									
		Advanced Waste Treatment at Village of Twin Lakes		Water Quality Management Plan for Elizabeth and Marie Lakes[a]		Water Quality Management Plan for Powers, Tombeau, and Benedict Lakes[a]		Water Quality Management Plan for Silver Lake[a]		Water Quality Management Plan for Camp and Center Lakes[a]		Total	
		Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance
1971	1	$ 36,000	$ 49,800	$ 7,940	$ 1,800	$ 8,330	$ 1,250	$ 6,455	$ 2,160	$ 236,575	$ 38,900	$ 295,300	$ 93,910
1972	2	36,000	49,800	7,940	1,800	8,330	1,250	6,455	2,160	236,575	38,900	295,300	93,910
1973	3	36,000	49,800	7,940	1,800	8,330	1,250	6,455	2,160	236,575	38,900	295,300	93,910
1974	4	36,000	49,800	7,940	1,800	8,330	1,250	6,455	2,160	236,575	38,900	295,300	93,910
1975	5	36,000	49,800	7,940	1,800	8,330	1,250	6,455	2,160	236,575	38,900	295,300	93,910
1976	6	36,000	49,800	7,940	1,800	8,330	1,250	6,455	2,160	236,575	38,900	295,300	93,910
1977	7	36,000	49,800	7,940	1,800	8,330	1,250	6,455	2,160	236,575	38,900	295,300	93,910
1978	8	36,000	49,800	7,940	1,800	8,330	1,250	6,455	2,160	236,575	38,900	295,300	93,910
1979	9	36,000	49,800	7,940	1,800	8,330	1,250	6,455	2,160	236,575	38,900	295,300	93,910
1980	10	36,000	49,800	7,940	1,800	8,330	1,250	6,455	2,160	236,575	38,900	295,300	93,910
1981	11	--	49,800	--	1,800	--	1,250	--	2,160	--	38,900	--	93,910
1982	12	--	49,800	--	1,800	--	1,250	--	2,160	--	38,900	--	93,910
1983	13	--	49,800	--	1,800	--	1,250	--	2,160	--	38,900	--	93,910
1984	14	--	49,800	--	1,800	--	1,250	--	2,160	--	38,900	--	93,910
1985	15	--	49,800	--	1,800	--	1,250	--	2,160	--	38,900	--	93,910
1986	16	--	49,800	--	--	--	--	--	--	--	35,000	--	84,800
1987	17	--	49,800	--	--	--	--	--	--	--	35,000	--	84,800
1988	18	--	49,800	--	--	--	--	--	--	--	35,000	--	84,800
1989	19	--	49,800	--	--	--	--	--	--	--	35,000	--	84,800
1990	20	--	49,800	--	--	--	--	--	--	--	35,000	--	84,800
Total		$ 360,000	$ 996,000	$ 79,400	$ 27,000	$ 83,300	$ 18,750	$ 64,550	$ 32,400	$ 2,365,750	$ 758,500	$ 2,953,000	$ 1,832,650
Annual	Average	$ 18,000	$ 49,800	$ 3,970	$ 1,350	$ 4,165	$ 938	$ 3,228	$ 1,620	$ 118,288	$ 37,925	$ 147,650	$ 91,633

[a] *For a detailed breakdown of the component lake water quality management plan element costs, see Table 52.*

Source: Harza Engineering Company and SEWRPC.

Table 68

SCHEDULE OF CAPITAL AND OPERATION AND MAINTENANCE COSTS OF THE RECOMMENDED WATER POLLUTION ABATEMENT PLAN ELEMENT OF THE FOX RIVER WATERSHED PLAN FOR RACINE COUNTY: 1971-1990

Calendar Year	Project Year	Stream Water Quality Improvements				Lake Water Quality Improvements											
		Advanced Waste Treatment at City of Burlington		Advanced Waste Treatment at Western Racine County Sewerage District		Water Quality Management Plan for Bohner Lake[a]		Water Quality Management Plan for Browns Lake[a]		Water Quality Management Plan for Eagle Lake[a]		Water Quality Management Plan for Tichigan Lake[a]		Water Quality Management Plan for Wind Lake[a]		Total	
		Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance
1971	1	$ 134,800	$ 132,000	$ 71,900	$ 66,000	$ 3,625	$ 1,000	$ 163,045	$ 23,000	$ 128,600	$ 23,450	$ 112,955	$ 28,060	$ 149,575	$ 33,750	$ 764,500	$ 307,260
1972	2	134,800	132,000	71,900	66,000	3,625	1,000	163,045	23,000	128,600	23,450	112,955	28,060	149,575	33,750	764,500	307,260
1973	3	134,800	132,000	71,900	66,000	3,625	1,000	163,045	23,000	128,600	23,450	112,955	28,060	149,575	33,750	764,500	307,260
1974	4	134,800	132,000	71,900	66,000	3,625	1,000	163,045	23,000	128,600	23,450	112,955	28,060	149,575	33,750	764,500	307,260
1975	5	134,800	132,000	71,900	66,000	3,625	1,000	163,045	23,000	128,600	23,450	112,955	28,060	149,575	33,750	764,500	307,260
1976	6	134,800	132,000	71,900	66,000	3,625	1,000	163,045	23,000	128,600	23,450	112,955	28,060	149,575	33,750	764,500	307,260
1977	7	134,800	132,000	71,900	66,000	3,625	1,000	163,045	23,000	128,600	23,450	112,955	28,060	149,575	33,750	764,500	307,260
1978	8	134,800	132,000	71,900	66,000	3,625	1,000	163,045	23,000	128,600	23,450	112,955	28,060	149,575	33,750	764,500	307,260
1979	9	134,800	132,000	71,900	66,000	3,625	1,000	163,045	23,000	128,600	23,450	112,955	28,060	149,575	33,750	764,500	307,260
1980	10	134,800	132,000	71,900	66,000	3,625	1,000	163,045	23,000	128,600	23,450	112,955	28,060	149,575	33,750	764,500	307,260
1981	11	--	132,000	--	66,000	--	1,000	--	23,000	--	23,450	--	28,060	--	33,750	--	307,260
1982	12	--	132,000	--	66,000	--	1,000	--	23,000	--	23,450	--	28,060	--	33,750	--	307,260
1983	13	--	132,000	--	66,000	--	1,000	--	23,000	--	23,450	--	28,060	--	33,750	--	307,260
1984	14	--	132,000	--	66,000	--	1,000	--	23,000	--	23,450	--	28,060	--	33,750	--	307,260
1985	15	--	132,000	--	66,000	--	1,000	--	23,000	--	23,450	--	28,060	--	33,750	--	307,260
1986	16	--	132,000	--	66,000	--	--	--	21,000	--	21,000	--	26,570	--	29,000	--	295,570
1987	17	--	132,000	--	66,000	--	--	--	21,000	--	21,000	--	26,570	--	29,000	--	295,570
1988	18	--	132,000	--	66,000	--	--	--	21,000	--	21,000	--	26,570	--	29,000	--	295,570
1989	19	--	132,000	--	66,000	--	--	--	21,000	--	21,000	--	26,570	--	29,000	--	295,570
1990	20	--	132,000	--	66,000	--	--	--	21,000	--	21,000	--	26,570	--	29,000	--	295,570
Total		$1,348,000	$ 2,640,000	$ 719,000	$ 1,320,000	$ 36,250	$ 15,000	$ 1,630,450	$ 450,000	$ 1,286,000	$ 456,750	$ 1,129,550	$ 553,750	$ 1,495,750	$ 651,250	$ 7,645,000	$6,086,750
Annual Average		$ 67,400	$ 132,000	$ 35,950	$ 66,000	$ 1,813	$ 750	$ 81,522	$ 22,500	64,300	$ 22,838	$ 56,478	$ 27,688	$ 74,788	$ 32,563	$ 382,250	$ 304,338

[a]*For a detailed breakdown of the component lake water quality management plan element costs, see Table 52.*

Source: Harza Engineering Company and SEWRPC.

Table 69

SCHEDULE OF CAPITAL AND OPERATION AND MAINTENANCE COSTS OF THE RECOMMENDED WATER POLLUTION ABATEMENT PLAN ELEMENT OF THE FOX RIVER WATERSHED PLAN FOR WALWORTH COUNTY: 1971-1990

Calendar Year	Project Year	Stream Water Quality Improvements						Lake Water Quality Improvements									
		Advanced Waste Treatment at Village of East Troy		Advanced Waste Treatment at City of Lake Geneva		Secondary Waste Treatment at Village of Genoa City		Water Quality Management Plan for Beulah Lake[a]		Water Quality Management Plan for Como Lake[a]		Water Quality Management Plan for Geneva Lake[a]		Water Quality Management Plan for Pell Lake[a]		Total	
		Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance
1971	1	$ 42,700	$ 53,500	$ 138,900	$ 140,300	$ 12,600	$ 15,700	$ 10,800	$ 1,500	$ 260,105	$ 38,500	$ 20,000	--	$ 1,917	$ 650	$ 487,022	$ 250,150
1972	2	42,700	53,500	138,900	140,300	12,600	15,700	10,800	1,500	260,105	38,500	20,000	--	1,917	650	487,022	250,150
1973	3	42,700	53,500	138,900	140,300	12,600	15,700	10,800	1,500	260,105	38,500	20,000	--	1,917	650	487,022	250,150
1974	4	42,700	53,500	138,900	140,300	12,600	15,700	10,800	1,500	260,105	38,500	20,000	--	1,917	650	487,022	250,150
1975	5	42,700	53,500	138,900	140,300	12,600	15,700	10,800	1,500	260,105	38,500	20,000	--	1,917	650	487,022	250,150
1976	6	42,700	53,500	138,900	140,300	12,600	15,700	10,800	1,500	260,105	38,500	20,000	--	1,917	650	487,022	250,150
1977	7	42,700	53,500	138,900	140,300	12,600	15,700	10,800	1,500	260,105	38,500	20,000	--	1,917	650	487,022	250,150
1978	8	42,700	53,500	138,900	140,300	12,600	15,700	10,800	1,500	260,105	38,500	20,000	--	1,917	650	487,022	250,150
1979	9	42,700	53,500	138,900	140,300	12,600	15,700	10,800	1,500	260,105	38,500	20,000	--	1,917	650	487,022	250,150
1980	10	42,700	53,500	138,900	140,300	12,600	15,700	10,800	1,500	260,105	38,500	20,000	--	1,917	650	487,022	250,150
1981	11	--	53,500	--	140,300	--	15,700	--	1,500	--	38,500	--	--	--	650	--	250,150
1982	12	--	53,500	--	140,300	--	15,700	--	1,500	--	38,500	--	--	--	650	--	250,150
1983	13	--	53,500	--	140,300	--	15,700	--	1,500	--	38,500	--	--	--	650	--	250,150
1984	14	--	53,500	--	140,300	--	15,700	--	1,500	--	38,500	--	--	--	650	--	250,150
1985	15	--	53,500	--	140,300	--	15,700	--	1,500	--	38,500	--	--	--	650	--	250,150
1986	16	--	53,500	--	140,300	--	15,700	--	--	--	33,000	--	--	--	--	--	242,500
1987	17	--	53,500	--	140,300	--	15,700	--	--	--	33,000	--	--	--	--	--	242,500
1988	18	--	53,500	--	140,300	--	15,700	--	--	--	33,000	--	--	--	--	--	242,500
1989	19	--	53,500	--	140,300	--	15,700	--	--	--	33,000	--	--	--	--	--	242,500
1990	20	--	53,500	--	140,300	--	15,700	--	--	--	33,000	--	--	--	--	--	242,500
Total		$ 427,000	$ 1,070,000	$ 1,389,000	$ 2,806,000	$ 126,000	$ 314,000	$ 108,000	$ 22,500	$2,601,050	$ 742,500	$ 200,000	--	$ 19,170	$ 9,750	$ 4,870,220	$4,964,750
Annual Average		$ 21,350	$ 53,500	$ 69,450	$ 140,300	$ 6,300	$ 15,700	$ 5,400	$ 1,125	$ 130,053	$ 37,125	$ 10,000	--	$ 959	$ 488	$ 243,511	$ 248,238

[a] *For a detailed breakdown of the component lake water quality management plan element costs, see Table 52.*

Source: Harza Engineering Company and SEWRPC.

Table 70

SCHEDULE OF CAPITAL AND OPERATION AND MAINTENANCE COSTS OF THE RECOMMENDED WATER POLLUTION ABATEMENT PLAN ELEMENT OF THE FOX RIVER WATERSHED PLAN FOR WAUKESHA COUNTY: 1971-1990

Calendar Year	Project Year	Stream Water Quality Improvements				Lake Water Quality Improvements									
		Advanced Waste Treatment in Upper Watershed[a]		Advanced Waste Treatment Village of Mukwonago		Water Quality Management Plan for Phantom Lake[b]		Water Quality Management Plan for Little Muskego Lake[b]		Water Quality Management Plan for Big Muskego Lake[b]		Water Quality Management Plan for Pewaukee Lake[b]		Total	
		Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance
1971	1	$ 2,456,800	$ 1,072,000	$ 66,300	$ 76,200	$ 11,475	$ 4,800	$ 401,265	$ 68,900	$ 8,925	$ 18,250	$ 424,525	$ 46,250	$ 3,369,290	$ 1,286,400
1972	2	2,456,800	1,072,000	66,300	76,200	11,475	4,800	401,265	68,900	8,925	18,250	424,525	46,250	3,369,290	1,286,400
1973	3	2,456,800	1,072,000	66,300	76,200	11,475	4,800	401,265	68,900	8,925	18,250	424,525	46,250	3,369,290	1,286,400
1974	4	2,456,800	1,072,000	66,300	76,200	11,475	4,800	401,265	68,900	8,925	18,250	424,525	46,250	3,369,290	1,286,400
1975	5	2,456,800	1,072,000	66,300	76,200	11,475	4,800	401,265	68,900	8,925	18,250	424,525	46,250	3,369,290	1,286,400
1976	6	2,456,800	1,072,000	66,300	76,200	11,475	4,800	401,265	68,900	8,925	18,250	424,525	46,250	3,369,290	1,286,400
1977	7	2,456,800	1,072,000	66,300	76,200	11,475	4,800	401,265	68,900	8,925	18,250	424,525	46,250	3,369,290	1,286,400
1978	8	2,456,800	1,072,000	66,300	76,200	11,475	4,800	401,265	68,900	8,925	18,250	424,525	46,250	3,369,290	1,286,400
1979	9	2,456,800	1,072,000	66,300	76,200	11,475	4,800	401,265	68,900	8,925	18,250	424,525	46,250	3,369,290	1,286,400
1980	10	2,456,800	1,072,000	66,300	76,200	11,475	4,800	401,265	68,900	8,925	18,250	424,525	46,250	3,369,290	1,286,400
1981	11	--	1,072,000	--	76,200	--	4,800	--	68,900	--	18,250	--	46,250	3,369,290	1,286,400
1982	12	--	1,072,000	--	76,200	--	4,800	--	68,900	--	18,250	--	46,250	--	1,286,400
1983	13	--	1,072,000	--	76,200	--	4,800	--	68,900	--	18,250	--	46,250	--	1,286,400
1984	14	--	1,072,000	--	76,200	--	4,800	--	68,900	--	18,250	--	46,250	--	1,286,400
1985	15	--	1,072,000	--	76,200	--	4,800	--	68,900	--	18,250	--	46,250	--	1,286,400
1986	16	--	1,072,000	--	76,200	--	--	--	66,000	--	--	--	37,000	--	1,251,200
1987	17	--	1,072,000	--	76,200	--	--	--	66,000	--	--	--	37,000	--	1,251,200
1988	18	--	1,072,000	--	76,200	--	--	--	66,000	--	--	--	37,000	--	1,251,200
1989	19	--	1,072,000	--	76,200	--	--	--	66,000	--	--	--	37,000	--	1,251,200
1990	20	--	1,072,000	--	76,200	--	--	--	66,000	--	--	--	37,000	--	1,251,200
Total		$24,568,000	$21,440,000	$ 663,000	$1,524,000	$ 114,750	$ 72,000	$4,012,650	$1,363,500	$ 89,250	$ 273,750	$ 4,245,250	$ 878,750	$33,692,900	$25,552,000
Annual Average		$ 1,228,400	$ 1,072,000	$ 33,150	$ 76,200	$ 5,738	$ 3,600	$ 200,632	$ 68,175	$ 4,463	$ 13,688	$ 212,263	$ 43,938	$ 1,684,646	$ 1,277,600

[a] *For a detailed breakdown of the component stream water quality management plan element costs for the upper watershed, see Appendix F.*

[b] *For a detailed breakdown of the component lake water quality management plan element costs, see Table 52.*

Source: Harza Engineering Company and SEWRPC.

Fox River watershed and to convey these wastes to a single large sewage treatment plant located below Waukesha. The four existing sewage treatment plants in the upper watershed would be eventually abandoned. It is important to note that the recommended sanitary sewerage system configuration in the upper Fox River watershed is only one of three system configurations that could meet, through the provision of advanced waste treatment, the established water use objectives and standards. As noted in Chapter V of this volume, all three upper watershed system alternatives could be expected to provide the water quality management necessary to meet the aforementioned objectives and standards. The one-plant system alternative is being recommended on the basis that it would eliminate the discharge of all sewage treatment plant effluent to the stream system of the watershed above the City of Waukesha, would most fully realize the economies of scale inherent in the operation of larger plants, and would eliminate the need to duplicate expensive staff and equipment.

Implementation of this plan recommendation requires the creation of a new institutional structure to build, operate, and maintain the single large sewage treatment plant and the primary trunk sewer system extending up the river valley from the plant to serve the various municipalities concerned. Under the plan recommendations, each local unit of government within the upper watershed would continue to build, operate, and maintain its own local sewerage system and would, therefore, continue to maintain control over the staged extension of these local systems, as well as of the geographical areas to be served by these local systems. Thus, each city and village in the upper watershed would continue to build, operate, and maintain the local collection systems in the incorporated areas under the general governmental powers, while it would be necessary for towns in the upper watershed to form appropriate sanitary or utility districts to build and maintain the local collection system in unincorporated areas. The areawide sewerage agency, however established, would provide only the trunk sewer and the sewage treatment service to the individual local units of government concerned.

Until very recently, a mechanism assisted for the establishment of an institutional structure that could readily implement the plan recommendation for an integrated sanitary sewerage system to serve the upper Fox River watershed in the form of a metropolitan sewerage district. As noted in Chapter XIV of Volume 1 of this report, however, the Wisconsin Supreme Court in 1969 invalidated the method by which such metropolitan sewerage districts were to be established. As yet, the Wisconsin Legislature has not acted to provide replacement-enabling legislation for the creation of new metropolitan sewerage districts. Therefore, this institutional structure is not at present available for plan implementation.

Another method exists, however, to implement this important element of the Fox River watershed plan. This method would involve the execution of a voluntary intergovernmental cooperation agreement, pursuant to Section 66.30 of the Wisconsin Statutes, between the 12 local governments concerned, namely: the Cities of Brookfield, New Berlin, and Waukesha; the Villages of Lannon, Menomonee Falls, Pewaukee, and Sussex; and the Towns of Brookfield, Delafield, Lisbon, Pewaukee, and Waukesha. Under this approach each of the 12 local municipalities would become a signatory to an intergovernmental agreement establishing a commission or other body which would plan, build, maintain, and operate the necessary trunk sewer system and the single large sewage treatment plant. The contractual agreement would specify all of the necessary arrangements, including such matters as membership on the governing body, financing, and a method by which any ensuing conflicts could be arbitrated and resolved. There already exists within the Southeastern Wisconsin Region an excellent example of the use of this technique. This example is the North Shore Water Utility, cooperatively established by contract between the City of Glendale and the Villages of Fox Point and Whitefish Bay, all in Milwaukee County, for the purpose of providing municipal water supply service to these three communities. This cooperative approach has the advantage of avoiding the creation of a special-purpose unit of government and relying instead upon the abilities and the resources of the existing general-purpose local units of government. Certain limitations, however, are inherent in the voluntary nature of this approach. These include, among others, the fact that there is no means by which all of the concerned local units of government can be required to even consider, much less be compelled to take, the necessary cooperative action. Thus, a single local unit of government, by electing not to participate in a cooperative intergovernmental venture, could thwart the efforts of all of the other local units of government concerned in their search for a sound solution to a serious and pressing areawide problem.

It is recommended that an effort be made to implement the upper Fox River watershed sewerage system plan element through the establishment, on a voluntary basis, of an intergovernmental cooperative commission. It is further recommended that the Waukesha County University-Extension Service provide a forum for the discussion of this plan element among the involved local units of government, which discussion should serve to remove any obstacles to implementation of the plan element.

Should such an effort to establish an intergovernmental cooperative contract commission fail, it is then recommended that the Wisconsin Department of Natural Resources, acting pursuant to its statutory responsibilities with respect to water resources, as set forth in Chapter 144 of the Wisconsin Statutes, take the lead in initiating the necessary legislation to provide once again for the establishment of metropolitan sewerage districts. It is further recommended that, should such action be necessary, the Waukesha County Board of Supervisors and each of the 12 local units of government concerned with the establishment of an areawide sewerage system in the upper Fox River watershed lend their support in seeking the necessary legislation. Alternatively, it is recommended that the concerned state agencies and units of government seek legislation to permit the county government to become the mechanism for the provision of the necessary areawide sewerage service.

This plan element also recognizes the longstanding plans of the Metropolitan Sewerage Commission of the County of Milwaukee to serve relatively small areas of the Fox River watershed in the Cities of Brookfield, Muskego, and New Berlin and the Village of Menomonee Falls. It is, therefore, recommended that the Metropolitan Sewerage Commission of the County of Milwaukee contract with the aforementioned units of government for the provision of sanitary sewerage service to these relatively small areas lying west of the subcontinental divide but not involving any substantial diversion of surface waters across this divide.

Improvement of Existing Sewage Treatment in Lower Watershed

It is recommended that the Cities of Burlington and Lake Geneva; the Villages of East Troy, Mukwonago, and Twin Lakes; and the Western Racine County Sewerage District undertake such steps as necessary to provide advanced waste treatment at the existing sewage treatment plants operated by these units of government.

Establishment of Lake Sewerage Systems

The provision of sanitary sewerage systems is recommended in the Fox River watershed plan at eight major lakes: Browns, Como, Eagle, Little Muskego, Pewaukee, Tichigan, Wind, and Camp and Center Lakes. At five of the eight lakes—Eagle, Tichigan, Wind, Como, and Camp and Center—the recommended sanitary sewerage system provides for the treatment of wastes a new sewage treatment plant providing secondary treatment with disinfection. At the three remaining lakes—Little Muskego, Pewaukee, and Browns—waste treatment would be provided at existing or replacement sewage treatment plants discussed under the recommended stream water quality plan element.

It is recommended that the Lake Pewaukee Sanitary District, Town of Delafield, and the Sanitary District No. 1, Town of Pewaukee, which together represent the unincorporated area around Pewaukee Lake, along with the town boards of Delafield and Pewaukee, cooperate with the other municipalities in the upper Fox River watershed in the establishment of an integrated sewerage system for the upper watershed area as discussed above. This system would provide advanced waste treatment for the wastes generated in the sanitary districts on Pewaukee Lake. It is recommended that the sanitary districts assume responsibility for constructing the trunk, lateral, and branch sewers to collect wastes within the districts.

It is recommended that the town boards of the Towns of Dover, Geneva, Salem, and Waterford create, pursuant to Sections 60.301 and 60.315, sanitary districts to serve existing and proposed urban development around Eagle, Como, Camp and Center, and Tichigan Lakes, respectively. Such districts, along with the Sanitary District No. 1 (Wind Lake), Town of Norway, should be charged with the responsibility of implementing the recommended lake sanitary sewerage system plan elements included in the Fox River watershed plan. It is recommended that the Browns Lake Sanitary District, Town of Burlington, assume the responsibility of implementing the recommended sanitary sewerage system plan for Browns Lake, and, with the City of Burlington, cooperatively take such steps as necessary to provide advanced waste treatment of the District's waste at the City of Burlington sewage treatment plant. It is recommended that the City of Muskego take such steps as necessary to expand the existing sewerage systems at Little Muskego Lake to serve all urban areas around the lake, with the system to be connected to the Milwaukee Metropolitan Sewerage System as soon as possible.

Lake Algae Control and Weed Harvesting

The comprehensive Fox River watershed plan recommends the provision as necessary of continuing programs for the chemical control of nuisance algal blooms at Big Muskego, Little Muskego, Phantom, Pewaukee, Bohner, Browns, Eagle, Tichigan, Wind, Como, Camp and Center, and Silver (Kenosha County) Lakes, and the provision as necessary of continuing programs for the machine harvesting of aquatic weed growths at Big Muskego; Little Muskego; Phantom; Pewaukee; Bohner; Browns; Eagle; Tichigan; Wind; Beulah; Como; Pell; Camp and Center; Elizabeth and Marie; Powers, Tombeau, and Benedict; and Silver (Kenosha County) Lakes.

The provision of lake improvement programs, such as those recommended above, can be accomplished in several ways, depending upon the local governmental structure. Cities are empowered, pursuant to Sections 62.11(5) and 62.23(18) of the Wisconsin Statutes, to make improvements on lakes for the protection and welfare of public health and wildlife. Villages, under Sections 61.34 and 61.35 of the Wisconsin Statutes, have similar powers to carry on improvement programs for lakes. Towns are specifically given authority in Section 60.29(29) of the Wisconsin Statutes to make improvements in any lake situated in the town. Alternatively, towns may, through Sections 60.301 and 60.315 of the Wisconsin Statutes, establish sanitary districts for a variety of purposes, including lake improvement.

Accordingly, it is recommended that the City of Muskego undertake the recommended algae control and aquatic weed harvesting programs for Big Muskego and Little Muskego Lakes; the Village of Pewaukee, the Lake Pewaukee Sanitary District, Town of Delafield, and the Sanitary District No. 1, Town of Pewaukee, cooperatively undertake the recommended algae control and aquatic weed harvesting programs for Pewaukee Lake; the Browns Lake Sanitary District, Town of Burlington, undertake the recommended algae control and aquatic weed harvesting programs for Browns Lake; the sanitary district recommended to be created for sewerage purposes in the Town of Dover undertake the recommended algae control and aquatic weed harvesting programs for Eagle Lake; the sanitary district recommended to be created for sewerage purposes in the Town of Waterford undertake the recommended algae control and aquatic weed harvesting programs for Tichigan Lake; the Sanitary District No. 1, Town of Norway, undertake the recommended algae control and aquatic weed harvesting programs for Wind Lake; the sanitary district recommended to be created for sewerage purposes in the Town of Geneva undertake the recommended algae control and aquatic weed harvesting programs for Como Lake; and the sanitary district recommended to be created for sewerage purposes in the Town of Salem undertake the algae control and aquatic weed harvesting programs for Camp and Center Lakes.

It is recommended further that a sanitary district be created in the Town of Mukwonago and that this district, in cooperation with the Village of Mukwonago, undertake the recommended algae control and aquatic weed harvesting programs for Phantom Lakes; a sanitary district be created in the Town of Burlington to undertake the recommended algae control and aquatic weed harvesting programs for Bohner Lake; a sanitary district be created in the Town of Salem and, in cooperation with the Village of Silver Lake, undertake the recommended algae control and aquatic weed harvesting programs for Silver (Kenosha County) Lake; a sanitary district be created in the Towns of Bloomfield and Randall to undertake aquatic weed harvesting programs for Powers, Benedict, and Tombeau Lakes; and the Village of Twin Lakes undertake the recommended aquatic weed harvesting program for Elizabeth and Marie Lakes.

Responsibility for these lake improvement programs would thus be placed with the appropriate general-purpose local unit of government when cities and villages are involved and with appropriate sanitary districts when unincorporated areas are involved. In the alternative to the creation of sanitary districts, it is recommended that the town governments undertake the recommended lake improvements programs.

Soil and Water Conservation Practices

The comprehensive Fox River watershed plan recommends that, in addition to the continuing programs for the institution of sound soil and water conservation practices throughout the watershed, specific attention be given to the provision of bench terraces with tile outlets on those agricultural lands subject to erosion within the tributary watersheds of the following 17 lakes: Phantom; Pewaukee; Bohner; Eagle; Wind; Beulah; Como; Geneva; Pell; Camp and Center; Elizabeth and Marie; Powers, Tombeau, and Benedict; and Silver (Kenosha County) Lakes. The basic institutional mechanism recommended for achieving this objective is the appropriate County Soil and Water Conservation District, together with technical assistance provided by the U. S. Soil Conservation Service and cooperating agencies.

It is accordingly recommended that the Kenosha, Racine, Walworth, and Waukesha Soil and Water Conservation District Supervisors, pursuant to Section 92. 09(1) of the Wisconsin Statutes, formulate proposed land use regulations for the purpose of conserving soil resources, controlling erosion, and reducing water pollution in the Fox River watershed. Such regulations should specifically include provisions for bench terracing on those agricultural lands subject to erosion within the tributary watersheds of the aforementioned lakes. Such special land use regulations may also include the construction of upland water control structures, such as terrace outlets, erosion control dams, dikes, ponds, and diversion channels, and the institution of sound soil and water conservation practices, such as contour farming, grassed waterways, reforestation, contour stripcropping, and seeding and planting of lands with plants, trees, and grasses. It should be noted that such special land use regulations require not only a recommendation by the County Soil and Water Conservation District Board of Supervisors after public hearings and approval by the County Board but also will require a referendum in which two-thirds of the land occupiers affected approve the regulations.

It is further recommended that the U. S. Soil Conservation Service provide staff technical assistance as necessary in the implementation of this watershed plan recommendation. It is also recommended that the U. S. Agricultural and Stabilization Service, through its Agricultural Conservation Program (ACP), give priority to any proposals dealing with cost sharing for the construction of the recommended bench terraces. Finally, it should be noted that the town boards of the Towns of Mukwonago, Pewaukee, Burlington, Dover, Norway, East Troy, Geneva, Linn, Bloomfield, Salem, Randall, and Wheatland could seek authority, under Section 60. 18(21) of the Wisconsin Statutes, should they desire to appropriate money under Section 60. 29(44) for the purpose of assisting in the construction of the recommended bench terraces as natural resource conservation projects.

Septic Tank Sewage Disposal Systems

It is recommended that Kenosha County, Racine County, and Waukesha County,[12] as well as all cities and villages within the watershed not already having done so, adopt sanitary codes, pursuant to Sections 59. 07(51), 62. 11(5), and 140. 09 of the Wisconsin Statutes, that would prohibit the installation of septic tank sewage disposal systems on soils within the Region that have "very severe limitations" for such systems, as established in the regional soil survey, and prohibit septic tank sewage disposal systems on soils that have "severe limitations" for such systems, as established in the regional soil survey, unless such limitations are overcome at the time of development. These units of government should further carefully regulate the installation of such systems on soils not having such limitations so as to prevent any further installation of systems that are periodically inoperative or which drain directly into surface waters of the watershed.

By way of supplementing such local regulations, it is also recommended that the Wisconsin Department of Natural Resources, pursuant to Section 144. 025(2)(q) of the Wisconsin Statutes, similarly prohibit and regulate the installation of septic tank sewage disposal systems. In addition, it is recommended that the Wisconsin Division of Health fully utilize the regional soil survey and interpretive analyses in prohibiting, under Chapters H 62 and H 65 of the Wisconsin Administrative Code, the subdivision of land for urban development, where such development would result in health problems created by the inability of the soils to absorb properly the sewage effluent.

Stream Basin Survey

It is recommended that the Wisconsin Department of Natural Resources, pursuant to its pollution control powers under Section 144. 025 of the Wisconsin Statutes, continue to conduct periodic

[12] *Walworth County has already adopted the necessary sanitary code.*

surveys of the Fox River basin, including the collection and analyses of water samples, the monitoring of major sources of pollution, and the preparation of pollution control orders addressed to each stream polluter. Such surveys should be made within the watershed at regular intervals of no more than five years. It is further recommended that the Department of Natural Resources reevaluate any pollution control orders outstanding in the Fox River basin and result to legal enforcement of such orders, pursuant to Sections 144.025(2)(d), 144.09, and 144.536 of the Wisconsin Statutes.

Water Quality Monitoring Program

It is recommended that the Wisconsin Department of Natural Resources and the Southeastern Wisconsin Regional Planning Commission continue the cooperative water quality monitoring program previously inaugurated within the Region, increasing the sampling program to include monthly sampling at selected locations and continuous sampling during one week of the summer season at selected locations. The costs of conducting this program are set forth in Table 71.

WATER SUPPLY PLAN ELEMENT IMPLEMENTATION

The water supply elements of the comprehensive Fox River watershed plan consist primarily of recommendations concerning institution of a sound ground water supply management program in the watershed, including action to assure the proper location and spacing of wells. It is recommended that the various municipalities in the watershed utilizing the deep sandstone aquifer for water supply now or in the future carefully consider the plan recommendations concerning well location and spacing, as set forth in Chapter VI of this volume, so as to achieve proper utilization of this important aquifer. In addition, it is recommended that the county and local units of government in the watershed and in the Region carefully protect the recharge areas of this aquifer from improper land use development which might reduce the amount of recharge water reaching the aquifer or which might result in pollution of the aquifer.

Vernon Marsh Reservoir Supply Plan

It has been recommended under the resource protection plan element discussed above that the Wisconsin Department of Natural Resources acquire all of the land necessary for the recommended expansion of the Vernon Marsh wildlife conservancy and temporary floodwater storage area. It is recognized that this area has potential as a future water supply reservoir, and the watershed plan accordingly recommends that this flexibility be maintained for meeting possible development needs beyond the plan design year. It is further recognized that, should it ever become necessary to develop this area as a surface water supply reservoir, an agency other than the Department of Natural Resources would have to acquire the needed land from the Department and construct the necessary reservoir.

FINANCIAL AND TECHNICAL ASSISTANCE

Upon adoption of the various land use, resource protection, outdoor recreation, flood control facility, and pollution abatement facility watershed plan elements and any necessary schedules of capital costs, it becomes necessary for the areawide governmental agencies concerned and the local units of government within the watershed to utilize effectively all sources of financial and technical assistance available for the timely execution of the recommended plan elements. In addition to current tax revenue sources, such as property taxes, fees, fines, public utility earnings, highway aids, educational aids, and state collected taxes, the areawide agencies and local units of government can also make use of other revenue sources, such as borrowing, special taxes and assessments, state and federal grants, and gifts. Various types of technical assistance useful in plan implementation are also available from county, state, and federal agencies. The type of assistance extends from the technical advice on land and water management practices provided by the U. S. Soil Conservation Service to the educational, advisory, and review services offered by the University of Wisconsin Extension and the Regional Planning Commission itself.

Borrowing

Areawide agencies and local units of government are normally authorized to borrow so as to effectuate their powers and discharge their duties. Chapter 67 of the Wisconsin Statutes generally empowers counties, cities, villages, and towns to borrow money and to issue municipal obligations not to exceed 5 percent of the equalized assessed valuation of its taxable property, with certain exceptions, including school bonds and revenue bonds. Such borrowing powers, which are related directly to implementation of the comprehensive

Table 71

SCHEDULE OF CAPITAL AND OPERATION AND MAINTENANCE COSTS OF THE RECOMMENDED WATER RESOURCES MONITORING PROGRAM FOR THE FOX RIVER WATERSHED BY COUNTY BY YEAR: 1971-1990

Calendar Year	Project Year	Kenosha County		Racine County		Walworth County		Waukesha County	
		Four Water Quality Stations and One Crest Gage		Six Water Quality Stations, One Gaging Station, and Two Crest Gages		Six Water Quality Stations		Thirteen Water Quality Stations, Two Gaging Stations and One Crest Gage	
		Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance	Facility Construction	Operation and Maintenance
1971	1	--	$ 1,300	$ 6,000	$ 3,100	--	$ 1,800	$ 6,000	$ 6,650
1972	2	--	1,300	--	3,100	--	1,800	--	6,650
1973	3	--	1,300	--	3,100	--	1,800	--	6,650
1974	4	--	1,300	--	3,100	--	1,800	--	6,650
1975	5	--	1,300	--	3,100	--	1,800	--	6,650
1976	6	--	1,300	--	3,100	--	1,800	--	6,650
1977	7	--	1,300	--	3,100	--	1,800	--	6,650
1978	8	--	1,300	--	3,100	--	1,800	--	6,650
1979	9	--	1,300	--	3,100	--	1,800	--	6,650
1980	10	--	1,300	--	3,100	--	1,800	--	6,650
1981	11	--	1,300	--	3,100	--	1,800	--	6,650
1982	12	--	1,300	--	3,100	--	1,800	--	6,650
1983	13	--	1,300	--	3,100	--	1,800	--	6,650
1984	14	--	1,300	--	3,100	--	1,800	--	6,650
1985	15	--	1,300	--	3,100	--	1,800	--	6,650
1986	16	--	1,300	--	3,100	--	1,800	--	6,650
1987	17	--	1,300	--	3,100	--	1,800	--	6,650
1988	18	--	1,300	--	3,100	--	1,800	--	6,650
1989	19	--	1,300	--	3,100	--	1,800	--	6,650
1990	20	--	1,300	--	3,100	--	1,800	--	6,650
Total		--	$ 26,000	$ 6,000	$ 62,000	--	$ 36,000	$ 6,000	$133,000
Annual Average		--	$ 1,300	$ 300	$ 3,100	--	$ 1,800	$ 300	$ 6,650

[a] *Includes an estimated $300 annual operation and maintenance costs for each water quality monitoring station; an estimated $1,000 annual operation and maintenance costs for each stream gaging station; and an estimated $150 annual operation and maintenance costs for each crest gage.*

Source: SEWRPC.

Fox River watershed plan, include:

1. The counties may issue bonds for county park and related open-space land acquisition and development.

2. Cities and villages may borrow and issue bonds for the construction of water supply and distribution systems, sanitary sewerage systems, and sewage treatment plants, and for park and related open-space land acquisition and development.

3. Towns may issue bonds for acquiring river fronts, lakeshores, woodlots, and scenic and historic sites.

Section 60.307 of the Wisconsin Statutes specifically authorizes town sanitary districts to borrow money and to issue bonds for the construction or extension of storm sewer, sanitary sewer, and water supply systems. Section 66.202 of the Wisconsin Statutes authorizes metropolitan sewerage districts to borrow money and to issue bonds for the construction of sanitary sewerage facilities. Farm drainage boards are authorized under Section 88.12 of the Wisconsin Statutes to issue bonds for any and all of their functions. In addition, the powers of cooperative contract commissions created under Section 66.30 of the Wisconsin Statutes were recently clarified[13] to include borrowing by the contracting bodies of such commissions for acquiring, constructing, and equipping regional projects.

Federal Loans: Federal advances and loan programs are available not only for the planning and construction of public works but also for resource conservation. A brief description of those federal loan programs of significance to Fox River watershed plan implementation are:

1. Interest free advances for public works planning are available to local units of government from the U. S. Department of Housing and Urban Development to assist in planning essential public works and community facilities. These advances are to be repaid when construction begins.

2. Long-term construction loans are available to local units of government under

[13] *Chapter 238, Laws of Wisconsin, 1965.*

50,000 population and their agencies from the U. S. Department of Housing and Urban Development for needed public facilities for which financing is not available elsewhere on reasonable terms.

3. Resource conservation and development loans are available to local units of government and soil and water conservation districts from the U. S. Department of Agriculture for planning and carrying out a balanced program of resource conservation development and utilization.

4. Low interest forestry loans are available to farmers and farm associations from the U. S. Farmers Home Administration for reforestation and the establishment of forestry practices and programs.

5. Recreation loans are available to farmers from the U. S. Stabilization and Conservation Service for purchasing and developing land and water recreation resources and facilities, including private camping grounds, swimming areas, tennis courts, cottages, lakes, docks, nature trails, and shooting preserves.

6. Rural water and sewer loans are available to rural units of government from the U. S. Farmers Home Administration for developing water supply and waste disposal systems. To qualify, such rural units of government must have less than 5,500 population and be unable to obtain financial assistance elsewhere.

Special Taxes and Assessments

Counties and cities have special assessment powers for park and parkway acquisition and improvements under Sections 27.065 and 27.10(4), respectively, of the Wisconsin Statutes. Counties are empowered under Section 27.06 of the Wisconsin Statutes to levy a mill tax to be collected into a separate fund and to be paid out only upon order of the county park commission for the purchase of land and other commission expenses. Farm drainage boards, town sanitary districts, metropolitan sewerage districts, cities, and villages also have taxing and special assessment powers under Sections 88.06, 63.06, 60.309, 59.96(9), and 62.18(16) of the Wisconsin Statutes. Although soil and water conservation districts have no taxing, bonding, or assessment powers, such districts may recover the cost and expenses, with interest, of performing work or operations as authorized by a court under Section 92.11 of the Wisconsin Statutes.

Park and Open-Space Land and Development Grants

Several federal grant programs are available to state and local units of government, and one state grant program is available to local units of government for the financing of park land acquisition and development. In general, the local units of government and agencies in the Region are eligible for these grants; however, the eligibility of individual projects is based upon certain planning and other prerequisites and must be determined for each specific project. The following is a brief description of these programs.

State Outdoor Recreation Aid Program (ORAP): This program, administered by the Wisconsin Department of Natural Resources, provides grants to metropolitan counties and cities in amounts up to 50 percent of the cost of acquiring recreational lands and rights-in-land to be used for urban area park systems.

Federal Open-Space Program: This program, administered by the U. S. Department of Housing and Urban Development, provides grants to the state and local units of government in amounts up to 50 percent of the cost of acquisition and development of land for parks and open spaces, provided an areawide intergovernmental open-space acquisition agreement is in effect.

Federal Land and Water Conservation Fund: This program, administered by the U. S. Department of the Interior, Bureau of Outdoor Recreation, through the Wisconsin Department of Natural Resources, provides grants to state and local units of government in amounts up to 50 percent of the cost of acquisition and improvement of outdoor recreation areas.

Federal Cropland Adjustment Program (Greenspan): This program, administered by the U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service, provides grants to local units of government in amounts up to 50 percent of the cost of acquisition and conversion of cropland to park and recreation purposes.

Federal Urban Beautification Program: This program, administered by the U. S. Department of

Housing and Urban Development, provides grants to local units of government in amounts up to 50 percent of the cost of improving and beautifying publicly owned or controlled land.

Water Supply and Sewerage System Grants

Several state and federal grant programs are available to local units of government for the financing of water systems, sewer facilities, storm water drainage systems, and sewage treatment facilities. A brief description of these programs follows.

State Water Resource Program: This program, administered by the Wisconsin Department of Natural Resources, provides financial assistance in amounts up to one-third of the total combined financing and net interest cost of approved pollution prevention and abatement projects.

Basic Water and Sewer Facilities Program: This program, administered by the U. S. Department of Housing and Urban Development, provides grants up to 50 percent to local units of government, including sewer and water districts, toward the cost of constructing water supply, treatment, storage, and transmission systems; sanitary sewer collection and transmission systems; and storm water collection and transmission systems.

Federal Water Pollution Control Program: This program, administered by the U. S. Department of the Interior, Federal Water Pollution Control Administration, provides grants up to 55 percent to local units of government toward the cost of constructing sewage treatment works and intercepting sewers that prevent the discharge of untreated or inadequately treated sewage into any waters.

Federal Farmers Home Administration Program: A number of programs administered by the U. S. Department of Agriculture, Farmers Home Administration, provide grants toward the cost of developing domestic water supply and waste collection and disposal systems to rural units of government up to 5,500 population if these units of government are unable to obtain credit at reasonable terms.

Soil and Water Conservation Grants

There are several programs available for conservation and protection of the agricultural lands and environmental corridors recommended in the Fox River watershed plan for preservation. A brief description of these programs follows.

State Soil and Water Conservation Program: This program, administered by the State Soil Conservation Board, provides grants to the county soil and water conservation districts in amounts up to 50 percent toward the cost of approved soil and water conservation projects.

Federal Agricultural Conservation Program: This program, administered by the U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service, provides grants in amounts up to 50 percent of the total project cost to farmers for carrying out approved soil, water, woodland, and wildlife conservation practices.

Federal Resource Conservation and Development Program: This program, administered by the U. S. Department of Agriculture, provides cost sharing up to 100 percent for flood control works and up to 50 percent for construction of water conservation works and improved land use measures.

Federal Cropland Adjustment Program: This program, also administered by the U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service, provides grants in amounts up to 50 percent of the cost to farmers to divert cropland to protective conservation uses for 5- to 10-year periods, the cost being based upon the value of the crops which would be produced. This program also provides cost sharing up to 50 percent toward the cost of carrying out good conservation practices, such as establishment of vegetative cover, forest cover, good wildlife habitat, and preservation of natural beauty.

Federal Multiple-Purpose Watershed Program: This program, administered by the U. S. Department of Agriculture, Soil Conservation Service, through the State Soil Conservation Board, provides cost sharing up to 100 percent to qualified sponsors, such as soil and water conservation, flood control, drainage, or irrigation districts, for flood prevention works and up to 50 percent towards agricultural water management, public recreation, fish and wildlife development, acquisition of certain recreational land rights, and agricultural land planning and treatment.

State Water Quality Regulation Enforcement Program: This program, administered by the Wisconsin Department of Natural Resources, provides annual grants to counties in amounts up to $1,000 in partial support of the cost of administering and enforcing county water protection or shoreland use regulations.

Water Resources Investigation Program

The U. S. Department of the Interior, Geological Survey, administers a cooperative water resources investigation program that provides federal matching funds in amounts up to 50 percent of the cost of projects under the program. This program includes the installation, calibration, operation, and maintenance of stream gage recording stations.

General Works Projects—U. S. Army Corps of Engineers

Substantial federal financial and technical assistance is available for the construction of approved flood control works under the general works projects program carried out by the U. S. Army Corps of Engineers upon U. S. Congressional approval of a particular project. After feasibility studies and public hearings, the U. S. Army Corps of Engineers will undertake at no cost to the local unit of government the construction of such flood control works as levees, dams, and reservoirs. All land, easements, and necessary rights-of-way, however, must be provided by the local unit of government. In addition, the local unit of government must agree to maintain and to operate all facilities constructed under the program in accordance with regulations prescribed by the Secretary of the Army.

Gifts

Donations of lands, interests in lands, or monies from private individuals and corporations should not be overlooked as sources of possible assistance in regional plan implementation, particularly with respect to park acquisition and environmental corridor preservation. The potential contributions, both in leadership and funds from private groups, should not be underestimated. Such gifts, either in lands, interests in lands, or monies, may, moreover, be used toward the local contribution in obtaining various state and federal grants.

Technical Assistance

Certain federal, state, regional, and county agencies provide various levels and types of technical assistance useful in watershed plan implementation to local units of government upon request. Limited guidance and assistance is usually provided without cost, or such assistance may be provided for a nominal fee. In some cases the local unit of government may contract with the agency for more extensive technical assistance services. A summary of the various levels and types of assistance available by agency follows.

Federal Agencies: The U. S. Department of Agriculture, Soil Conservation Service, provides technical assistance to local units of government and soil and water conservation districts for resource conservation, development, and utilization programs. The Soil Conservation Service also provides technical assistance to local units of government in the adaptation of the detailed operational soil survey and interpretive analyses to urban planning and development problems under a "Memorandum of Understanding" with the Commission.

The U. S. Department of Agriculture, Farmers Home Administration, provides technical and management assistance to farmers and farm associations for forestry programs, soil improvement, fish production, and recreational enterprise.

The U. S. Department of the Interior, Bureau of Outdoor Recreation, provides limited technical assistance and advice to local units of government and private interests in recreational resource planning and programming.

State Agencies: The University of Wisconsin Extension, through the county agents and extension specialists, provides important educational and technical assistance to farmers and to local units of government in public affairs, soil and water conservation, and outdoor recreation. An example of such university assistance having a direct relationship to watershed plan implementation is the educational services on the use and adaptation of the detailed operational soil survey and interpretive analyses being provided under the previously cited Memorandum of Understanding between the University and the Commission. Since the work of the Commission is entirely advisory, the importance of organized educational efforts directed at achieving public understanding and acceptance of the regional plans cannot be overestimated. The University Extension can, in this respect, fulfill an indirect, yet most important, plan implementation function.

The Wisconsin Department of Natural Resources provides advice on water problems; fish management; and forest planting, protection, management, and harvesting and will contract with counties to prepare outdoor recreation plans which would establish county eligibility under the Federal Land and Water Conservation Program.

The Wisconsin Department of Natural Resources provides plan review services and supervision of the operation of public water supply and sewage treatment facilities and is authorized to provide technical assistance to local units of government and private groups in their efforts to initiate or engage in specific types of development, such as parks, recreation, resource development, water supply, and sewage disposal. The Department was recently authorized to extend assistance to local units of government for the purpose of securing uniformity of water resource protection regulations.

The State Soil Conservation Board is authorized to provide assistance to landowners and the county soil and water conservation districts in carrying out soil and water conservation practices.

Areawide Agencies: The Southeastern Wisconsin Regional Planning Commission, through its Community Assistance Division, provides limited educational, advisory, and review services to the local units of government, including participation in educational programs, such as workshops; provision of speakers; sponsorship of regional planning conferences; publication of bimonthly newsletters; selection of staff and consultants; preparation of planning programs; special base and soil mapping; preparation of suggested zoning, official mapping, and land division ordinances; information of federal and state aid programs; and the review of local planning programs, plan proposals, ordinances, and most state and federal grant applications. In addition, the Commission is empowered to contract with local units of government under Section 66.30 of the Wisconsin Statutes to make studies and offer advice on land use, transportation, community facilities, and other public improvements.

County Agencies: The county Soil and Water Conservation Districts are authorized to cooperate in furnishing technical assistance to landowners or occupiers and any public or private agency in preventing soil erosion and floodwater and sedimentation damage and in furthering water conservation and development.

Those counties with park or planning staffs provide certain technical services related to park design and general community planning and development problems to local units of government and private groups.

SUMMARY

This chapter has described the various means available and has recommended specific procedures for implementation of the recommended comprehensive Fox River watershed plan. The most important recommended plan implementation actions are summarized in the following paragraphs by level of government, responsible agency or unit of government, and by plan elements.

State Level

Wisconsin Department of Natural Resources: It is recommended that the State Natural Resources Board and the Department of Natural Resources:

1. Endorse the comprehensive Fox River watershed plan and direct its integration into the various conservation, park and outdoor recreation, environmental protection, water control, and technical and financial assistance programs conducted by various divisions of the Department.

2. Conduct periodic water pollution control surveys of the Fox River basin and reevaluate and enforce outstanding pollution control orders in accordance with the pollution abatement recommendations set forth in the Fox River watershed plan.

3. Cooperate with towns, villages, and cities in the watershed in the establishment of utility or sanitary districts as necessary to provide sanitary sewerage systems and sewage treatment facilities at eight major lakes: Little Muskego, Pewaukee, Browns, Eagle, Tichigan, Wind, Como, and Camp and Center Lakes.

4. Seek additional state-enabling legislation relative to the establishment of areawide or metropolitan sewerage districts so that: a) the Western Racine County Sewerage District can expand its boundaries in a logical and orderly manner to serve those

areas designated on the land use plan for urban development by 1990; b) a feasible alternative exists for the establishment of an areawide upper Fox River watershed sanitary sewerage system involving the construction of a system of trunk sewers and one large treatment plant with advanced waste treatment facilities below the City of Waukesha and the abandonment of all existing sewage treatment plants above the City of Waukesha; and c) a feasible alternative exists for the establishment of areawide sanitary sewerage systems and sewage treatment plants where necessary at the eight major lakes noted above.

5. Give due weight to the recommended Fox River watershed plan in the exercise of the Department's various water regulatory functions, including the construction of dikes and floodwalls in the Cities of Burlington and Waukesha; channel improvements in the headwater areas of Sugar and Honey Creeks; channel improvements and construction of levees along Hoosier Creek; and the construction of a multiple-purpose reservoir on Sugar Creek.

6. Encourage counties and local units of government in the watershed to follow the watershed plan recommendations relative to floodland and shoreland zoning when, prepared by such local units of government, review is made of floodland and shoreland zoning ordinances, pursuant to Sections 59.971 and 87.30 of the Wisconsin Statutes.

7. Adapt the regional soil survey and analyses as a guide in regulating the installation of soil absorption sewage disposal systems within the Region, prohibiting the installation of such systems on soils within the Region that have very severe limitations for the absorption of sewage effluent, as determined by the detailed operational soil surveys.

8. Endorse and integrate the environmental corridors and other high-value wetlands and woodlands shown on the recommended Fox River watershed plan into the state long-range conservation and outdoor recreation plans as a guide to park and related open-space development and to resource conservation and management practices within the Region.

9. Acquire the site recommended for the multiple-purpose recreation, flood control, and low-flow augmentation reservoir on Sugar Creek and establish and develop a state park on this site, including the construction of the reservoir itself.

10. Acquire the remaining 2,651 acres of land needed to complete state acquisition of the Vernon Marsh wildlife conservancy and temporary floodwater storage area.

11. Acquire those recommended high-value wetlands totaling 4,549 acres around the Tichigan, Honey Creek, Karcher Marsh, and New Munster wildlife areas in the watershed.

12. Acquire those recommended high-value woodlands totaling 4,369 acres along the western boundary of the watershed as additions to the existing Kettle Moraine State Forest.

13. Assign the highest appropriate priorities to all Land and Water Conservation Fund or ORAP applications for lands located within the urban environmental corridors and along the main stem of the Fox River.

14. Approve only such applications for state and federal aids in partial support of the construction and improvement of municipal pollution prevention and abatement facilities that are located and designed in general accordance with the recommended Fox River watershed plan.

15. Recommend to the State Legislature that consideration be given to the establishment of a Greenway Tax Law patterned after the well-established Forest Crop Law and direct toward providing property tax incentives for private landowners who retain and manage high-value woodlands throughout the watershed and the state.

16. Increase the amount of technical aid and assistance available to private landowners relative to the proper management of woodland and wetland resources.

Wisconsin Department of Local Affairs and Development: It is recommended that the Department of Local Affairs and Development:

1. Endorse the comprehensive Fox River watershed plan and direct its integration into the various functions of the Department.

2. Give due weight to the recommended watershed land use plan element in reviewing proposed annexations, incorporations, and consolidations.

3. Promote implementation of the Fox River watershed plan in its program of providing technical assistance to local units of government.

4. Take the lead in initiating a legislative study designed to probe the inconsistencies now existing between property taxation and land development policies in Wisconsin and recommend appropriate remedial action.

Wisconsin Department of Transportation: It is recommended that the Department of Transportation:

1. Give due weight to the recommended Fox River watershed plan in its transportation facility planning and construction activities, with particular respect to the replacement of bridge structures in the stream valleys of the watershed so that the flood control objectives of the watershed plan are achieved.

2. Coordinate the establishment, construction, and maintenance of the recommended Fox River parkway scenic drive in cooperation with the county highway committees.

Wisconsin Division of Health: It is recommended that the Health and Social Service Board and the State Division of Health:

1. Endorse the comprehensive Fox River watershed plan, with particular respect to the land use plan element and the rational urban service areas implied therein, in the exercise of its subdivision review and approval powers.

2. Adapt the regional soil survey and analyses as a guide in reviewing subdivision plats so as to prohibit the installation of soil absorption sewage disposal systems on soils that have very severe limitations for such systems, thereby delaying the subdivision of land covered by such soils until such time as public sanitary sewerage service becomes available.

Wisconsin Soil Conservation Board: It is recommended that the Wisconsin Soil Conservation Board:

1. Endorse the comprehensive Fox River watershed plan, with particular respect to the recommended land use plan element, including the agricultural land use and environmental corridor recommendations, as a guide in the coordination of County Soil and Water Conservation District projects.

2. Apportion appropriate state and federal funds to the County Soil and Water Conservation Districts within the watershed to enable them to implement agricultural programs which serve to implement the recommended watershed plan.

Local Level

Kenosha, Racine, Walworth, and Waukesha County Boards of Supervisors: It is recommended that the County Boards of the four major constituent counties comprising the Fox River watershed, upon the recommendation of the appropriate agencies and committees:

1. Adopt the recommended Fox River watershed plan as it applies to each county as a guide to the future development of the Fox River watershed portion of the county.

2. Support the establishment of the Fox River Watershed Committee by the Southeastern Wisconsin Regional Planning Commission as a continuing intergovernmental advisory body concerned with watershed plan adjustment and implementation.

3. Establish a County Park and Planning Commission or county planning department and reassign, as appropriate, all county zoning, subdivision, plat review, and park functions. (Kenosha)[14]

[14] *Parentheses indicate that the recommended action is only applicable to the named unit or units of government.*

4. Officially adopt the comprehensive park and parkway elements of the Fox River watershed plan upon recommendation of the County Park and Planning Commission.

5. Adopt the recommended "Schedules of Capital Costs" set forth herein for plan implementation and allocate annually the monies as so scheduled, including the purchase of all lands designated as urban environmental corridor and main stem environmental corridor along the Fox River.

6. Amend the County Zoning Ordinance as it applies to riverine areas to provide for the eventual elimination of flood-vulnerable structures located in the floodways and floodplains of the Fox River through nonconforming use provisions and to provide for sound floodland use regulations. (Kenosha, Walworth, and Waukesha)

7. Continue operation and maintenance of streamflow gages and establish new gages. (Waukesha and Racine)

8. Amend the County Zoning Ordinance as it applies to the entire watershed to provide for the recommended exclusive residential, agricultural, conservancy, and park districts. (Kenosha, Walworth, and Waukesha)

9. Adopt soil conservation land use regulations as formulated by the Soil and Water Conservation District Supervisors.

10. Adopt a County Sanitary Code applicable on a county-wide basis to provide for regulation of the design and installation of septic tank sewage disposal systems utilizing the detailed soil survey data. (Kenosha, Racine, and Waukesha)

11. Report to the Wisconsin Department of Natural Resources any alleged encroachments on the navigable channels of the Fox River system.

12. Create or amend the county subdivision control ordinance to prohibit further land division and development in the floodways and floodplains of the Fox River watershed and to provide park land dedication or fees in lieu of dedication.

13. Support attempts to seek additional state-enabling legislation relative to the establishment of areawide or metropolitan sewerage districts.

14. Cooperate with the Wisconsin Department of Transportation in the establishment of a Fox River Parkway Scenic Drive. (Kenosha, Racine, and Waukesha)

Kenosha, Racine, Walworth, and Waukesha County Park and Planning Agencies: It is recommended that the Kenosha, Racine, Walworth, and Waukesha County Park and Planning agencies:

1. Recommend to the County Board adoption of the recommended outdoor recreation, park and parkway, and natural resource plan elements of the Fox River watershed plan.

2. Formulate and petition the County Board to amend the existing County Zoning Ordinance to effectuate the watershed land use plan element.

3. Formulate detailed county plans for the ultimate acquisition of all recommended urban environmental corridors in the watershed, as well as the rural environmental corridors recommended for acquisition along the main stem of the Fox River.

4. Include in the detailed county park plan measures for the removal of existing residences subject to first floor inundation by the 100-year recurrence interval flood within the floodway. (Kenosha)

5. Develop the Minooka Park site as a regional outdoor recreational area. (Waukesha)

6. Acquire and develop the Western Racine County Park site as a regional outdoor recreation area. (Racine)

7. Expand the existing Fox River Park into a regional outdoor recreation area. (Kenosha)

8. Acquire and ultimately develop all additional high-value outdoor recreation sites as set forth in the recommended plan.

9. Request by resolution the Wisconsin Department of Natural Resources to acquire and develop the proposed multiple-purpose Sugar Creek Reservoir and park site (Walworth); the acquisition of additional lands in the Vernon Marsh wildlife conservancy area (Waukesha); the acquisition of additional high-value wetlands for the Tichigan and Honey Creek wildlife areas (Racine and Walworth), the Karcher Marsh wildlife area (Racine), and the New Munster wildlife area (Kenosha); and the acquisition of high-value woodlands along the western boundary of the watershed as additions to the existing Kettle Moraine State Forest. (Walworth and Waukesha)

Soil and Water Conservation Districts: It is recommended that the Soil and Water Conservation Districts of Kenosha, Racine, Walworth, and Waukesha Counties:

1. Adopt the recommended Fox River watershed plan as it affects each respective District and request those state and federal agencies existing in the District to provide such assistance as would serve to implement the recommended land use, natural resource protection, and water pollution abatement plan elements.

2. Formulate soil and water regulations necessary to assist in implementation of the recommended watershed land use and natural resource plan elements.

Common Councils, Village Boards, and Town Boards: It is recommended that, upon referral to, and recommendation of, the local plan commissions, each Common Council, Village Board, and Town Board within the watershed, as appropriate and as noted:

1. Support the establishment of the Fox River Watershed Committee as a continuing intergovernmental coordinating body concerned with the Fox River watershed plan adjustment and implementation.

2. Adopt the recommended Fox River watershed plan as a guide to the future development of the community as that plan affects each community.

3. Amend existing or adopt new local zoning ordinances so as to provide land use regulations similar to those contained in the SEWRPC Model Zoning Ordinance and adopt changes to the zoning district maps, as appropriate, to reflect the recommended land use plan element of the Fox River watershed plan, or file a certified resolution certifying amendments or resolutions to the County Zoning Ordinance. Include in such ordinances floodland and shoreland regulations, as appropriate and as necessary to achieve the objectives of the Fox River watershed plan. Such regulations should include provision for the discontinuance of nonconforming uses in the floodways and floodplains.

4. Instruct local assessors that tax relief is available to owners of land zoned for agriculture and conservancy use in accordance with the recommended Fox River watershed plan.

5. Amend or adopt land division ordinances, as appropriate, prohibiting further land division and development in the floodways and floodplains of the perennial channel system of the Fox River watershed and assuring park land dedication or fees in lieu of dedication.

6. Prepare and adopt or amend official maps showing, as appropriate, park and parkway land use plan elements.

7. Include floodway and floodplain regulations in local building, housing, subdivision, and sanitary ordinances.

8. Consider and give due weight to the rational urban service areas implied in the Fox River watershed plan in all deliberations concerning proposed annexations, consolidations, and incorporations.

9. Establish an intergovernmental cooperative sewerage commission or metropolitan sewerage commission to provide for an advanced waste treatment plant and trunk sewer facilities in the upper Fox River watershed, together with abandonment of

existing treatment plants. (Cities of Brookfield, New Berlin, and Waukesha; Villages of Lannon, Menomonee Falls, Pewaukee, and Sussex; and the Towns of Brookfield, Delafield, Lisbon, Pewaukee, and Waukesha, and any existing or future sanitary or utility districts in such towns)

10. Provide for improved sewage treatment, including advanced waste treatment at existing plants. (Cities of Burlington and Lake Geneva and the Villages of East Troy, Mukwonago, and Twin Lakes)

11. Establish such sanitary, utility, and metropolitan sewerage districts or intergovernmental cooperative sewerage commissions as necessary to implement the recommendations governing the establishment of sanitary sewerage systems at the following major lakes: Como, Eagle, Little Muskego, Tichigan, and Camp and Center Lakes. (City of Muskego and the Towns of Dover, Salem, and Waterford)

12. Undertake levee construction and channel improvements, including the construction of intermittent dikes and floodwalls. (Cities of Burlington and Waukesha)

13. Assist the county park agencies in the acquisition of all land lying within the urban environmental corridors and the rural corridors along the main stem of the Fox River. (Cities of Brookfield, Burlington, and Waukesha; Villages of Big Bend, Lannon, Menomonee Falls, Rochester, Silver Lake, and Waterford; and the Towns of Brookfield, Burlington, Mukwonago, Pewaukee, Rochester, Salem, Vernon, Waterford, Waukesha, and Wheatland)

14. Acquire or assist the county park agencies in the acquisition of all lands lying within the urban environmental corridors not located on the main stem of the Fox River. (Cities of Brookfield, Burlington, Lake Geneva, Muskego, and Waukesha; Villages of East Troy, Fontana-on-Geneva Lake, Genoa City, Menomonee Falls, Pewaukee, Twin Lakes, and Williams Bay; and the Towns of Bloomfield, Brookfield, Burlington, Geneva, Mukwonago, Norway, Pewaukee, Salem, Walworth, and Waukesha)

16. Acquire and develop all other potential outdoor recreation sites as recommended in the Fox River watershed plan and as not recommended for county level acquisition.

17. Approve county official maps governing park and parkway acquisition adopted pursuant to the recommendations contained herein.

Plan Commissions of the Cities, Villages, and Towns Within the Watershed: It is recommended that the plan commissions of all cities, villages, and towns within the watershed:

1. Adopt the watershed plan elements and certify such adoption to their governing body.

2. Formulate and recommend to their governing body amendments to their existing land use control ordinances to effectuate the land use plan elements of the watershed plan.

3. Prepare for submission to their governing body detailed local plans relative to the acquisition of urban environmental corridors and rural environmental corridors along the main stem of the Fox River and selected high-value and other potential outdoor recreation sites.

Municipal Water and Sanitary Districts: It is recommended that any municipal water and sanitary district now existing or hereinafter created within the watershed:

1. Acknowledge the recommended watershed plan, thereafter determining proper utility service areas in accordance with such plan and adopt and adhere to utility extension policies that are consistent with the rational urban service area implied by the plan.

2. Implement the recommendations governing the establishment of sanitary sewerage systems at the following major lakes: Browns, Pewaukee, and Wind. (Browns Lake Sanitary District; Lake Pewaukee Sanitary District; Sanitary District No. 1, Town of Pewaukee; and Sanitary District No. 1, Town of Norway)

3. Design and install public water supply and sewerage systems so as to preclude service by such systems to proposed development located in floodplains, on soils having very severe or severe limitations for urban development, or within the recommended regional environmental corridors and agricultural areas.

Areawide Level

Western Racine County Sewerage District: It is recommended that the Western Racine County Sewerage district:

1. Acknowledge the recommended Fox River watershed plan, including the land use and water quality control elements, and thereafter determine proposed sewer service areas in accordance with the plan and adopt and adhere to utility extension and service policies that are consistent with the rational urban service areas implied by this plan.

2. Provide advanced treatment and disinfection at the Rochester sewage treatment plant.

3. Support attempts to seek additional state-enabling legislation relative to the establishment of areawide or metropolitan sewerage districts so as to remove eventually all restrictions to rational service area boundary extensions.

Hoosier Creek Drainage District: It is recommended that the Hoosier Creek Drainage District:

1. Acknowledge the recommended Fox River watershed plan and undertake channel improvements and the construction of dikes in accordance with the recommendations contained therein.

Federal Level

U. S. Department of Housing and Urban Development: It is recommended that the U. S. Department of Housing and Urban Development:

1. Acknowledge the comprehensive Fox River watershed plan and use such plan as a guide in the administration and granting of federal aids for urban beautification, open-space acquisition, park development, and sewer and water facilities.

2. Assign the highest appropriate priorities to all applications for urban beautification, open-space acquisition, and park development grants that are in partial support of the acquisition and development of those sites recommended for public use in the plan.

3. Approve only those applications for sewer and water facility grants that are located and designed in accordance with the land use and water pollution abatement elements of the Fox River watershed plan.

U. S. Department of Interior, Federal Water Pollution Control Administration: It is recommended that the U. S. Department of Interior, Federal Water Pollution Control Administration:

1. Acknowledge the recommended Fox River watershed plan and utilize the plan as a guide in the administration and granting of federal aids for the construction of sewage treatment plants and related facilities within the watershed.

2. Approve only those grant applications for the construction of sewage treatment plants and related facilities that are located and designed in accordance with the land use and water pollution abatement elements of the Fox River watershed plan.

U. S. Department of Interior, Geological Survey: It is recommended that the U. S. Department of Interior, Geological Survey:

1. Continue to maintain a cooperative program of water resources investigation in the watershed, including the expansion of a continuous stream gaging program within the watershed.

U. S. Department of Agriculture, Farmers Home Administration: It is recommended that the U. S. Department of Agriculture, Farmers Home Administration:

1. Acknowledge the recommended Fox River watershed plan and utilize the plan as a guide in the administration and granting of loans and aids for water supply and waste disposal plants and facilities within the watershed.

2. Approve only those grant applications for the construction of water supply and waste treatment facilities that are located and designed in accordance with the land use and water pollution abatement elements of the Fox River watershed plan.

U. S. Department of Agriculture, Soil Conservation Service: It is recommended that the U. S. Department of Agriculture, Soil Conservation Service:

1. Acknowledge the recommended Fox River watershed plan and utilize the plan as a guide in the administration and granting of federal aids for resource conservation and development and for construction of multiple-purpose watershed projects within the Region and in the provision of technical assistance for land and water conservation.

U. S. Department of the Army, Corps of Engineers: It is recommended that the U. S. Department of the Army, Corps of Engineers:

1. Acknowledge the recommended Fox River watershed plan and resume the suspended flood control study of the Fox River watershed, giving due consideration and weight to the implementation of the levee construction, channel improvements, and reservoir construction elements of the plan.

Chapter X

SUMMARY AND CONCLUSIONS

INTRODUCTION

This report is the second in a series of two volumes which together present the major findings and recommendations of the Southeastern Wisconsin Regional Planning Commission Fox River watershed planning program. The first volume, published in April 1969, set forth the basic principles and concepts underlying the study and presented in summary form the basic facts pertinent to the preparation of a comprehensive plan for the physical development of the Fox River watershed, with particular emphasis upon the existing state of the land and water resources of the basin and the developmental and environmental problems associated with these resources. The first volume also contained forecasts of anticipated future growth and change within the watershed and an analysis of water law as such law relates to watershed plan preparation and implementation, with particular emphasis upon the legal aspects of flood control and pollution abatement.

This, the second and final volume of the series, sets forth watershed development objectives, principles, and standards; presents alternative plans for land use and water control facility development, including both flood control and water pollution abatement facilities, and for natural resource preservation and enhancement within the watershed; and recommends a comprehensive watershed development plan designed to meet the watershed development objectives under existing and probable future conditions. It presents estimates of the costs of implementing the recommended plan over a 20-year plan implementation period and recommends means for plan implementation. In addition, this volume provides a comparative analysis of the changes which may be expected to occur within the watershed by 1990 if present development trends are allowed to continue without redirection in the public interest.

WATERSHED DEVELOPMENT OBJECTIVES

The primary objective of the Fox River watershed planning program is to assist the federal, state, and local units of government in abating the serious water and water-related resource problems existing within the Fox River basin by developing a workable plan to guide the staged development of water control facilities and related resource conservation and management programs for the watershed. The problems to be abated include flood damage, water pollution and conflicting water uses, soil erosion, deteriorating fish and wildlife habitat, and the complex effects of rapidly changing land use. Accordingly, following ascertainment of present and probable future conditions within the watershed,[1] a framework of watershed development objectives with supporting principles and standards was established to guide the design of alternative land use and water control facility plans for the watershed and to provide a basis for the evaluation of the relative merits of these alternative plans. The nine watershed development and management objectives and supporting principles and standards set forth in this volume relate to land use and water control facility development, engineering design, and economic feasibility and were formulated within the context of broader regional development objectives. Briefly, this framework of watershed development objectives and standards envisions a future watershed environment which is varied, safe, healthful, efficient, and aesthetically pleasing.

ALTERNATIVE PLANS

In the preparation of the comprehensive plan for the physical development of the watershed, a concerted effort was made to offer for public evaluation all physically feasible alternative plan elements which might satisfy one or more of the watershed development objectives. Each alternative plan element was evaluated insofar as possible in terms of engineering, economic, and legal feasibility and with respect to the satisfaction of

---

[1] *The reader may at this point wish to review Chapter XV, ''Summary,'' of Volume 1 of this report, which summarizes the inventory, analysis, and forecast findings of the study, thereby describing qualitatively and quantitatively the resource-related problems of the Fox River watershed requiring attention. The comprehensive watershed development plan recommended in this volume is addressed to the resolution of these problems.*

the watershed development objectives. The alternative plan elements considered can best be visualized in terms of various combinations of land use patterns and water control facilities.

The land use base element of the comprehensive Fox River watershed plan is set within the context of the adopted regional land use plan. Under this plan regional and watershed development objectives and standards are used to modify land use development trends within the Region and the watershed in order to achieve a safer, more healthful, pleasant, and efficient future land use pattern, while meeting the gross land use demand requirements of the forecast population and employment levels. The land use base element emphasizes the efficient provision of utility services, cohesive urban development on appropriately suitable soils, preservation of prime agricultural lands, preservation of unique resource areas, and protection of floodland areas.

Under the land use base element, residential development within the watershed would be channeled into low-, medium-, and high-density residential areas developed as planned neighborhood units and providing within each unit all of the necessary supporting community facilities.[2] Prime agricultural areas and primary environmental corridor areas, including the surface waters and associated shorelands and floodlands, and the best remaining potential park and related open-space sites would be preserved and protected from urban development. Existing land uses not developed in conformance with these proposals would be considered nonconforming, and provisions would be made for their eventual discontinuance and removal. The attainment of a sound land use pattern throughout the watershed and particularly within the riverine areas of the watershed thus comprises the basic and most important recommendation of the comprehensive watershed plan.

In the adaptation, refinement, and detailing of the adopted regional land use plan for the Fox River watershed, three alternative natural resource protection plan elements and three alternative outdoor recreation and related open-space plan elements were considered. With respect to resource protection, the three alternatives considered were:

1. A minimum alternative, which would provide basically for the preservation of the remaining, undeveloped primary environmental corridors of the watershed by acquisition for public park and parkway purposes in those areas of the watershed which are expected to be in urban use by 1990, the plan design year, and through appropriate floodland, shoreland, and conservancy zoning in those areas of the watershed which are expected to remain in rural use through 1990. In addition, this minimum alternative would include the acquisition of, for public use as a wildlife conservancy and temporary floodwater storage reservoir, a potential multiple-purpose reservoir site in the Vernon Marsh area; a future multiple-purpose reservoir site on Sugar Creek; and certain selected high-value wetlands and woodlands located adjacent to existing publicly owned and leased woodland, wetland, and wildlife areas in the watershed. The primary environmental corridor and related area to be acquired under this alternative would total about 29,500 acres, or 23 percent, of the primary environmental corridor area within the watershed.

2. An intermediate alternative, which would, in addition to the proposals contained in the first alternative, provide for the preservation through acquisition for public use of all remaining, undeveloped primary environmental corridor areas along the main stem of the Fox River in southeastern Wisconsin, thus providing for a continuous parkway along the Fox River from its headwaters in the Village of Menomonee Falls to the Illinois State line. The additional environmental corridor area to be acquired under this alternative would total about 7,400 acres, or an additional 6 percent, of the primary environmental corridor area within the watershed, over and above the first alternative.

3. An optimum alternative, which would, in addition to the proposals contained in the first and second alternatives, provide for the public acquisition of additional, selected, undeveloped primary environ-

[2] *For a definition and explanation of the planned neighborhood unit concept, see SEWRPC Planning Report No. 7, Volume 3, Recommended Regional Land Use and Transportation Plans--1990, Appendix D.*

mental corridor areas, particularly high-value lake-oriented woodlands and wetlands within the corridor areas. The additional environmental corridor area to be acquired under this alternative would total about 11,200 acres, or an additional 9 percent, of the primary environmental corridor area within the watershed, over and above the first and second alternatives.

With respect to outdoor recreation, the three alternatives considered were:

1. A minimum alternative, designed to provide sufficient public outdoor recreation area within the watershed to meet the anticipated user demands of the 1990 resident population of the watershed and the Region, as approximated by the adopted regional land use development standards of 10 acres of local park land per thousand resident population and 4 acres of regional park land per thousand resident population. Included in this alternative was the acquisition and development of four new major regional park sites to supplement the four existing regional park sites within the watershed, as well as the acquisition and development of additional local park sites for community and neighborhood use. New park area to be acquired under this alternative would total about 5,000 acres, over and above the 2,078 acres of existing park land in the watershed.

2. An intermediate alternative, which would, in addition to the proposals contained in the first alternative, include the acquisition and development of additional outdoor recreation site area needed to meet a portion of the demand for outdoor recreation within the watershed generated by out-of-Region users, the additional area required being selected from the best remaining high-value potential park sites within the watershed. Additional park area to be acquired under this alternative would total about 7,200 acres, over and above the first alternative.

3. An optimum alternative, which would, in addition to the proposals contained in the first two alternatives, provide for the preservation of sufficient park land to meet all of the outdoor recreational demand expected to be generated by out-of-Region users. Additional park area to be acquired under this alternative would total about 5,400 acres, over and above the first and second alternatives.

In addition to the land use base element and the alternative natural resource protection and outdoor recreation plan elements, an uncontrolled existing trend land use alternative was prepared and evaluated. This alternative is not to be construed as a plan but rather as a forecast of one of the many possible end results of unplanned development within the watershed. It was intended to serve not as a recommendation but as a basis of comparison for the evaluation of the potential benefits of the recommended watershed plan.

Coupled with the foregoing land use plan alternatives, a number of water control facility alternatives were explored. These included the following:

1. For flood control, in addition to floodland zoning and acquisition of floodland areas for public park and parkway use: floodland evacuation, levee construction and channel improvements, reservoir construction, and lake level control facilities.

2. For stream water pollution abatement: the provision of advanced waste treatment for both biochemical oxygen demand and nutrient removal, sewage diversion from the upper reaches of the watershed to the Milwaukee Metropolitan System, combined with the provision of advanced waste treatment for the lower watershed, the disposal of sewage effluent on land, teritiary treatment for biochemical oxygen demand removal with chemical spraying of the watercourses to control weed and algae growth, and low-flow augmentation utilizing Lake Michigan water, combined with chemical spraying of the watercourses to control weed and algae growth.

3. For lake pollution abatement: weed harvesting and algae control, bench terracing to control nutrient contribution from agricultural runoff, installation of sanitary sewerage systems to control nutrient contribution from urban land uses, lake mixing, nutrient removal, and algae harvesting.

Alternative water supply plans were also considered, including further development of the deep aquifer supply, further development of the shallow aquifer supply, and development of surface water supplies, the latter particularly through the construction of a large multi-purpose reservoir in the Vernon Marsh area of Waukesha County.

RECOMMENDED WATERSHED PLAN

Each of the alternative plan elements considered was evaluated individually and in various compatible combinations, and a comprehensive watershed plan synthesized. The resultant comprehensive watershed development plan, which is recommended for adoption as a guide to the physical development of the Fox River watershed, contains the following salient proposals:

Land Use Element

The land use element recommends regulation of land use development over the entire watershed through local zoning in order to assure the expansion of urban development into those areas of the watershed that can be readily served by centralized public water supply and gravity flow sanitary sewerage systems and that are covered by soils suitable for urban uses. The remaining prime agricultural areas of the watershed would be protected from destruction through urban encroachment, as would the remaining primary environmental corridor areas of the watershed. The latter encompass not only the surface water resources and associated shorelands and floodlands of the watershed but almost all of the best remaining woodlands, wetlands, wildlife habitat areas, and potential park sites. The environmental corridors would be protected from further urban encroachment and eventual deterioration and destruction by appropriate floodland, shoreland, and conservancy zoning in rural areas of the watershed and by public acquisition for park and parkway purposes in urban areas of the watershed. It should be noted in this respect that the floodland zoning and acquisition recommendations incorporated in the land use element of the plan constitute the basic flood control recommendations of the watershed plan.

In addition, the recommended plan provides for the acquisition of all of the environmental corridor along the main stem of the Fox River from its headwaters in the Village of Menomonee Falls to the Illinois State line for parkway purposes; the acquisition of the Vernon Marsh area in Waukesha County for multiple use as a wildlife conservancy area and temporary floodwater storage area and for reservation as a potential flood control and water supply reservoir; the acquisition of the Sugar Creek reservoir site for flood control, recreational, and low-flow augmentation purposes, and the acquisition of selected high-value woodlands and wetlands adjacent to existing publicly owned environmental corridor areas. The plan recommends the development of a 63 mile scenic parkway drive along the main stem of the Fox River, utilizing existing roadways.

The plan also recommends the acquisition of sufficient additional park area to meet the 1990 outdoor recreation demand within the watershed, including the demand generated by out-of-watershed and out-of-Region users, as well as by residents of the watershed. Included in this proposed recreational land area, totaling approximately 17,700 acres, are 2,617 acres for the acquisition and development of four new regional parks in the watershed: the Minooka, Sugar Creek, Western Racine County, and Fox River Parks. The recommended plan would provide sufficient outdoor recreation area to meet the forecast user demand for the five major outdoor recreation activities requiring additional land and thereby avoid damaging overuse of land, recreational resources, and recreational facilities; the concomitant deleterious effects on the resource base; and increasing conflicts between recreation users. Implementation of the resource protection plan element described in the preceeding paragraphs would result in the public acquisition of about 55 percent of the required outdoor recreation lands.

The land use plan element, which includes recommendations for basin-wide land use development, a resource protection element, and an outdoor recreation element, is graphically summarized on Map 16 set forth in Chapter VII of this volume.

Flood Control Elements

The recommended plan proposes the abatement of flood problems within the watershed through the following measures:

1. The construction of dikes and floodwalls in the City of Waukesha to protect the existing flood-vulnerable land uses and abate high flood damages in this channel reach.

2. The construction of dikes and floodwalls in the City of Burlington to protect the existing flood-vulnerable land uses and abate high flood damages in this channel reach.

3. Channel improvements in the headwater areas of Sugar and Honey Creeks to protect flood-vulnerable agricultural areas and improve agricultural drainage.

4. The construction of a multi-purpose recreation, flood control, and low-flow augmentation reservoir on Sugar Creek.

5. The construction of levees and channel improvements along the lower reaches of Hoosier Creek to protect flood-vulnerable agricultural areas, abate agricultural flood damages, and improve agricultural drainage.

6. The removal of 160 existing residences in the Silver Lake area of the watershed lying within the 10-year recurrence interval flood hazard lines. These residences are recommended to be removed both through public acquisition as they come onto the market and through the application of the nonconforming use provisions of local zoning ordinances. The remaining residences in the floodplain along this channel reach should be protected by floodproofing through action of the individual homeowners.

The foregoing flood control elements would support the recommended land use elements, which, as already noted, contain the major flood abatement recommendations; namely, that of floodland zoning and acquisition for public park and parkway use. The Fox River is presently an extremely well-regulated stream; and through the protection of its floodland areas in open use for floodwater storage, this desirable characteristic of the stream can be preserved as urbanization proceeds within the watershed.

The foregoing flood control elements would provide an average annual flood damage alleviation benefit of $144,550 and would substantially protect all major flood damage areas within the watershed against a 100-year recurrence interval flood with potential damages of $1.5 million.

Stream Water Pollution Abatement Elements

The recommended plan proposes the abatement of stream water pollution problems within the watershed through the following measures:

1. The provision of advanced waste treatment for biochemical oxygen demand and nutrient removal and disinfection at all major waste discharge locations within the watershed. This would include the provision of a single large sewage treatment plant providing advanced waste treatment to serve the entire upper watershed, along with a system of trunk sewers to convey the wastes from the upper watershed to this plant, and the provision of advanced waste treatment facilities at six of the ten existing individual sewage treatment plants in the lower reaches of the watershed at Mukwonago, Waterford–Rochester, East Troy, Lake Geneva, Burlington, and Twin Lakes, discharging wastes to the Fox River system.

   The two existing sewage treatment plants located at Silver Lake and Genoa City would continue to be operated as secondary treatment plants with post-chlorination for disinfection. The small size of these two plants and the consequently relatively small contribution of biochemical oxygen demand and nutrients to the receiving stream make it impractical to recommend advanced waste treatment facilities for these two plants. Similarly, the two existing sewage treatment plants located at Williams Bay and Fontana would continue to be operated as secondary treatment plants, discharging their treated effluents to seepage ponds.

   The sewage treatment plant for the upper watershed is recommended to be located downstream from the site of the existing Waukesha treatment plant. The trunk sewer system would extend from the plant site below Waukesha to Lannon with the trunk sewers generally following the course of the Fox River and with branches to Pewaukee and Sussex to provide service to these areas. The recommended location of the trunk sewers would permit gravity flow operation of the trunk sewers, and the four existing sewage treatment facilities above Waukesha at Pewaukee, Sussex, Brookfield, and Poplar Creek would be abandoned, along with the existing Waukesha sewage treatment plant, upon completion of the proposed system, thus eliminating all municipal waste discharges to the upper Fox River system.

2. The institution of improved soil and water conservation practices on the farm lands in the agricultural areas of the basin in order to minimize the effects of runoff from agricultural areas containing silt, fertilizers, herbicides, and pesticides on the stream water quality and on fish life.

3. The connection to public sanitary sewerage systems of 16 of the 19 major industrial waste sources and one of the four major resort waste sources. In addition, the plan recommends that all other industrial and resort waste discharges not connected to centralized public sanitary sewerage systems be given a level of treatment equivalent to secondary treatment and disinfection.

Implementation of the recommended stream and lake water quality management plan element would abate all of the 37 major sources of stream pollution existing (1966) within the watershed and reduce the municipal waste loadings on the stream system from 2, 800 pounds of BOD and 390 pounds of phosphorus per average day to 900 pounds and 30 pounds, a 68 percent and 92 percent reduction, respectively. Implementation of these recommendations would provide the stream water quality levels necessary to meet the state-established stream water use objectives and standards and would serve to restore substantially the quality of the water in the main stem of the Fox River and its major tributaries, thereby facilitating restoration of a game fishery, consisting of facultative species, and the safe use of the stream system for partial-body-contact recreational uses.

Lake Water Pollution Abatement Elements

The recommended plan proposes the abatement of lake pollution problems within the watershed through the following measures:

1. The provision of sanitary sewerage facilities at Little Muskego, Pewaukee, Browns, Eagle, Tichigan, Wind, Como, and Camp and Center Lakes. Such facilities would be provided at five of the eight lakes—Eagle, Tichigan, Wind, Como, and Camp and Center—through the establishment of new sanitary sewerage systems and treatment facilities providing secondary treatment with use of post-chlorination for disinfection. Sewer service at Little Muskego Lake would be provided initially at a temporary treatment facility and ultimately through conveyance to the Milwaukee Metropolitan Sewerage Commission system. Sewer service for Pewaukee Lake would be provided as an integral part of the proposed upper Fox River watershed sewerage system discussed above, with eventual advanced treatment of wastes at the single large sewage treatment plant in the upper watershed. Sewage treatment for wastes from the Browns Lake area would be provided at the Burlington sewage treatment plant, which would include advanced waste treatment of all wastes.

2. The provision of bench terraces with tile outlets on agricultural lands subject to erosion, together with additional appropriate land conservation measures, to control pollution from agricultural runoff on the tributary watersheds of Phantom; Pell; Pewaukee; Bohner; Eagle; Wind; Beulah; Como; Geneva; Camp and Center; Elizabeth and Marie; Powers, Tombeau, and Benedict; and Silver (Kenosha County) Lakes.

3. The provision of chemical control of nuisance algal blooms as necessary at Big Muskego, Little Muskego, Phantom, Eagle, Pewaukee, Bohner, Browns, Wind, Como, Tichigan, Camp and Center, and Silver (Kenosha County) Lakes.

4. Machine harvesting of the aquatic weed growths as necessary at Big Muskego; Little Muskego; Phantom; Eagle; Tichigan; Pewaukee; Bohner; Browns; Wind; Beulah; Como; Pell; Camp and Center; Elizabeth and Marie; Powers, Tombeau, and Benedict; and Silver (Kenosha County) Lakes.

The installation of the sanitary sewerage systems is recommended to eliminate the sanitary hazards that may presently exist in the lakes as a result of inadequate or malfunctioning individual on-site soil absorption sewage disposal systems and to reduce the nutrient input to the lakes. Soil and water conservation practices, including the construction of bench terraces, are recommended as the best means of reducing the nutrient input and sediment load from agricultural areas to the major lakes within the watershed. The algae control and weed harvesting operations are recommended to alleviate nuisances caused by excessive aquatic growths present in the many lakes within the watershed.

Water Supply

Because the water supply resources of the Fox River watershed are not only varied as to source but are also renewable, these resources, if carefully used and developed, will be adequate to meet the foreseeable demand within the watershed for water. The shallow aquifer underlying the watershed can be developed to meet all foreseeable demand for domestic and livestock watering purposes. Increased use of this aquifer for crop irrigation may result in some local water shortages and water supply conflicts. This aquifer is readily susceptible to pollution, and the quality of the water in this aquifer will have to be carefully protected. Important to this protection will be implementation of the recommendations contained in the land use base element of the recommended watershed plan, particularly those relating to the provision of public sanitary sewerage services to urban areas.

The most dependable source of large quantities of high quality water within the watershed is the deep sandstone aquifer. With the implementation of a good water management program, wells tapping this aquifer may be expected to continue to yield 1 to 2 million gallons per day per well through the design year of the plan. Proper well location and spacing, however, will be essential if the full potential of this source of supply is to be realized, as will protection of the recharge areas located in western Walworth, Washington, and Waukesha Counties. Such protection, particularly from intensive urban development, will be essential to avoid both pollution of this deep aquifer and any serious diminution of the amount of water available for recharge.

Although the development of an alternative source of water supply in the form of a large multipurpose reservoir located in the Vernon Marsh area of Waukesha County cannot be recommended at the present time for inclusion in the comprehensive watershed plan, the retention of full flexibility for the development of alternative sources of water supply within the watershed to meet the needs of development beyond the plan design year of 1990 indicates that the lands needed for this reservoir should be protected and preserved in essentially open use.

THE UNPLANNED ALTERNATIVE

The recommended comprehensive watershed plan was designed specifically to meet the established watershed development objectives and standards, which include the water use objectives and supporting water quality standards established by the State of Wisconsin for the Fox River and its major tributaries. Implementation of the recommended plan can, therefore, be expected to provide a safer, more healthful, and more pleasant, as well as more orderly and efficient, environment within the watershed. Implementation of the recommended watershed plan would assist in the resolution of many of the existing areawide development problems, would avoid the development of new problems, and would do much to protect and enhance the underlying and sustaining natural resource base.

The alternative would be to continue recent development trends within the watershed, utilizing only local development plans and policies to constrain the action of the urban land market in shaping the future development pattern within the watershed. This unplanned alternative would require the least amount of effort on an areawide basis toward regulation of development in the public interest and would require few restraints on the operation of the urban land market in determining the future character, intensity, and spatial distribution of land use development within the watershed. The unplanned alternative, however, could be expected to lead to a continued intensification of existing environmental problems within the watershed, including flooding and water pollution, and could be expected to result in the almost total destruction of the natural resource base and in the production of a land use pattern which would be as disorderly and inefficient as it would be ugly. Under the unplanned alternative, average annual flood costs within the watershed would be expected to increase from $77,000 per year at the present time to $112,000 per year in 1990; and damages on a single 100-year recurrence interval flood could be expected to increase from $857,000 at the present to $1.5 million in 1990. The established water use objectives and standards could not be expected to be met for over 25 miles, or 31 percent, of the main stem of the Fox River nor for significant reaches of the following major tributaries: Bassett Creek, Honey Creek, Pewaukee River, Sussex Creek, and White River. Finally, continued deterioration of the quality of water in the 45 major lakes of the watershed could be expected.

The need to protect the floodlands of the perennial stream system, the best remaining woodlands and wetlands, the best remaining wildlife habitat area, and the best remaining agricultural areas would be ignored, as would the value of developing an integrated system of park and open-space areas adequate to meet the forecast recreational demand and centered on the primary environmental corridors of the Region. Failure to recognize these needs and values has indeed been the case within the watershed in the past, as attested to by the growing developmental and environmental problems. Continuation of these past practices can only lead to a further deterioration and destruction of the natural resource base of the watershed, increasing costs for governmental facilities and services, and a decline in the overall quality of life within the watershed.

COST ANALYSIS

In order to assist the public officials concerned in evaluating the elements of the recommended Fox River watershed plan, a preliminary capital improvements program was prepared with the necessary land acquisition and facility construction staged and the attendant costs distributed over a 20-year plan implementation period. The adoption of capital improvements programs for implementation of the watershed plan will require determination by responsible public officials of not only those plan elements which are to be implemented, and the timing of such implementation, but also of the principal beneficiaries and the available means of financing.

The full capital investment cost of implementing the recommended comprehensive watershed plan based on the preliminary capital improvement program included in this report is estimated at $120 million over the 20-year plan implementation period. Of this total cost, $66 million, or 55 percent, is required for implementation of the recommended natural resource base protection and recreation-related land use plan elements; $29,600,000, or 25 percent, is required for implementation of the recommended stream water quality improvement elements; $19,561,120, or 16 percent, is required for implementation of the recommended lake water quality improvement elements; and $4,797,600, or 4 percent, is required for the recommended flood control and drainage improvement elements. The average annual capital cost of total plan implementation would be approximately $6 million per year, or approximately $24 per capita, the per capita cost being based on a population of 250,000 persons or somewhat less than the anticipated average resident population of the watershed between the 1963 existing population level of 159,500 persons and the anticipated 1990 population level of 359,000 persons.

It is very important to note that, of the total watershed plan implementation costs of $120 million, an estimated $46 million, or 38 percent, would be incurred by the federal, state, and local units of government concerned in any case simply to provide the facilities necessary to accommodate the forecast population growths and accompanying urbanization within the watershed. Expenditure of these funds in the absence of a comprehensive watershed plan would not serve to meet the watershed development objectives nor the state-established water use objectives and standards but could be expected to lead instead to a further deterioration of the overall quality of the environment within the watershed. Although the primary beneficiaries of the implementation of the recommended comprehensive watershed plan will be the residents of the watershed, certain regional, state, and national benefits would accrue from full plan implementation. In this respect full utilization of all sources of financial assistance of the state and federal levels of government is recommended. Such utilization could serve to reduce the local plan implementation costs for most of the plan elements by as much as 50 percent.

In order to assess the possible impact of implementation of the watershed plan on the public financial resources of the local units of government within the watershed, an analysis was made of the long-term historic public expenditures by the counties, cities, villages, and towns within the watershed for public park and public sanitary sewerage facilities. This analysis revealed that the local units of government in the watershed had expended, over the last 21 years, a total of about $36.7 million for the construction, operation, and maintenance of public sanitary sewerage facilities, or an average annual expenditure of $1.7 million, and about $13.6 million for the acquisition, development, maintenance, and operation of parks, or an average annual expenditure of $0.6 million. Based upon these past expenditures, three alternative forecasts were prepared to indicate the possible range of future expenditures by local units of government within the watershed for public sanitary sewerage and park purposes. When the average of the three alternative forecasts for both public sanitary sewerage and park purposes was compared with the estimated plan implementation costs for sewerage and park purposes, it became clear that, in general, the costs of implementing the watershed plan are such as to be reasonably attainable through continuing the current public expenditure patterns for sanitary sewerage purposes and expanding somewhat the expenditures for park purposes.

IMPLEMENTATION

The legal and governmental framework existing in the Fox River watershed is such that the existing state, county, and local units of government can readily implement all of the major recommendations contained in the comprehensive watershed plan. In Chapter IX of this volume, a comprehensive, cooperative, intergovernmental plan implementation program is set forth, which indicates the specific actions which will be required of each level, agency, and unit of government operating within the watershed if the recommended watershed plan is to be fully implemented. These levels, agencies, and units of government include, at the local level, the governing bodies of the cities, villages, towns, and counties within the watershed; at the state level, the Wisconsin Department of Natural Resources, Wisconsin Department of Local Affairs and Development, Wisconsin Department of Transportation, Wisconsin Division of Health, and the Wisconsin Soil Conservation Board; and at the federal level, the U. S. Department of Housing and Urban Development; the U. S. Department of Agriculture, Soil Conservation Service, Farmers Home Administration, and Agricultural Stabilization and Conservation Service; the U. S. Department of Interior, Federal Water Pollution Control Administration and Bureau of Outdoor Recreation; and the U. S. Department of the Army, Corps of Engineers. They also include areawide special-purpose units of government currently operating within the watershed, including the Western Racine County Sewerage District and the Hoosier Creek Drainage District.

The watershed plan element providing for the establishment of a single large sewage treatment plant below Waukesha which, along with a system of tributary trunk sewers, would serve the entire upper Fox River watershed, provides the area of most concern with respect to plan implementation. Implementation of this plan element would enable more advanced waste treatment and eventual abandonment of the five existing sewage treatment facilities in the upper Fox River watershed. The responsibility for the provision of sewer service in the upper Fox River watershed is presently divided between three cities, four villages, and five towns.

One way to implement this plan recommendation would be to establish a metropolitan sewerage district for the upper Fox River watershed, which district would be responsible for the planning, construction, operation, and maintenance of the large treatment plant and system of trunk sewers. Such metropolitan sewerage districts are authorized by Sections 66.20 through 66.209 of the Wisconsin Statutes. Because of a recent Wisconsin Supreme Court ruling that invalidated the procedures for establishing such metropolitan sewerage districts, however, this institutional structure is not presently available for use. This plan element could be implemented, however, through the establishment on a voluntary basis by the 12 local units of government concerned of an intergovernmental cooperative contract commission. Under this approach each of the 12 local municipalities would become a signatory to an intergovernmental agreement establishing a commission or other body which would plan, build, operate, and maintain the trunk sewer and the single large sewage treatment plant. The contractual agreement would specify all the necessary arrangements, including such matters as membership on the governing body, financing, and a method by which ensuing conflicts could be arbitrated and resolved. This cooperative approach has the advantage of avoiding the creation of another special-purpose unit of government. A serious limitation exists in the voluntary nature of this approach, however, in that all of the concerned local units of government cannot be required to even consider, much less be compelled to take, such cooperative action.

Despite this limitation it is recommended that an effort be made to implement the upper Fox River watershed sewerage system plan through the establishment on a voluntary basis of an intergovernmental cooperative commission. It is further recommended that the Waukesha County Extension Service provide a forum for the discussion of this plan element among the concerned local units of government. Should this approach fail, it is then recommended that the Wisconsin Department of Natural Resources and the concerned local units of government seek necessary enabling legislation to either provide for the establishment of a metropolitan sewerage district or for the county unit of government to become the mechanism for the provision of areawide sewerage service.

Primary emphasis in Fox River watershed plan implementation is placed upon actions by the Wisconsin Department of Natural Resources; the four county boards of the Counties of Kenosha, Racine, Walworth, and Waukesha; and by certain individual municipal units of government. It is recommended that the Wisconsin Department of Natural Resources continue to conduct periodic water pollution surveys and reevaluate and enforce pollution control orders in accordance with the Fox River watershed plan recommendations; encourage counties and local units of government in the watershed to follow the plan recommendations relative to floodland and shoreland zoning; acquire the recommended Sugar Creek multiple-purpose reservoir site, construct the dam and reservoir, and develop a state park site thereon; acquire the remaining acreage needed to complete acquisition of the Vernon Marsh wildlife conservancy area and temporary floodwater storage area; acquire certain additional high-value wetlands and woodlands; and recommend to the State Legislature that a Greenway Tax Law be established and patterned after the well-established Forest Crop Law.

It is recommended that the four county units of government establish sound floodland and shoreland zoning provisions within the County Zoning Ordinance; adopt sanitary codes regulating the installation of septic tank sewage disposal systems; acquire all of the lands designated as urban primary environmental corridors in the watershed and all lands designated as rural primary environmental corridors along the main stem of the Fox River; acquire and develop regional outdoor recreation areas in Kenosha, Racine, and Waukesha Counties; and acquire additional high-value outdoor recreation sites as additions to the county park systems.

It is further recommended that the Cities of Brookfield, New Berlin, and Waukesha; the Villages of Lannon, Menomonee Falls, Pewaukee, and Sussex; and the Towns of Brookfield, Delafield, Lisbon, Pewaukee, and Waukesha undertake the necessary cooperative action toward the establishment of an areawide sewerage system; that the Villages of East Troy, Mukwonago, and Twin Lakes and the Cities of Burlington and Lake Geneva, as well as the Western Racine County Sewerage District, provide for the installation of advanced sewage treatment facilities in the existing sewage treatment plants operated by these agencies; and that the Cities of Burlington and Waukesha seek technical and financial assistance from the U. S. Army Corps of Engineers or the U. S. Soil Conservation Service in undertaking the recommended levee construction and channel improvements, including intermittent dikes and floodwalls, within these cities.

The foregoing enumeration of certain recommended plan implementation activities for summary purposes does not mean that the other implementation actions recommended in Chapter IX of this volume and not repeated here may be neglected. In the final analysis, the implementation of the recommended Fox River watershed plan must proceed in a comprehensive, fully coordinated fashion, with the assistance and cooperation of all affected levels, units, and agencies of government within the watershed.

CONCLUSION

Although the cost of adopting and implementing the recommended comprehensive watershed plan for the Fox River basin may appear high, the cost of not doing so is even higher, not only as measured in monetary terms but also as measured in terms of an irreversible deterioration of the natural resource base and decline in the overall quality of the environment within the watershed. The failure to act upon the plan recommendations in a timely manner will inevitably commit local units of government within the watershed to the unnecessary expenditure of large amounts of public funds for corrective measures. If the existing trends in urbanization continue within the watershed, those elements of the recommended plan requiring public acquisition of land should be substantially implemented within the first 10 years of the plan design period or the opportunity to acquire these important lands may be lost for all time. If the floodlands of the perennial stream system are not protected from incompatible development as recommended in the plan, urban flood damages will continue to mount; and the construction of extensive artificial flood control structures will be eventually demanded. If the pollution abatement recommendations contained in the plan are not implemented, surface water quality may be expected to deteriorate rapidly within the watershed;

and its full development potential will never be realized. If the park and related open-space acquisition and development recommendations contained in the plan are not implemented, the growing demand for recreational facilities may be expected to press so heavily upon the recreational resources of the watershed as to cause the serious decline in their quality.

Time is of the essence, for if the recommended plan is not implemented, the urban development within the watershed may be expected to overwhelm the limited resource base, further intensifying existing developmental and environmental problems and creating new problems which will be extremely expensive to solve, if, indeed, solutions will be at all possible.

(This page intentionally left blank)

APPENDICES

(This page intentionally left blank)

Appendix A

TECHNICAL ADVISORY COMMITTEE ON NATURAL RESOURCES AND ENVIRONMENTAL DESIGN

Cyril Kabat . . . . Chairman	Assistant Director, Bureau of Research, Wisconsin Department of Natural Resources
Kurt W. Bauer . . . . Secretary	Executive Director, SEWRPC
Jacob D. Dumelle	Director, Lake Michigan Basin Office, Federal Water Pollution Control Administration, Great Lakes Region
George F. Hanson.	State Geologist and Director, University of Wisconsin Extension Division-Geological and Natural History Survey
Charles L. R. Holt, Jr.	District Chief, Water Resources Division, U. S. Geological Survey
Al J. Karetski	Director, Bureau of Local and Regional Planning, Wisconsin Department of Local Affairs and Development
Robert J. Mikula	County Landscape Architect, Milwaukee County Park Commission
Donald W. Niendorf.	Conservation Education Specialist, Soil Conservation Board of the University of Wisconsin
James R. Price	Division Engineer, Sewer Construction and Maintenance, Sewerage Commission of the City of Milwaukee
William W. Russell	State Conservationist, U. S. Soil Conservation Service
William Sayles	Director, Bureau of Water and Shoreland Management, Division of Environmental Protection, Wisconsin Department of Natural Resources
William F. Steuber.	Assistant State Highway Engineer, Division of Highways, Wisconsin Department of Transportation
Walter J. Tarmann	Executive Director, Waukesha County Park and Planning Commission
George B. Wesler	Chief, Planning and Reports Branch, U. S. Army Corps of Engineers
Donald G. Wieland	Division Engineer, Sewer Design, Sewerage Commission of the City of Milwaukee
Harvey E. Wirth	State Sanitary Engineer, Wisconsin Department of Health and Social Services
Theodore F. Wisniewski	Assistant to the Administrator, Division of Environmental Protection, Wisconsin Department of Natural Resources
Kenneth B. Young.	Associate Chief, Water Resources Division, U. S. Geological Survey

(This page intentionally left blank)

Appendix B

FOX RIVER WATERSHED COMMITTEE

*William D. Rogan . . . . Chairman	County Agri-Business Agent, Waukesha County
*Paul G. Jaeger . . . . Secretary	County Agri-Business Agent, Kenosha County
*Kurt W. Bauer	Executive Director, SEWRPC
Alexander H. Button	Inspector and Secretary, Linn Township Sanitary District
Arnold L. Clement	Planning Director and Zoning Administrator, Racine County
Willard R. Evans	Waukesha County Board Supervisor; Member, County Health Board; Chairman, Town of Pewaukee
Robert L. Frank	Citizen Member, Lake Geneva, Wisconsin
H. Copeland Greene.	Citizen Member, Genesee Depot, Wisconsin
Eugene Hollister	Chairman, Walworth County Board of Supervisors; Chairman, County Park and Planning Commission; Chairman, County Executive Committee; Member, County Agricultural Committee; Member, County Sheriff Committee (CD); Commissioner, SEWRPC
V. H. Holtdorf	Citizen Member, Silver Lake, Wisconsin
Stanley W. Ihlenfeldt	County Agri-Business Agent, Walworth County
James A. Johnson.	Zoning and Sanitation Supervisor, Walworth County
*Paul Johnson.	Acting Area Conservationist, U. S. Soil Conservation Service
John E. Jones	Citizen Member, Genesee, Wisconsin
*Thomas A. Kroehn.	Director, Region 2, Division of Environmental Protection, Wisconsin Department of Natural Resources
Elwin G. Leet	County Agricultural Agent, Racine County
Paul Lohaus	Chairman, Fox River Flood Control Committee, Burlington, Wisconsin
John H. Mielke	Consulting Engineer, Waukesha, Wisconsin
Bauer Mohr	Citizen Member, Rochester, Wisconsin
Roland F. Nicotera.	District Game Manager, Division of Fish, Game, and Enforcement, Wisconsin Department of Natural Resources, Waterford, Wisconsin
*Benjamin Richason	Professor of Geography, Carroll College, Waukesha, Wisconsin
*Herbert E. Ripley	Director of Environmental Health Services, Waukesha County Health Department
Phil Sander	Kenosha County Conservation Warden; Executive Secretary, Southeastern Wisconsin Sportsmen's Federation
Dr. Bruno E. Schiffleger	Citizen Member, Elkhorn, Wisconsin
George L. Schlitz	Citizen Member, Wheatland, Wisconsin
Wilbert Schrank	Racine County Agricultural Stabilization and Conservation Committee
Walter J. Tarmann	Executive Director, Waukesha County Park and Planning Commission

Rodney Vanden Noven . . . . Director of Public Works, City of Waukesha
Theodore Vogel . . . . Citizen Member, Chenequa, Wisconsin
*Franklin Walsh. . . . . Walworth County Board Supervisor; Member, County Agricultural Committee; Chairman, County Counseling Center Committee; Member, County Executive Committee; Member, County Finance Committee; Chairman, County Social Services Committee; Chairman, Town of Linn
Donald E. Wieselmann. . . . . Mayor, City of Muskego
Franklin Wirth. . . . . Mayor, City of Brookfield
John R. Zillmer . . . . Secretary, Ice Age Park and Trail Foundation

*Members of the Fox River Watershed Steering Committee

Appendix C

RAINFALL AND RUNOFF DATA FOR STORM WATER DRAINAGE AND FLOOD CONTROL FACILITY DESIGN

Figure C - I

POINT RAINFALL

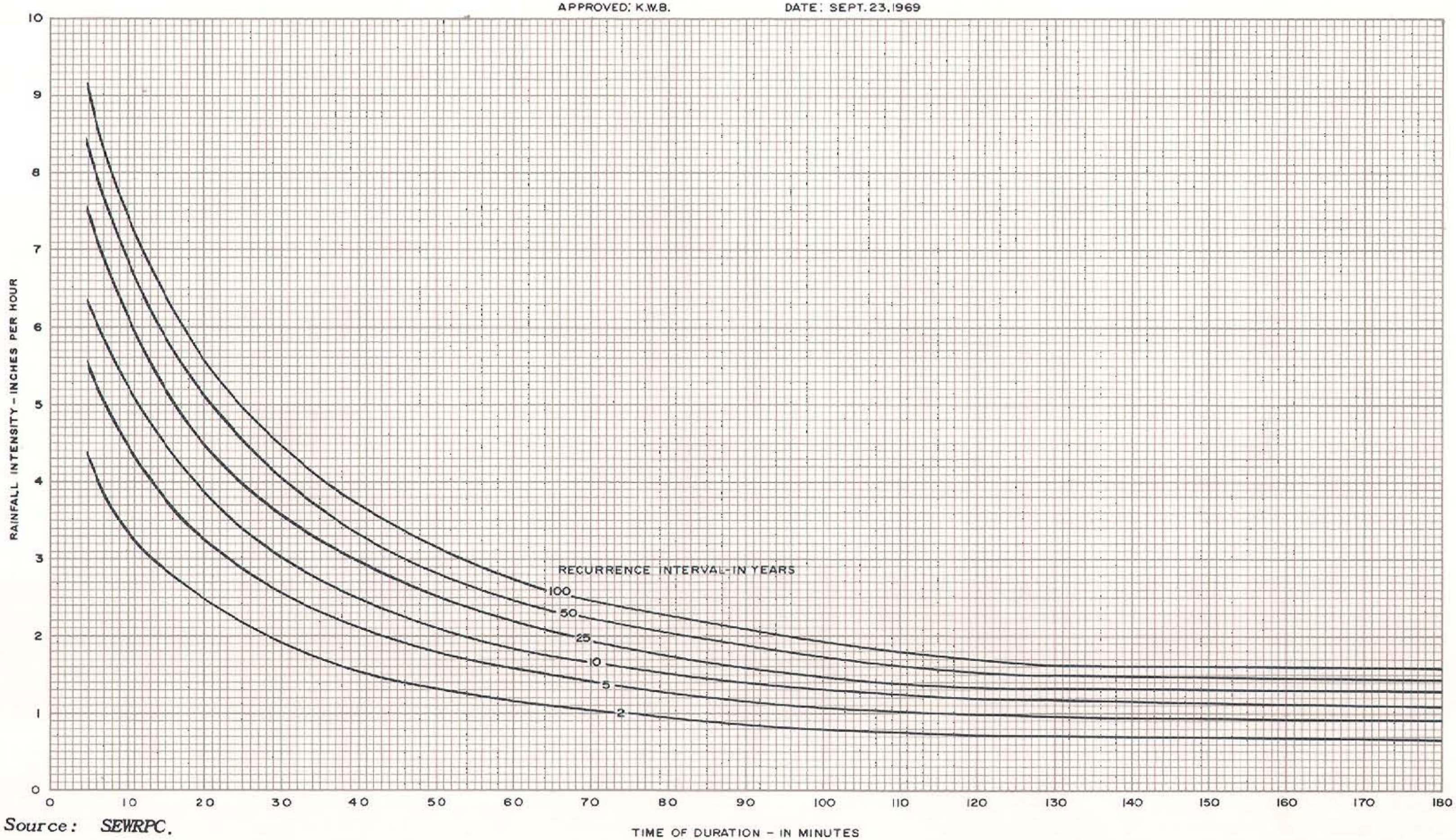
INTENSITY - DURATION - FREQUENCY

FOR DURATIONS OF 0 TO 180 MINUTES

MILWAUKEE, WISCONSIN

PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
WAUKESHA, WISCONSIN
FROM
U.S. WEATHER BUREAU RECORDS
FOR
PERIOD FROM 1903 THROUGH 1966

DRAWN: R.L.R.	DATE: JUNE 23, 1969
CHECKED: D.R.B.	DATE: SEPT. 23, 1969
APPROVED: K.W.B.	DATE: SEPT. 23, 1969



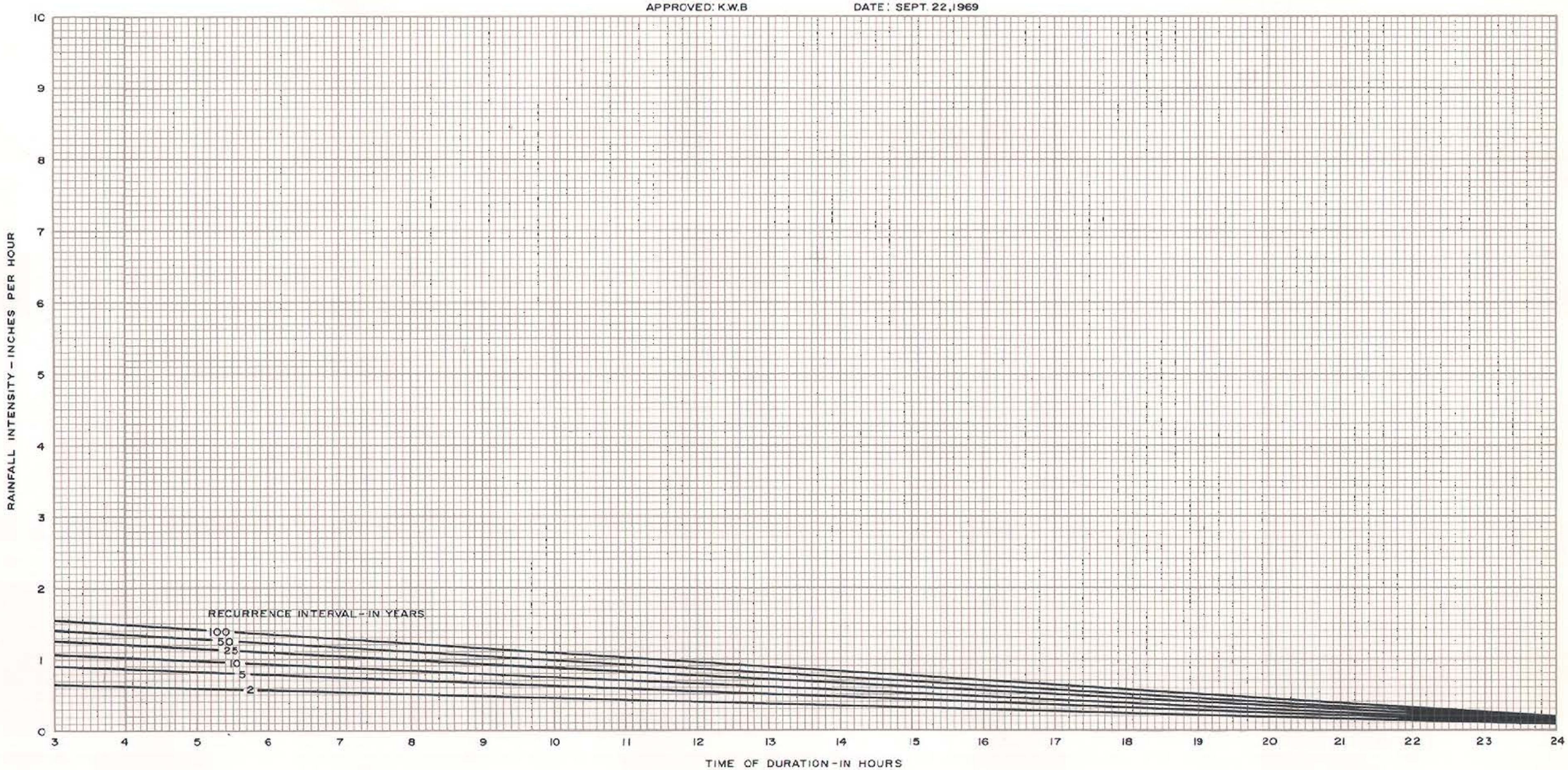
Source: *SEWRPC.*

Figure C-2

POINT RAINFALL
INTENSITY – DURATION – FREQUENCY
FOR DURATIONS OF 3 TO 24 HOURS
MILWAUKEE, WISCONSIN

PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
WAUKESHA, WISCONSIN
FROM
U.S. WEATHER BUREAU RECORDS
FOR
PERIOD FROM 1903 THROUGH 1966

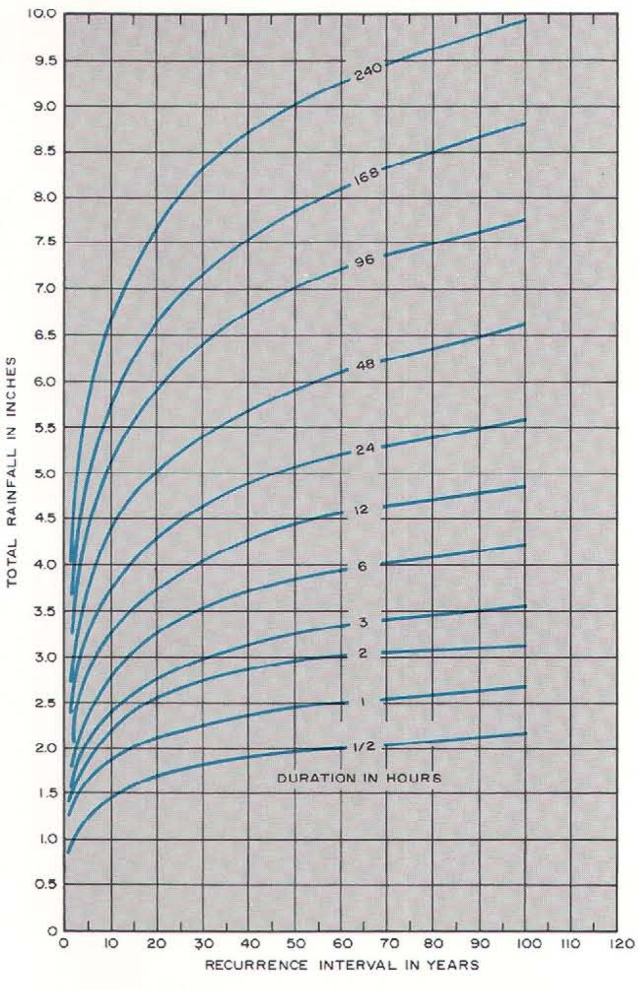
DRAWN: R.L.R — DATE: JUNE 22, 1969
CHECKED: D.R.B. — DATE: SEPT. 22, 1969
APPROVED: K.W.B — DATE: SEPT. 22, 1969



Source: SEWRPC.

Figure C-3

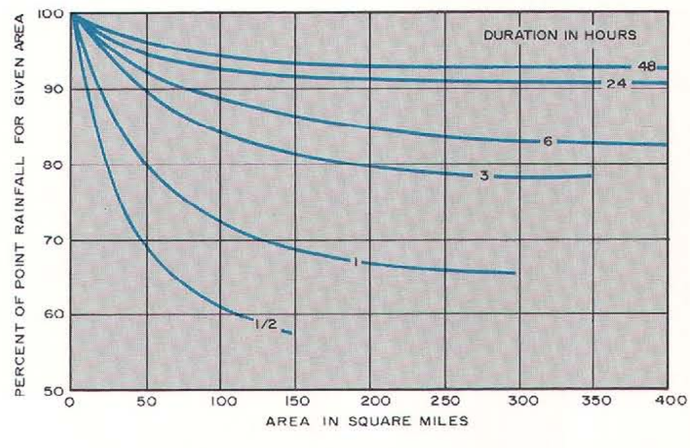
POINT RAINFALL DEPTH-DURATION-FREQUENCY RELATIONSHIPS IN THE REGION AND THE FOX RIVER WATERSHED



Source: SEWRPC.

Figure C-4

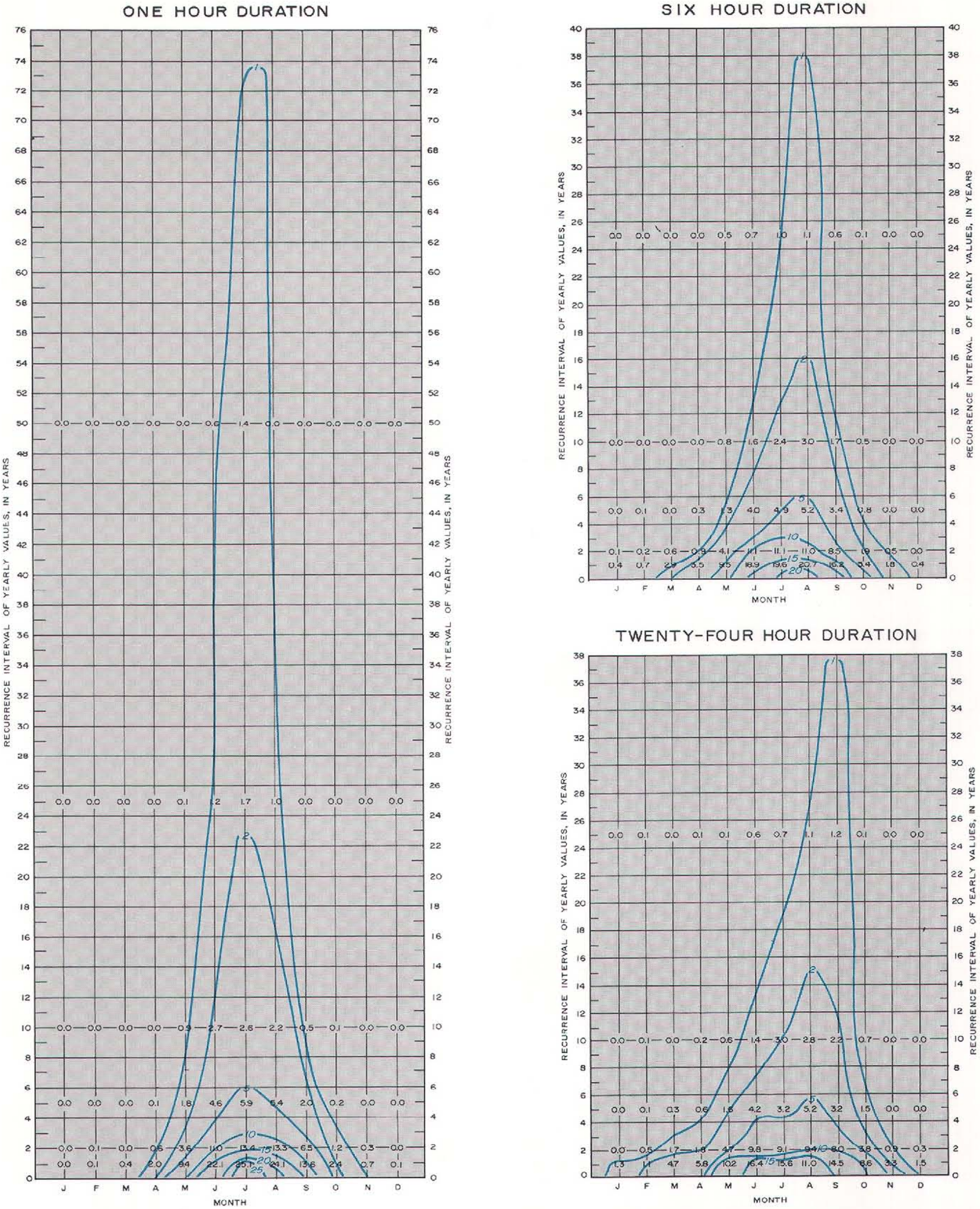
RAINFALL DEPTH-DURATION-AREA RELATIONSHIPS IN THE REGION AND THE FOX RIVER WATERSHED



Source: SEWRPC.

Figure C-5

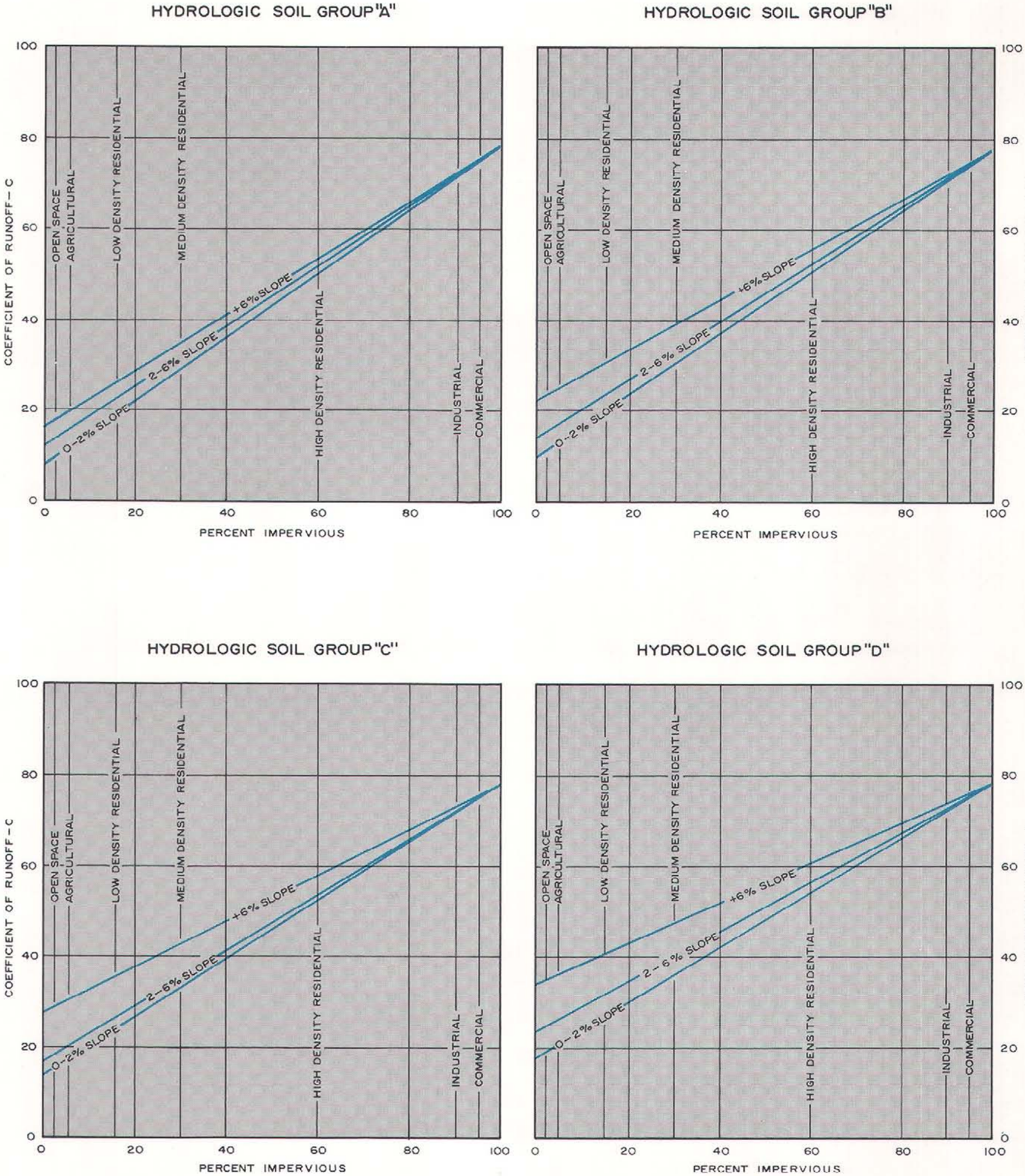
SEASONAL VARIATION OF RAINFALL FREQUENCY IN THE REGION AND THE FOX RIVER WATERSHED



PROBABILITY IN PERCENT OF OBTAINING A RAINFALL IN ANY MONTH OF A PARTICULAR YEAR EQUAL TO OR EXCEEDING THE YEARLY RECURRENCE INTERVAL OF THAT RAINFALL.

Source: SEWRPC.

Figure C-6
COEFFICIENT OF RUNOFF CURVES
FOR HYDROLOGIC SOIL GROUPS



Source: SEWRPC.

(This page intentionally left blank)

INTRODUCTION TO APPENDICES D, E, AND F

A comprehensive watershed plan setting forth the general location and characteristics of areas subject to inundation and of proposed water control facilities is necessary as a statement of how best to achieve agreed-upon, long-range watershed development objectives. Such a plan is, however, quite ineffective as a sound basis for plan implementation through the advanced reservation and acquisition of land for recommended facility construction, the exercise of local land use controls, and the extension of technical assistance and advice from the Regional Planning Commission to the concerned state and local units and agencies of government. It was, therefore, pointed out in the original Fox River Watershed Planning Program Prospectus that the more precise and definitive data required for the advanced reservation of right-of-way, the exercise of land use controls, and the proper extension of technical assistance would be provided as an integral part of the comprehensive watershed planning effort for certain reaches of the riverine areas of the watershed.

In the case of areas subject to inundation, such data would include large-scale maps showing the precise and accurate location of the 10- and 100-year recurrence interval flood hazard lines. Consequently, precise planning base maps were prepared under the Fox River study for 16.75 square miles of riverine area. These maps consist of 1" = 200' scale, four-foot-two-foot contour interval topographic maps, prepared to National Map Accuracy Standards and based upon a monumented control survey network which accurately relates the U. S. Public Land Survey System to the State Plane Coordinate System, thus permitting the accurate correlation of topographic and cadastral (property boundary line) data and, more importantly, permitting the accurate reproduction in the field of lines shown on the maps. These maps were prepared for those riverine areas of the watershed expected to experience the most rapid urbanization with the next decade, as well as for those areas of the watershed in which floodland evacuation and the construction of levees and floodwalls were being recommended (see Index Map F-1). The maps show the location of the 10- and 100-year recurrence interval flood hazard lines as these lines would be effected upon the landscape under the land use and water control facility development recommended in the watershed plan.

The precise planning base maps were prepared to meet the specifications recommended for official mapping in SEWRPC Planning Guide No. 2, Official Mapping Guide, and thereby provide a sound basis for the preparation of detailed local development plans and plan implementation devices, with particular emphasis upon sound floodland and shoreland zoning and upon the reservation of land for the ultimate construction of the recommended floodwalls and levees. A sample large-scale precise planning base map is shown on Map F-2. Copies of the precise planning base maps may be obtained from the Southeastern Wisconsin Regional Planning Commission, together with attendant horizontal and vertical control survey data. The Racine County Board of Supervisors has also prepared precise planning base maps for certain riverine areas of the watershed (see Index Map F-1). Copies of these maps may be obtained directly from Racine County.

In order to provide a sound basis for the preparation of detailed local development plans and plan implementation devices, including the enactment of floodland and shoreland zoning ordinances in those areas of the watershed not covered by the precise planning base maps, high water and streambed profiles were prepared as part of the Fox River watershed study for 223 miles of major stream channel. These profiles are reproduced in Appendix D and indicate the high water surface elevations which may be expected under the land use and water control facility development proposed in the adopted watershed plan for the 10- and 100-year recurrence interval floods, together with pertinent bridge, culvert, and water control facility locations and elevations and streambed profiles. Opposite each profile in Appendix D is reproduced a small-scale topographic map of the channel reach covered. These topographic maps are at a scale of 1" = 2000', with 10-foot contour intervals, and show the location and extent of the lands anticipated to be flooded by the 10- and 100-year recurrence interval flood events, as determined from the high water surface profiles. In order to more readily permit the high water surface profiles to be used to refine the location of the flood hazard lines through local field surveys, second order bench marks referred to Mean Sea Level Datum (1929 Adjustment) were set on or near all bridges, culverts, and dams on the major stream channel network as a part of the watershed study.

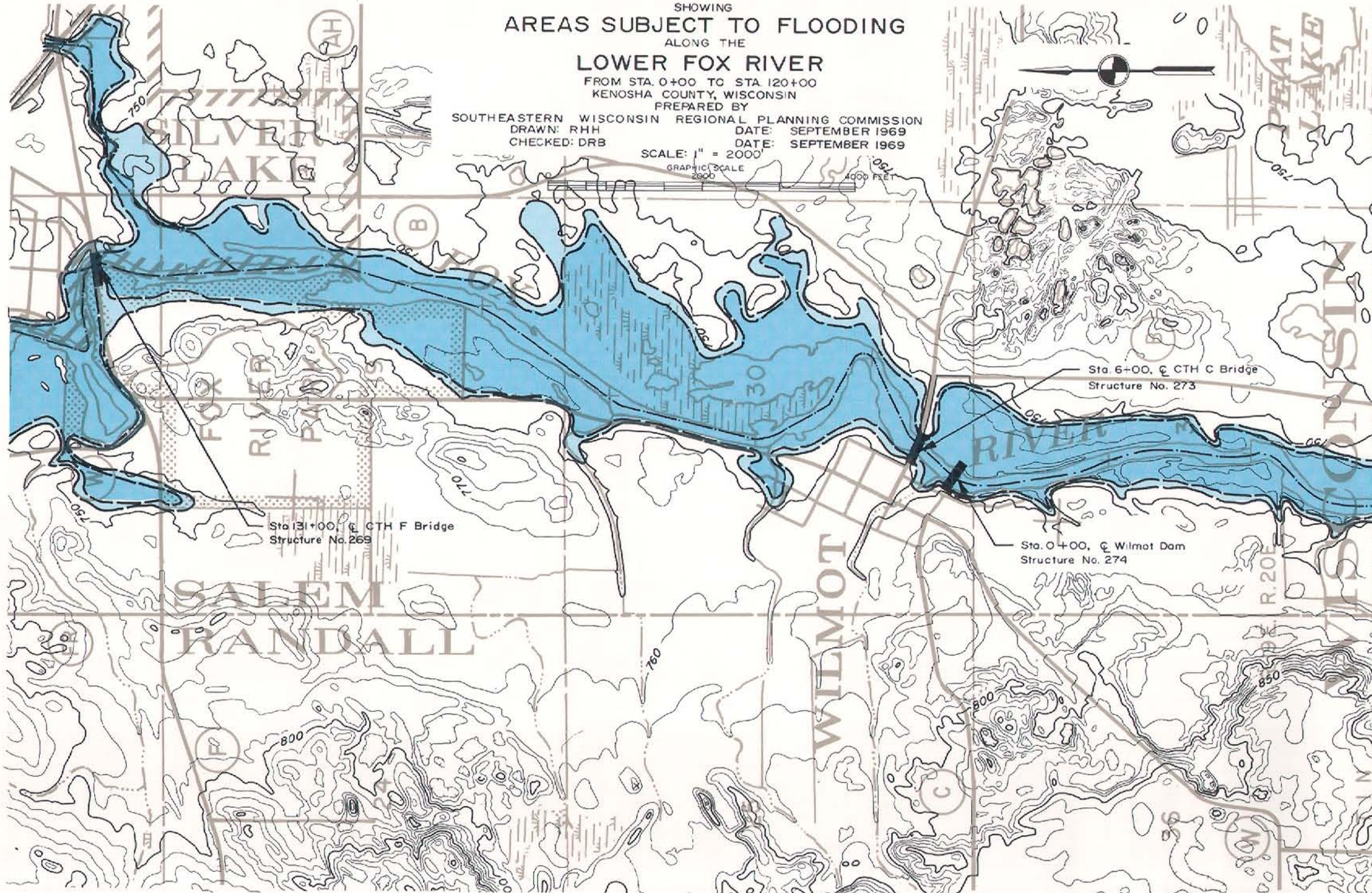
It is important to note that the high water surface profiles and flood hazard maps prepared under the Fox River watershed study are applicable to flood events which would occur under existing conditions of land use and water control facility development within the watershed, as well as flood events which may be expected to occur under future conditions of land use and water control facility development within the watershed, as recommended in the comprehensive watershed plan. Copies of the high water and streambed profiles and accompanying topographic maps showing the area subject to flooding, as reproduced in Appendix D, may be obtained from the Southeastern Wisconsin Regional Planning Commission at a scale twice that at which the profiles and maps are reproduced in Appendix D.

Accompanying the high water surface profiles are tables setting forth selected hydraulic information for each of 228 bridges[1] within the watershed (see Appendix E and Map E-1). These data include the bridge location; construction date, if known; recommended flow design frequency; bank full capacity; instantaneous peak discharge for the 10-, 50-, and 100-year recurrence interval flood events; corresponding elevations of the upstream high water surface; overbank depth; and head loss.

[1] In 1966 there were a total of 251 bridges and culverts on the 260 miles of perennial stream channel studied under the Fox River watershed planning program. All of these 251 bridges and culverts were inventoried in the Fox River watershed study. Twenty-three of the bridges and culverts, however, have been excluded from the hydraulic analysis summary table presented in Appendix E because they did not significantly affect the hydraulic capacity of the stream system. The exclusions consisted of culverts in the extreme headwater areas of the stream system, very high bridges and long viaducts that do not offer any appreciable constriction to flow in the channel floodway and floodplain, and bridges which are integral parts of dams.

HIGH WATER AND STREAM BED PROFILES AND TOPOGRAPHIC MAPS SHOWING AREAS SUBJECT TO FLOODING FOR THE FOX RIVER AND SELECTED MAJOR TRIBUTARIES

Map D-1
TOPOGRAPHIC MAP



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

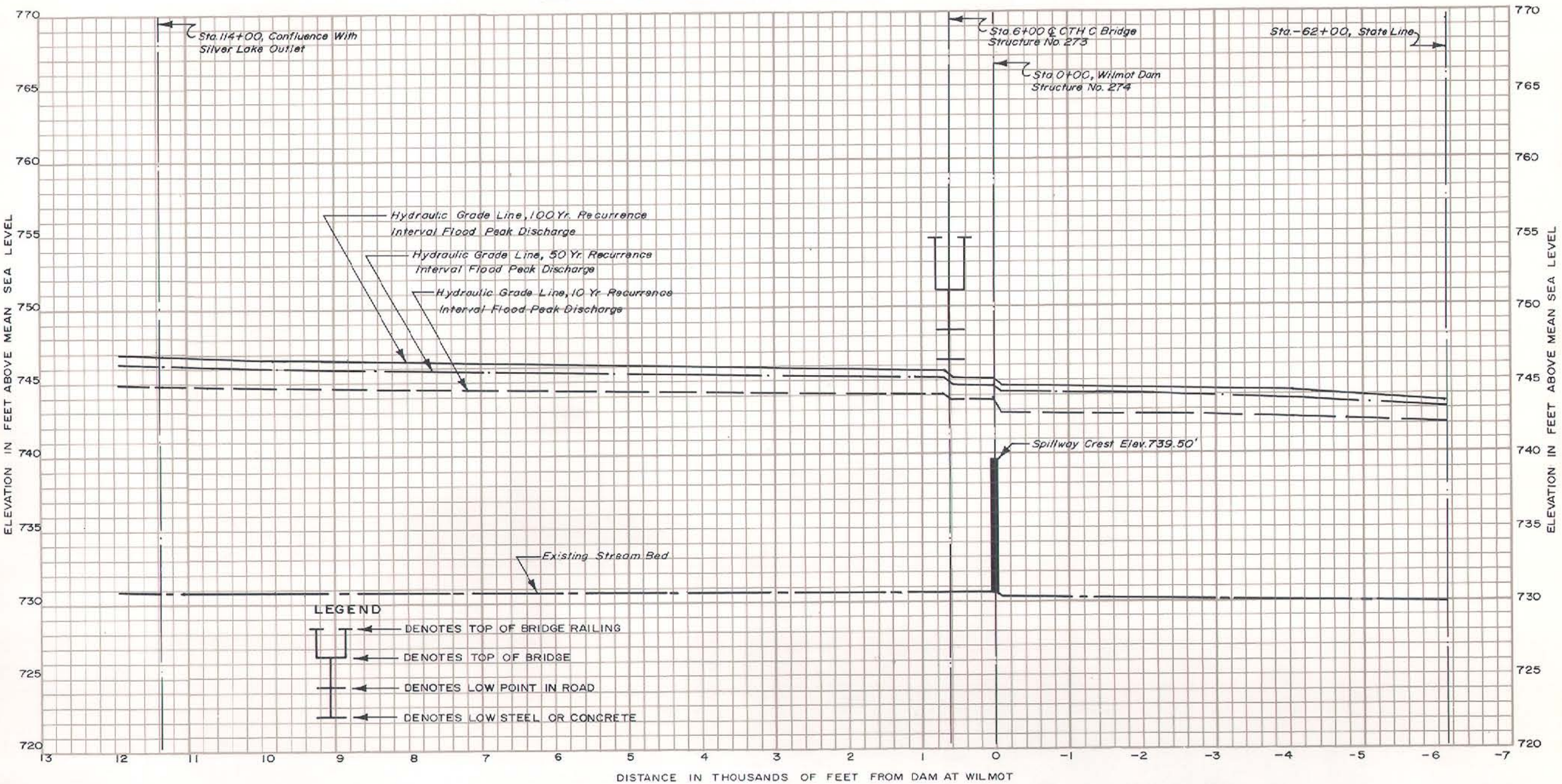
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

\+ DENOTES STATION TICK

Figure D-1

HIGH WATER AND STREAM BED PROFILES
OF THE
LOWER FOX RIVER
FROM STA. 0+00 TO STA. 120+00
KENOSHA COUNTY, WISCONSIN

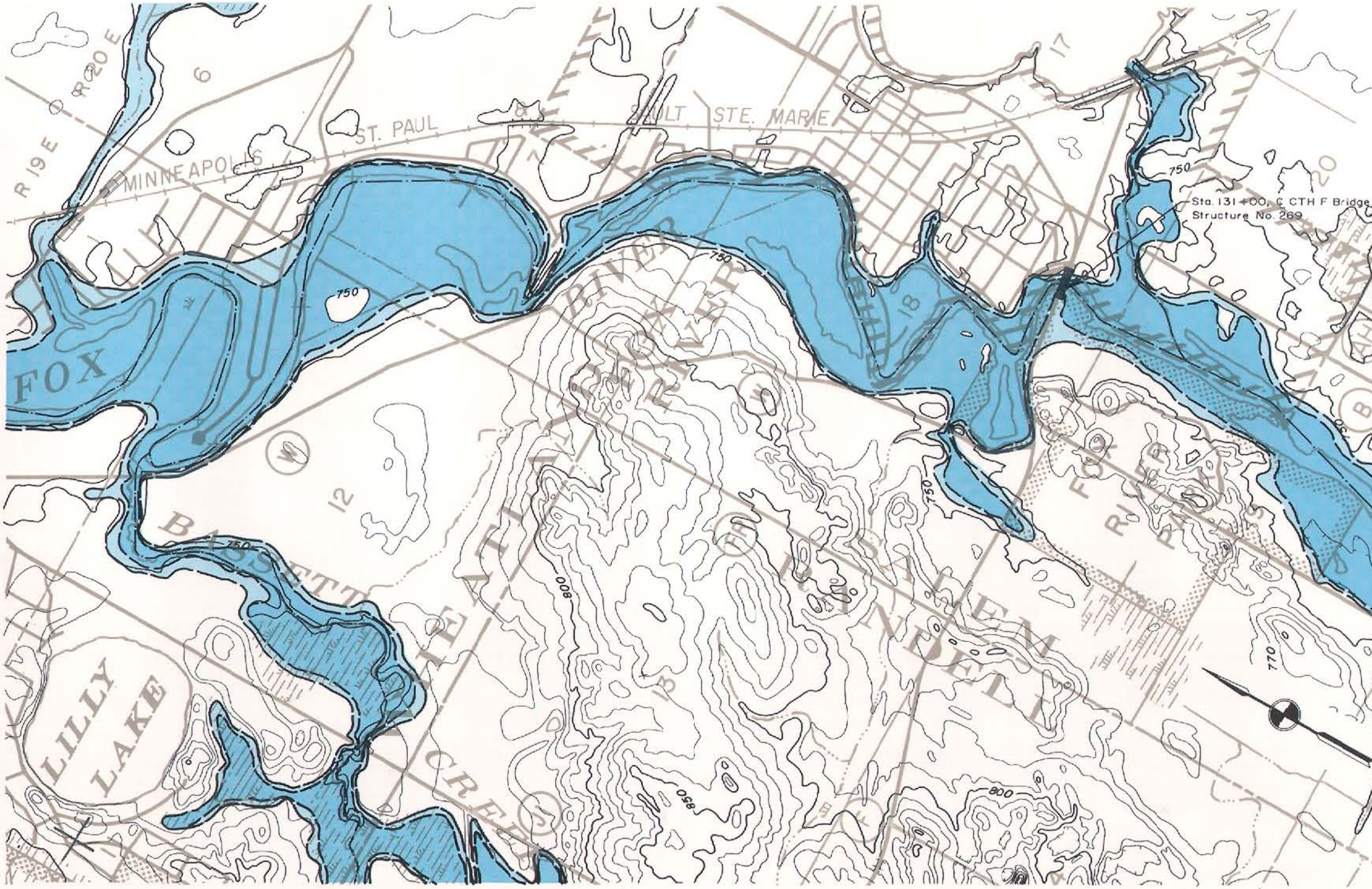
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RMW DATE: NOVEMBER 1969
CHECKED: DRB DATE: NOVEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-1 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
LOWER FOX RIVER

FROM STA.120+00 TO STA.300+00
KENOSHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: SEPTEMBER 1969
CHECKED: DRB DATE: SEPTEMBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

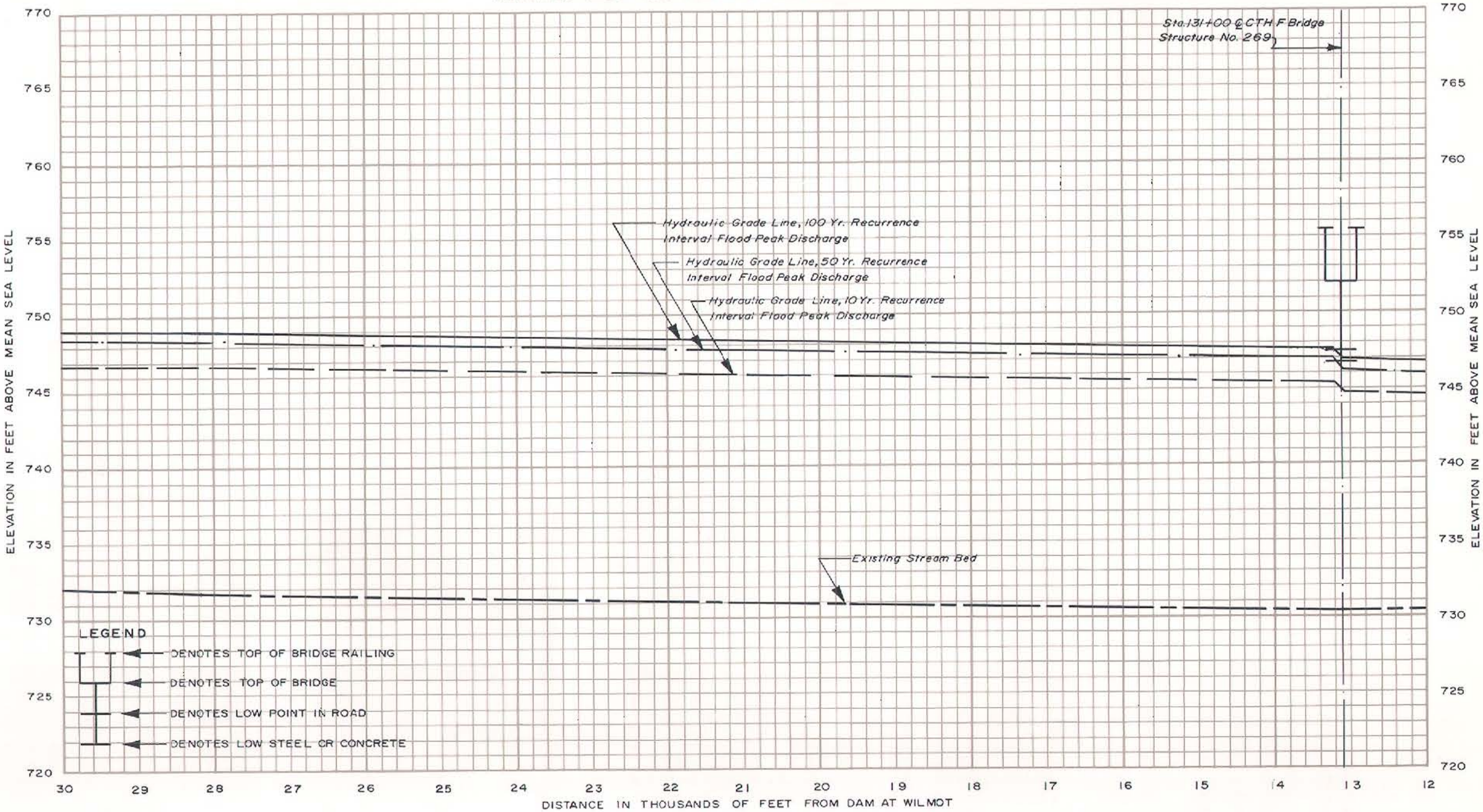
DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
+ DENOTES STATION TICK

Figure D-1 (continued)

HIGH WATER AND STREAM BED PROFILES
OF THE
LOWER FOX RIVER

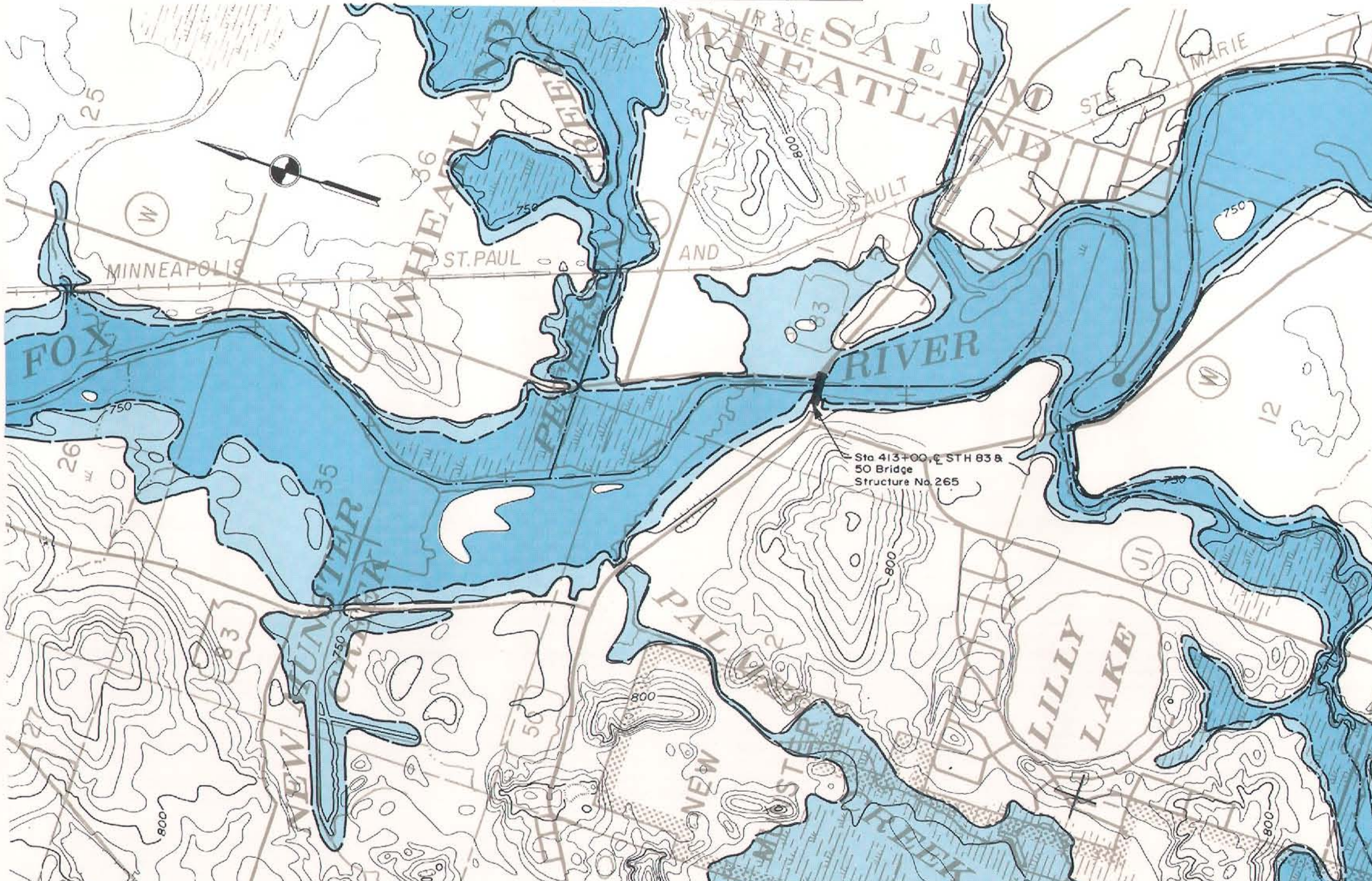
FROM STA. 120+00 TO STA. 300+00
KENOSHA COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: LHK DATE: NOVEMBER 1969
CHECKED: DRB DATE: NOVEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-1 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
LOWER FOX RIVER

FROM STA 300+00 TO STA. 480+00
KENOSHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: SEPTEMBER 1969
CHECKED: DRB DATE: SEPTEMBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY
Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

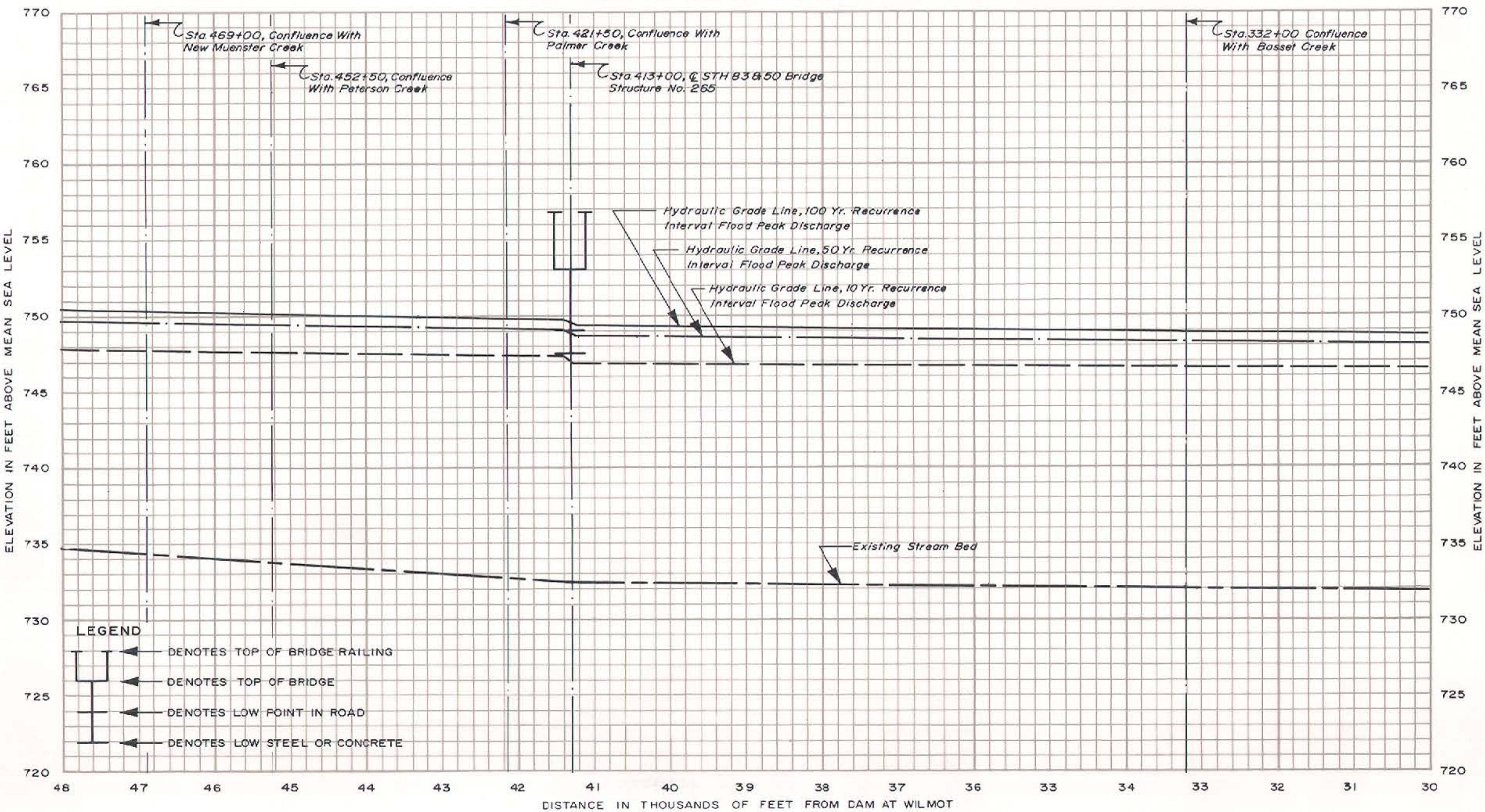
Figure D-1 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

LOWER FOX RIVER

FROM STA. 300+00 TO STA. 480+00
KENOSHA COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: LHK DATE: NOVEMBER 1969
CHECKED: DRB DATE: NOVEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-1 (continued)

TOPOGRAPHIC MAP

SHOWING

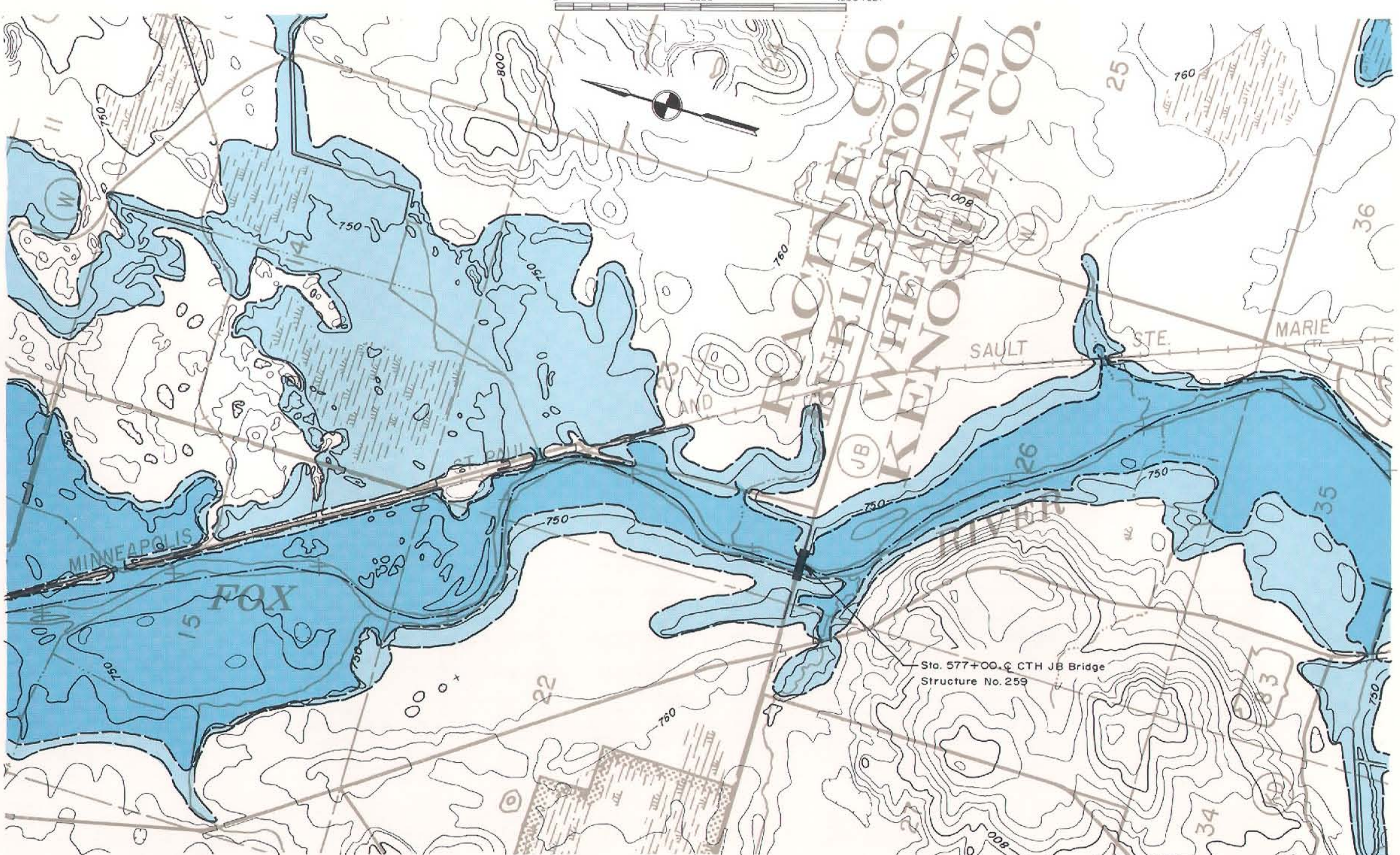
AREAS SUBJECT TO FLOODING

ALONG THE

LOWER FOX RIVER

FROM STA. 480+00 TO STA. 580+00
KENOSHA AND RACINE COUNTIES, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: JHW DATE: SEPTEMBER 1969
CHECKED: DRB DATE: SEPTEMBER 1969
SCALE: 1" = 2000'

GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
+ DENOTES STATION TICK

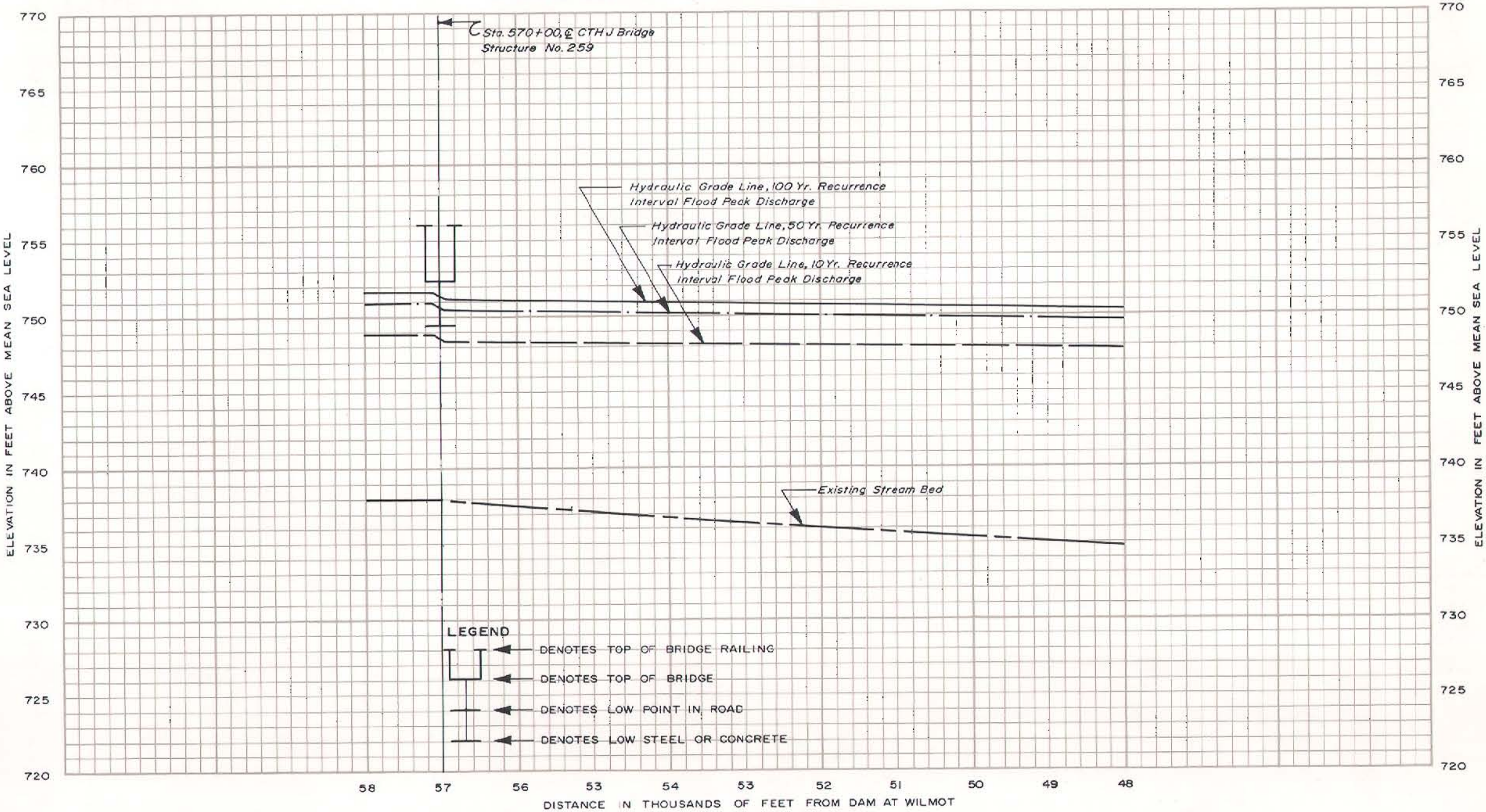
Figure D-I (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

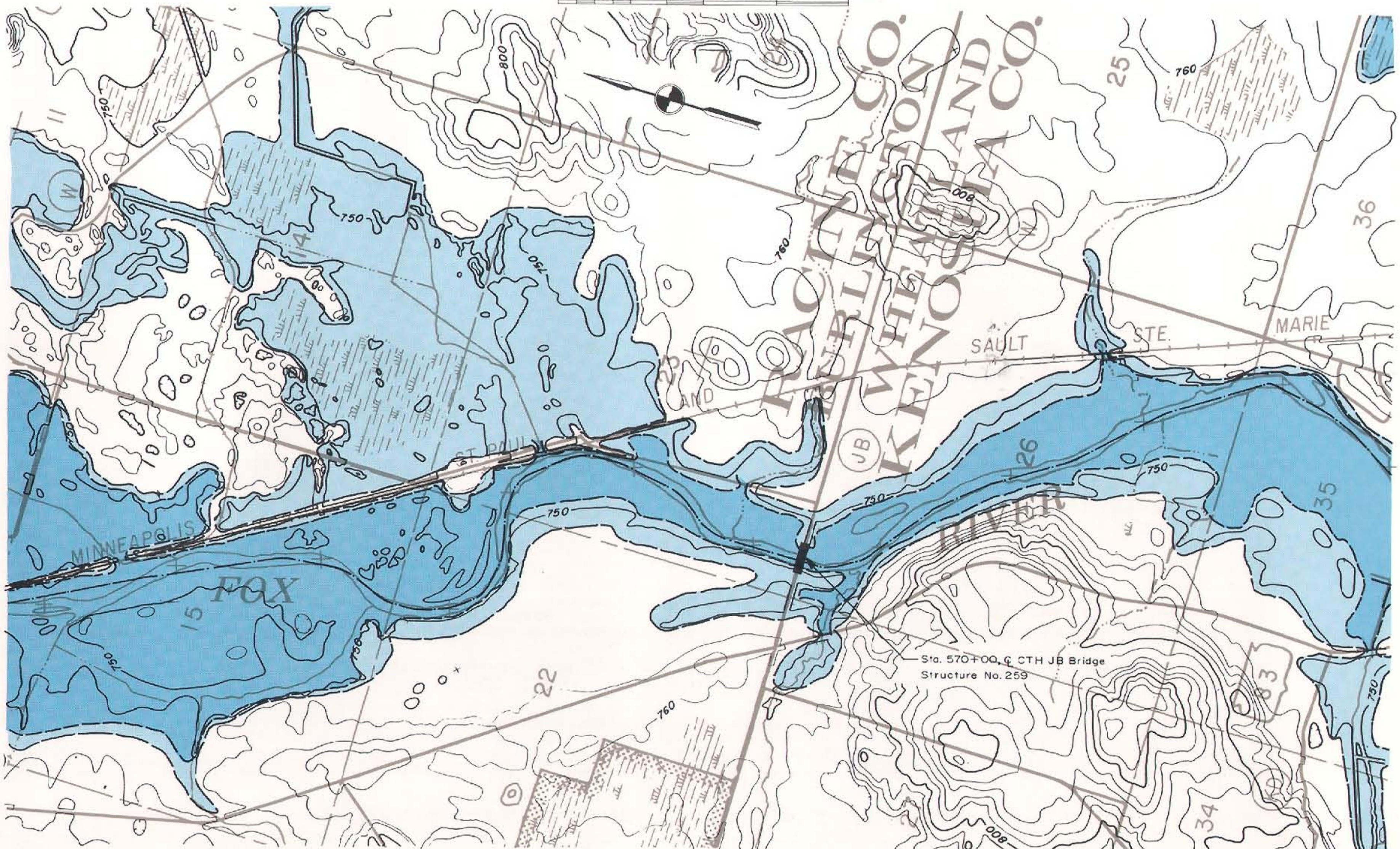
LOWER FOX RIVER

FROM STA. 480+00 TO STA. 580+00
KENOSHA AND RACINE COUNTIES, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: LHK DATE: NOVEMBER 1969
CHECKED: DRB DATE: NOVEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-1 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
LOWER FOX RIVER
FROM STA. 580+00 TO STA. 680+00
KENOSHA AND RACINE COUNTIES, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: JHW DATE: SEPTEMBER 1969
CHECKED: DRB DATE: SEPTEMBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND
DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-1 (continued)

HIGH WATER AND STREAM BED PROFILES OF THE LOWER FOX RIVER

FROM STA. 580-00 TO STA. 680+00

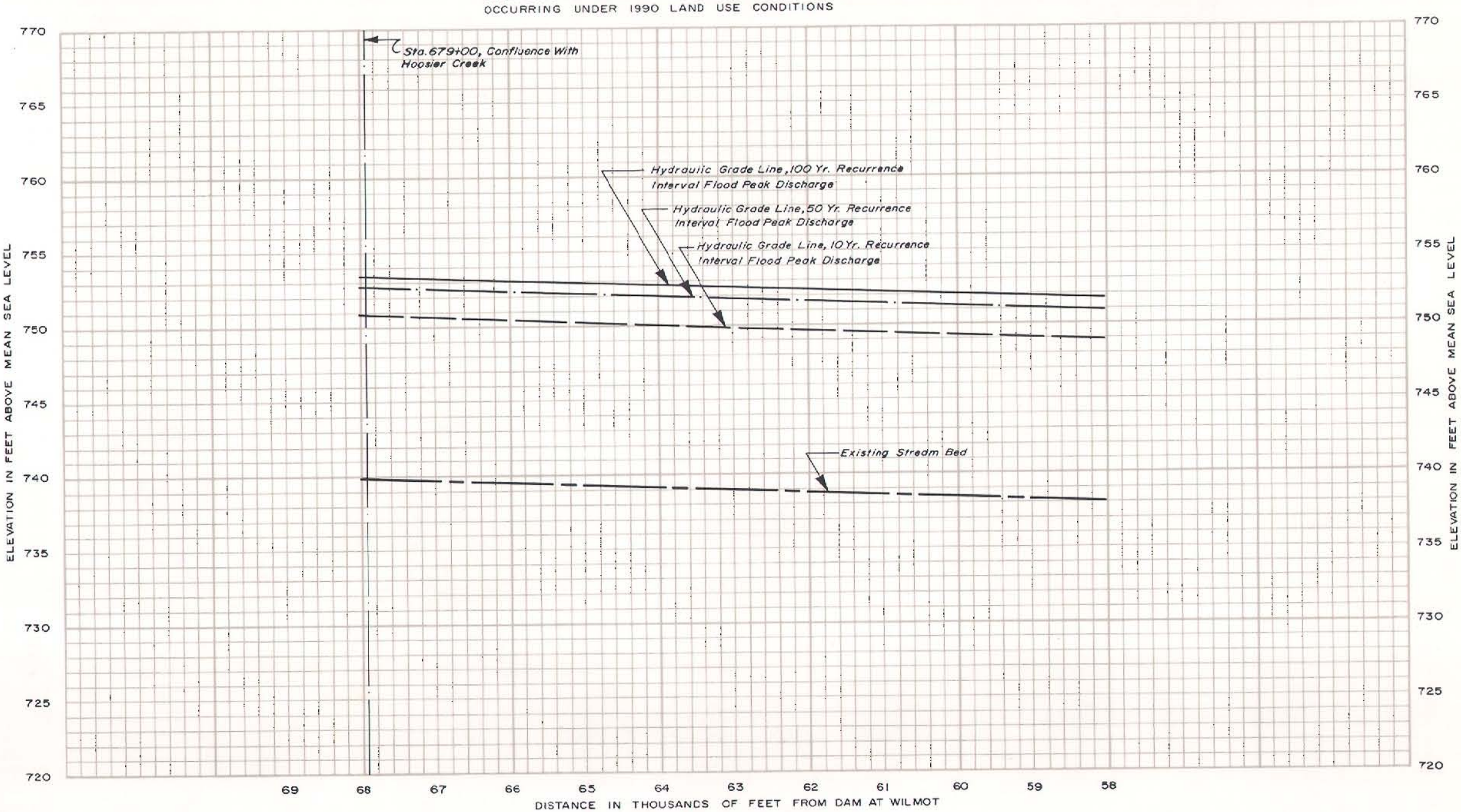
RACINE COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: NOVEMBER 1969

CHECKED: DRB DATE: NOVEMBER 1969

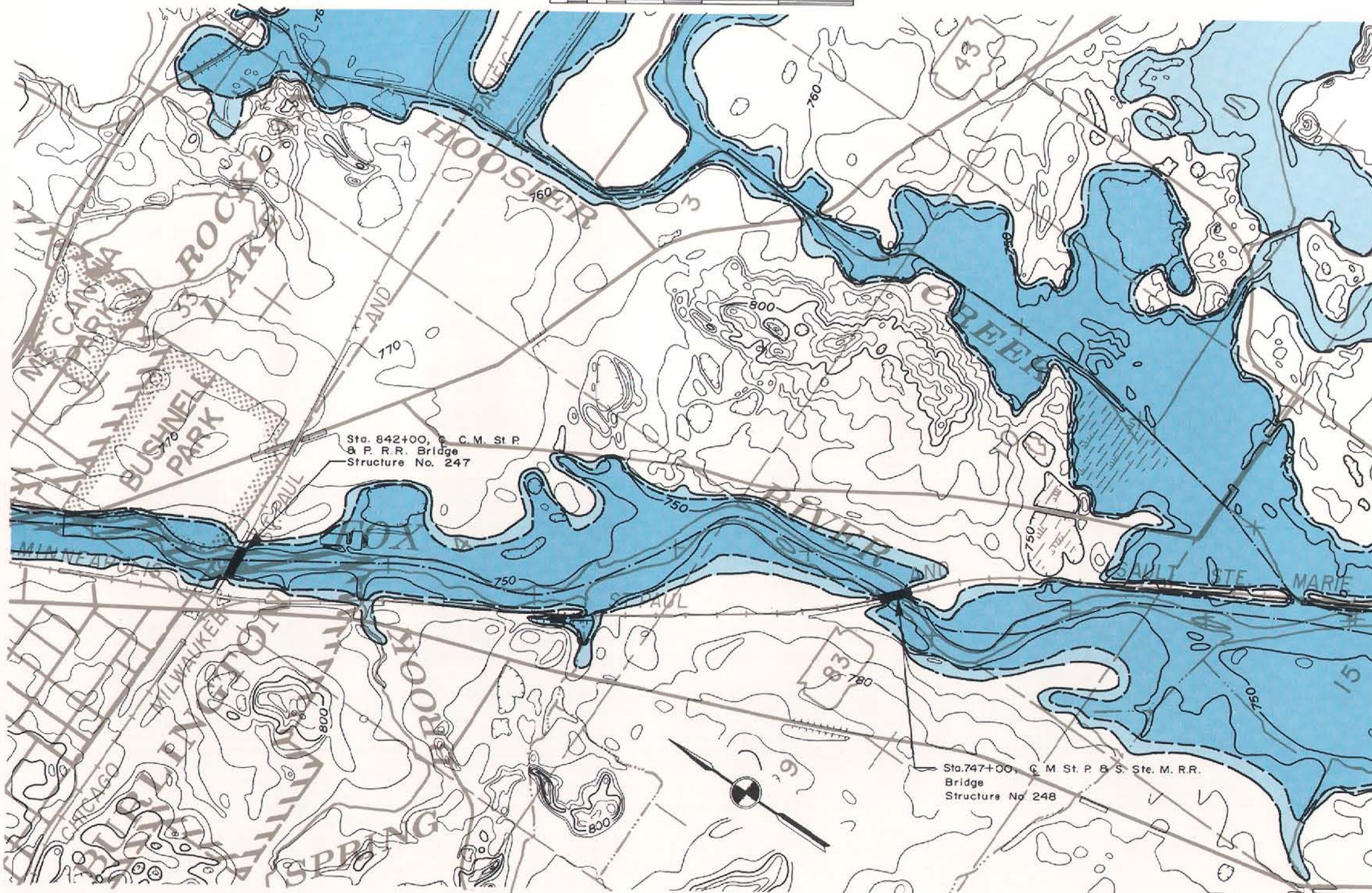
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-I (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
LOWER FOX RIVER
FROM STA. 680+00 TO STA. 860+00
RACINE COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: SEPTEMBER 1969
CHECKED: DRB DATE: SEPTEMBER 1969
SCALE: 1" = 2000'

GRAPHIC SCALE
0 2000 4000 FEET



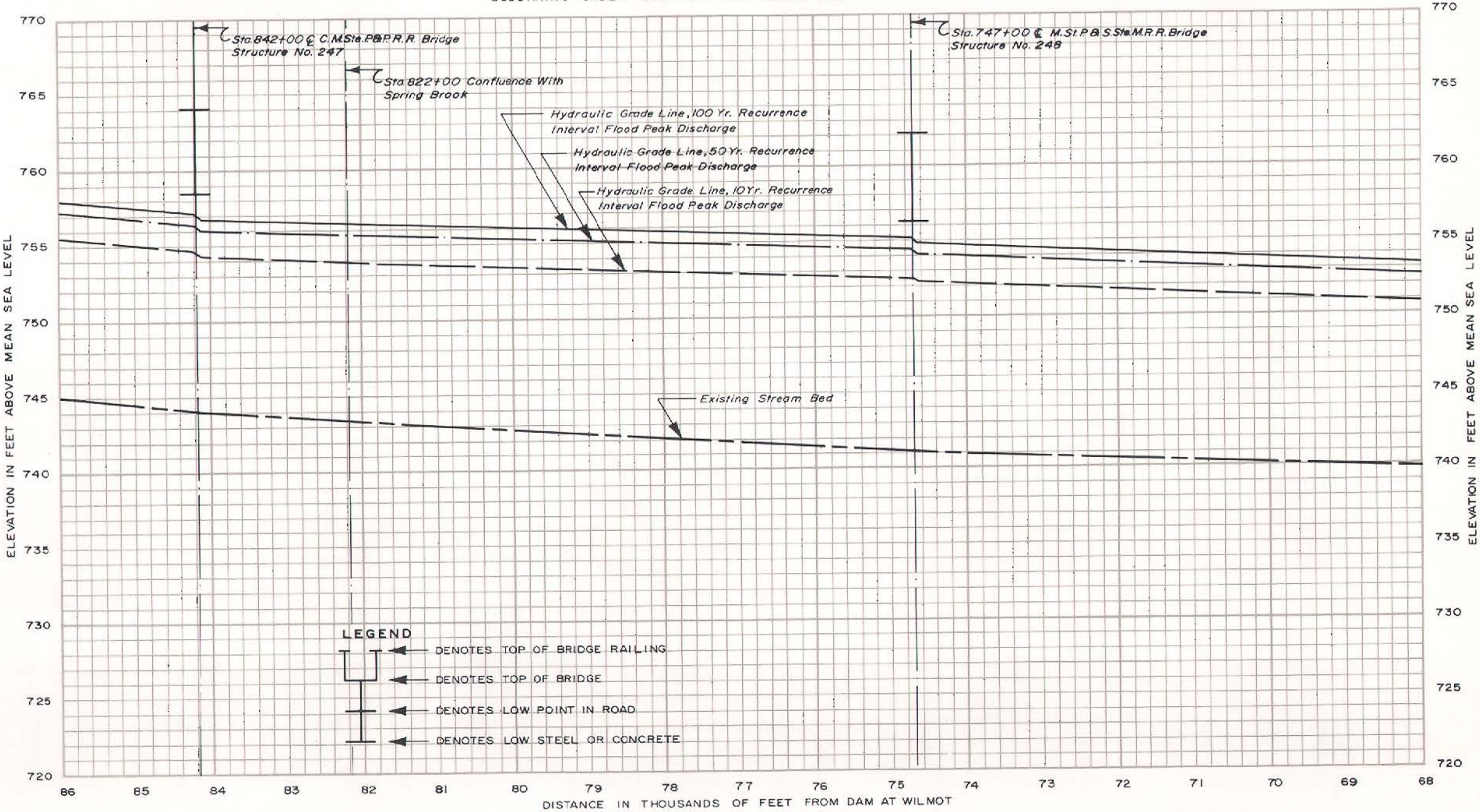
LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 + 00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-1 (continued)

HIGH WATER AND STREAM BED PROFILES
OF THE
LOWER FOX RIVER
FROM STA. 680+00 TO STA. 860+00
RACINE COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: LHK DATE: NOVEMBER 1969
CHECKED: DRB DATE: NOVEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS

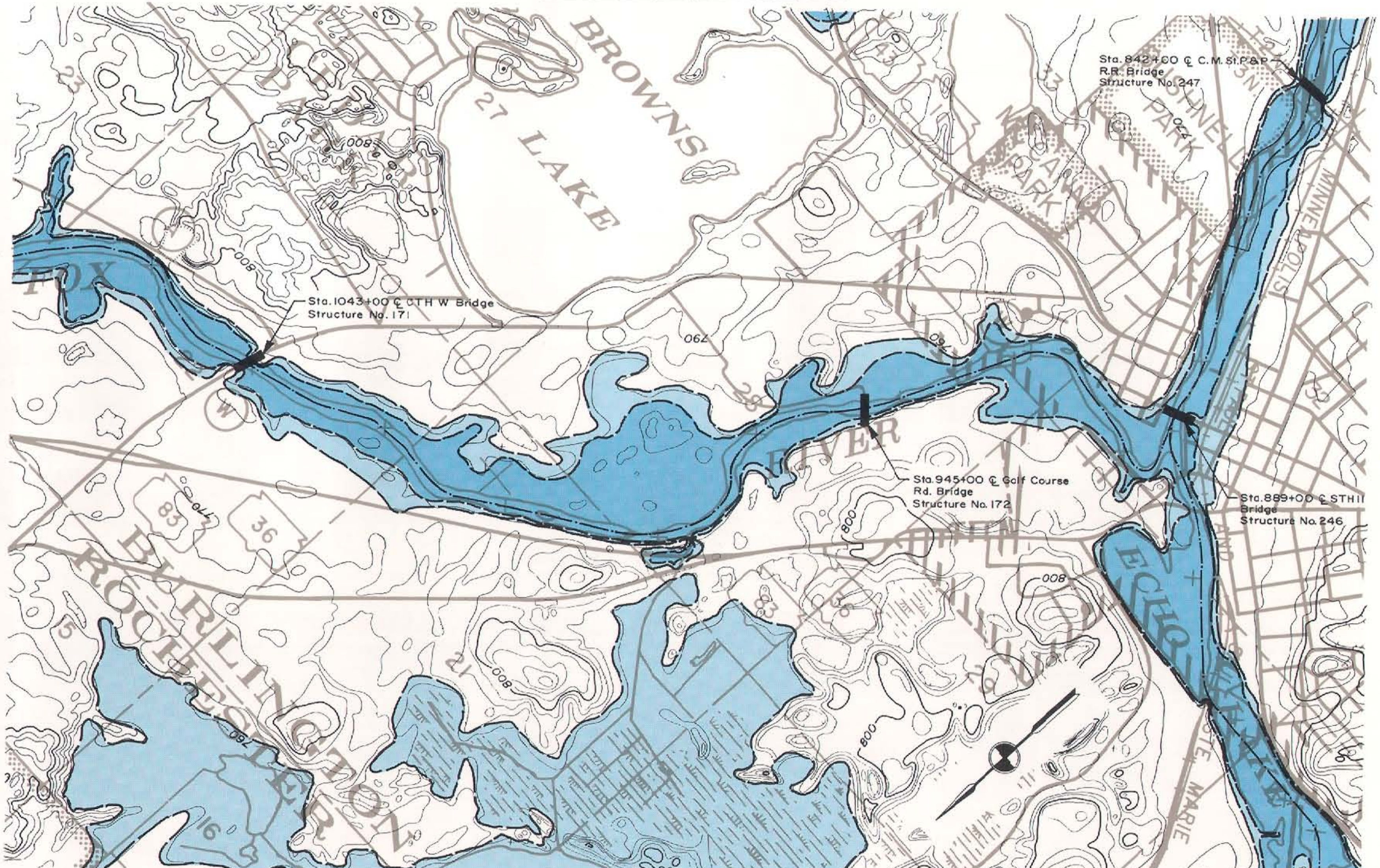


NOTE: BURLINGTON CITY DATUM = MEAN SEA LEVEL DATUM, 1929 ADJUSTMENT MINUS 175.25'

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

Map D-1 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
LOWER FOX RIVER

FROM STA. 860+00 TO STA. 1040+00
RACINE COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: SEPTEMBER 1969
CHECKED: DRB DATE: SEPTEMBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

	DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
	DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
	DENOTES APPROXIMATE CENTER LINE OF FLOODWAY
Sta. 131+00	DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
	ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
+	DENOTES STATION TICK

Figure D-1 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

LOWER FOX RIVER

FROM STA. 860+00 TO STA. 1040+00

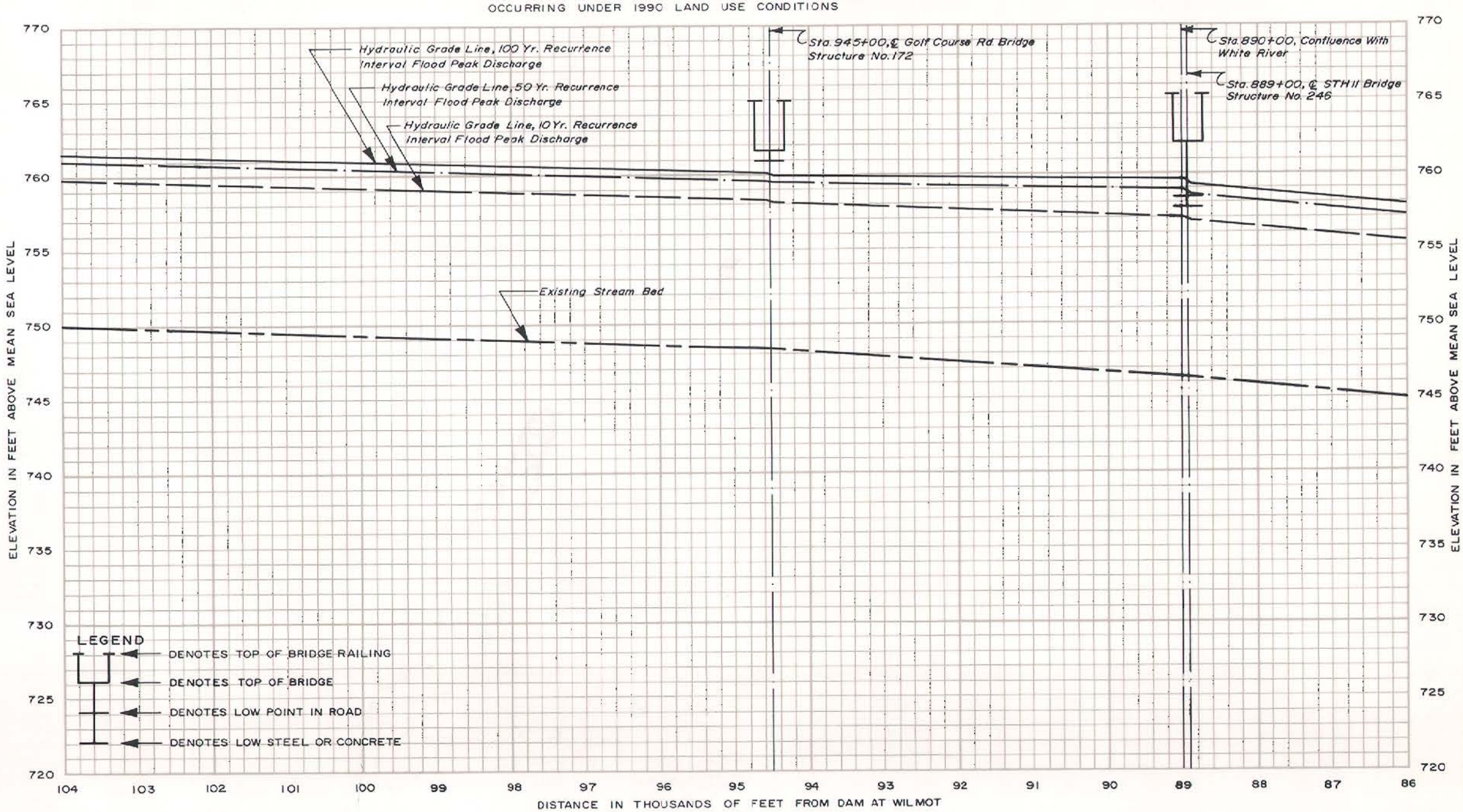
RACINE COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: NOVEMBER 1969

CHECKED: DRB DATE: NOVEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



NOTE: BURLINGTON CITY DATUM = MEAN SEA LEVEL DATUM, 1929 AJUSTMENT MINUS 175.25'

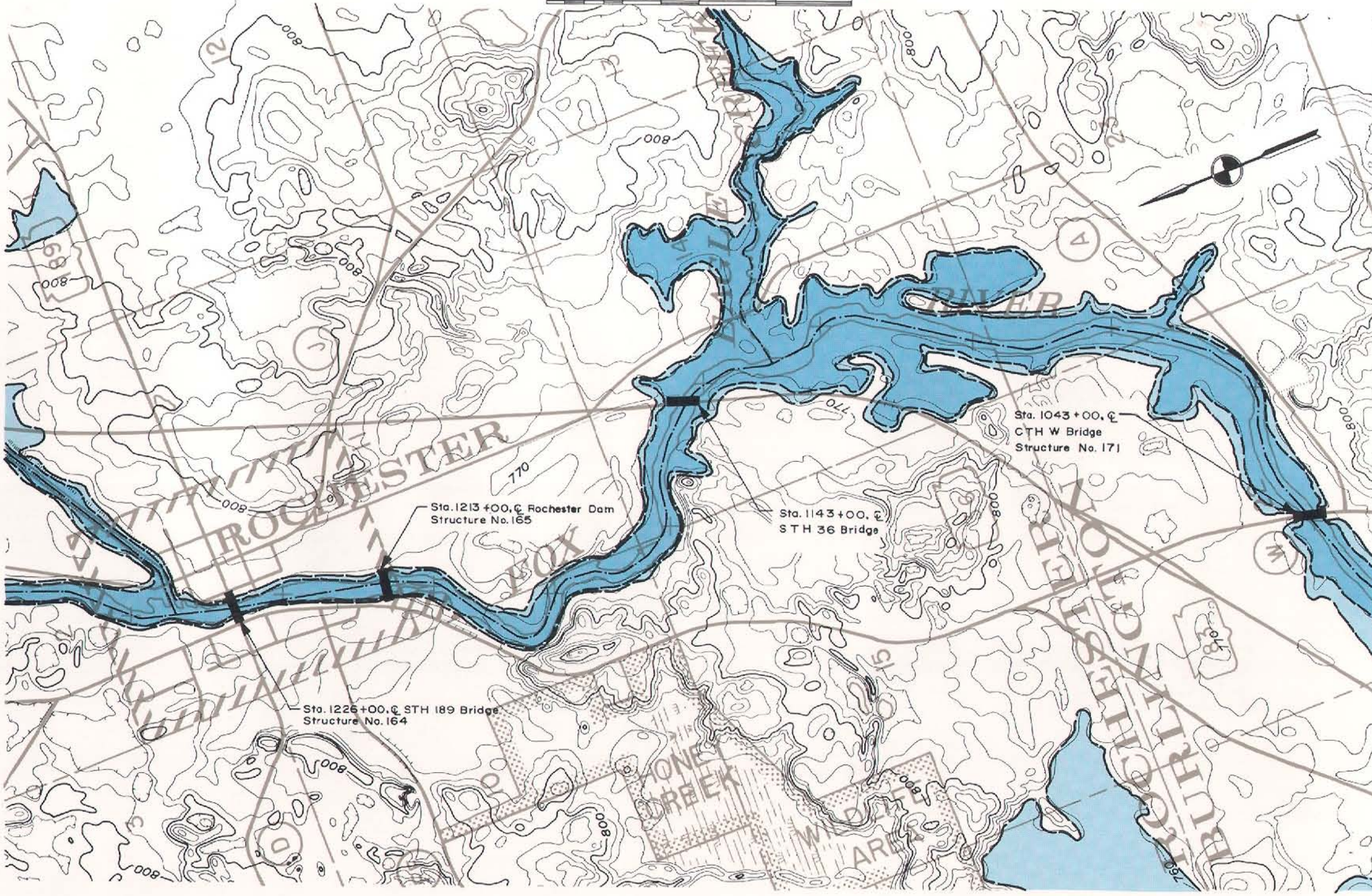
Source: U.S. Soil Conservation Service; SEWRPC.

Map D-1 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
LOWER FOX RIVER

FROM STA. 1040+00 TO STA. 1140+00
RACINE COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: JHW DATE: SEPTEMBER 1969
CHECKED: DRB DATE: SEPTEMBER 1969

SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

\+ DENOTES STATION TICK

Figure D-1 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

LOWER FOX RIVER

FROM STA. 1040+00 TO STA. 1140+00

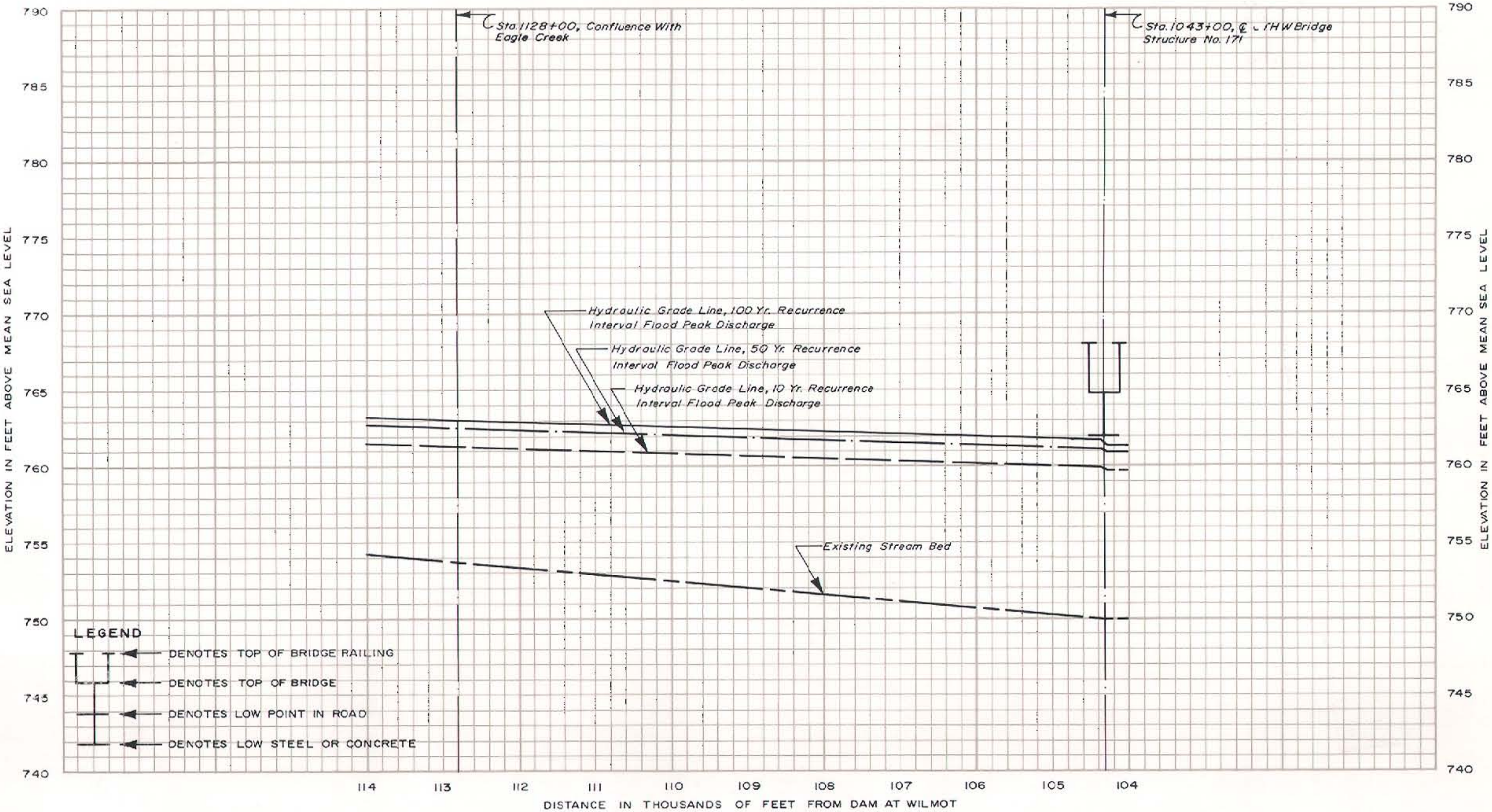
RACINE COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: NOVEMBER 1969

CHECKED: DRB DATE: NOVEMBER 1969

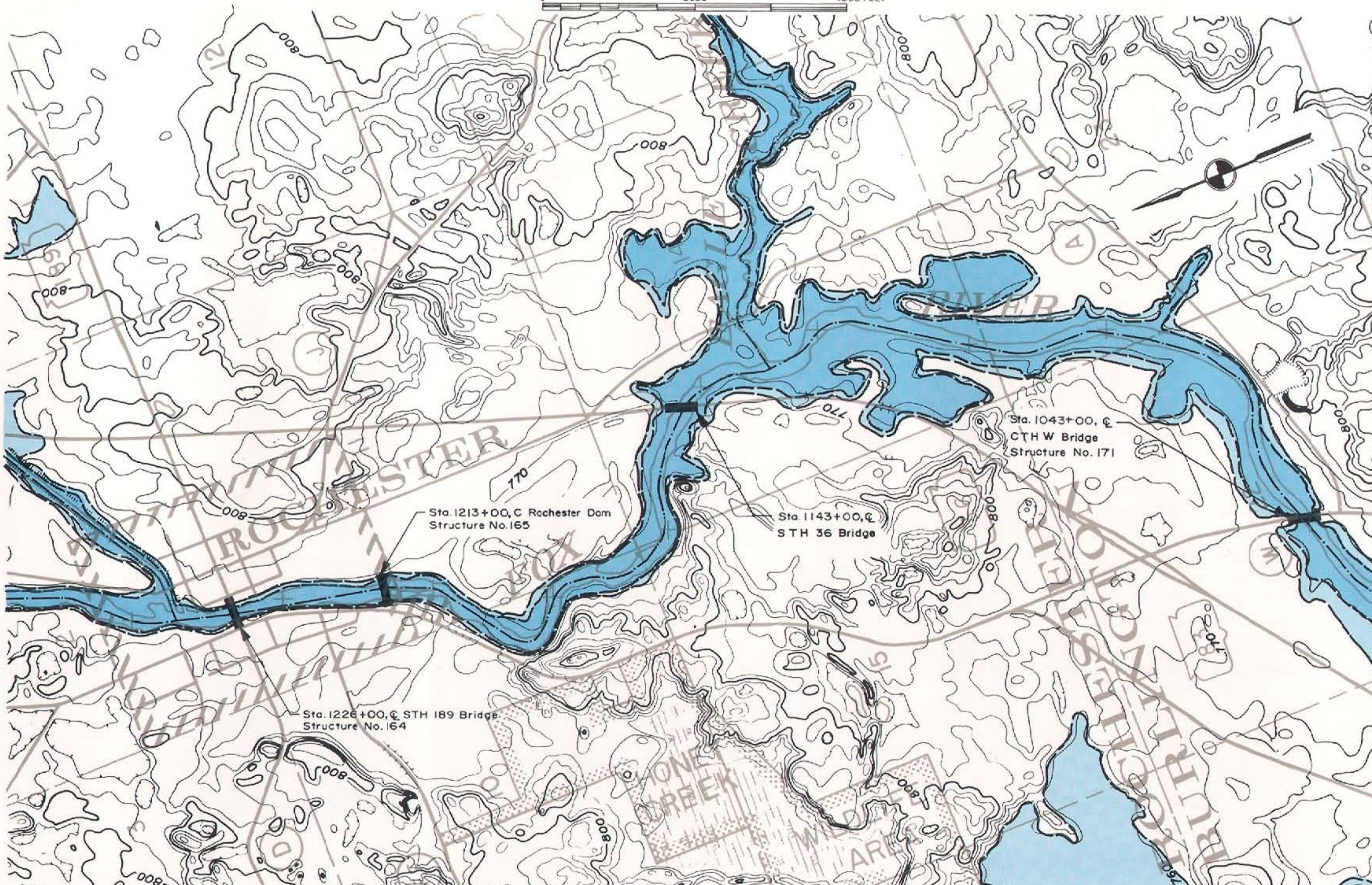
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-I (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
LOWER FOX RIVER

FROM STA. 1140+00 TO STA. 1240+00
RACINE COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: JHW DATE: SEPTEMBER 1969
CHECKED: DRB DATE: SEPTEMBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND
DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
\+ DENOTES STATION TICK

Figure D-I (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

LOWER FOX RIVER

FROM STA. 1140+00 TO STA. 1240+00

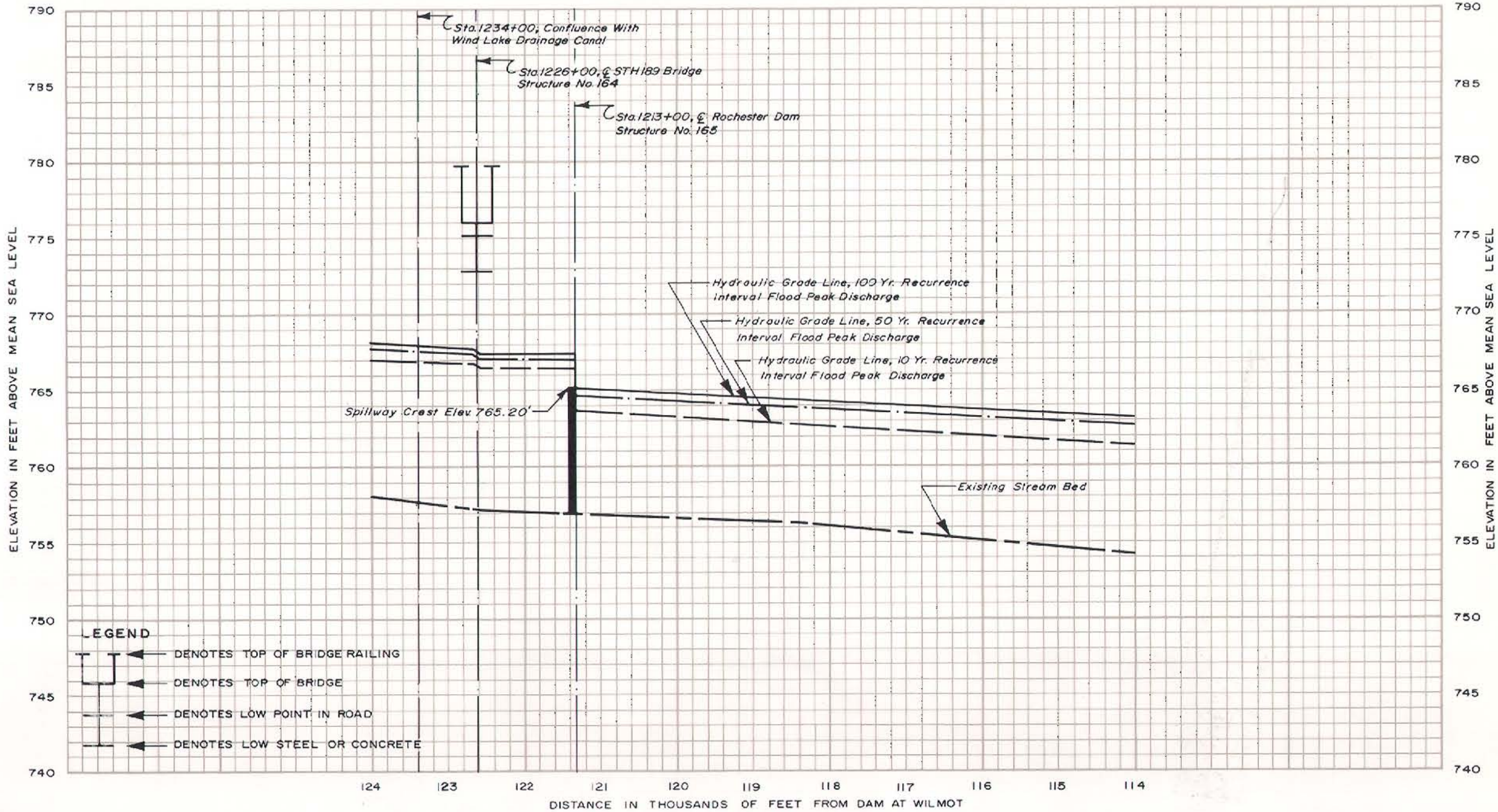
RACINE COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: NOVEMBER 1969

CHECKED: DRB DATE: NOVEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

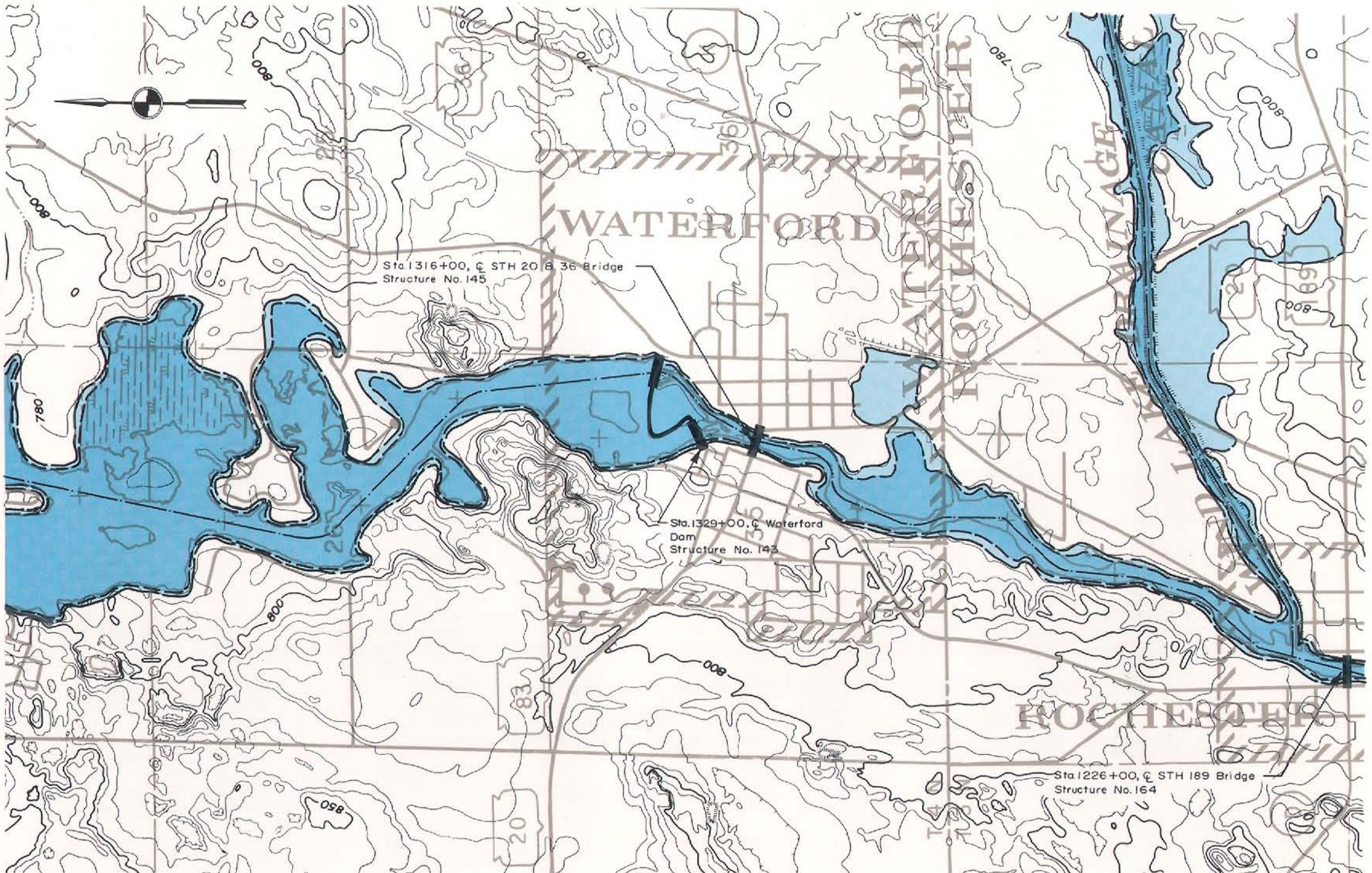
Map D-1 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
LOWER FOX RIVER

FROM STA. 1240+00 TO STA. 1420+00
RACINE COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: RHH DATE: SEPTEMBER 1969
CHECKED: DRB DATE: SEPTEMBER 1969

SCALE: 1" = 2000'

GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

DENOTES STATION TICK

Figure D-1 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

LOWER FOX RIVER

FROM STA. 1240+00 TO STA. 1420+00

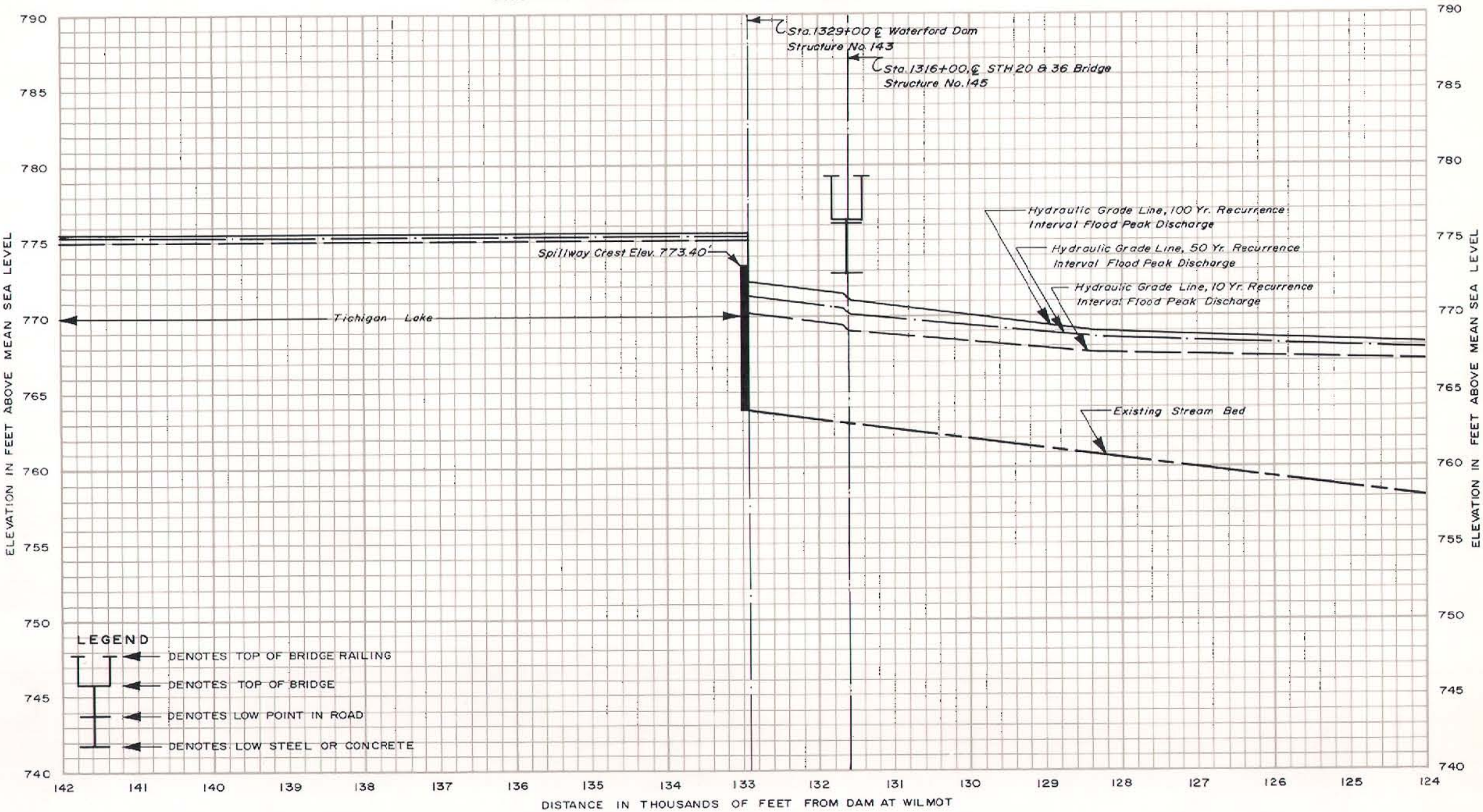
RACINE COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: NOVEMBER 1969

CHECKED: DRB DATE: NOVEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



NOTE: WATERFORD VILLAGE DATUM = MEAN SEA LEVEL DATUM, 1929 ADJUSTMENT MINUS 580.38'

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

Map D-1 (continued)

TOPOGRAPHIC MAP

SHOWING

AREAS SUBJECT TO FLOODING

ALONG THE

LOWER FOX RIVER

FROM STA. 1420+00 TO STA. 1520+00

RACINE COUNTY, WISCONSIN

PREPARED BY

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

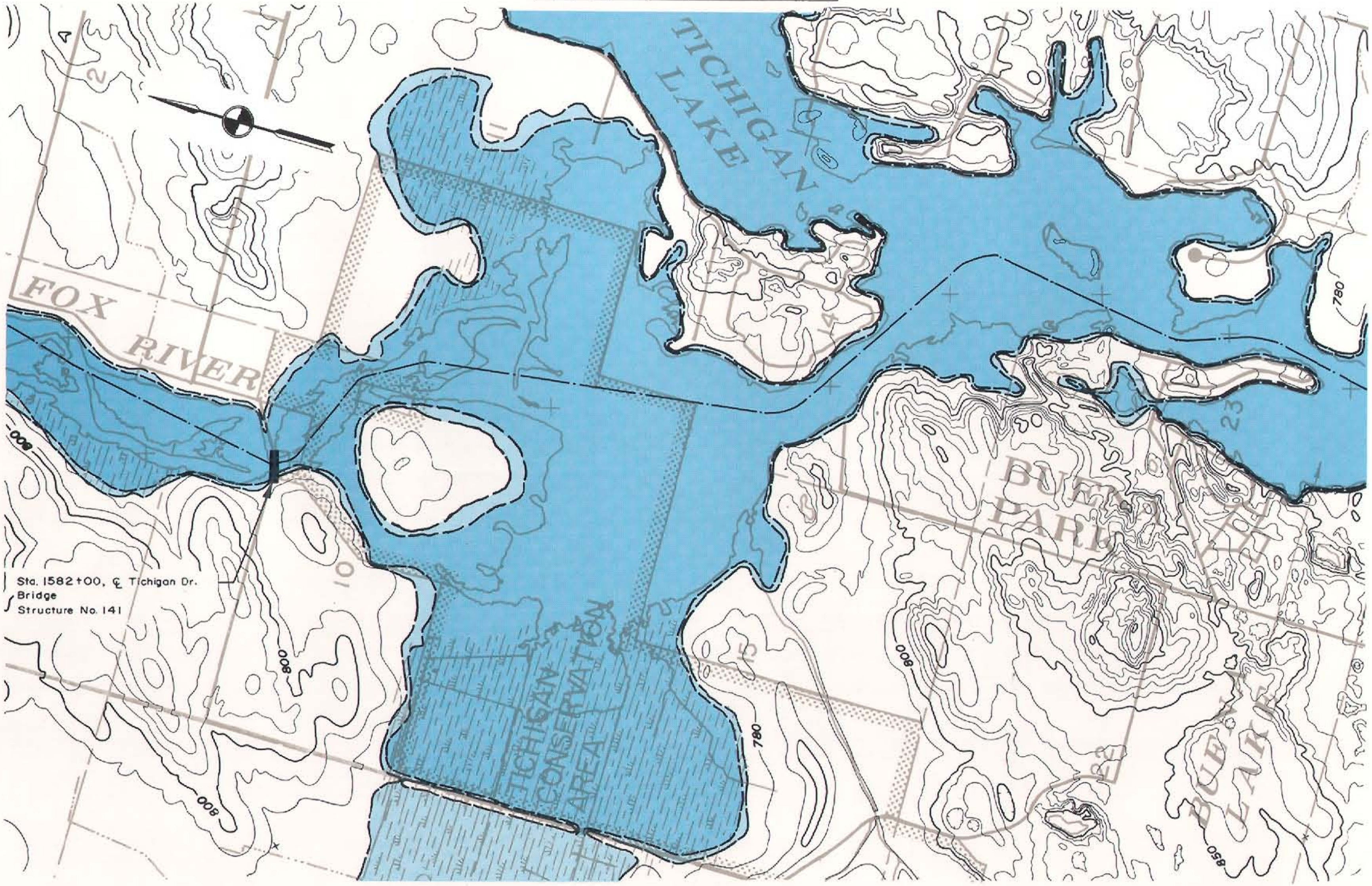
DRAWN: JHW DATE: SEPTEMBER 1969

CHECKED: DRB DATE: SEPTEMBER 1969

SCALE: 1" = 2000'

GRAPHIC SCALE

0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

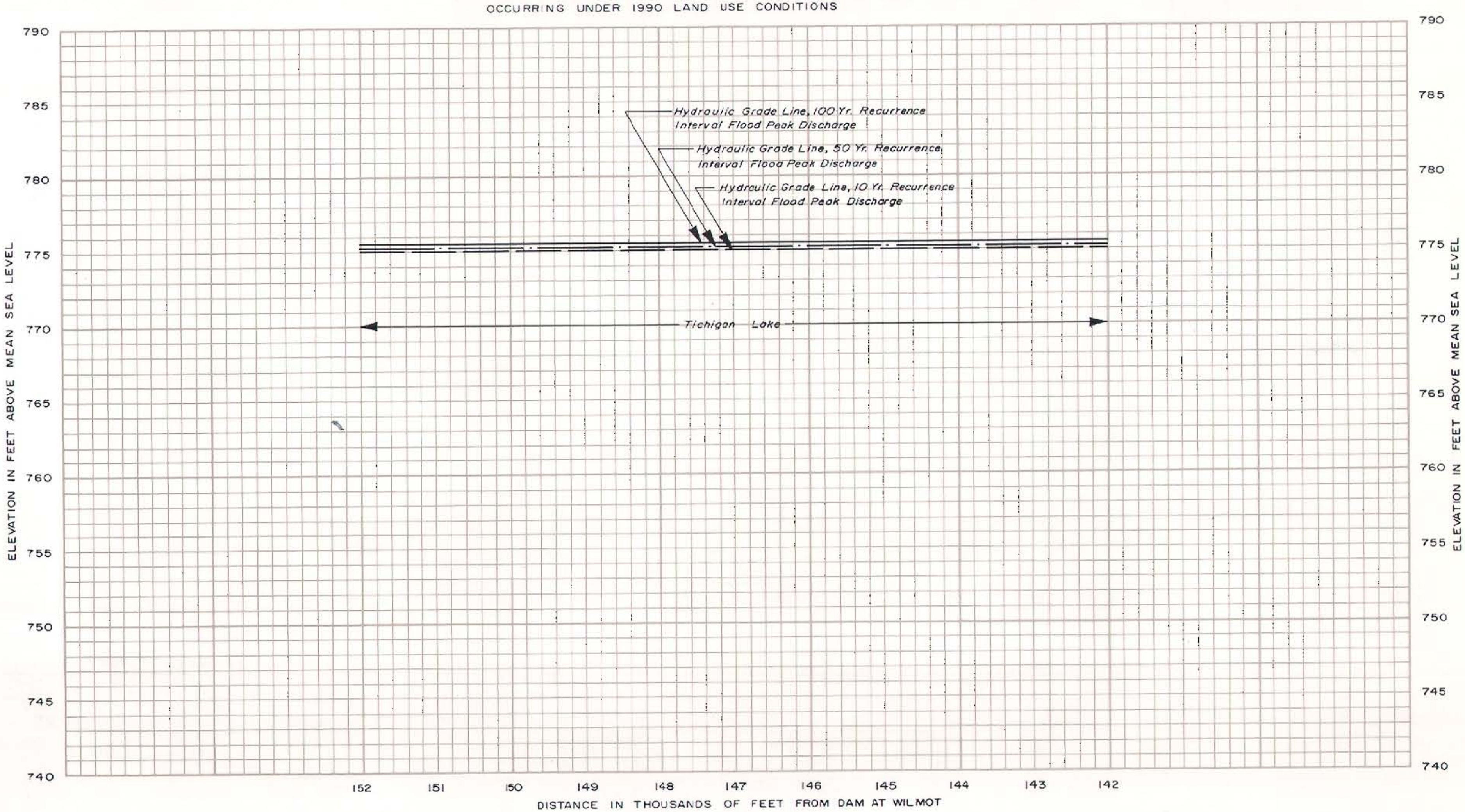
Sta. 131 + 00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

\+ DENOTES STATION TICK

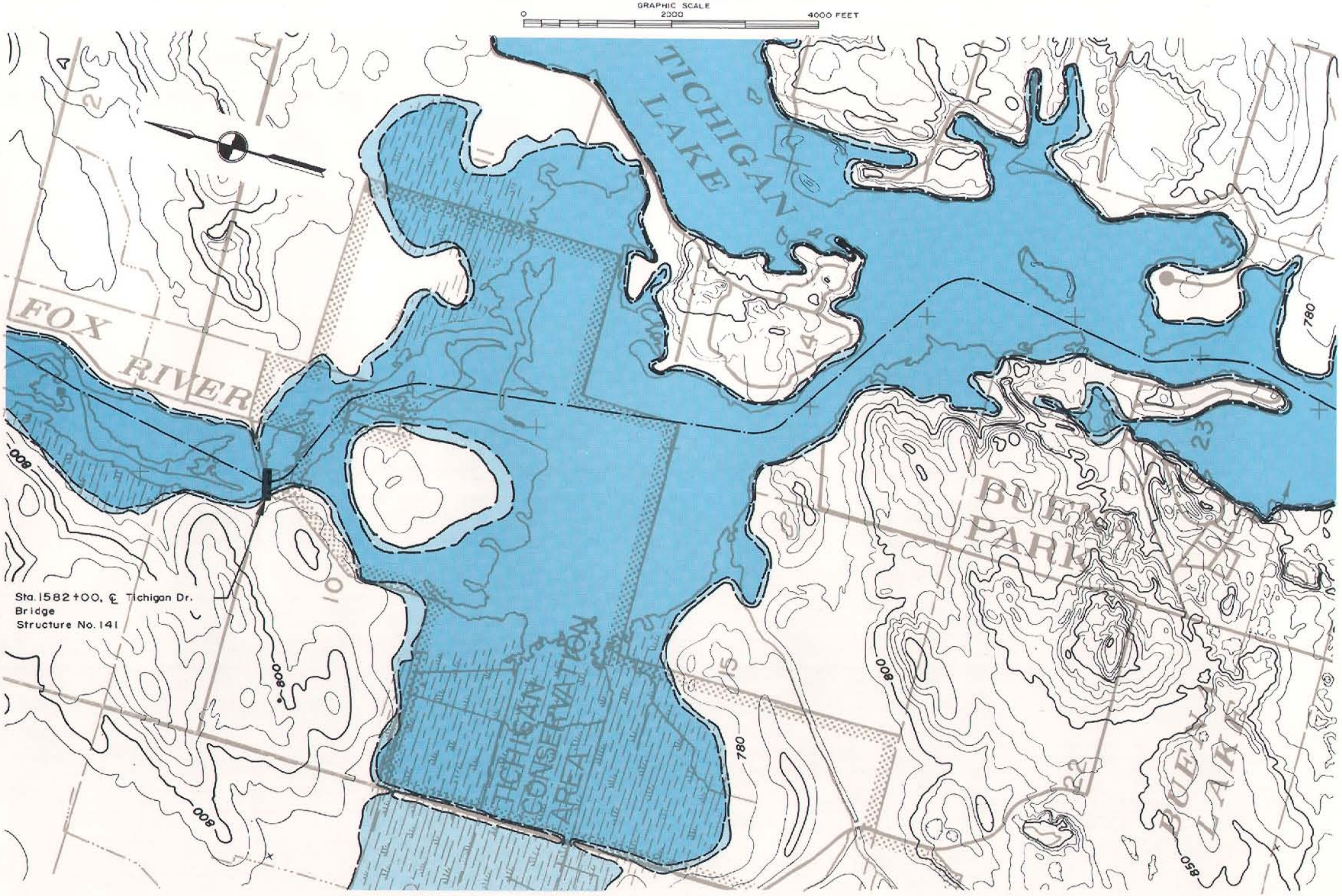
Figure D-I (continued)

HIGH WATER AND STREAM BED PROFILES
OF THE
LOWER FOX RIVER
FROM STA. 1420+00 TO STA. 1520+00
RACINE COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: LHK DATE: NOVEMBER 1969
CHECKED: DRB DATE: NOVEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS



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

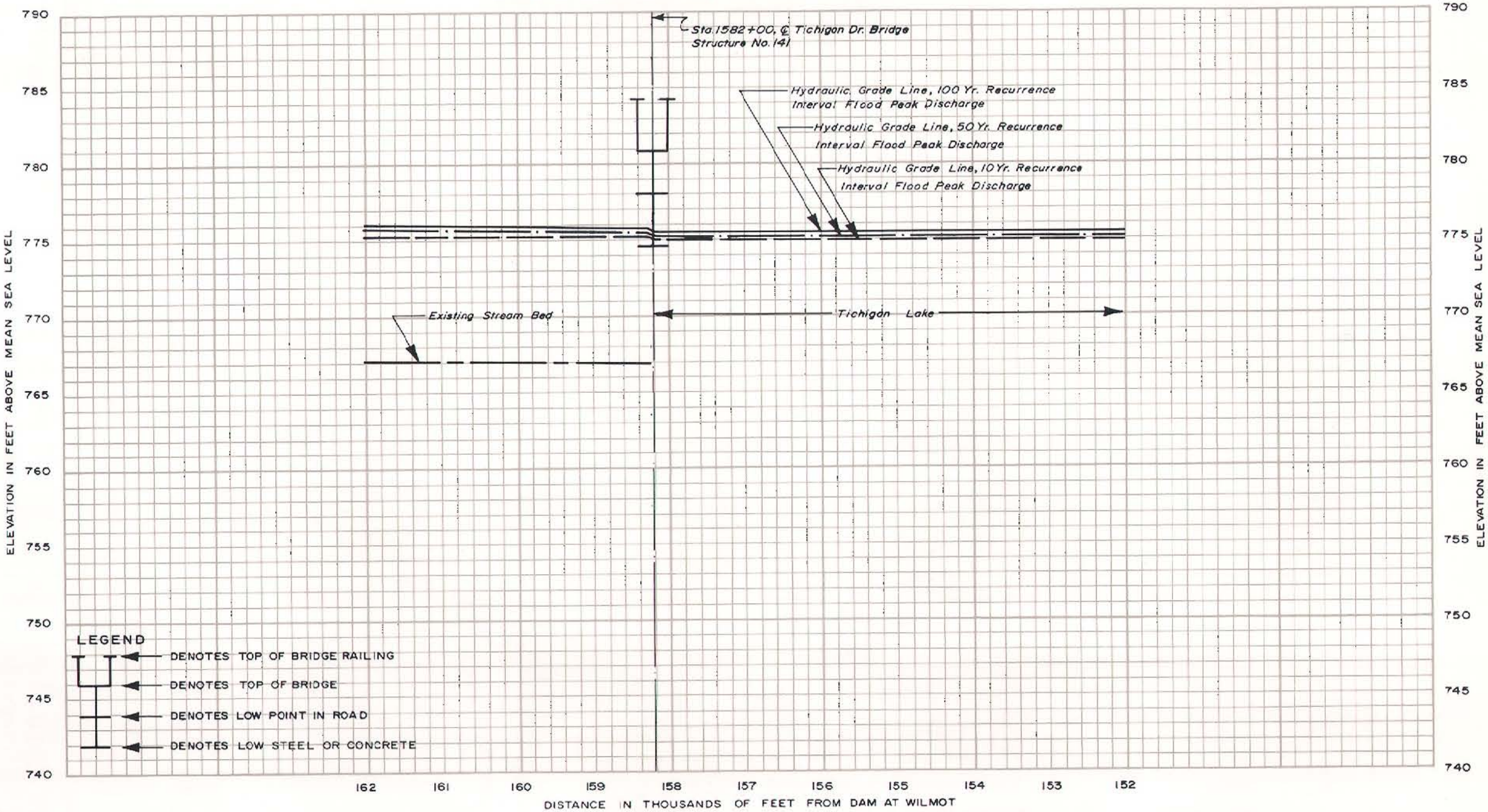
Map D-1 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
LOWER FOX RIVER
FROM STA. 1520+00 TO STA. 1620+00
RACINE COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: JHW DATE: SEPTEMBER 1969
CHECKED: DRB DATE: SEPTEMBER 1969
SCALE: 1" = 2000'



LEGEND
DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY
Sta. 131 + 00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-1 (continued)

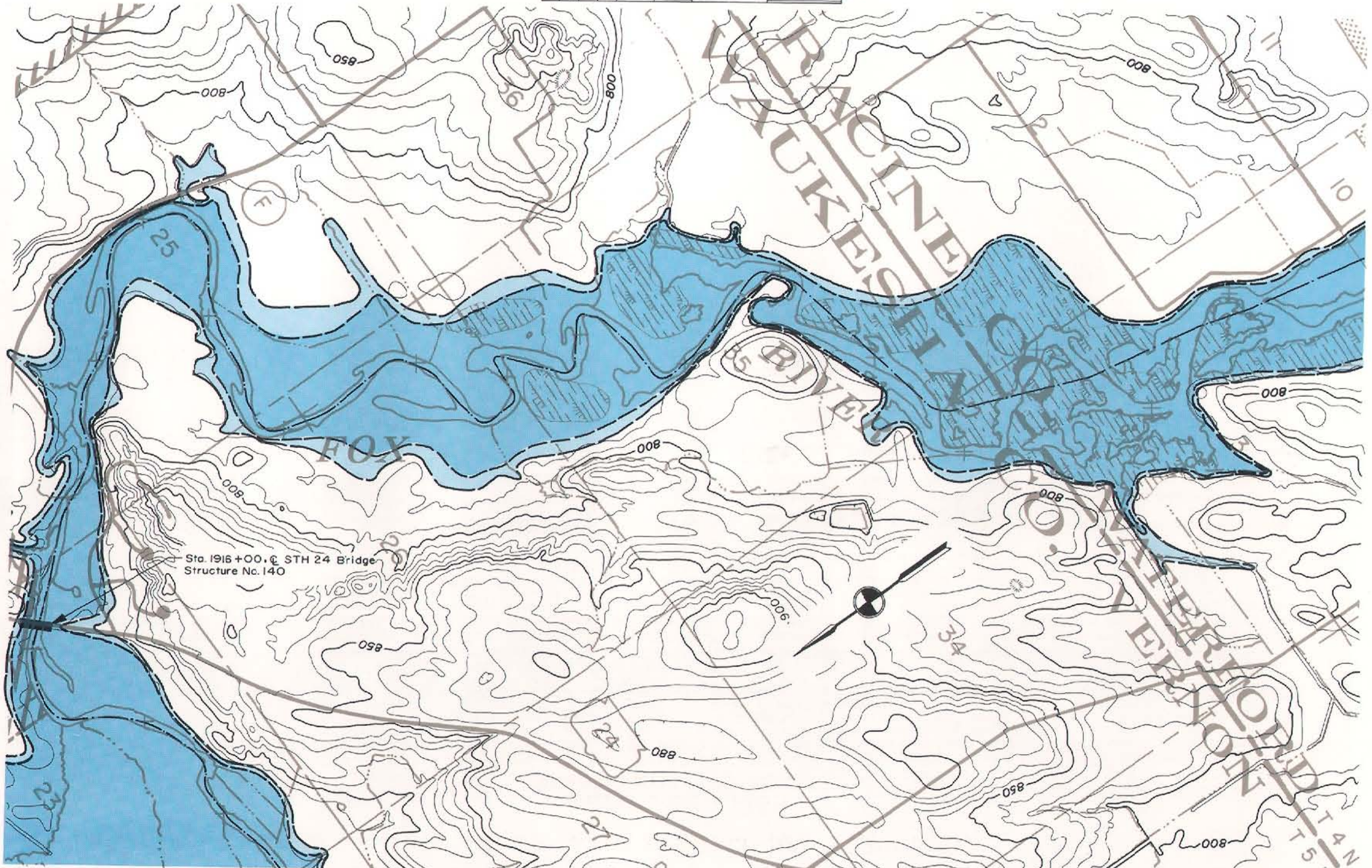
HIGH WATER AND STREAM BED PROFILES
OF THE
LOWER FOX RIVER
FROM STA. 1520+00 TO STA. 1620+00
RACINE COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: LHK DATE: NOVEMBER 1969
CHECKED: DRB DATE: NOVEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-1 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
LOWER FOX RIVER

FROM STA. 1620+00 TO STA. 1800+00
RACINE AND WAUKESHA COUNTIES, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: SEPTEMBER 1969
CHECKED: DRB DATE: SEPTEMBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET

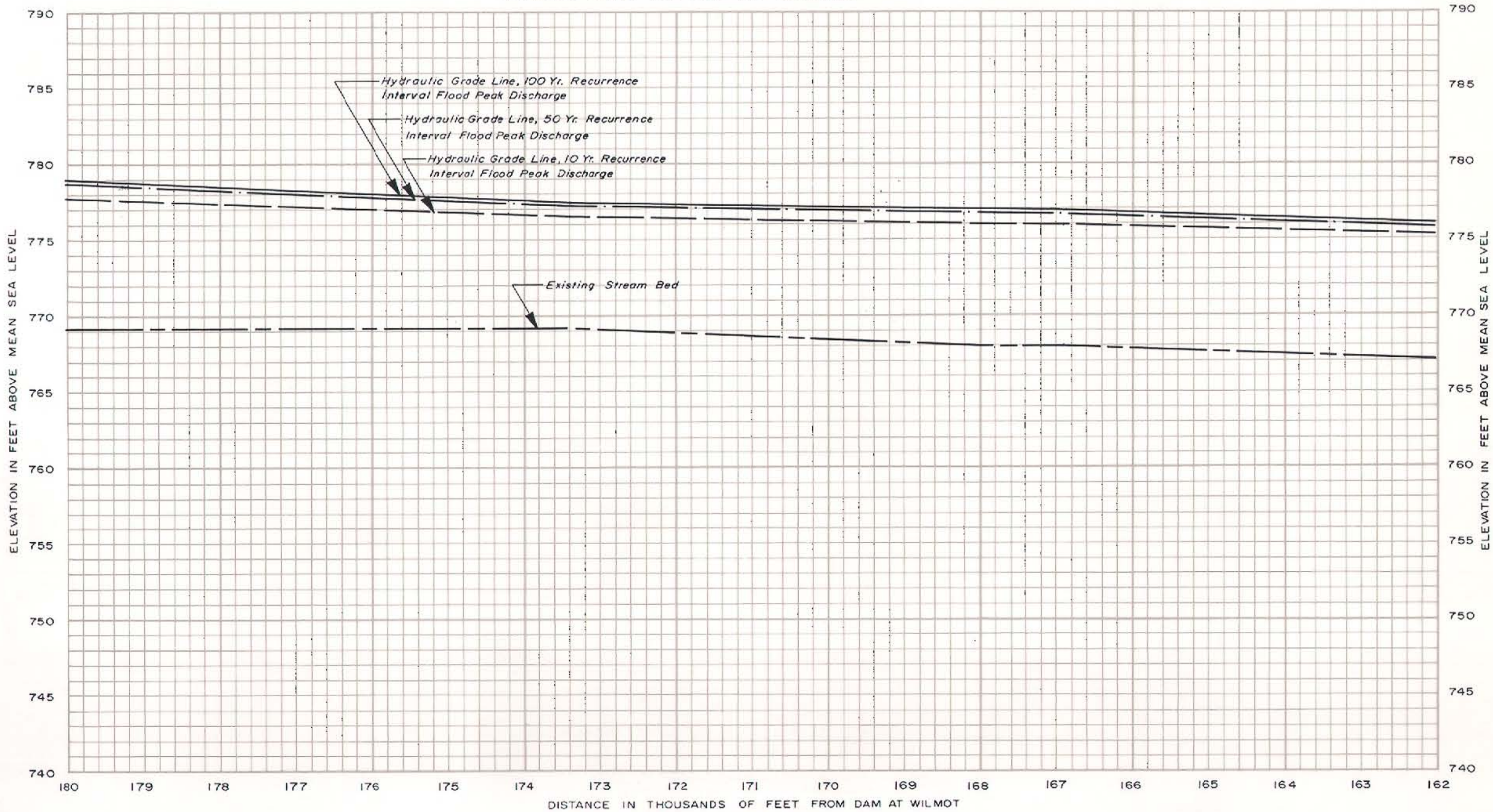


LEGEND
DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY
Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-1 (continued)

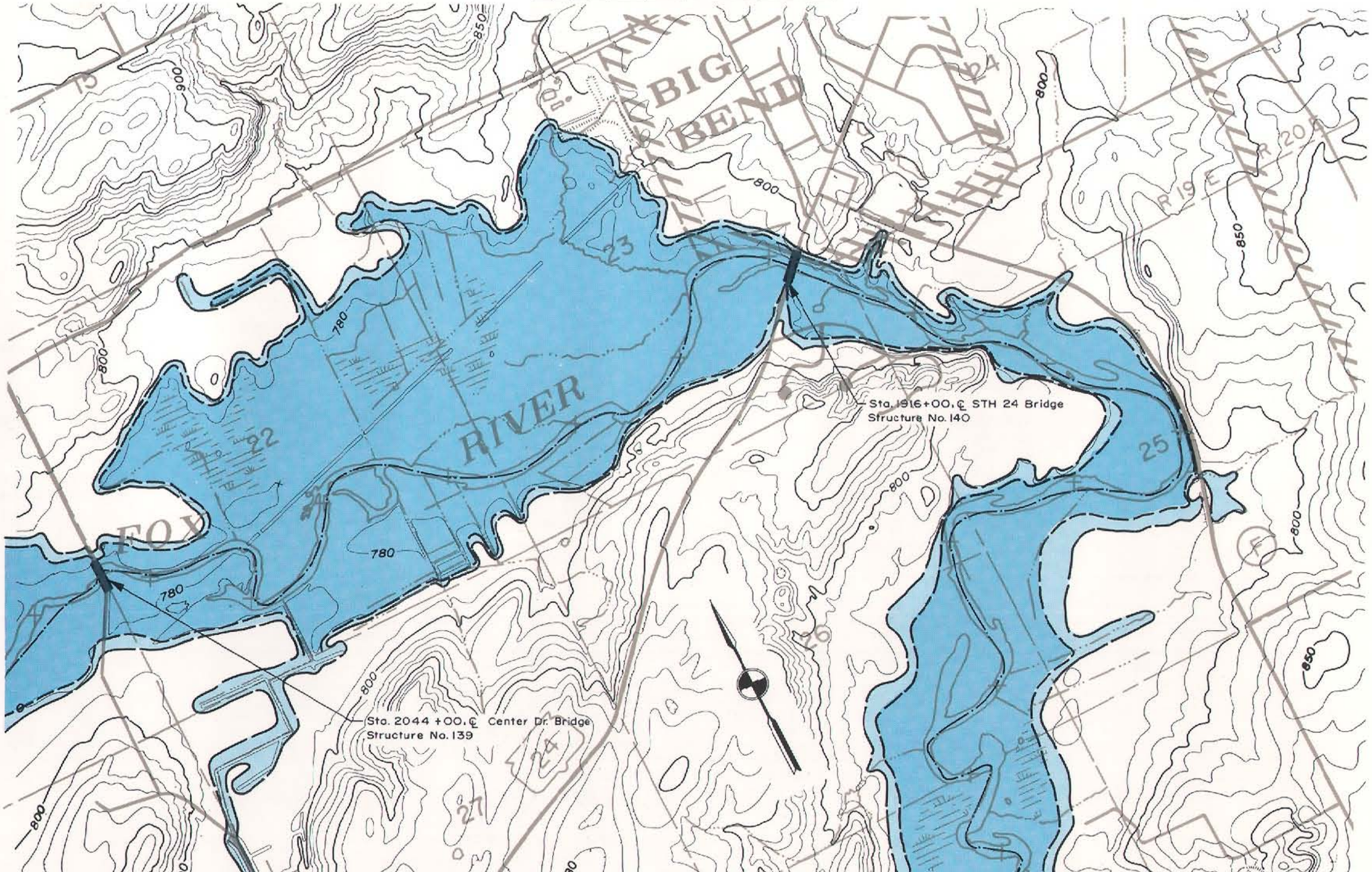
HIGH WATER AND STREAM BED PROFILES
OF THE
LOWER FOX RIVER

FROM STA. 1620+00 TO STA. 1800+00
RACINE COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: LHK DATE: NOVEMBER 1969
CHECKED: DRB DATE: NOVEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-1 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
LOWER FOX RIVER
FROM STA. 1800+00 TO STA. 1980+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: SEPTEMBER 1969
CHECKED: DRB DATE: SEPTEMBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND
DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY
Sta 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

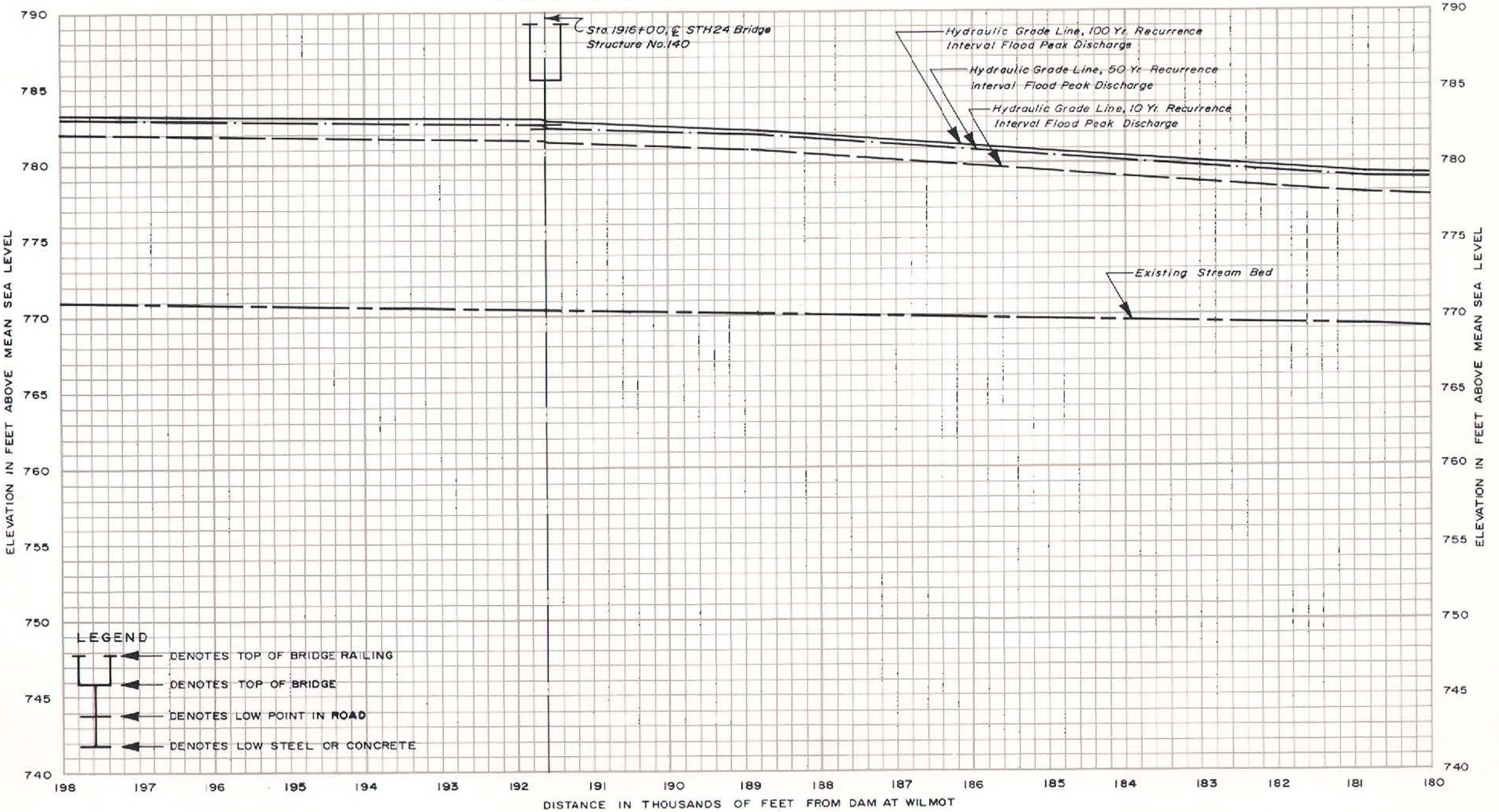
Figure D-1 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

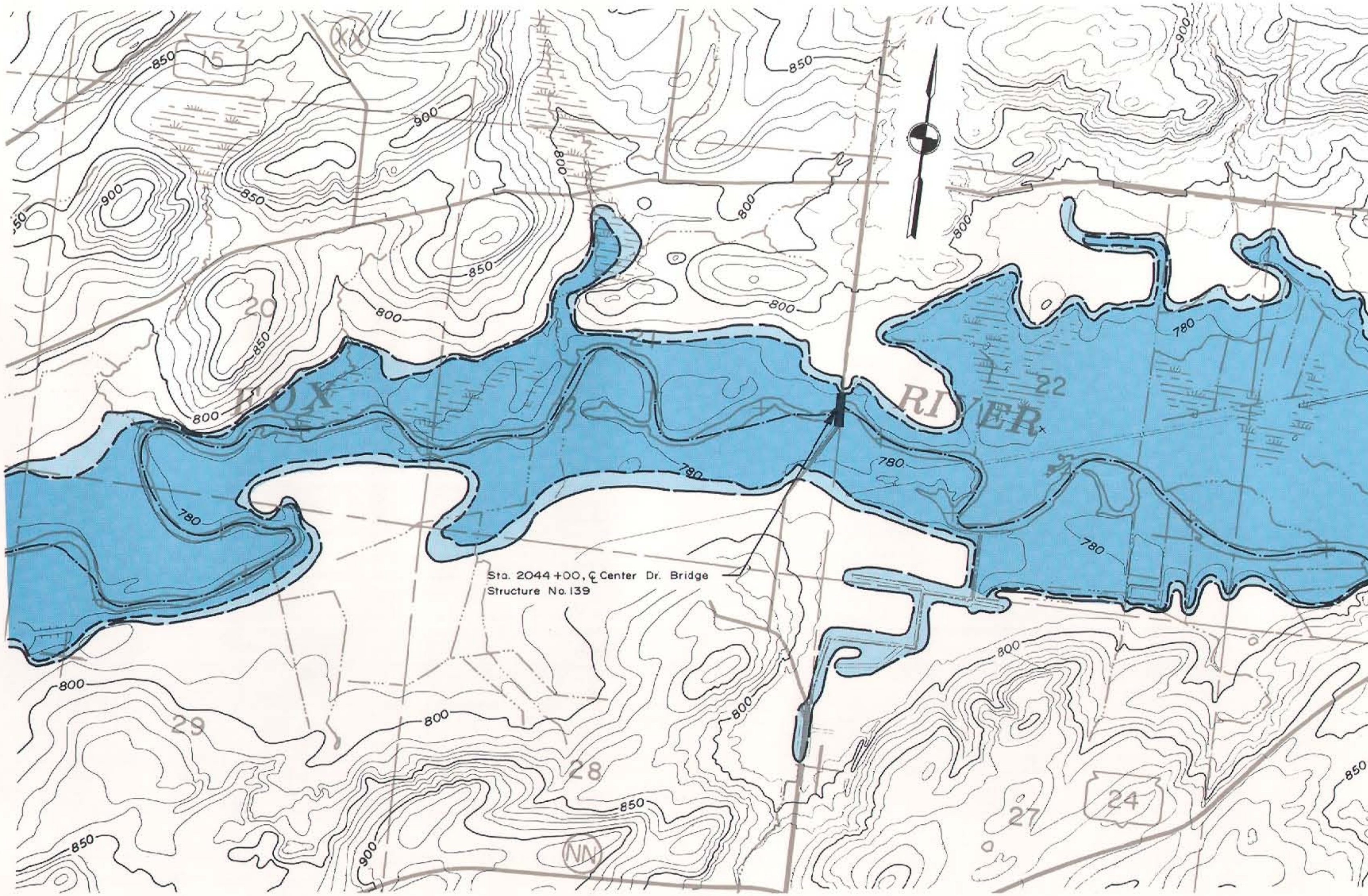
LOWER FOX RIVER

FROM STA. 1800+00 TO STA. 1980+00
RACINE AND WAUKESHA COUNTIES, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: LHK DATE: NOVEMBER 1969
CHECKED: DRB DATE: NOVEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-1 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
LOWER FOX RIVER
FROM STA. 1980+00 TO STA. 2160+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: SEPTEMBER 1969
CHECKED: DRB DATE: SEPTEMBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND
DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-1 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

LOWER FOX RIVER

FROM STA. 1980+00 TO STA. 2160+00

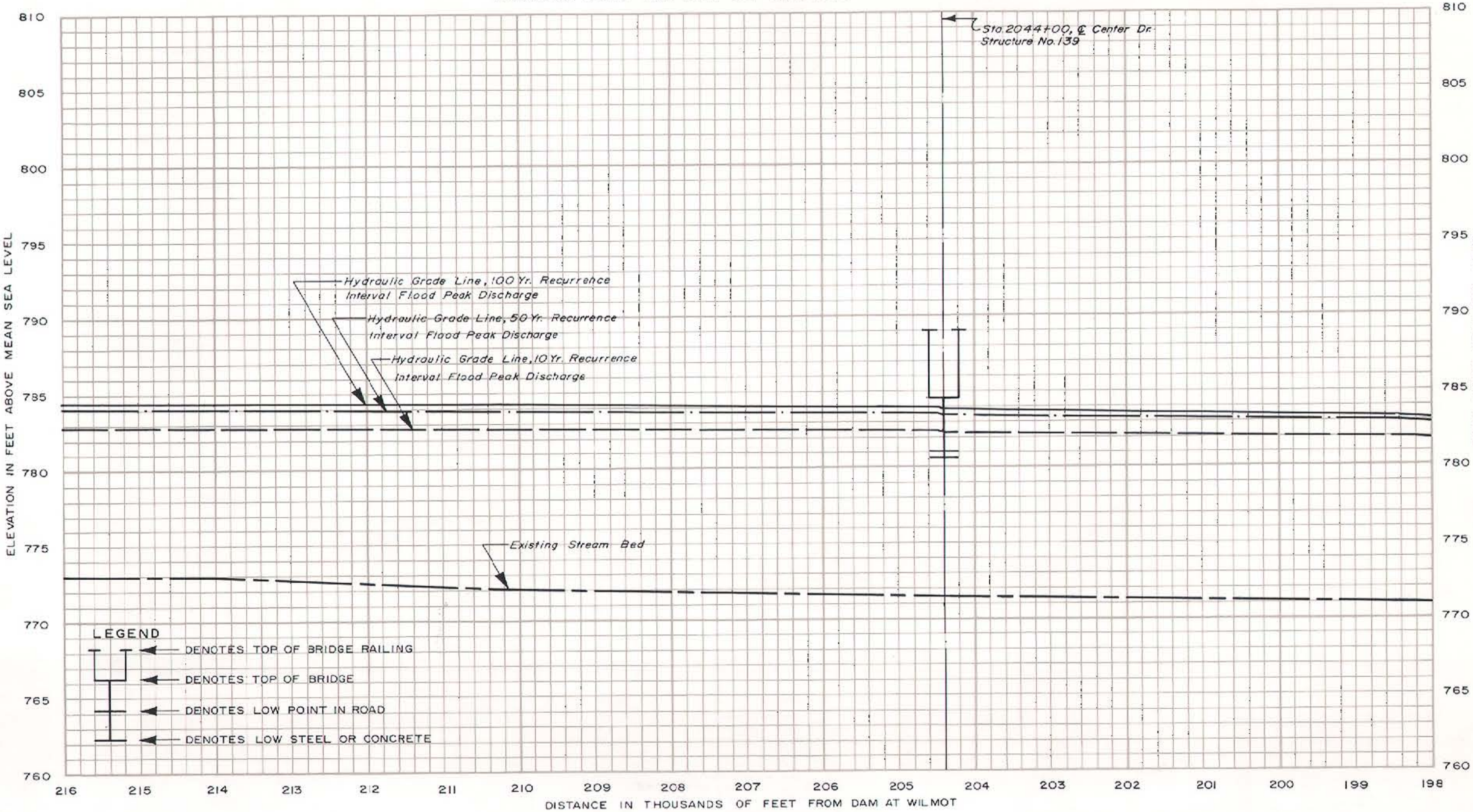
WAUKESHA COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: NOVEMBER 1969

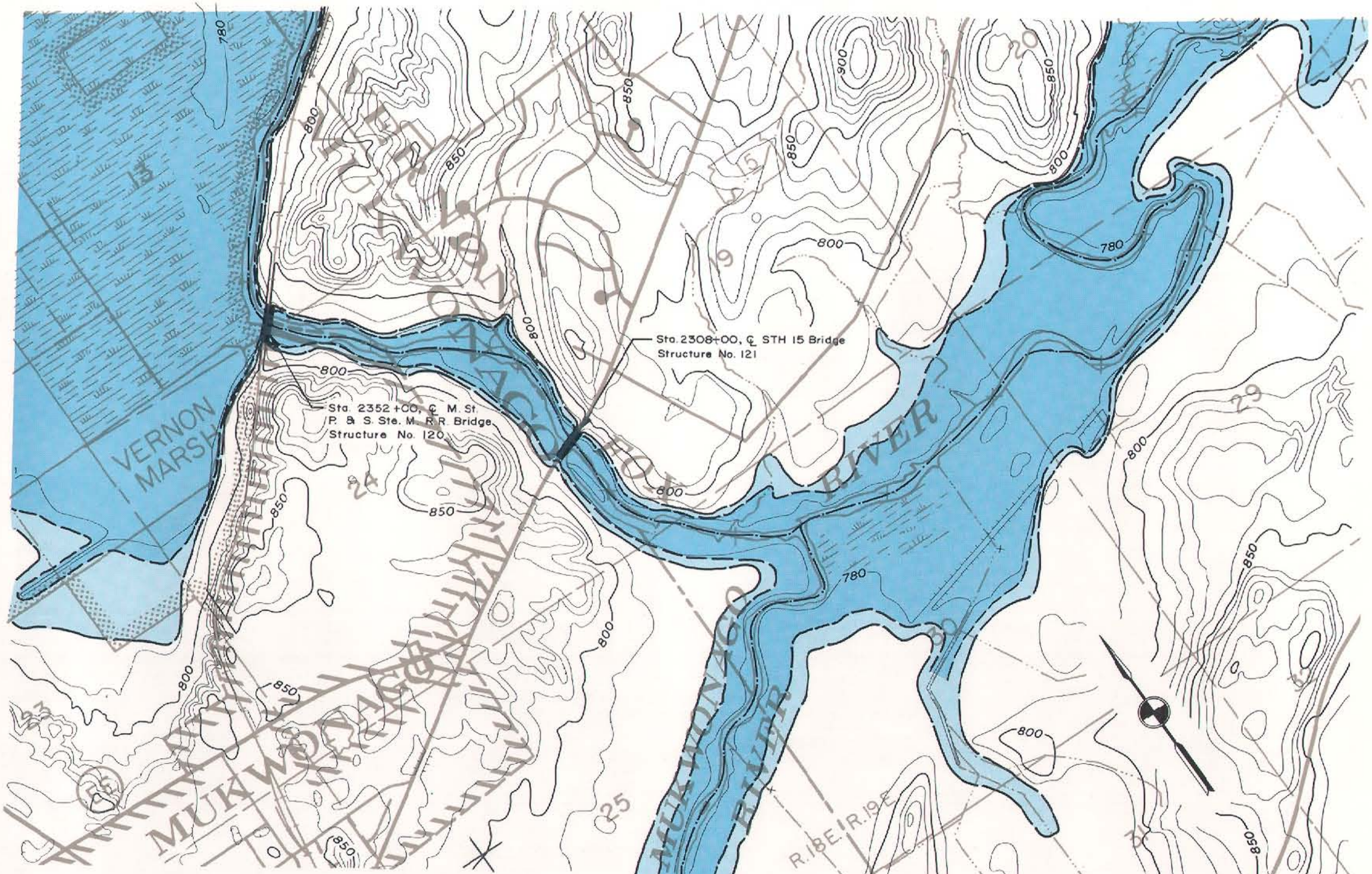
CHECKED: DRB DATE: NOVEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-1 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
LOWER FOX RIVER
FROM STA. 2160+00 TO STA. 2340+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: SEPTEMBER 1969
CHECKED: DRB DATE: SEPTEMBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

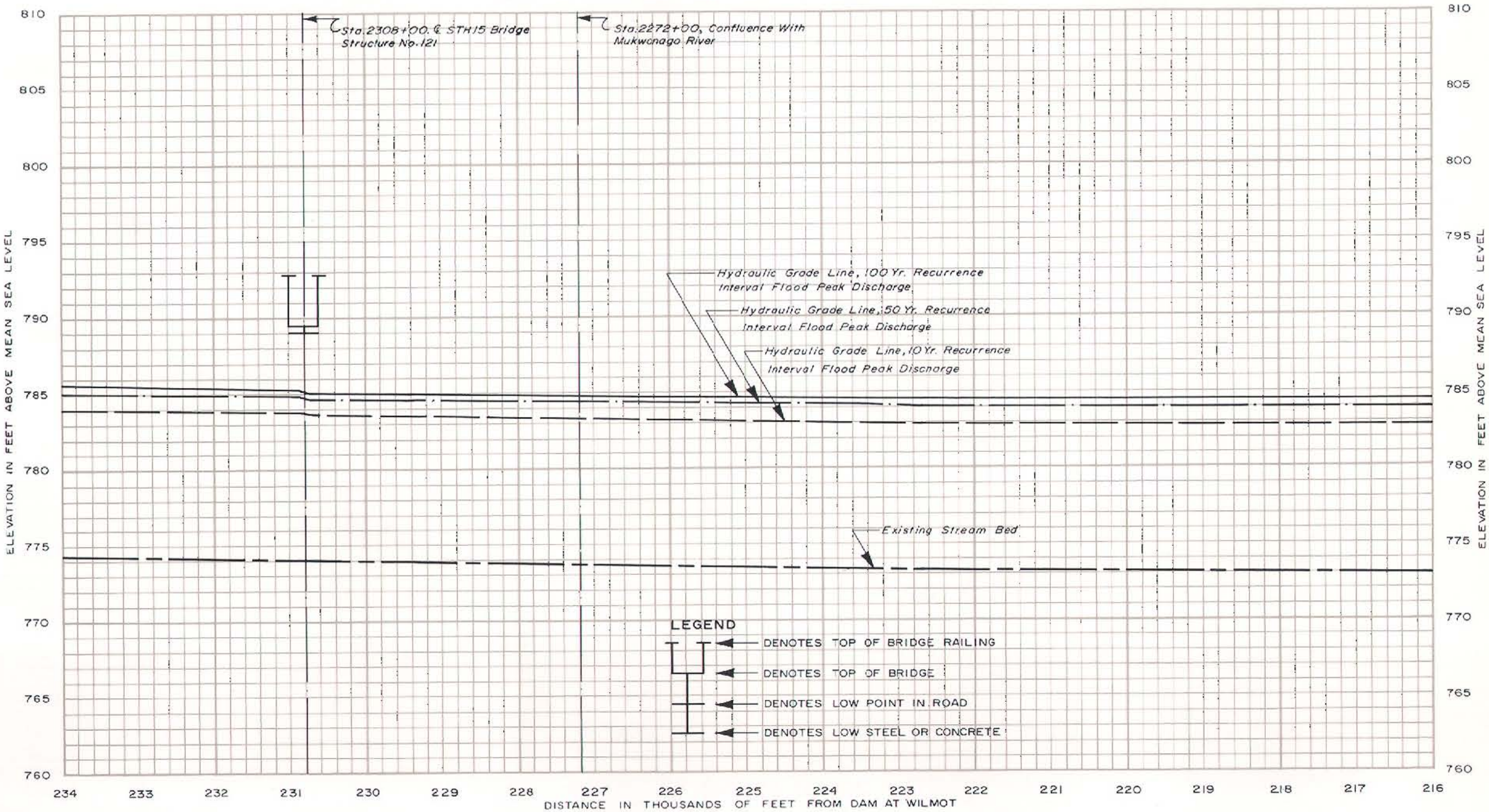
DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

DENOTES STATION TICK

Figure D-1 (continued)

HIGH WATER AND STREAM BED PROFILES
OF THE
LOWER FOX RIVER
FROM STA. 2160+00 TO STA. 2340+00
WAUKESHA COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: LHK DATE: NOVEMBER 1969
CHECKED: DRB DATE: NOVEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS



NOTE: MUKWONGO VILLAGE DATUM = MEAN SEA LEVEL DATUM, 1929 ADJUSTMENT MINUS 752.55'

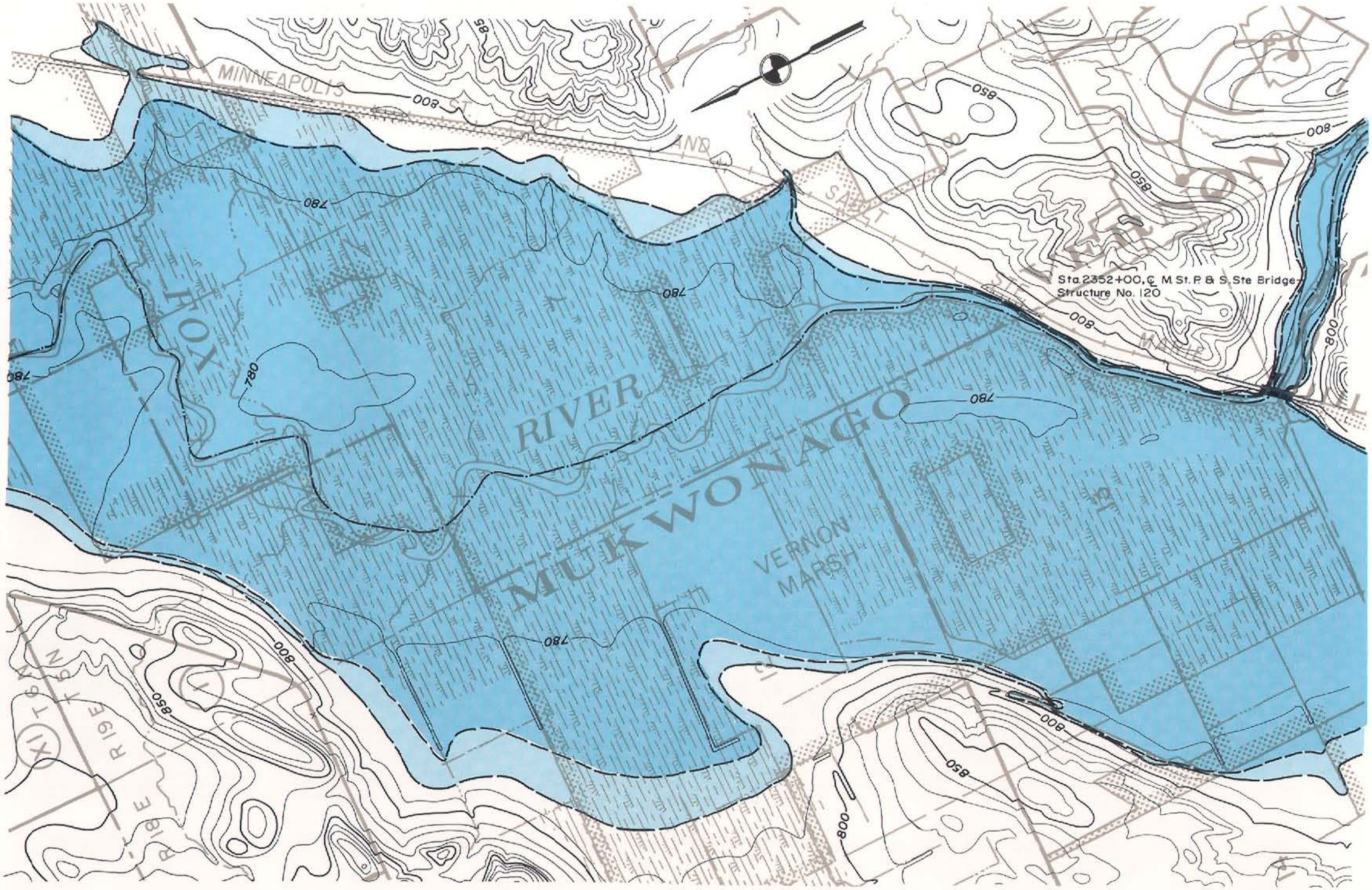
Source: U. S. Soil Conservation Service, SEWRPC.

Map D-1 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
LOWER FOX RIVER

FROM STA. 2340+00 TO STA. 2520+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: JHW — DATE: SEPTEMBER 1969
CHECKED: DRB — DATE: SEPTEMBER 1969

SCALE: 1" = 2000'
GRAPHIC SCALE
0 — 2000 — 4000 FEET



DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

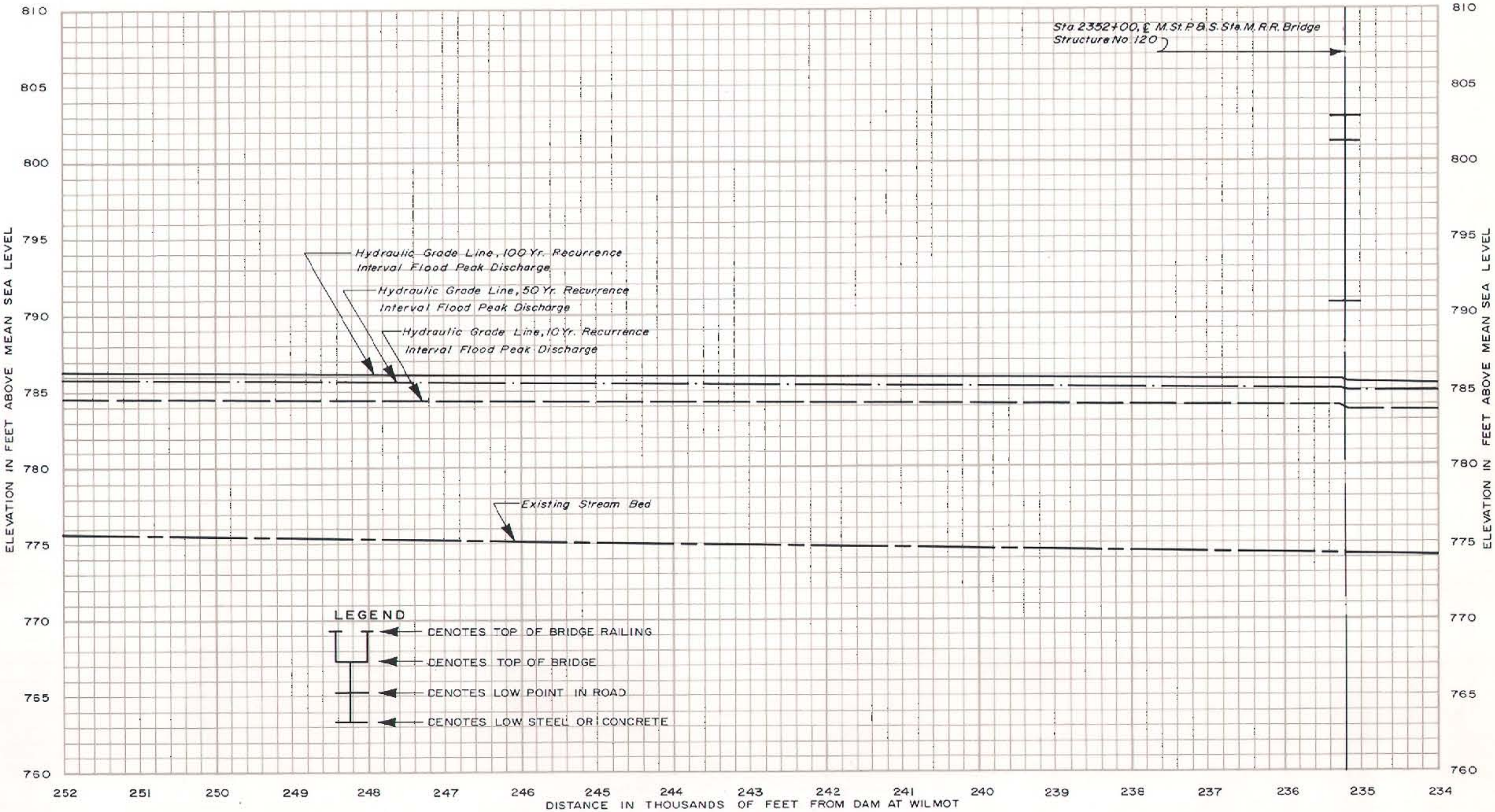
Sta. 131 +00 — DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

+ — DENOTES STATION TICK

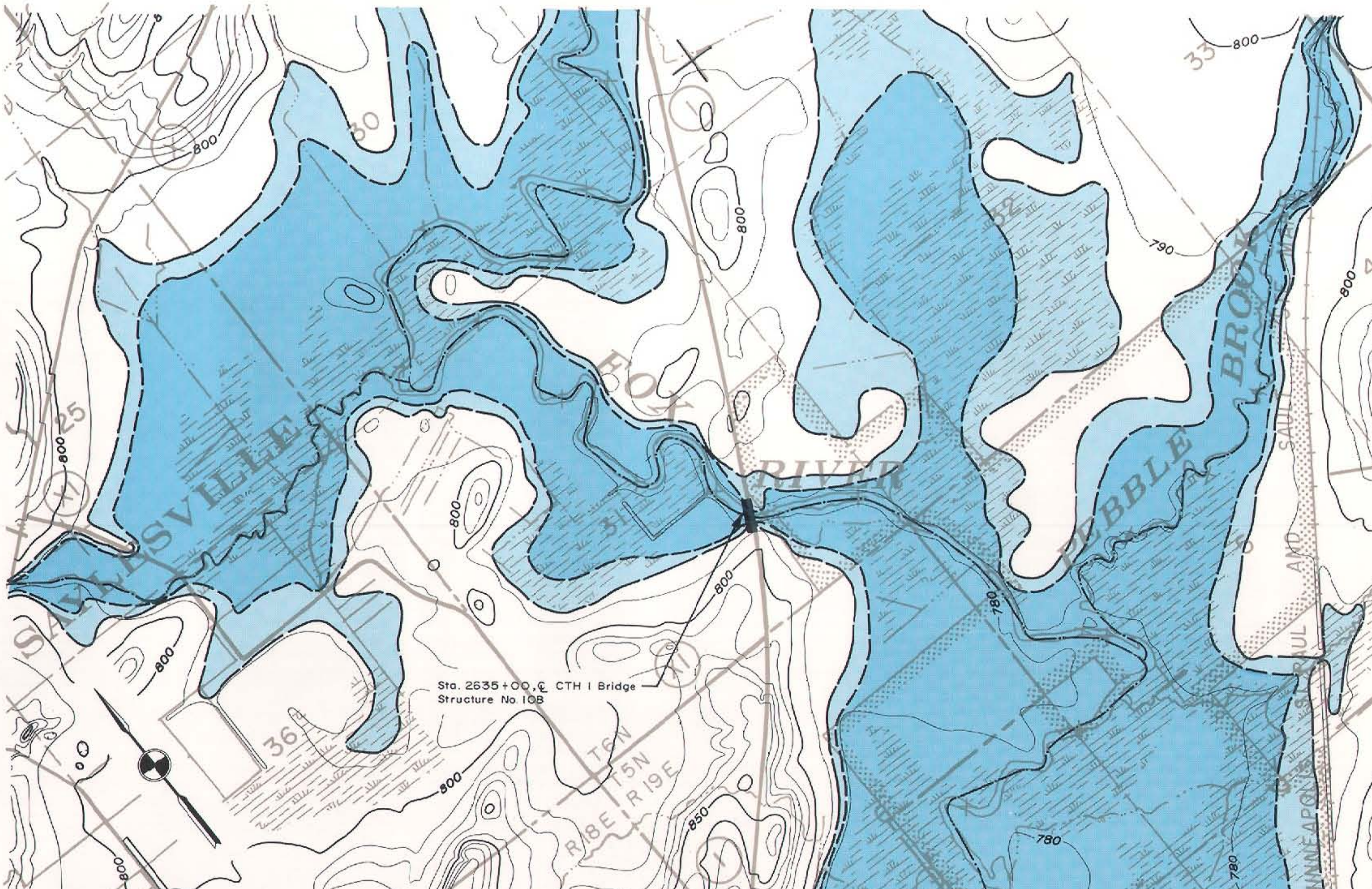
Figure D-1 (continued)

HIGH WATER AND STREAM BED PROFILES
OF THE
LOWER FOX RIVER
FROM STA. 2340+00 TO STA. 2520+00
WAUKESHA COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: LHK DATE: NOVEMBER 1969
CHECKED: DRB DATE: NOVEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-1 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
LOWER FOX RIVER
FROM STA. 2520+00 TO STA. 2700+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: SEPTEMBER 1969
CHECKED: DRB DATE: SEPTEMBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



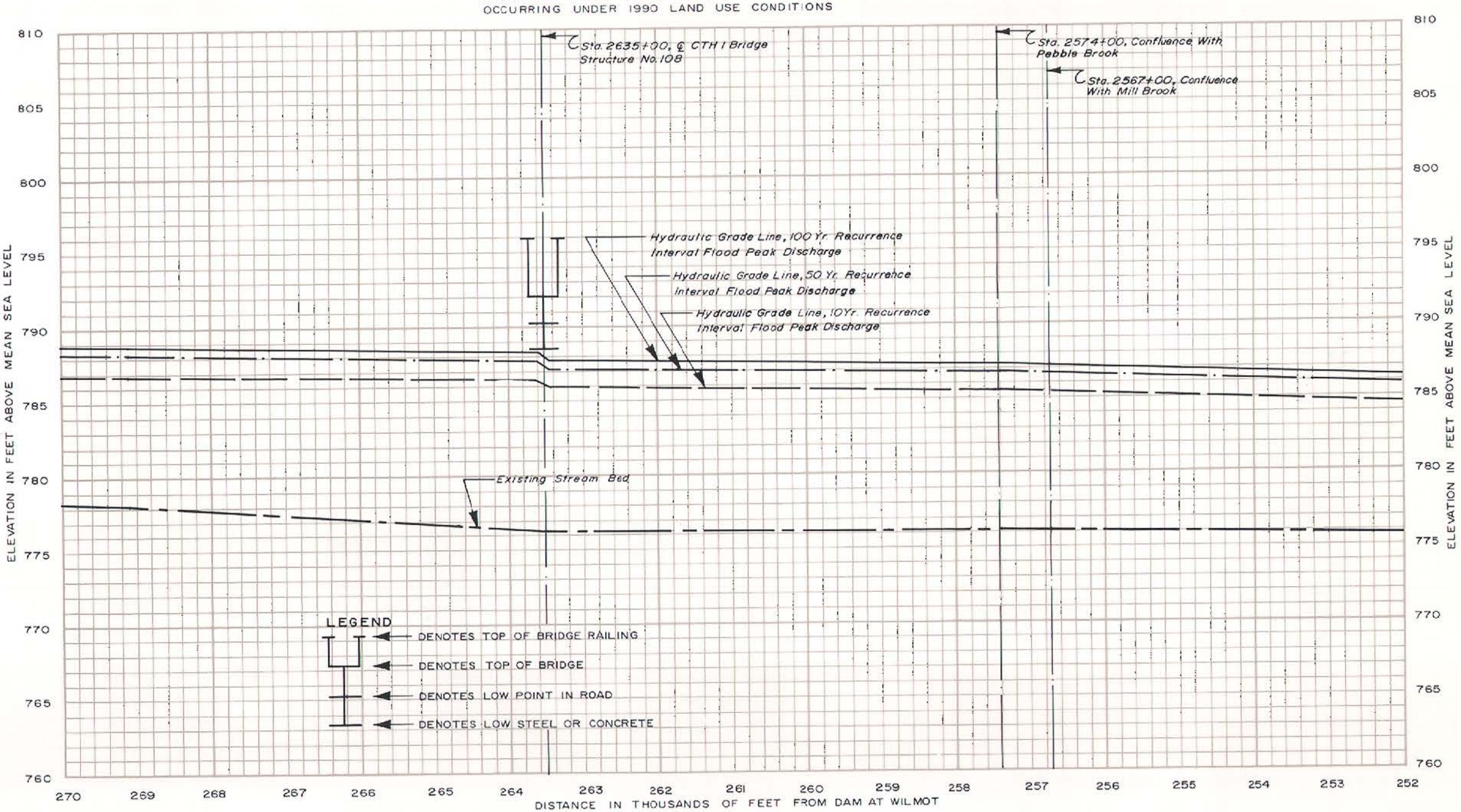
LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
+ DENOTES STATION TICK

Figure D-I (continued)

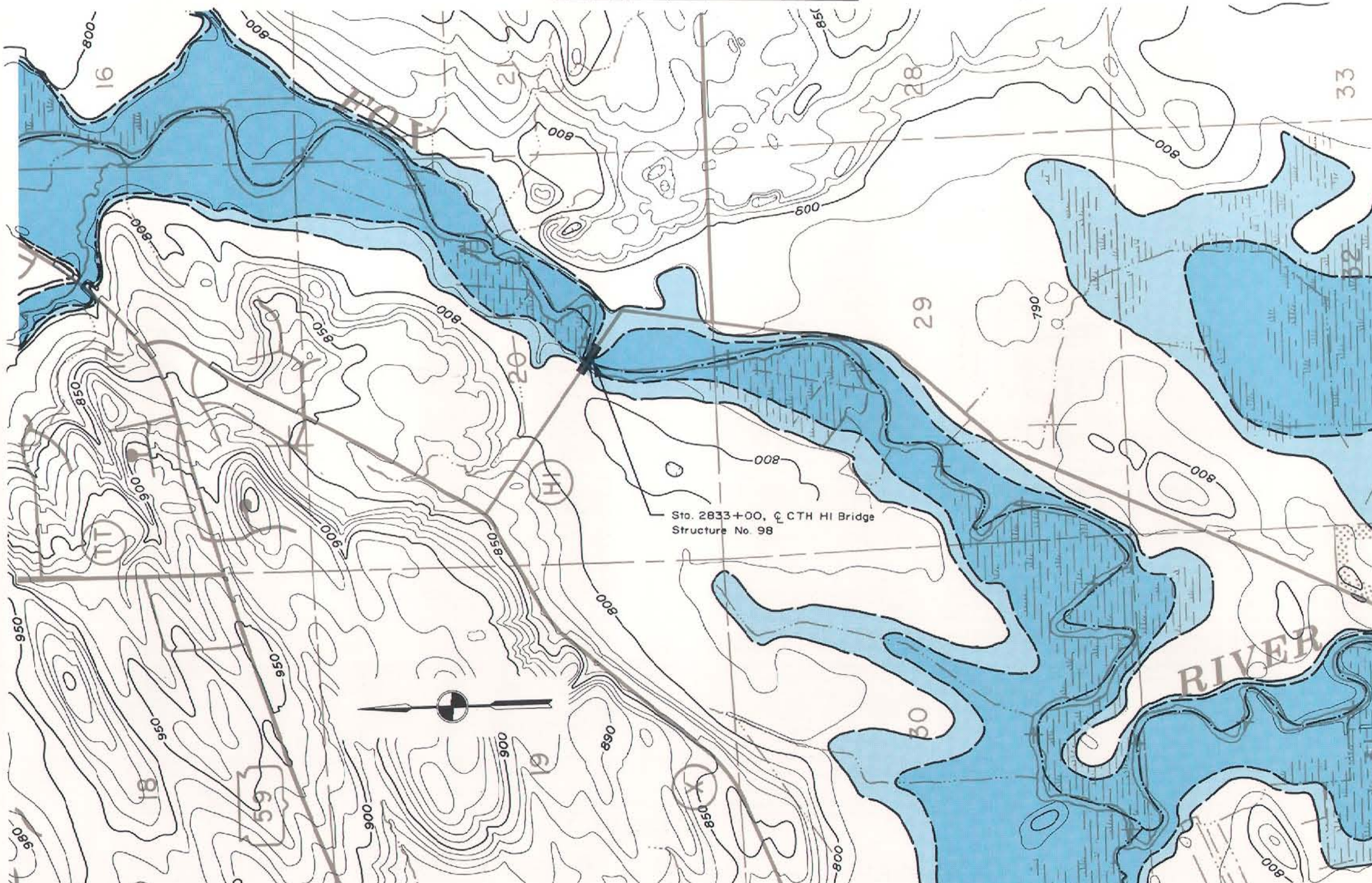
HIGH WATER AND STREAM BED PROFILES
OF THE
LOWER FOX RIVER
FROM STA. 2520+00 TO STA. 2700+00
WAUKESHA COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: LHK DATE: NOVEMBER 1969
CHECKED: DRB DATE: NOVEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-I (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
LOWER FOX RIVER

FROM STA. 2700+00 TO STA. 2800+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: SEPTEMBER 1969
CHECKED: DRB DATE: SEPTEMBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND
DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
+ DENOTES STATION TICK

Figure D-1 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

LOWER FOX RIVER

FROM STA. 2700+00 TO STA. 2800+00

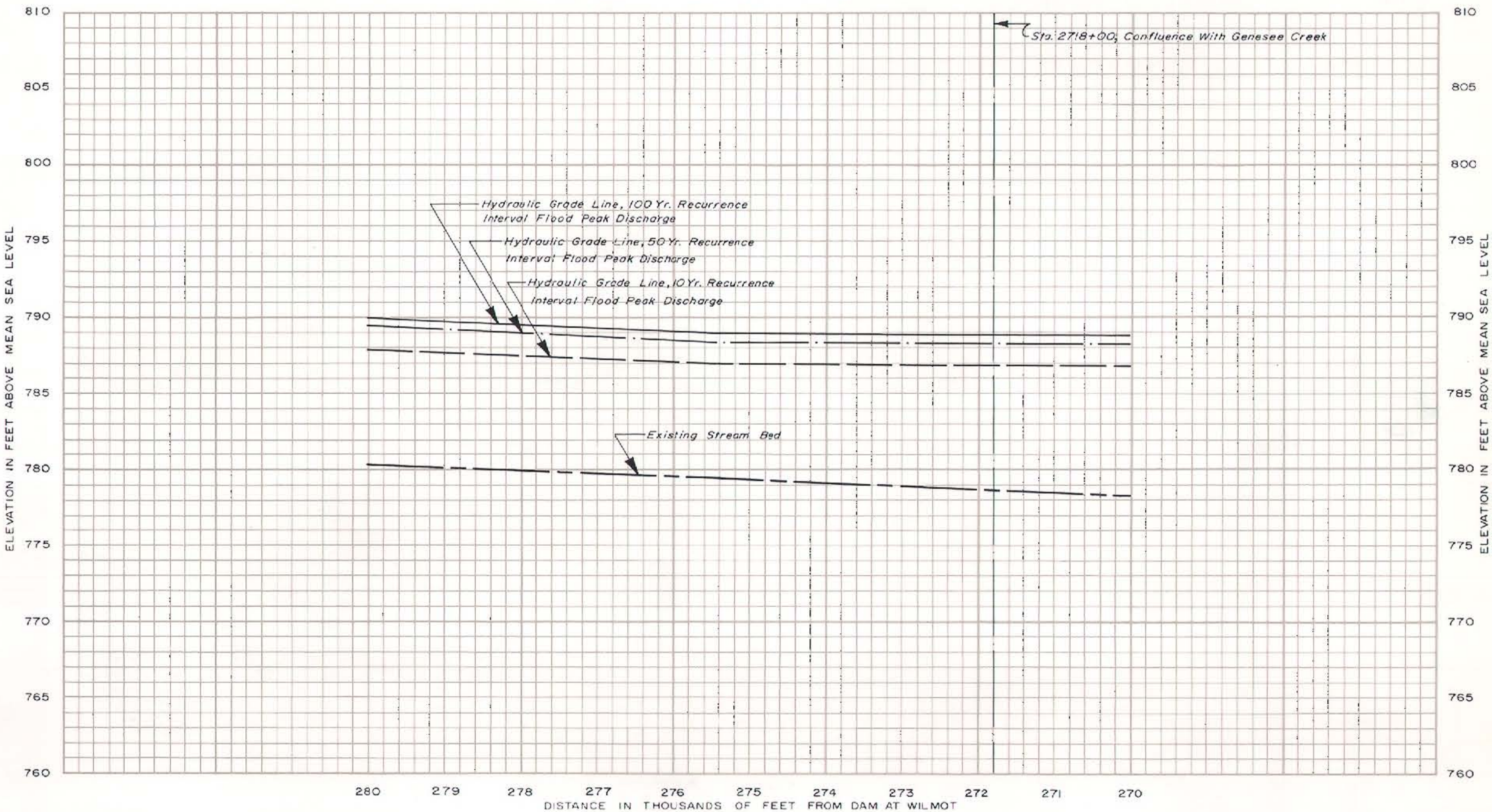
WAUKESHA COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: NOVEMBER 1969

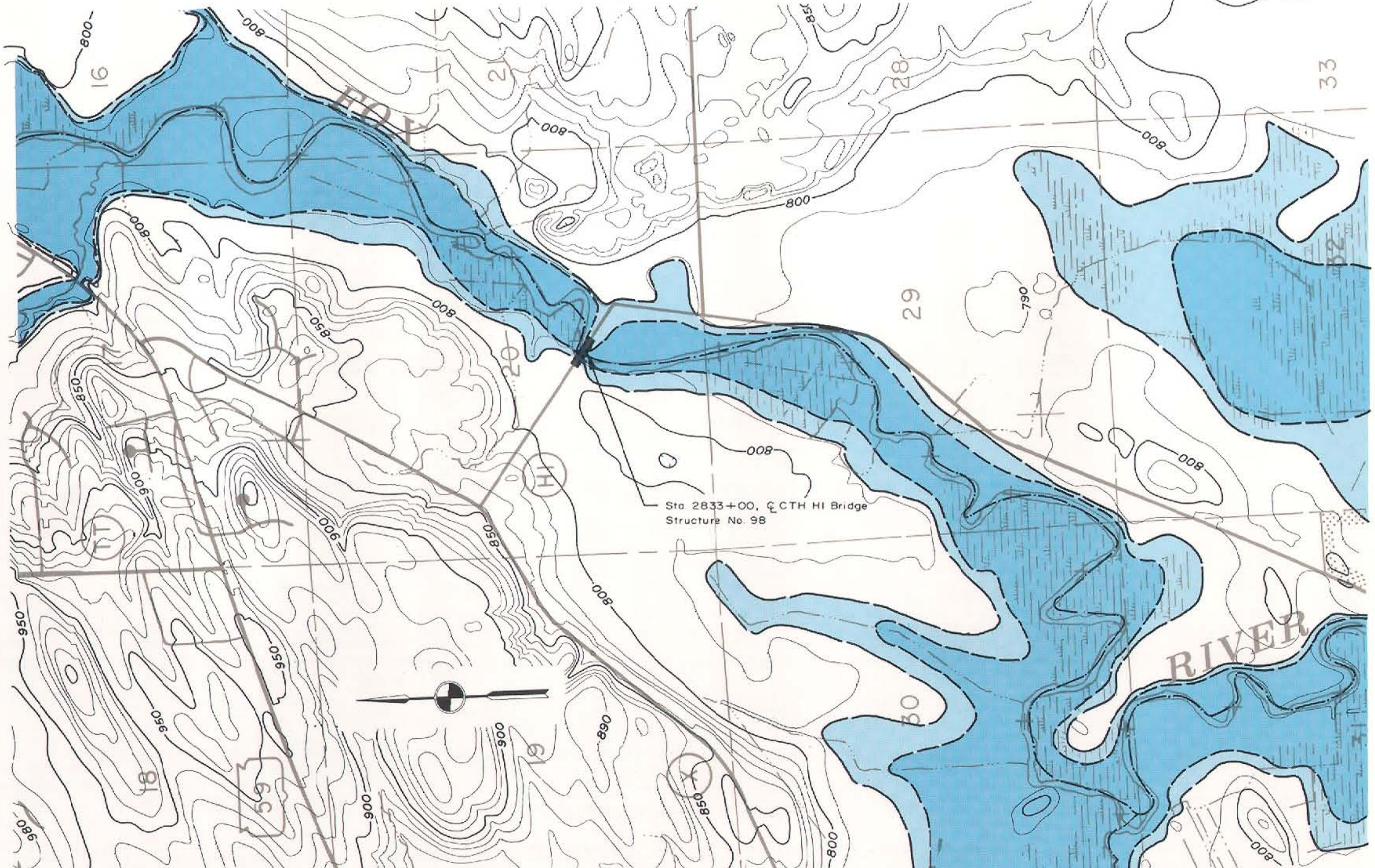
CHECKED: DRB DATE: NOVEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-1 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
LOWER FOX RIVER
FROM STA. 2800+00 TO STA. 2900+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: SEPTEMBER 1969
CHECKED: DRB DATE: SEPTEMBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND
DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY
Sta. 131 + 00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
+ DENOTES STATION TICK

Figure D-1 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

LOWER FOX RIVER

FROM STA. 2800+00 TO STA. 2900+00

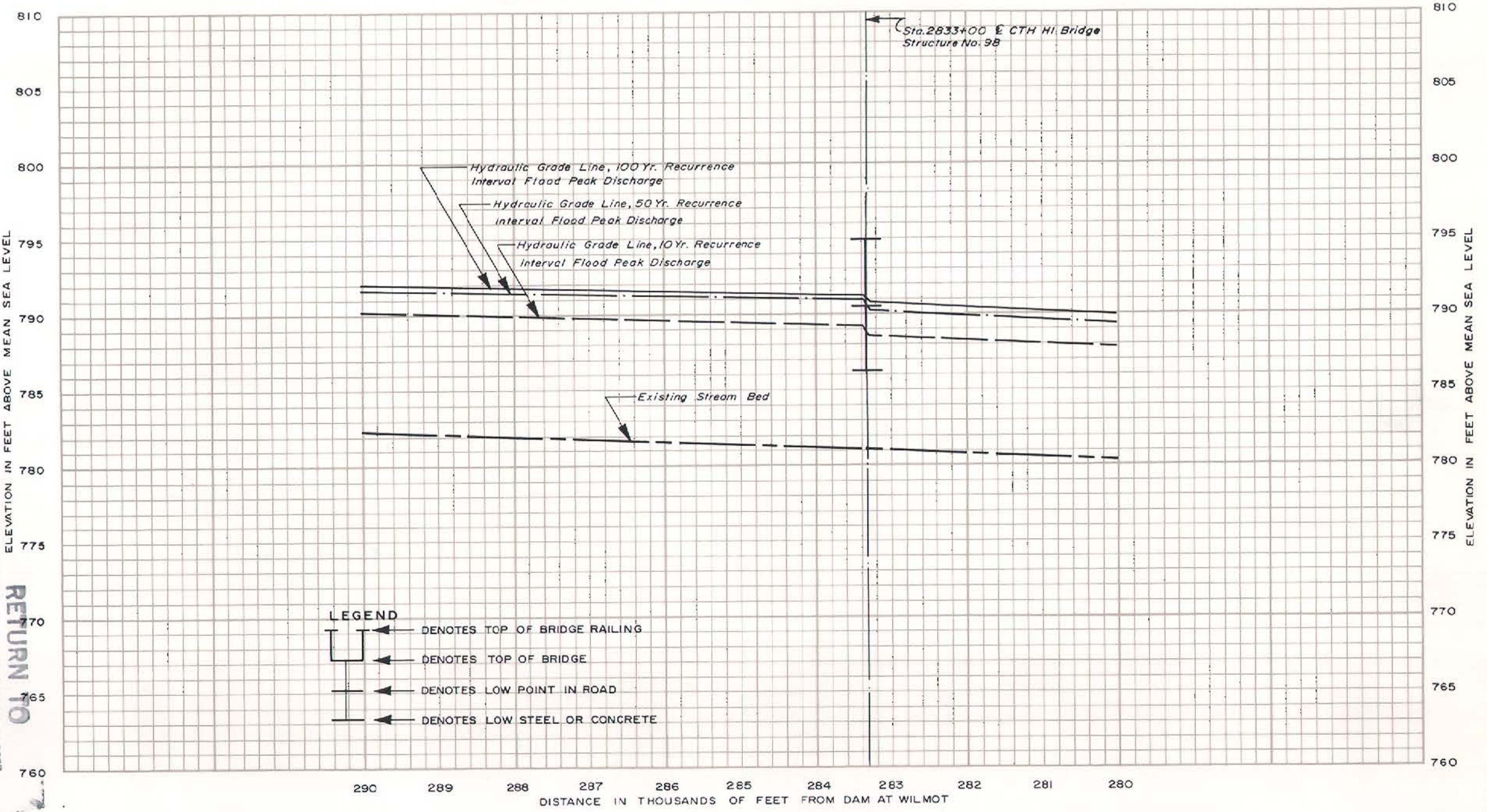
WAUKESHA COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: NOVEMBER 1969

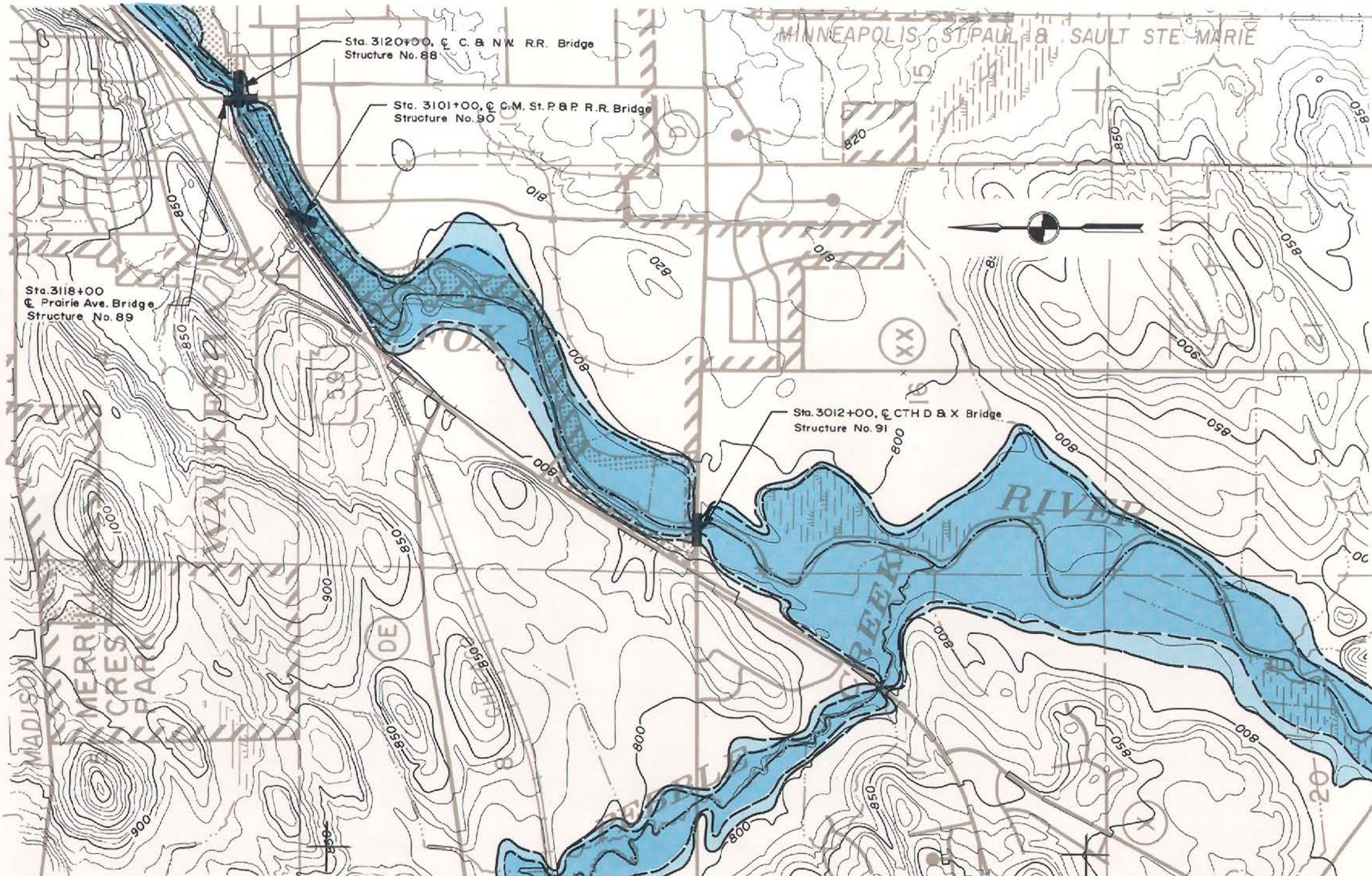
CHECKED: DRB DATE: NOVEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

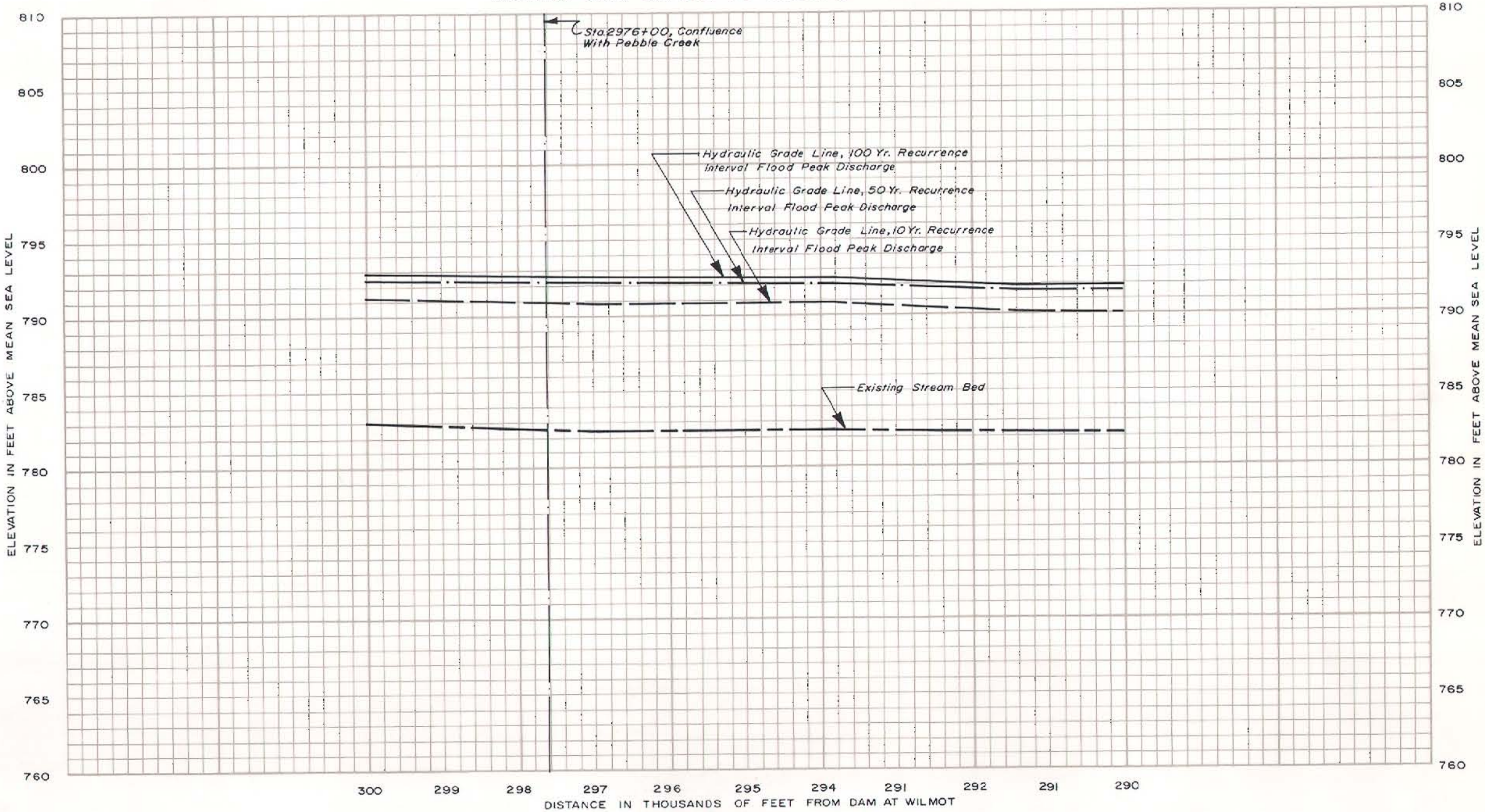
Map D-1 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
LOWER FOX RIVER
FROM STA. 2900+00 TO STA. 3000+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: SEPTEMBER 1969
CHECKED: DRB DATE: SEPTEMBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND
DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY
Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-1 (continued)

HIGH WATER AND STREAM BED PROFILES
OF THE
LOWER FOX RIVER
FROM STA. 2900+00 TO STA. 3000+00
WAUKESHA COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: LHK DATE: NOVEMBER 1969
CHECKED: DRB DATE: NOVEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS



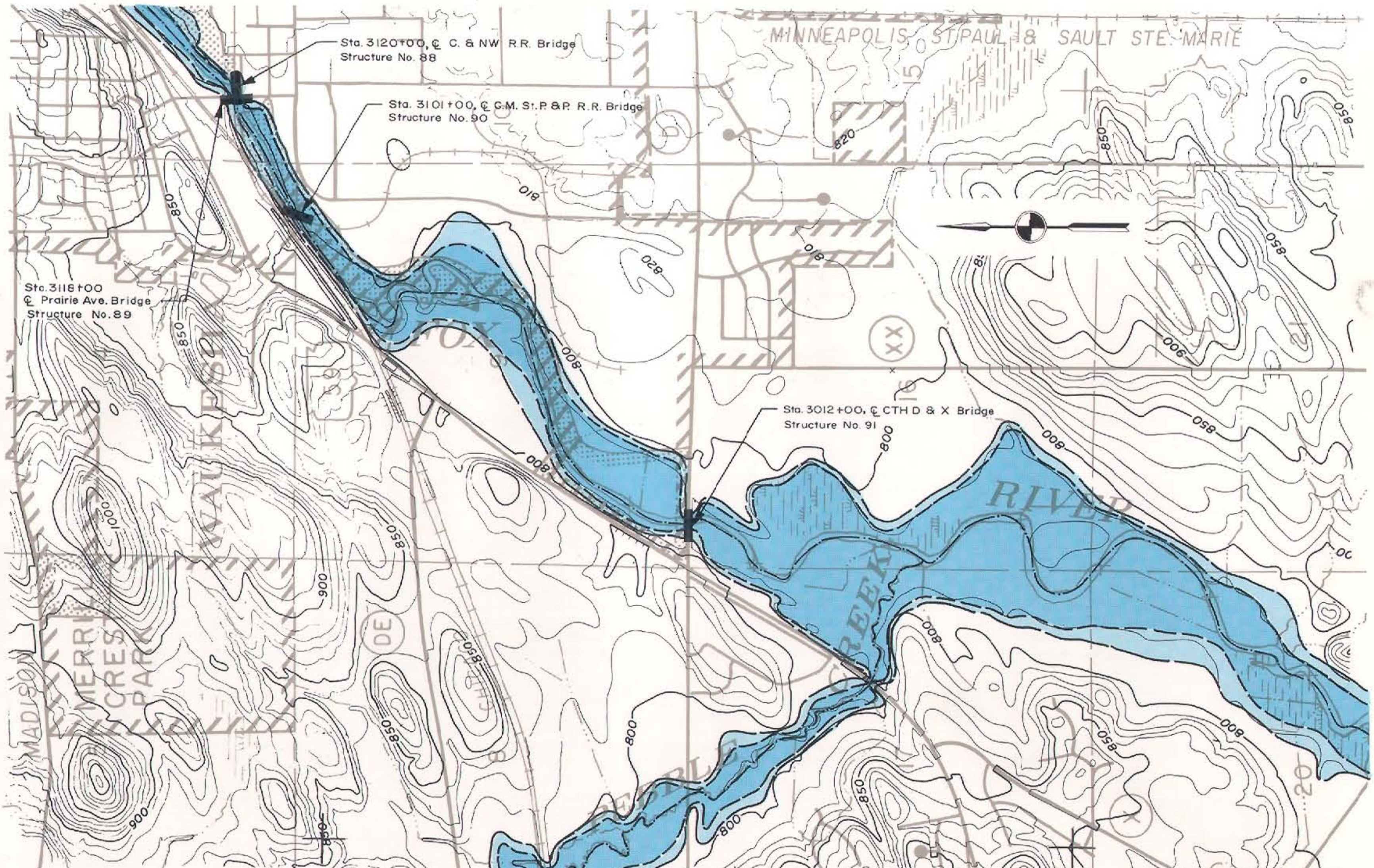
Source: U. S. Soil Conservation Service; SEWRPC.

Map D-2
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
UPPER FOX RIVER
FROM STA. 3000+00 TO STA. 3100+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: RHH DATE: SEPTEMBER 1969
CHECKED: DRB DATE: SEPTEMBER 1969

SCALE: 1" = 2000'

GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL, 1929 ADJUSTMENT

DENOTES STATION TICK

Figure D-2

HIGH WATER AND STREAM BED PROFILES

OF THE

UPPER FOX RIVER

FROM STA. 3000+00 TO STA. 3100+00

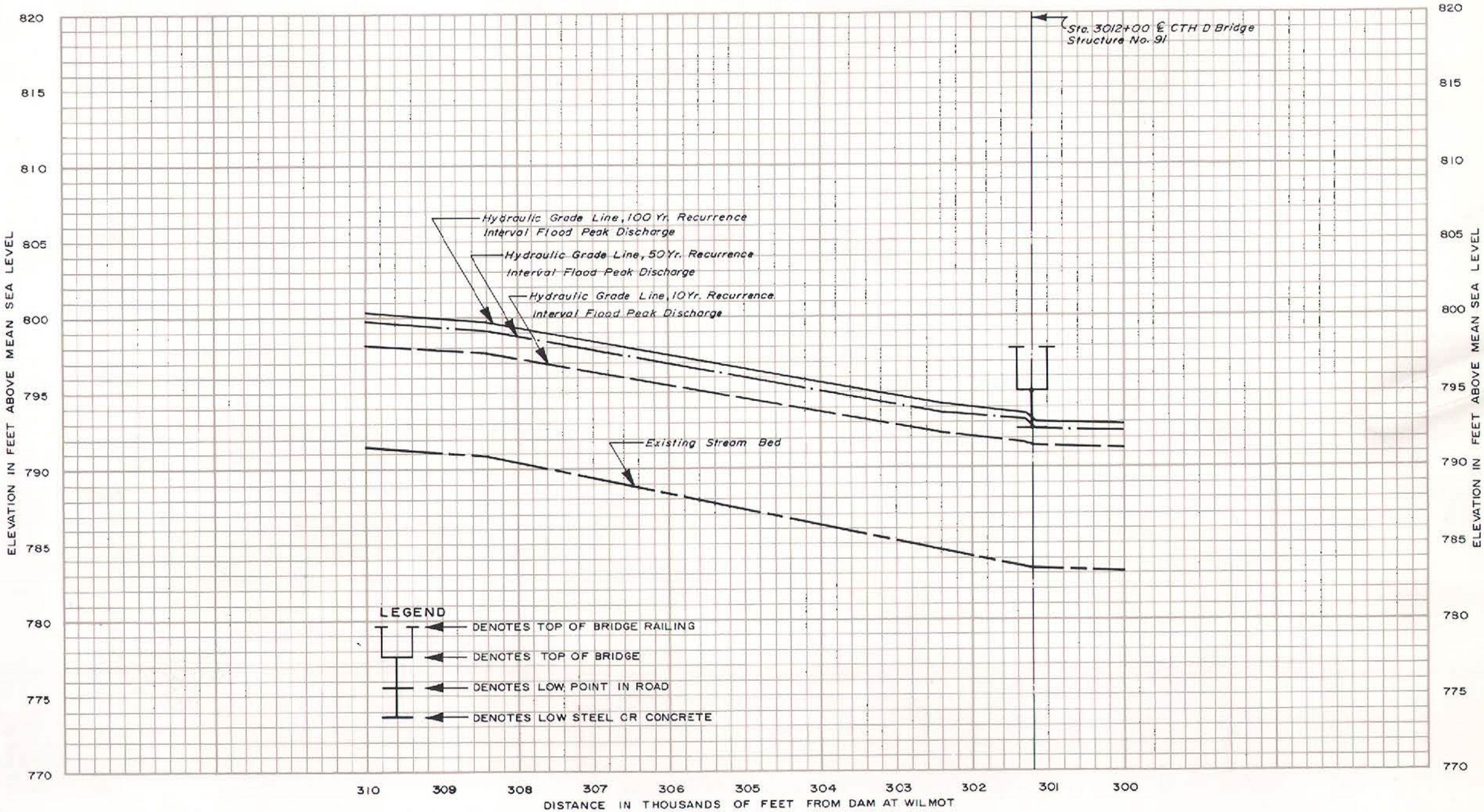
WAUKESHA COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: NOVEMBER 1969

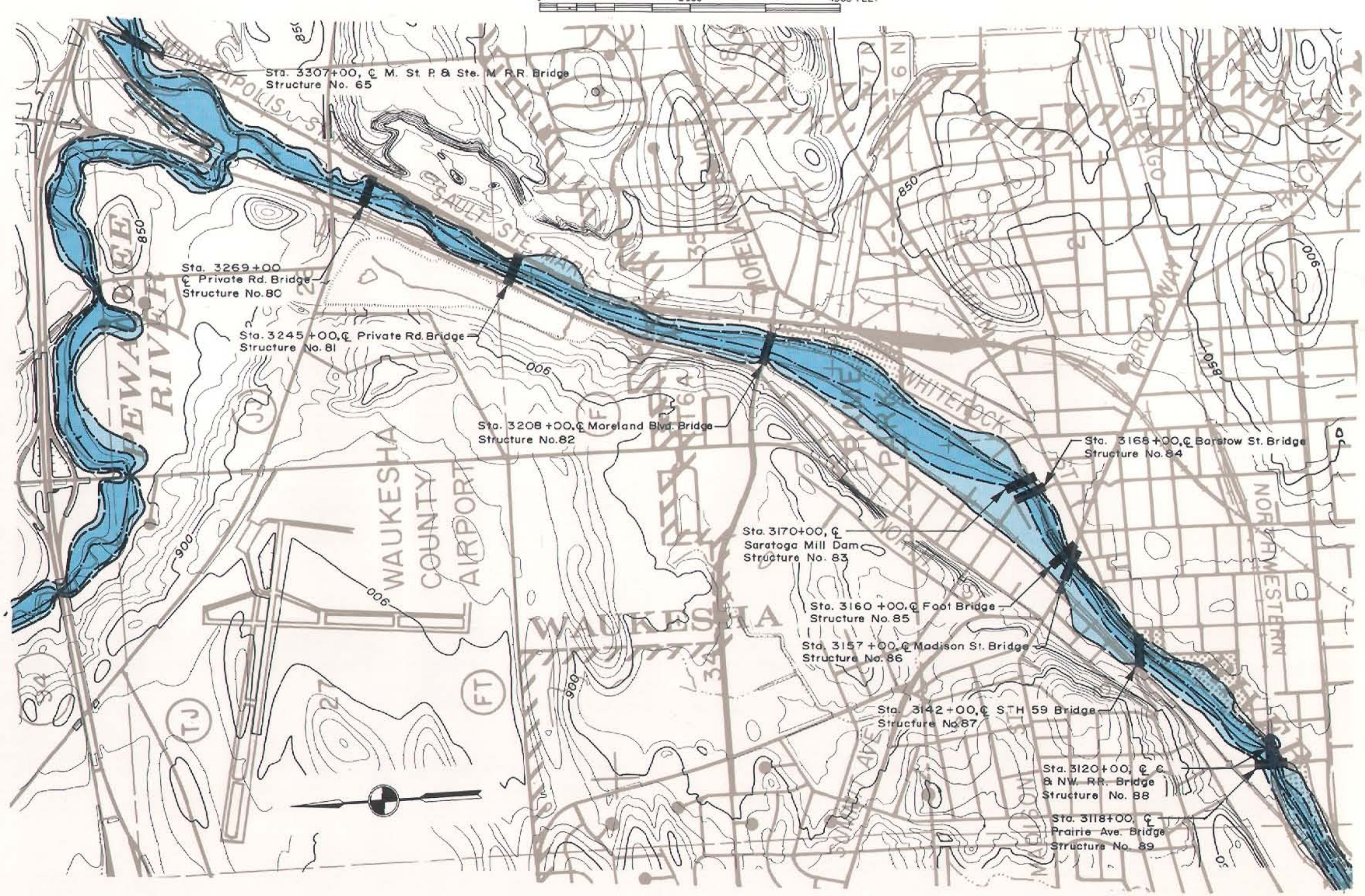
CHECKED: DRB DATE: NOVEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-2 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
UPPER FOX RIVER
FROM STA. 3100+00 TO STA. 3280+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: SEPTEMBER 1969
CHECKED: DRB DATE: SEPTEMBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-2 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

UPPER FOX RIVER

FROM STA. 3100+00 TO STA. 3280+00

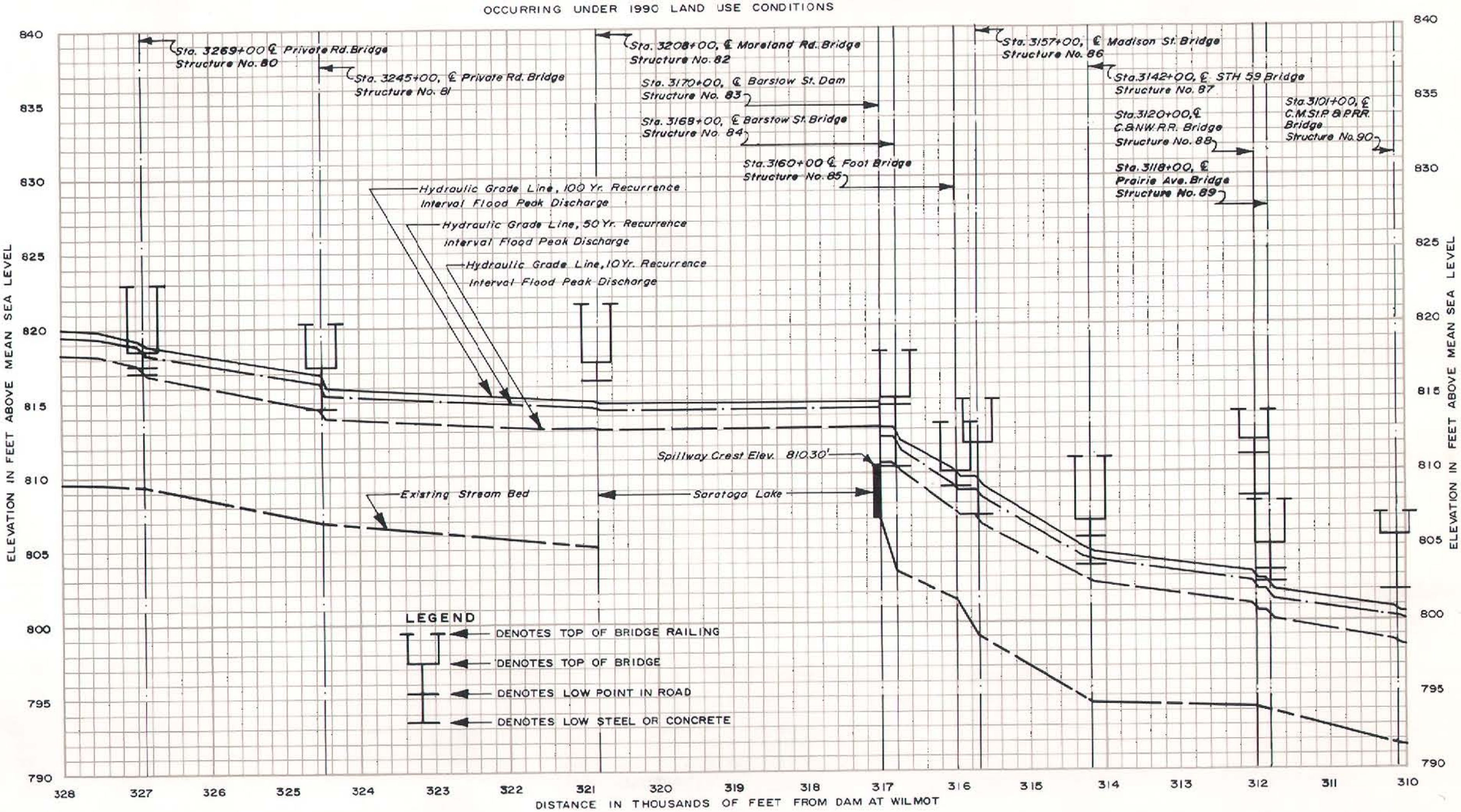
WAUKESHA COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: NOVEMBER 1969

CHECKED: DRB DATE: NOVEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS

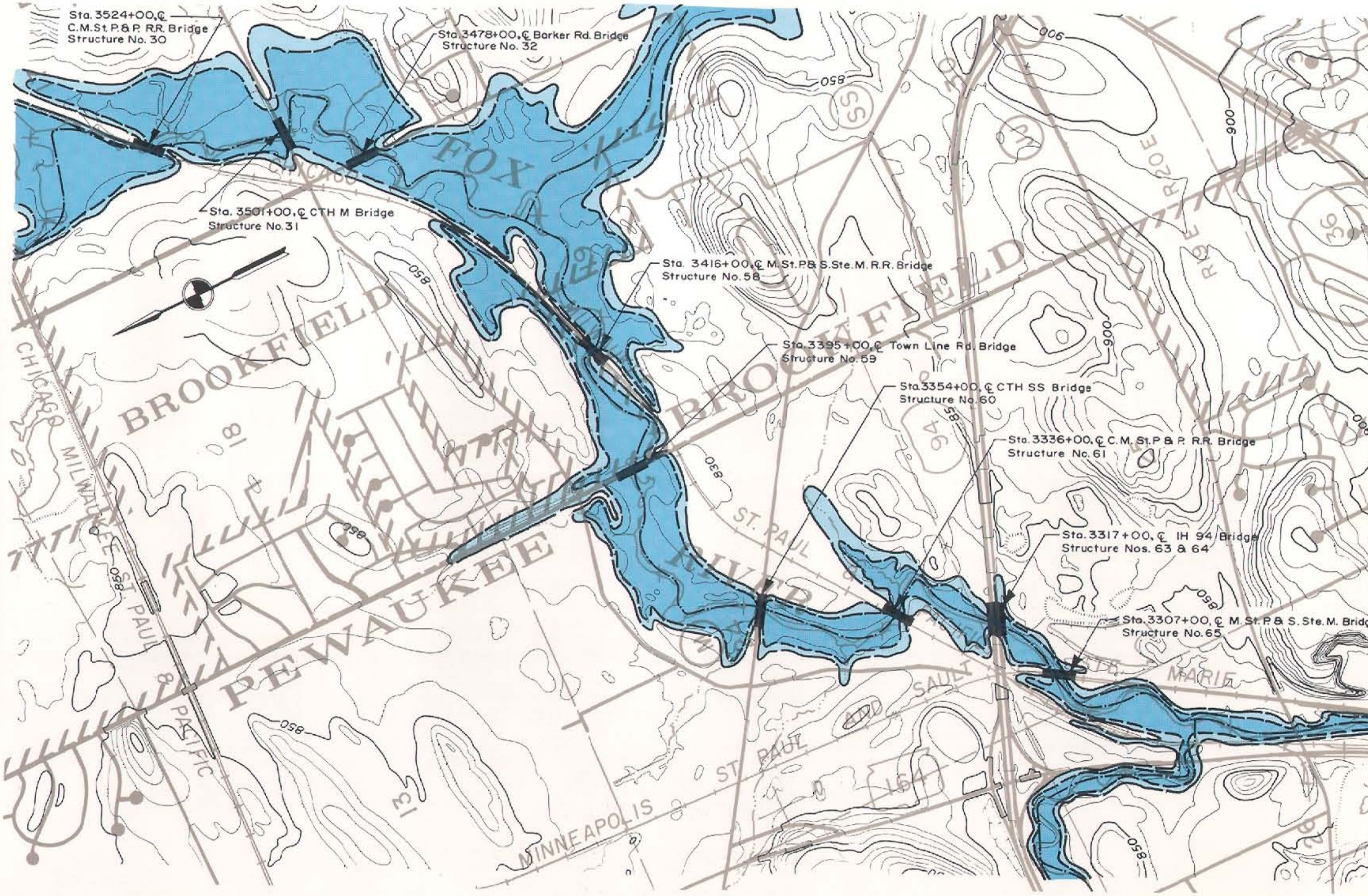


NOTE: WAUKESHA CITY DATUM = MEAN SEA LEVEL DATUM, 1929 ADJUSTMENT MINUS 780.55'

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

Map D-2 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
UPPER FOX RIVER

FROM STA. 3280+00 TO STA. 3460+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: SEPTEMBER 1969
CHECKED: DRB DATE: SEPTEMBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND
DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-2 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

UPPER FOX RIVER

FROM STA. 3280+00 TO STA. 3460+00

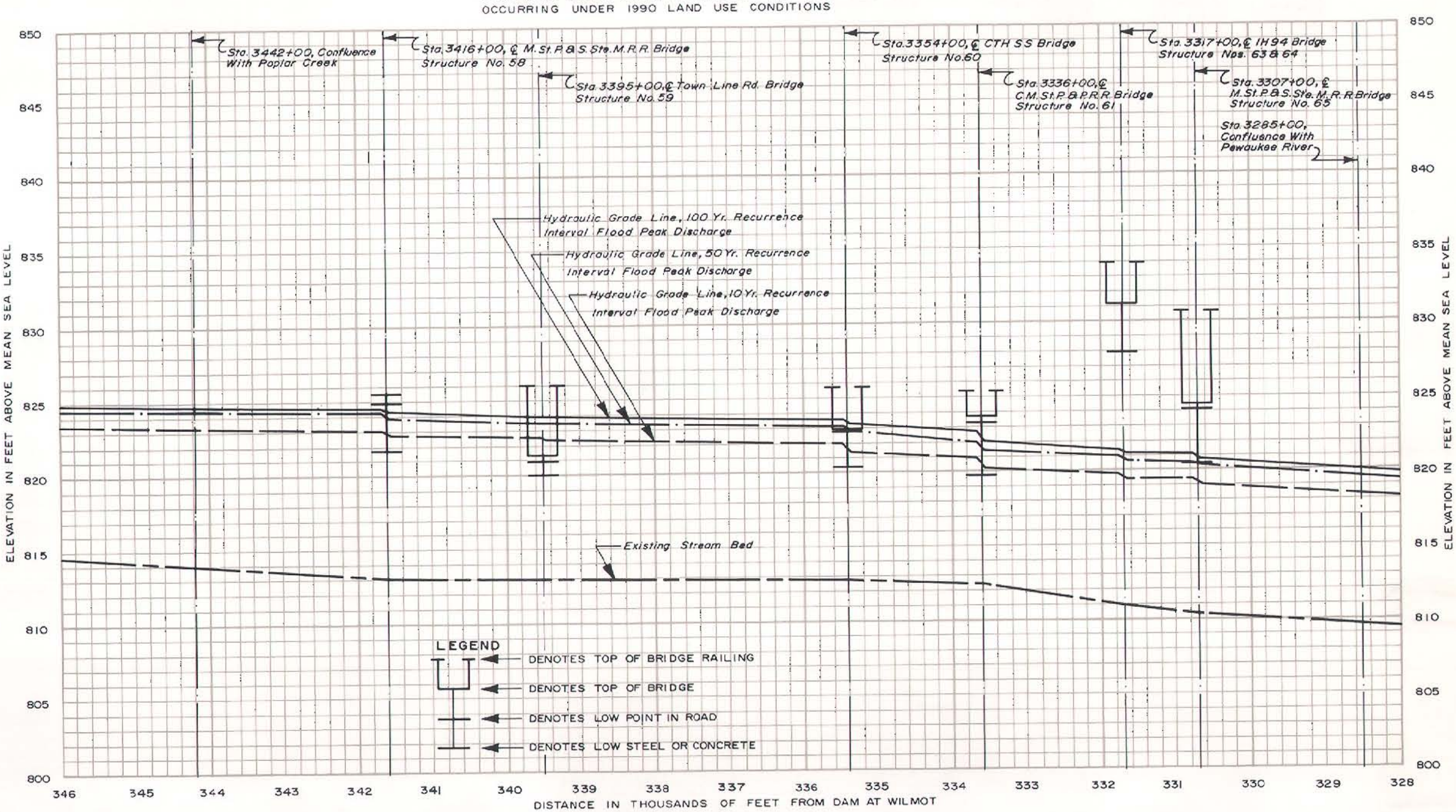
WAUKESHA COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: NOVEMBER 1969

CHECKED: DRB DATE: NOVEMBER 1969

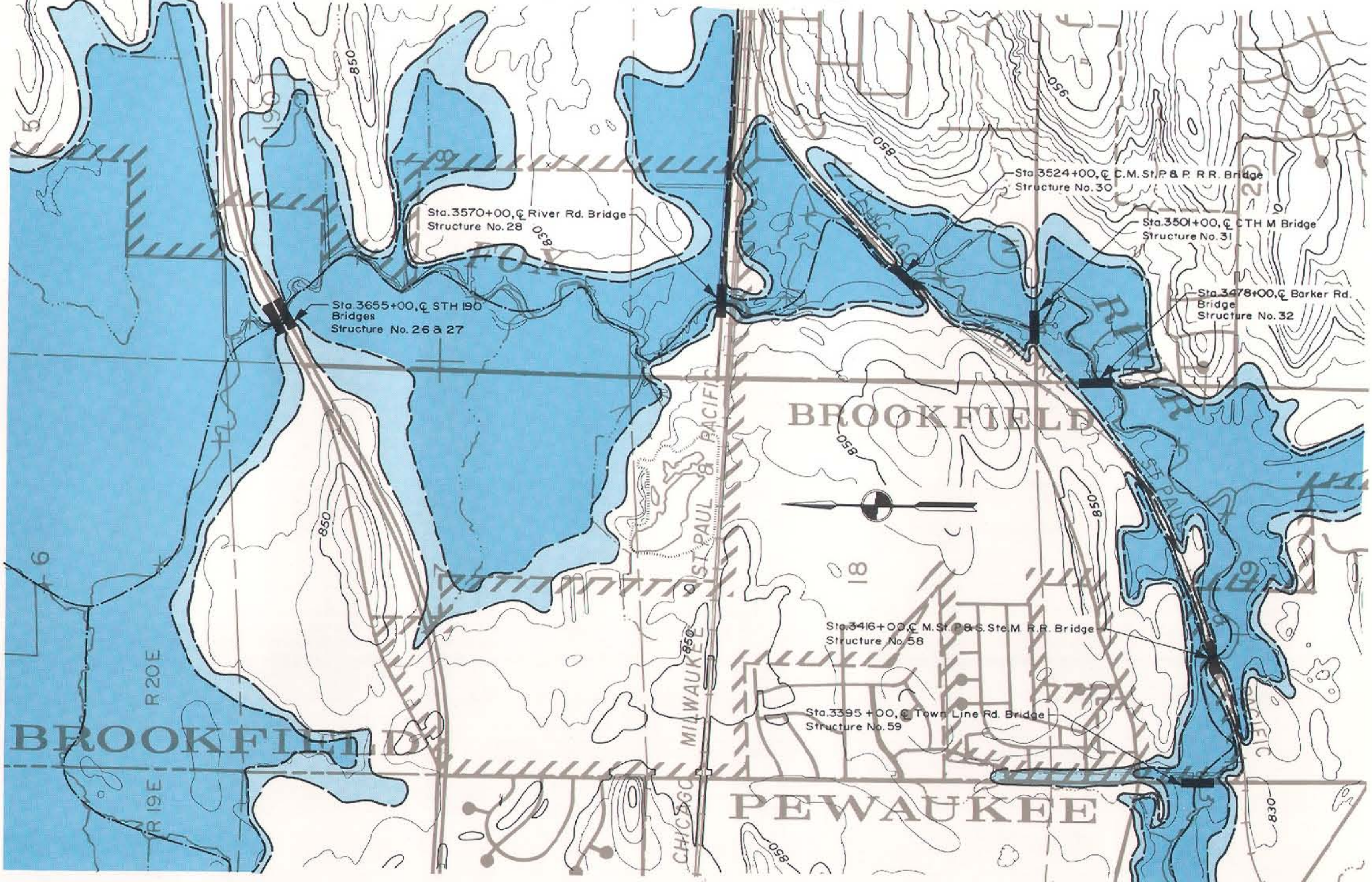
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-2 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
UPPER FOX RIVER

FROM STA. 3460+00 TO STA. 3640+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: SEPTEMBER 1969
CHECKED: DRB DATE: SEPTEMBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL, 1929 ADJUSTMENT

DENOTES STATION TICK

Figure D-2 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

UPPER FOX RIVER

FROM STA. 3460+00 TO STA. 3640+00

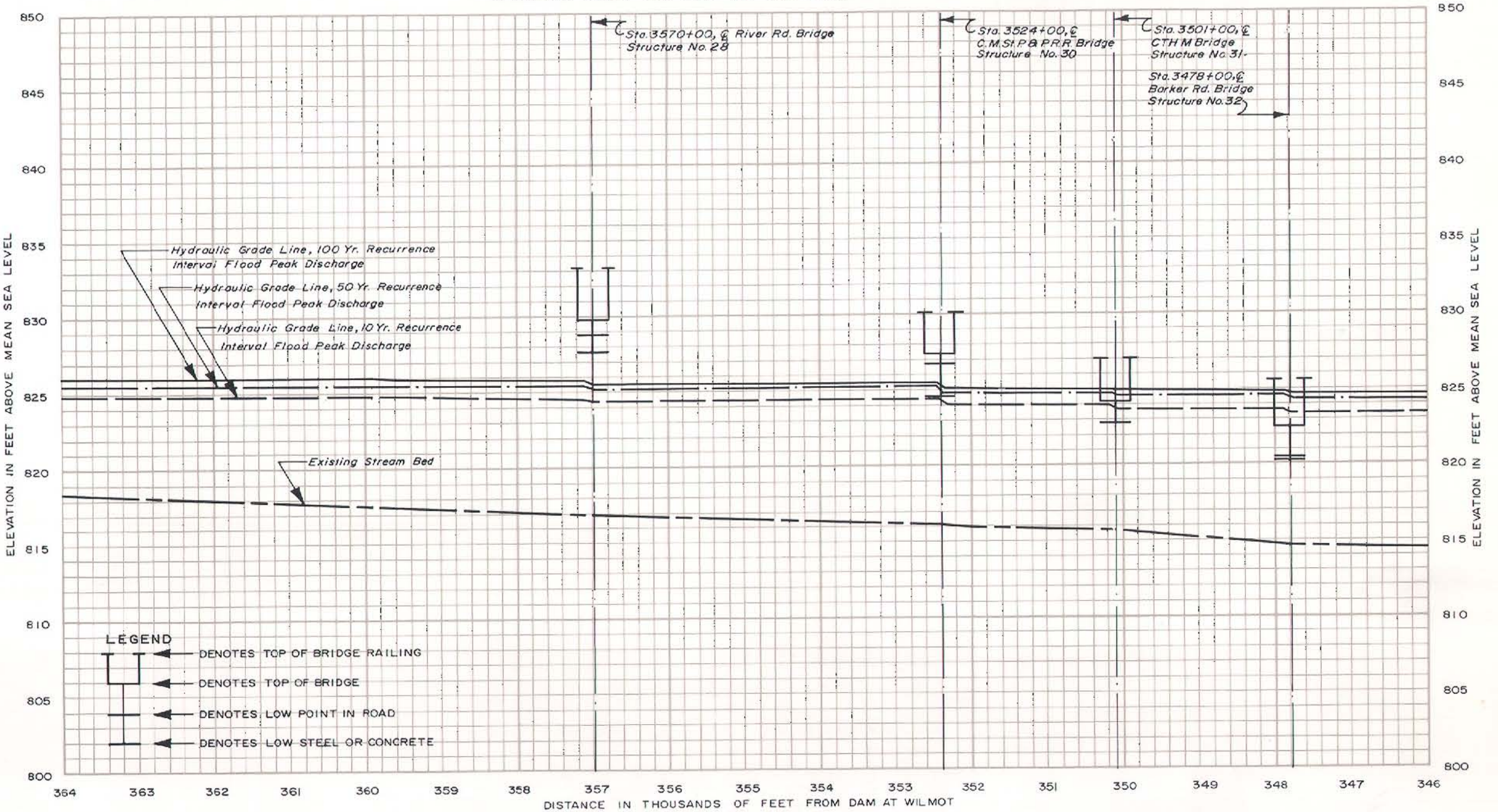
WAUKESHA COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: NOVEMBER 1969

CHECKED: DRB DATE: NOVEMBER 1969

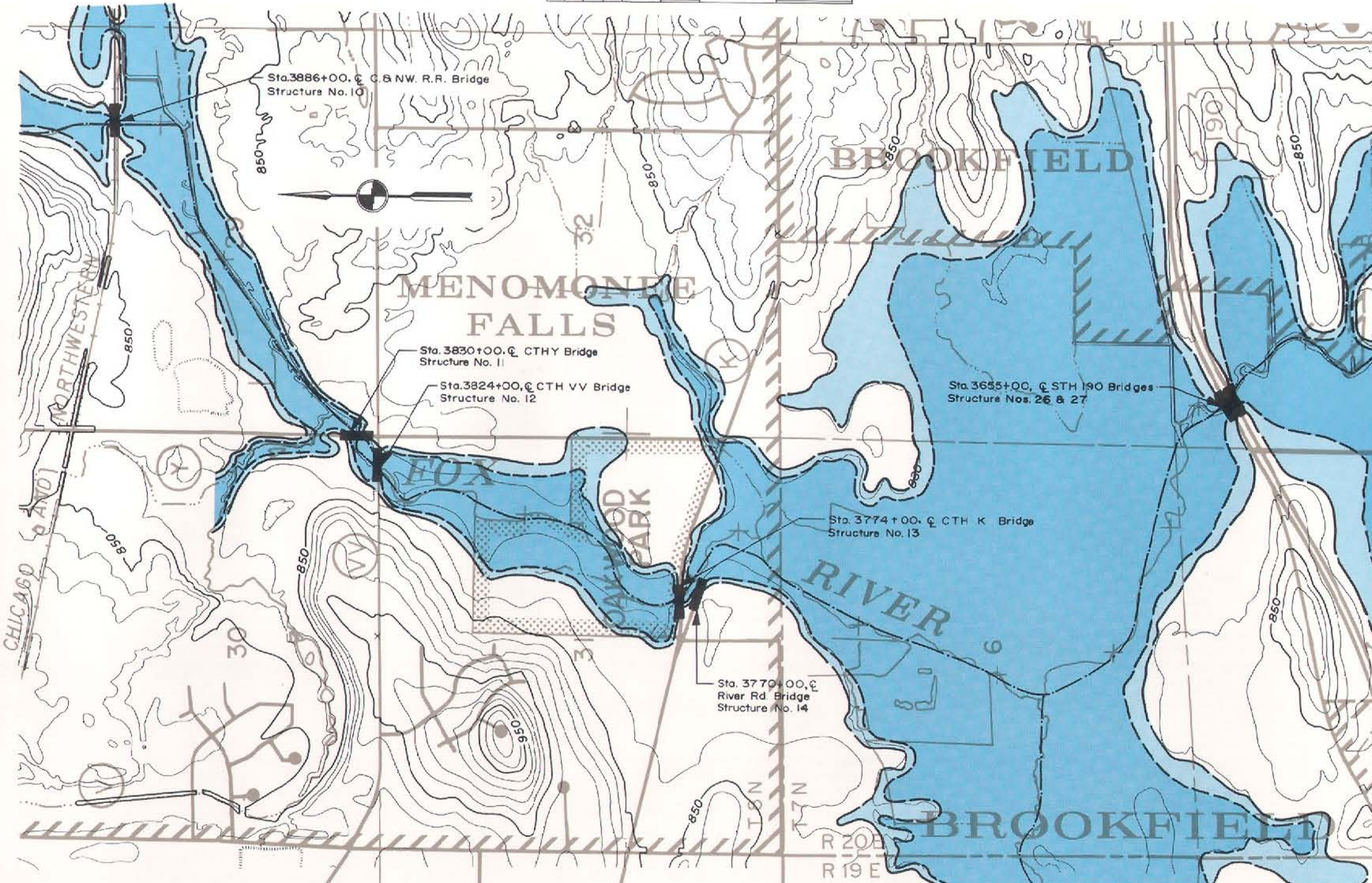
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-2 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
UPPER FOX RIVER

FROM STA. 3640+00 TO STA. 3740+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: SEPTEMBER 1969
CHECKED: DRB DATE: SEPTEMBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

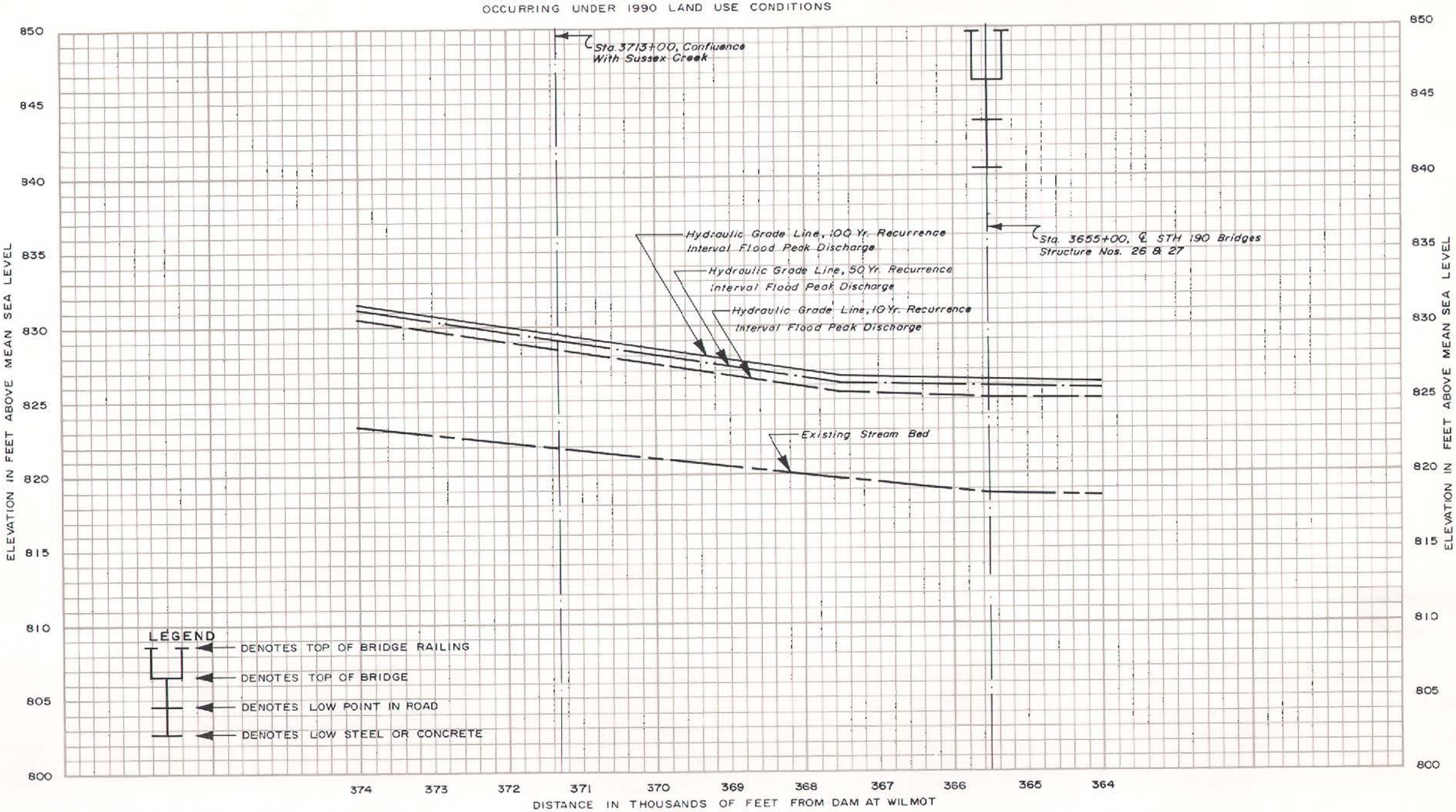
Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

DENOTES STATION TICK

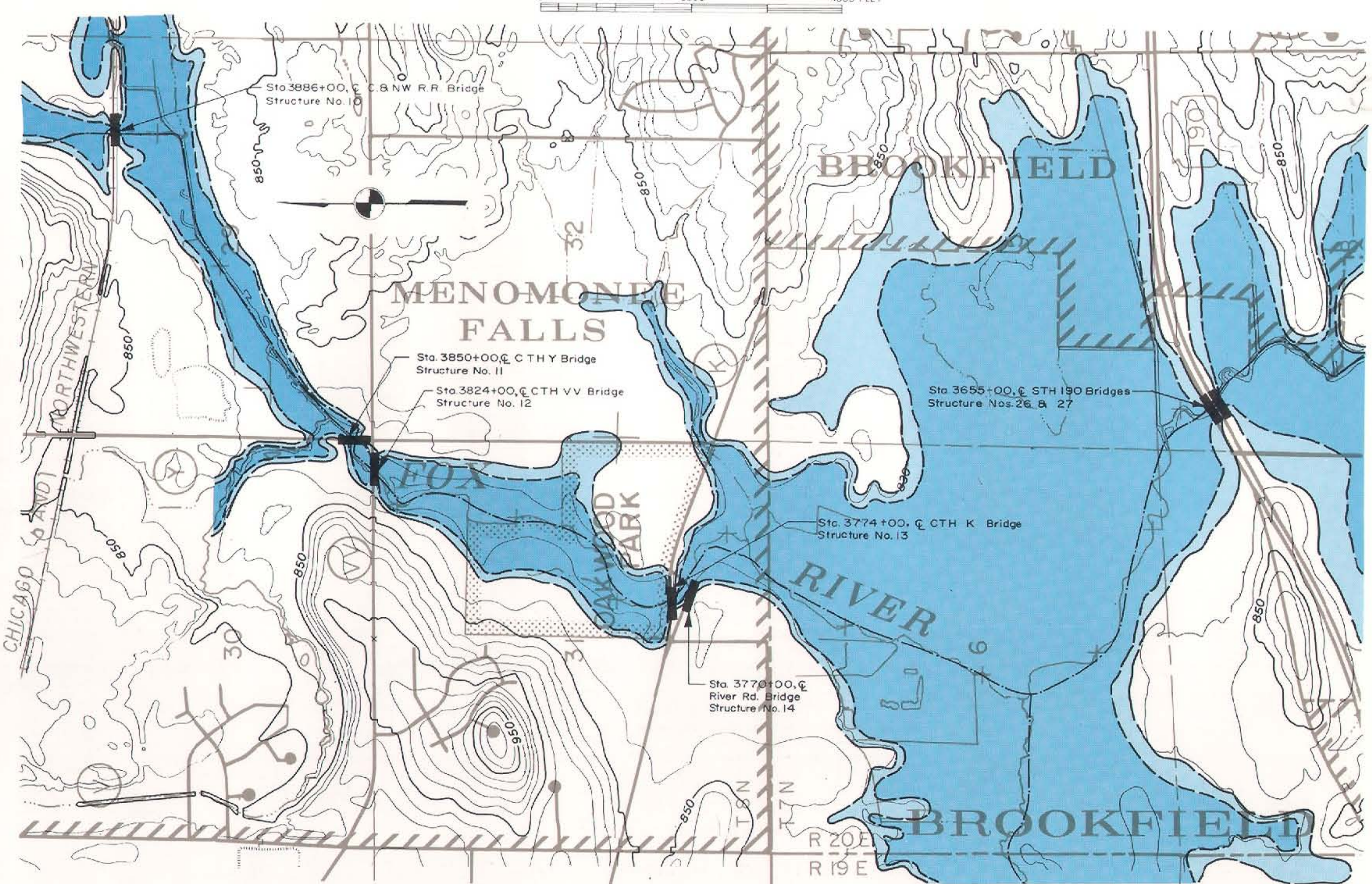
Figure D-2 (continued)

HIGH WATER AND STREAM BED PROFILES
OF THE
UPPER FOX RIVER
FROM STA. 3640+00 TO STA. 3740+00
WAUKESHA COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: LHK DATE: NOVEMBER 1969
CHECKED: DRB DATE: NOVEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-2 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
UPPER FOX RIVER
FROM STA 3740+00 TO STA. 3860+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN RHH DATE: SEPTEMBER 1969
CHECKED: DRB DATE: SEPTEMBER 1969
SCALE 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND
DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY
Sta 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
+ DENOTES STATION TICK

Figure D-2 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

UPPER FOX RIVER

FROM STA. 3740+00 TO STA. 3860+00

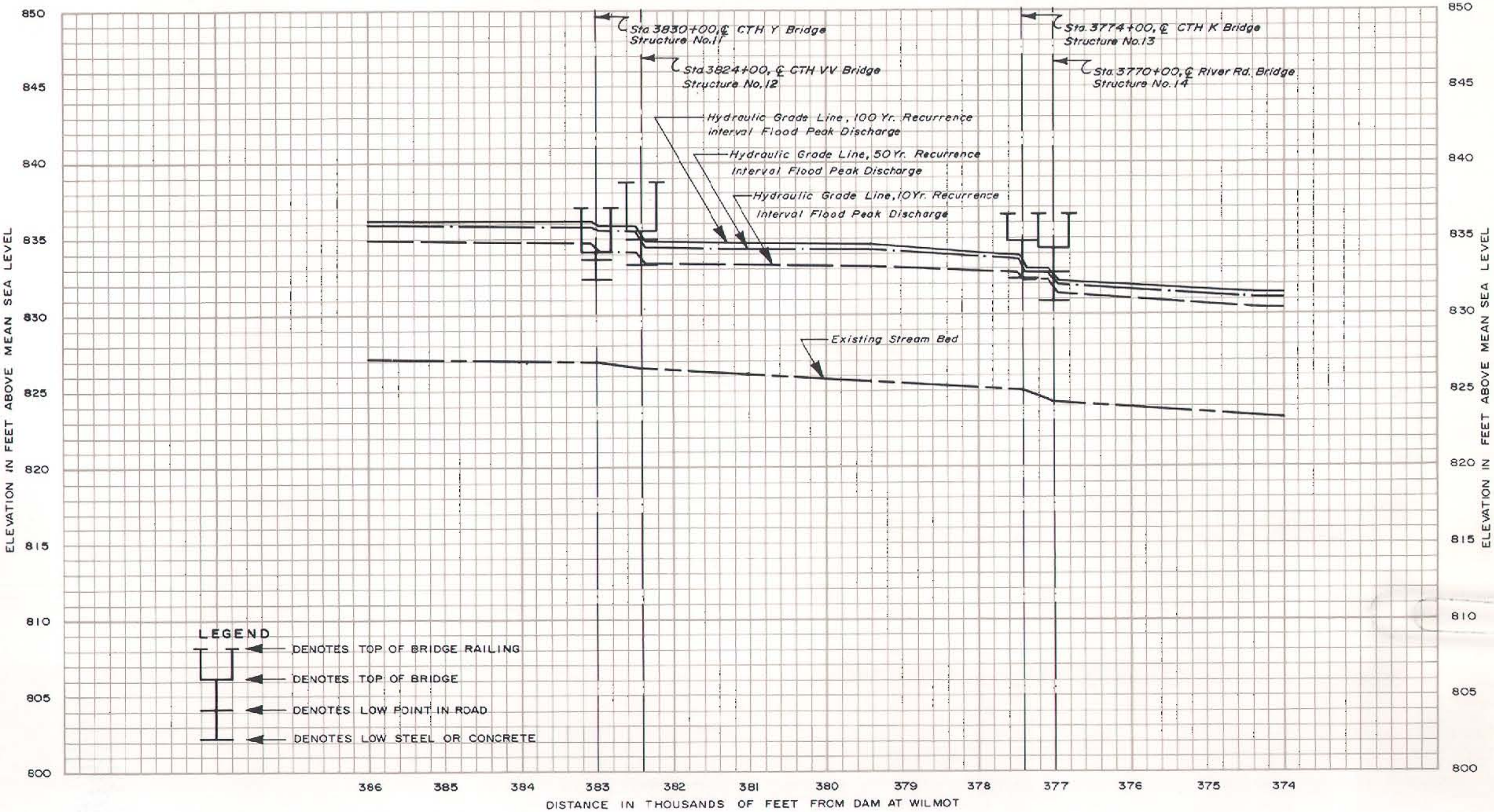
WAUKESHA COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: NOVEMBER 1969

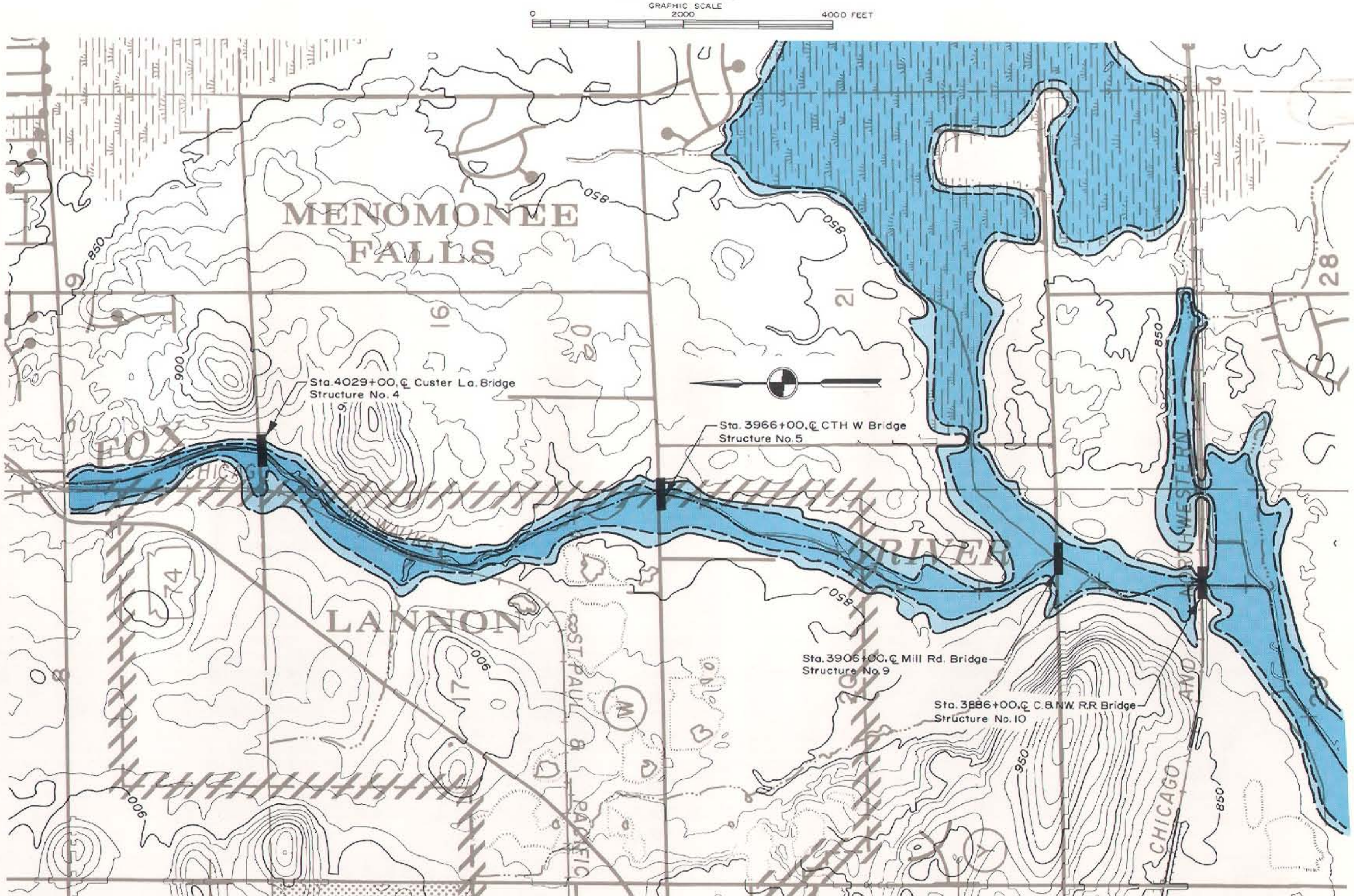
CHECKED: DRB DATE: NOVEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-2 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
UPPER FOX RIVER
FROM STA. 3860+00 TO STA. 4040+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'

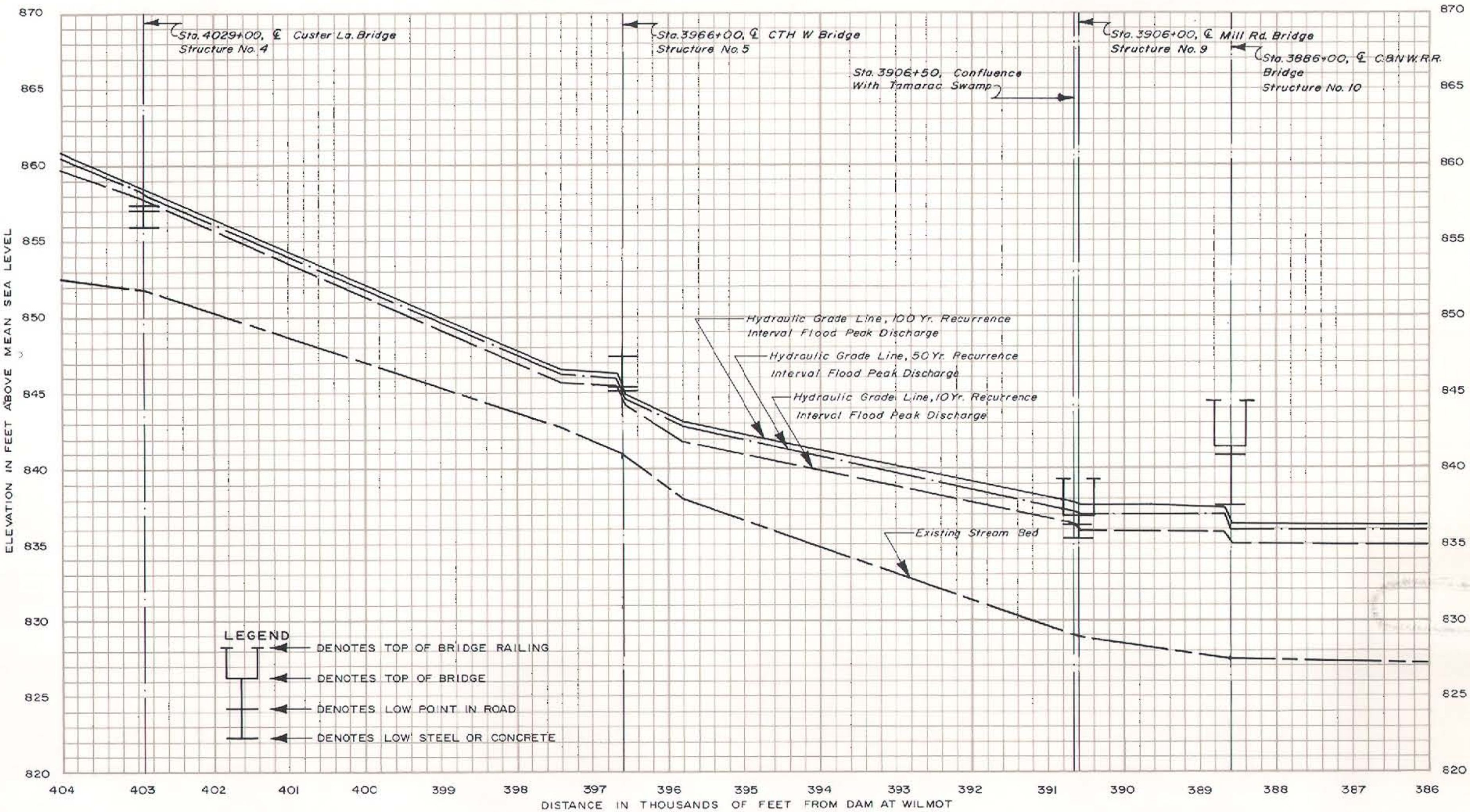


LEGEND
DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY
Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-2 (continued)

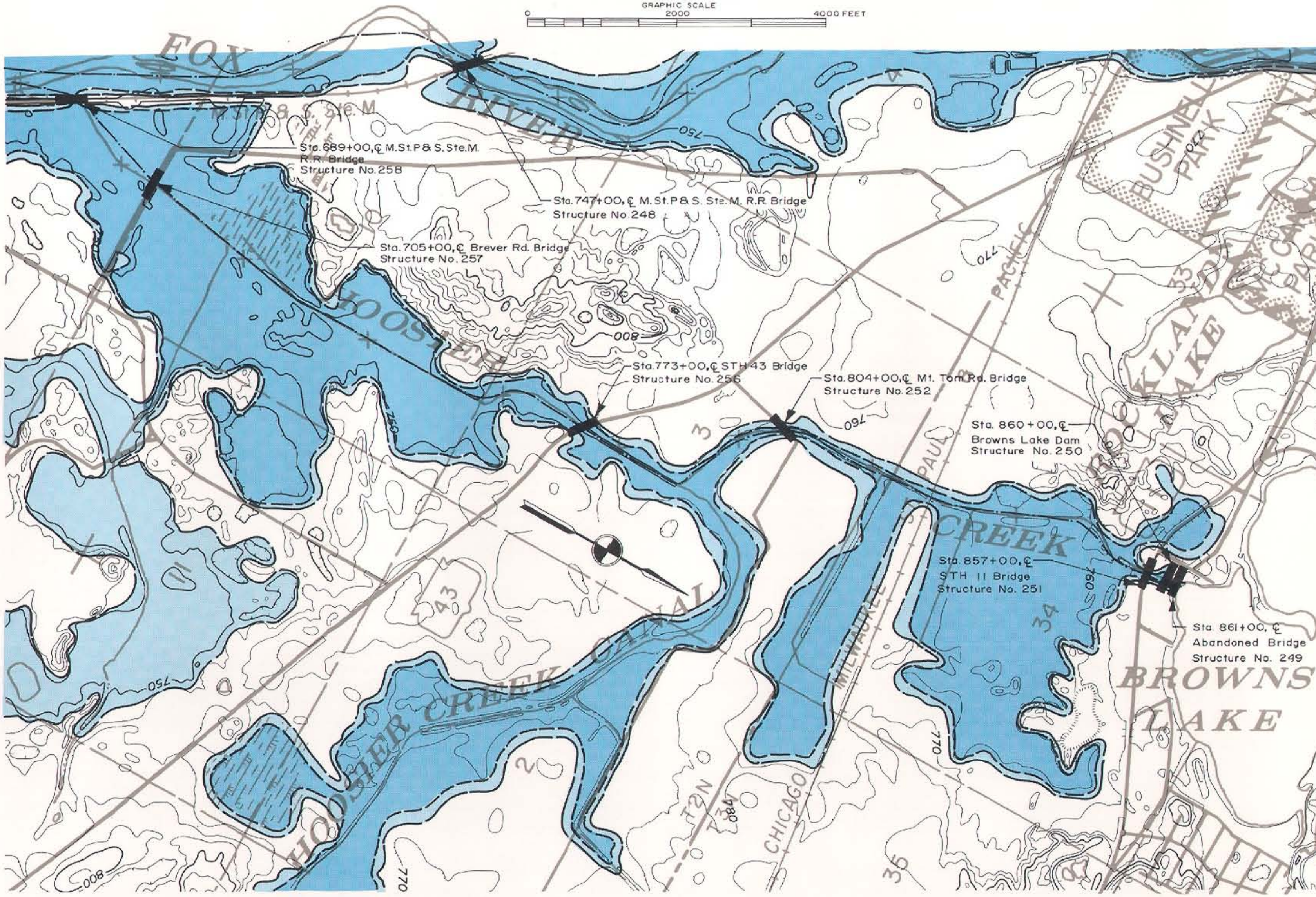
HIGH WATER AND STREAM BED PROFILES
OF THE
UPPER FOX RIVER

FROM STA.3860+00 TO STA.4040+00
WAUKESHA COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: LHK DATE: NOVEMBER 1969
CHECKED: DRB DATE: NOVEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-3
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
HOOSIER CREEK
FROM STA. 679+00 TO STA. 780+00
RACINE COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

+ DENOTES STATION TICK

Figure D-3

HIGH WATER AND STREAM BED PROFILES

OF THE

HOOSIER CREEK

FROM STA. 679+00 TO STA. 780+00

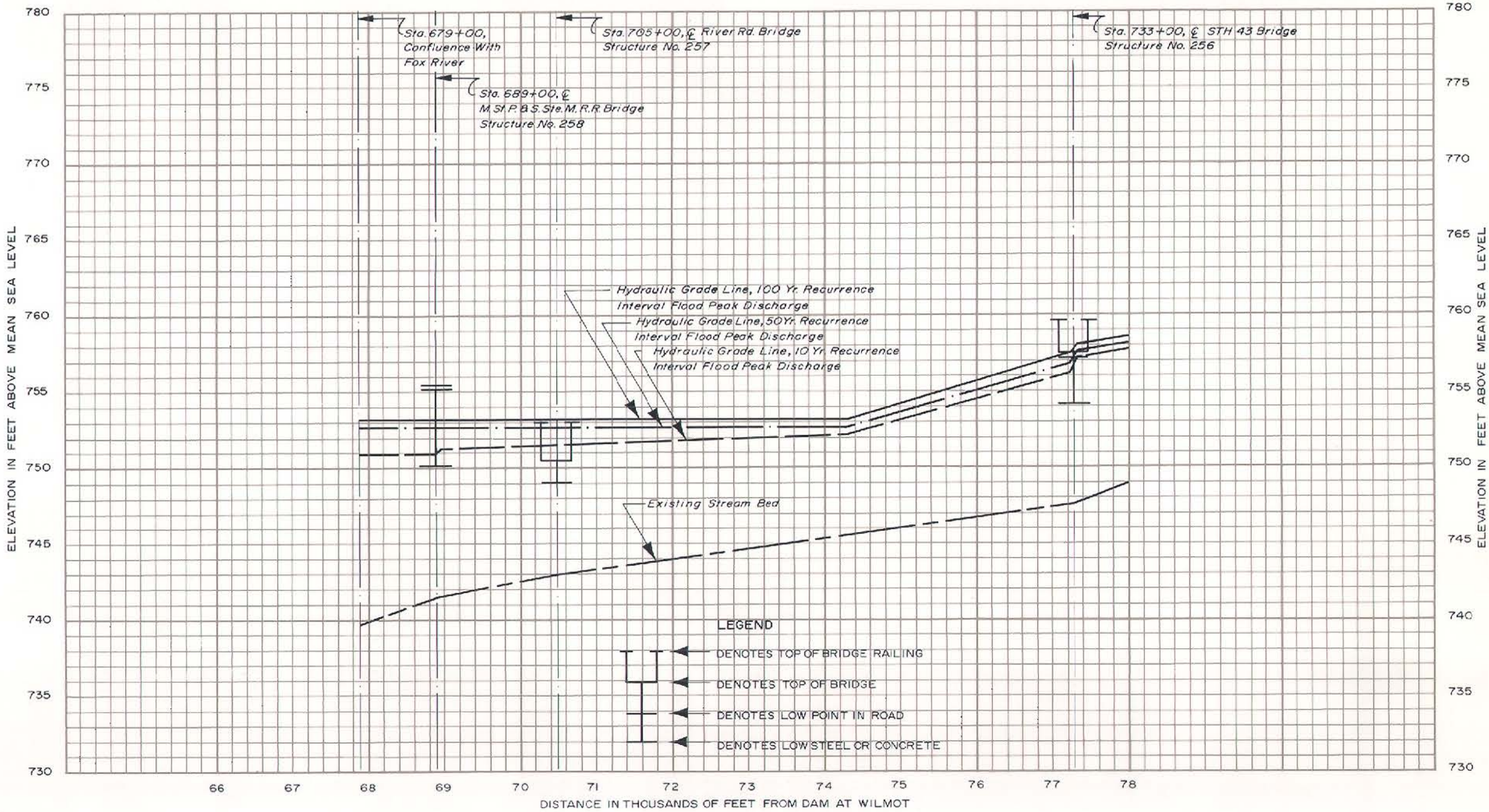
RACINE COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: DSF DATE: NOVEMBER 1969

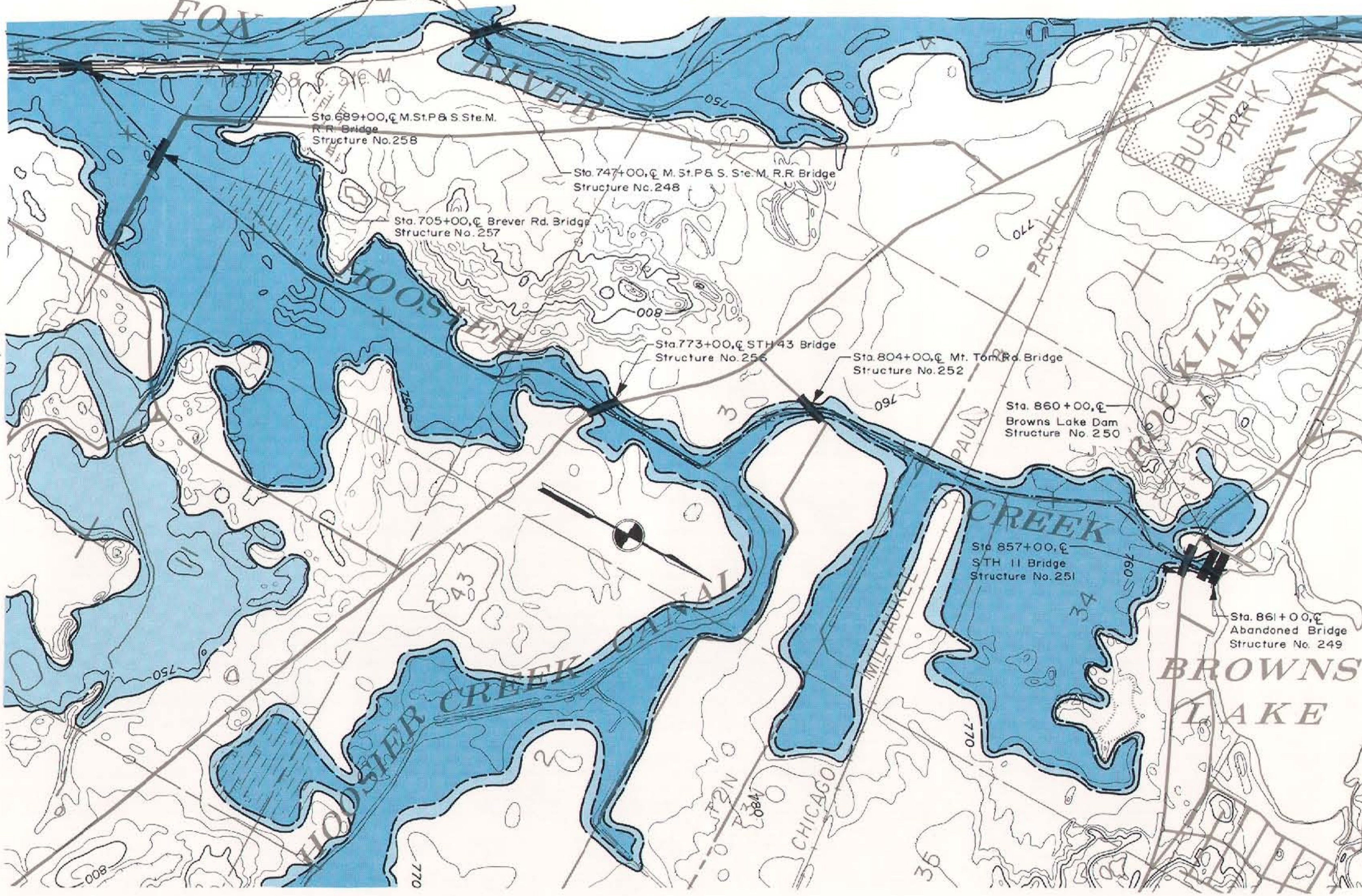
CHECKED: DRB DATE: NOVEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



Source: U.S. Soil Conservation Service, SEWRPC

Map D-3 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
HOOSIER CREEK
FROM STA. 780+00 TO STA. 867+00
RACINE COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

DENOTES STATION TICK

Figure D-3

HIGH WATER AND STREAM BED PROFILES

OF THE

HOOSIER CREEK

FROM STA. 780+00 TO STA. 867+00

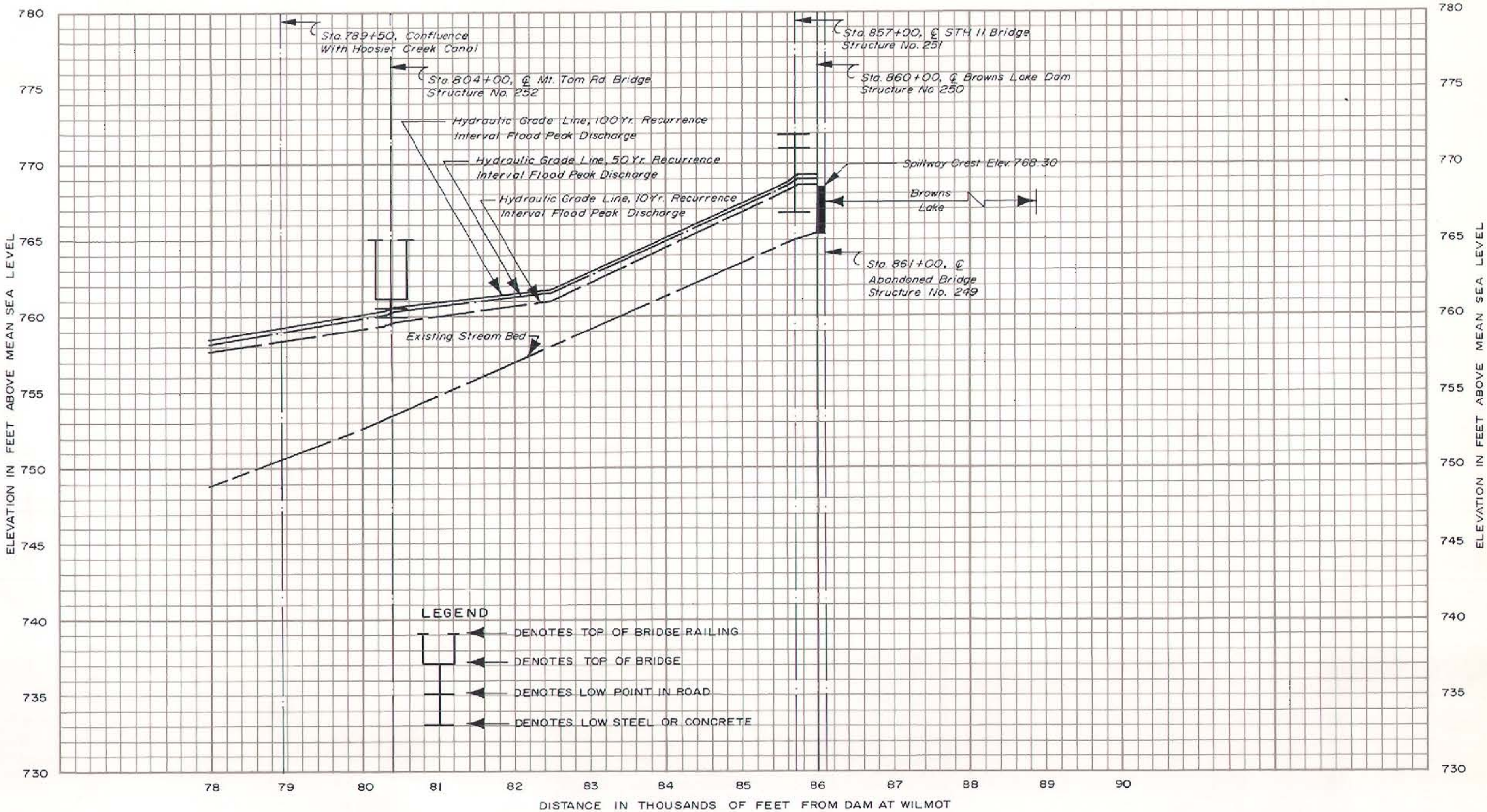
RACINE COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: RHH DATE: NOVEMBER 1969

CHECKED: DRB DATE: NOVEMBER 1969

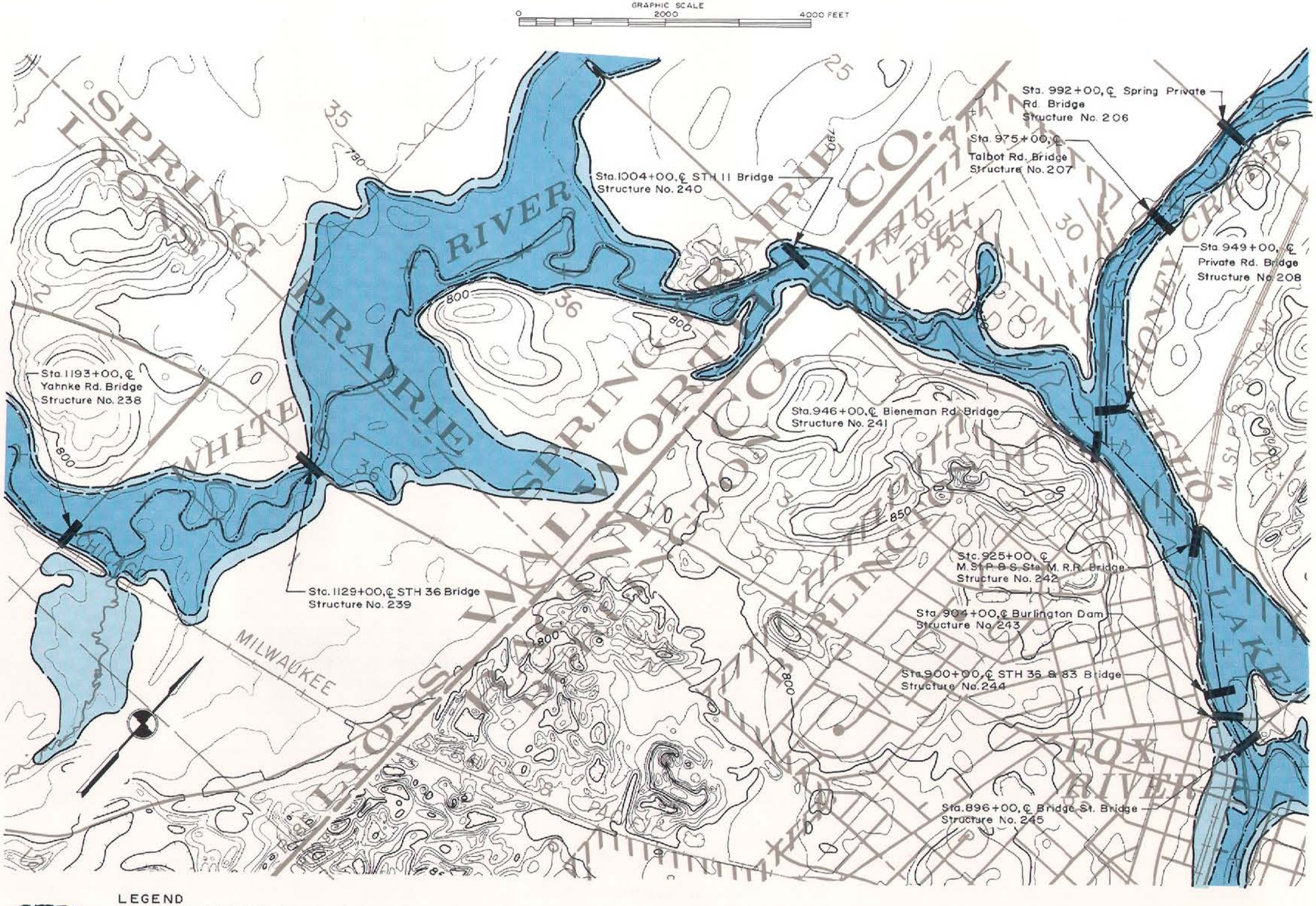
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-4
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
WHITE RIVER

FROM STA. 800+00 TO STA. 1000+00
RACINE AND WALWORTH COUNTIES, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'

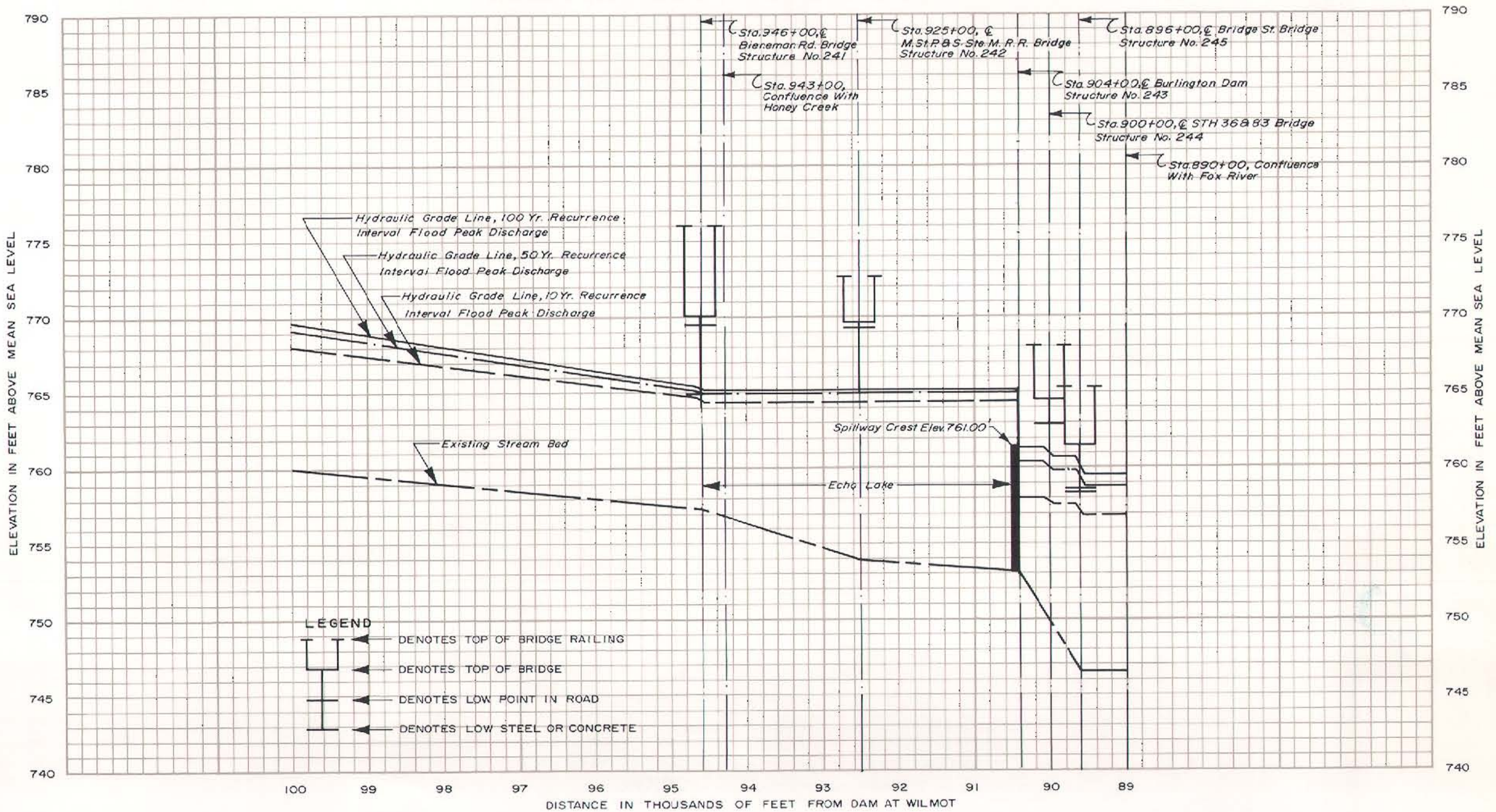


LEGEND
DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-4

HIGH WATER AND STREAM BED PROFILES
OF THE
WHITE RIVER
FROM STA. 890+00 TO STA. 1000+00
RACINE COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: LHK DATE: NOVEMBER 1969
CHECKED: DRB DATE: NOVEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS

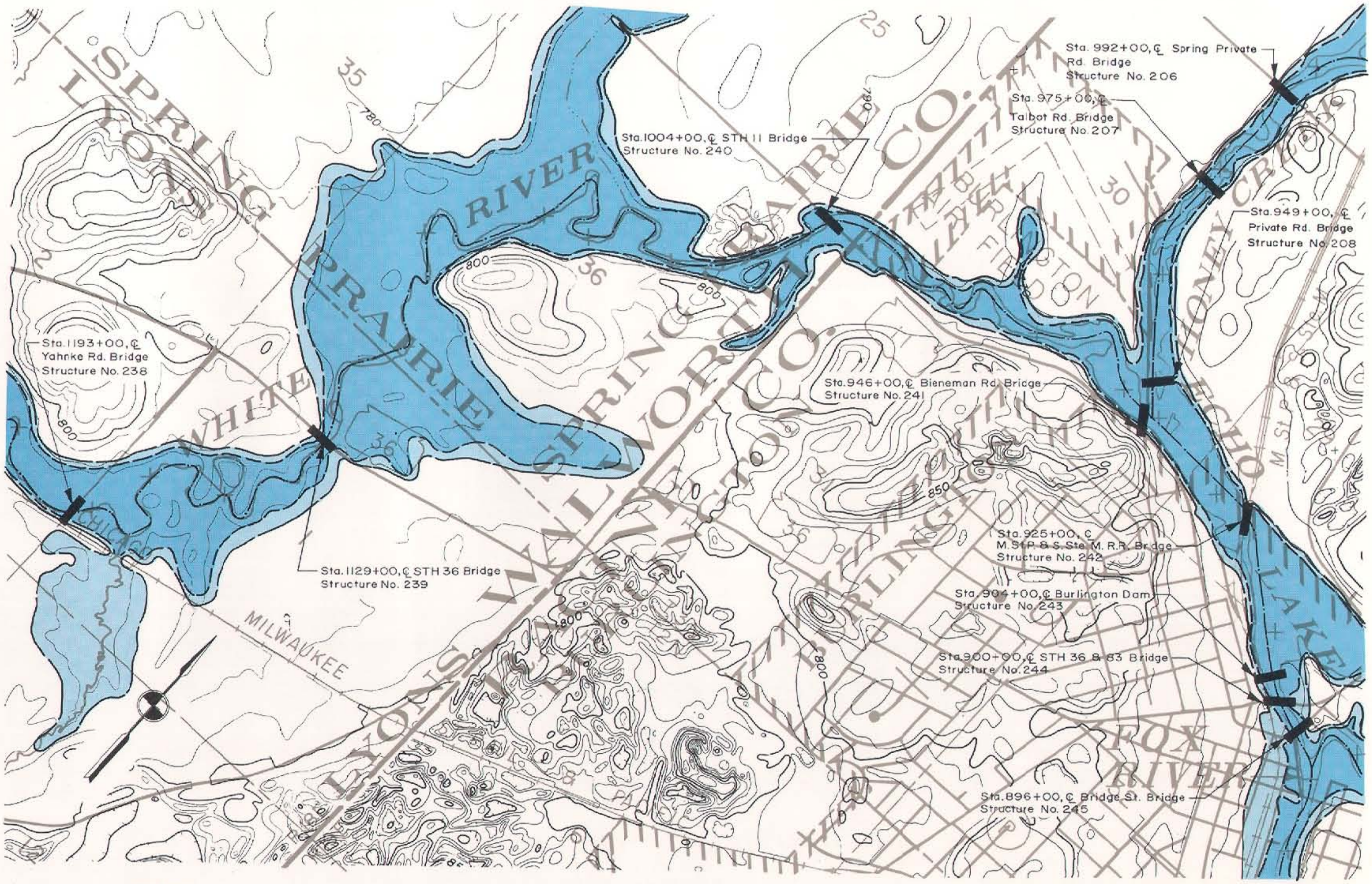


NOTE: BURLINGTON CITY DATUM = MEAN SEA LEVEL DATUM, 1929 ADJUSTMENT MINUS 175.25'

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

Map D-4 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
WHITE RIVER

FROM STA.1000+00 TO STA. 1100+00
RACINE AND WALWORTH COUNTIES, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-4 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

WHITE RIVER

FROM STA. 1000+00 TO STA. 1100+00

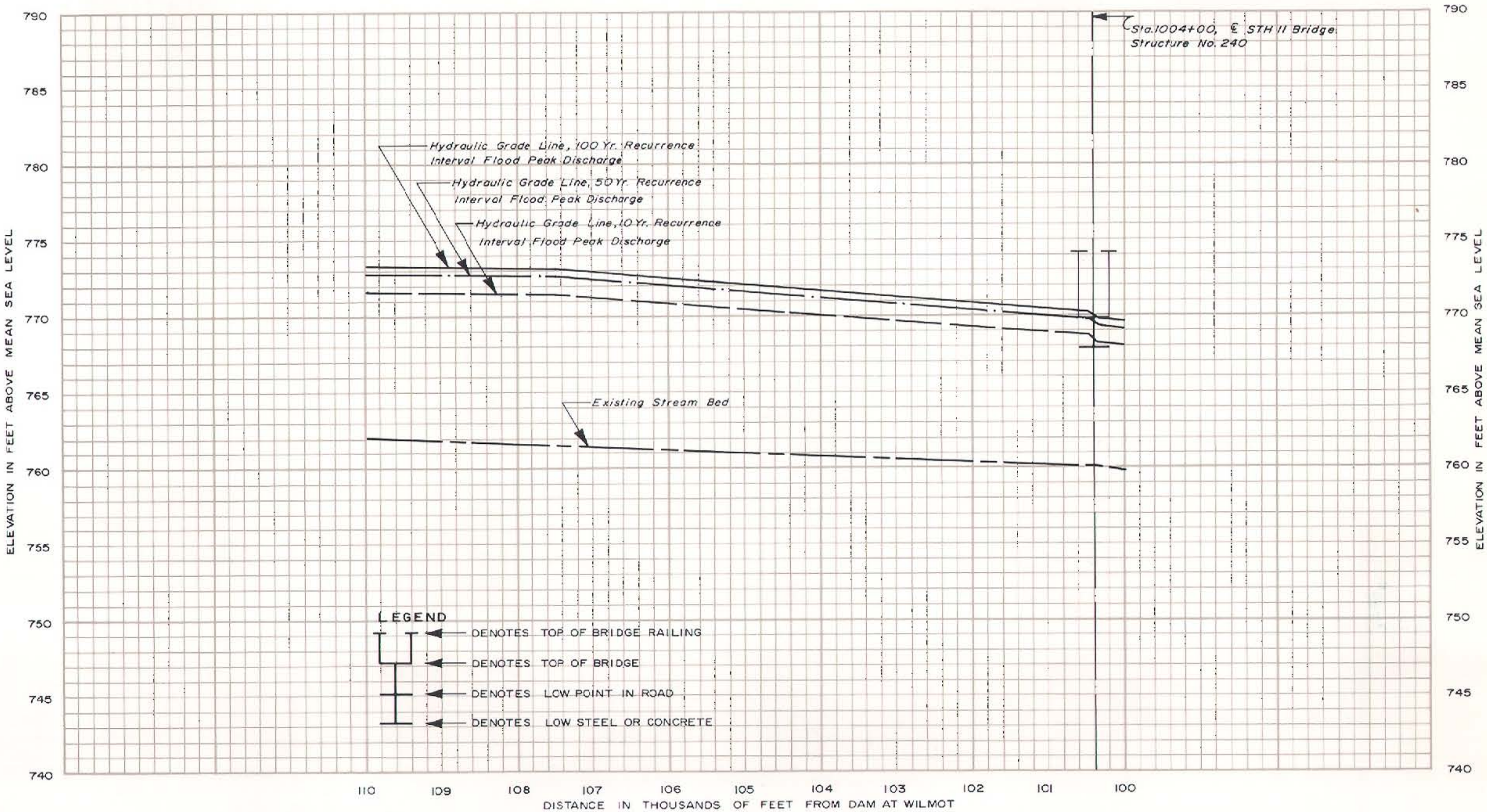
WALWORTH COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: NOVEMBER 1969

CHECKED: DRB DATE: NOVEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS

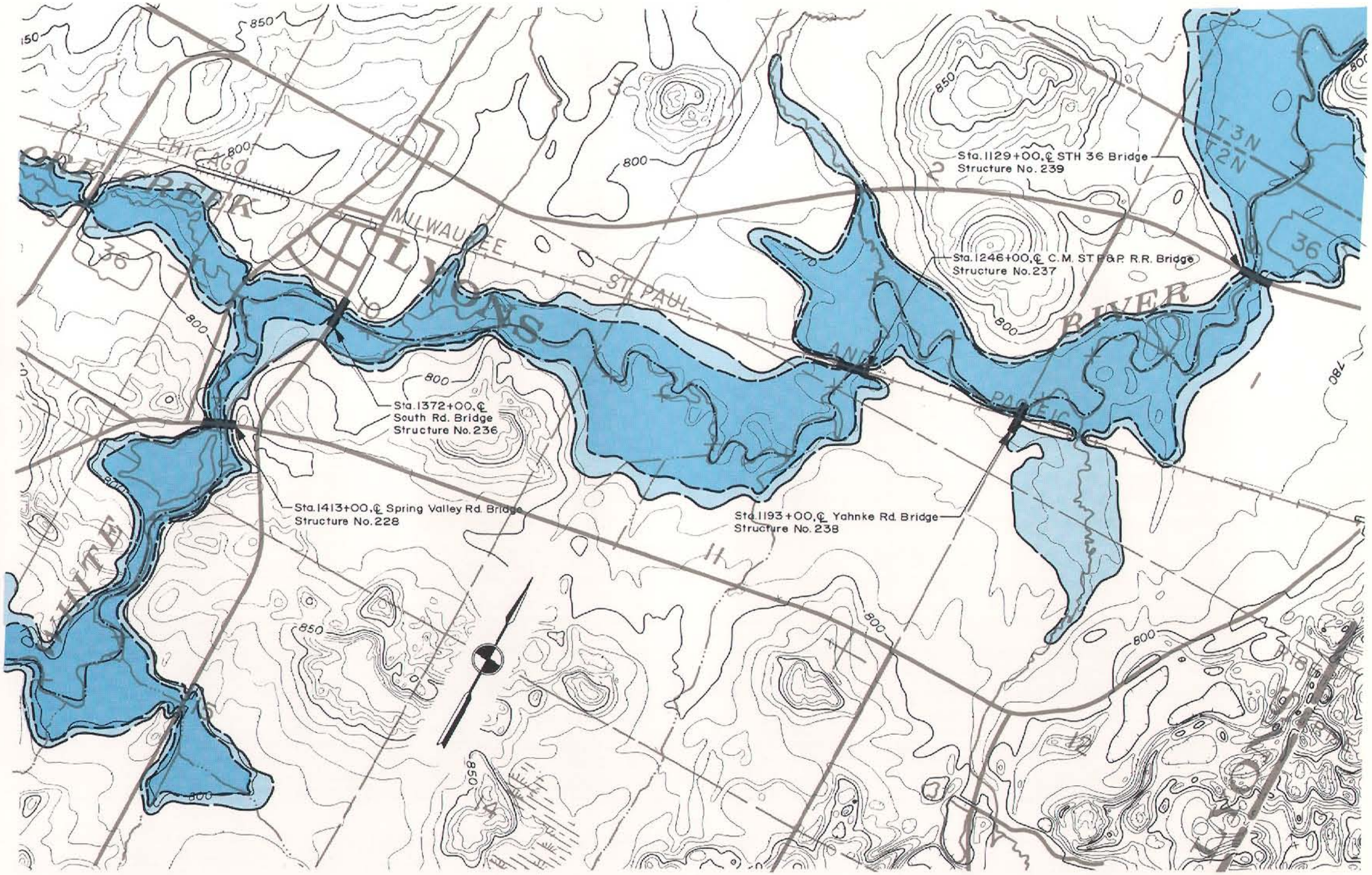


NOTE: BURLINGTON CITY DATUM = MEAN SEA LEVEL DATUM, 1929 ADJUSTMENT MINUS 175.25'

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

Map D-4 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
WHITE RIVER

FROM STA. 1100+00 TO STA. 1280+00
RACINE AND WALWORTH COUNTIES, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

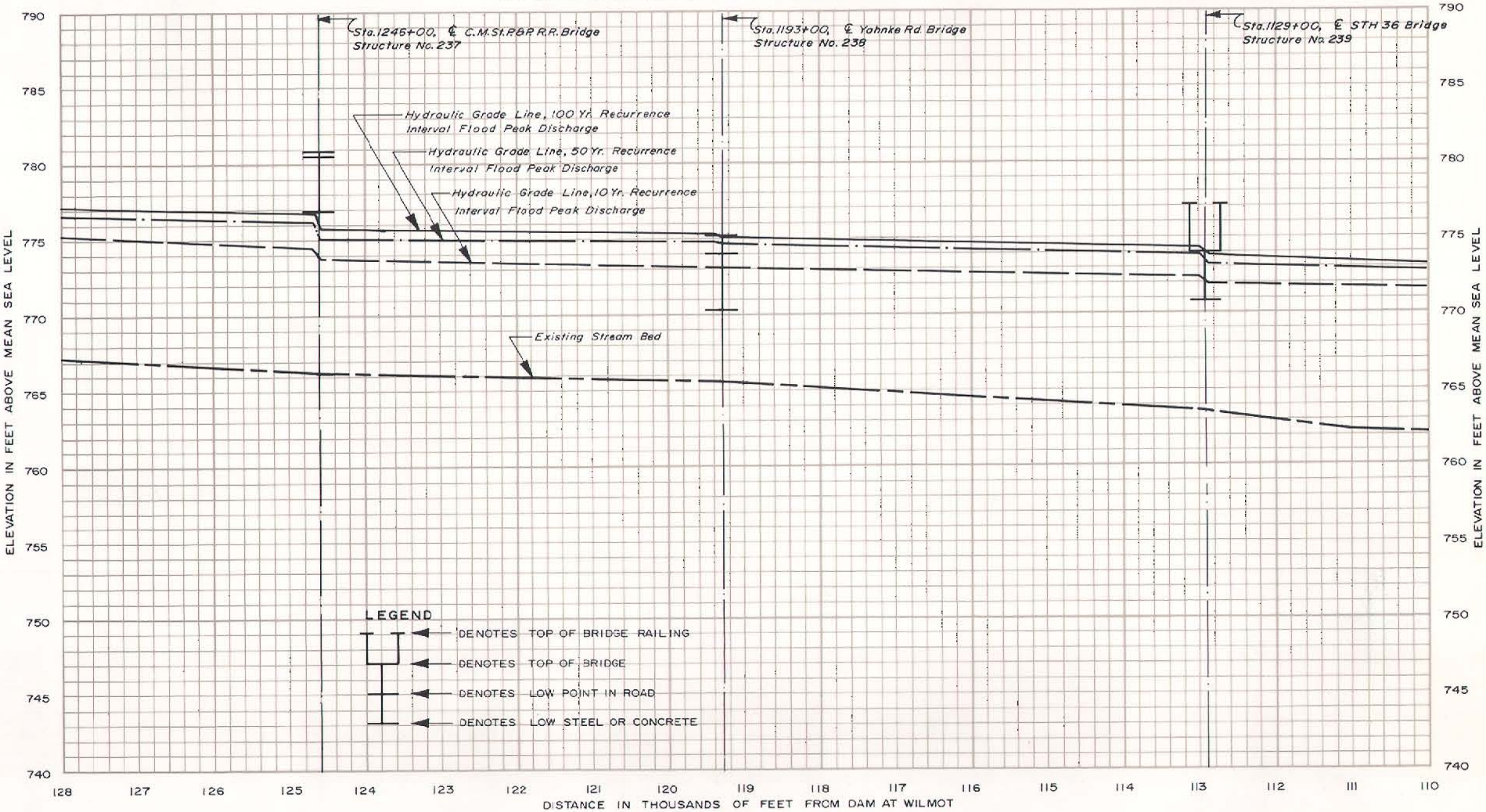
Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

\+ DENOTES STATION TICK

Figure D-4 (continued)

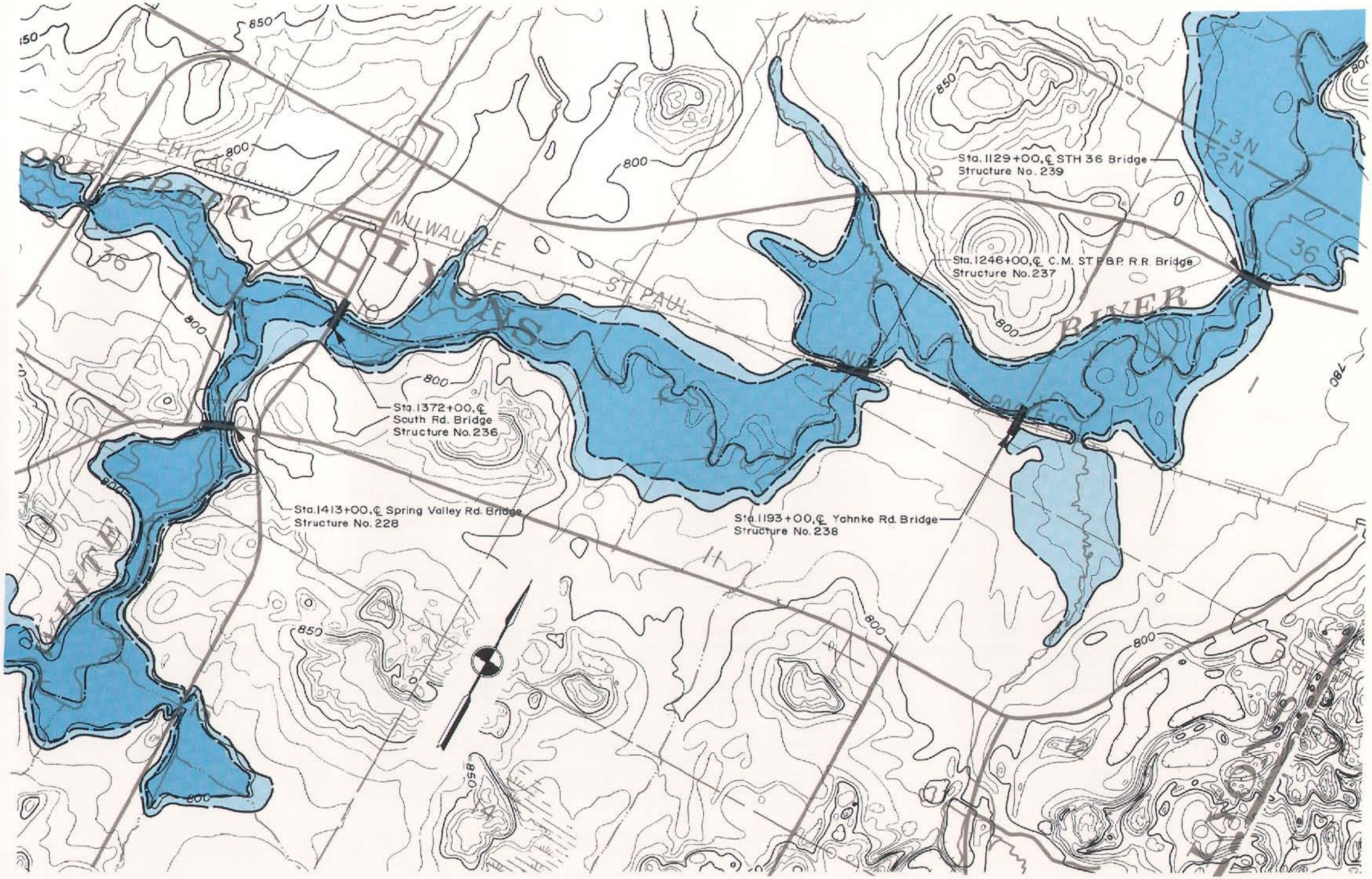
HIGH WATER AND STREAM BED PROFILES
OF THE
WHITE RIVER
FROM STA. 1100+00 TO STA. 1280+00
WALWORTH COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: LHK DATE: NOVEMBER 1969
CHECKED: DRB DATE: NOVEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-4 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
WHITE RIVER

FROM STA. 1280+00 TO STA. 1440+00
RACINE AND WALWORTH COUNTIES, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
+ DENOTES STATION TICK

Figure D-4 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

WHITE RIVER

FROM STA. 1280+00 TO STA. 1440+00

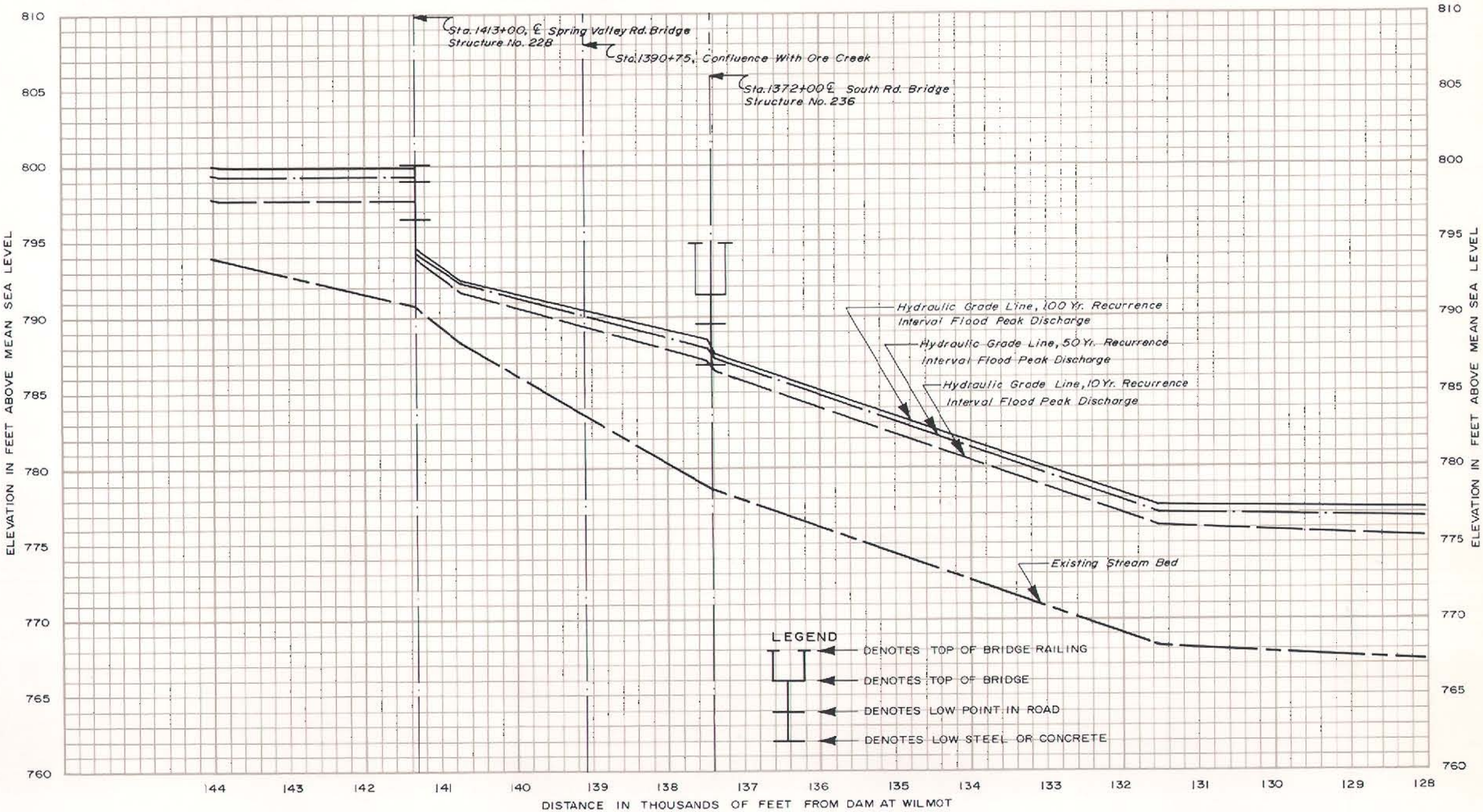
WALWORTH COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: NOVEMBER 1969

CHECKED: DRB DATE: NOVEMBER 1969

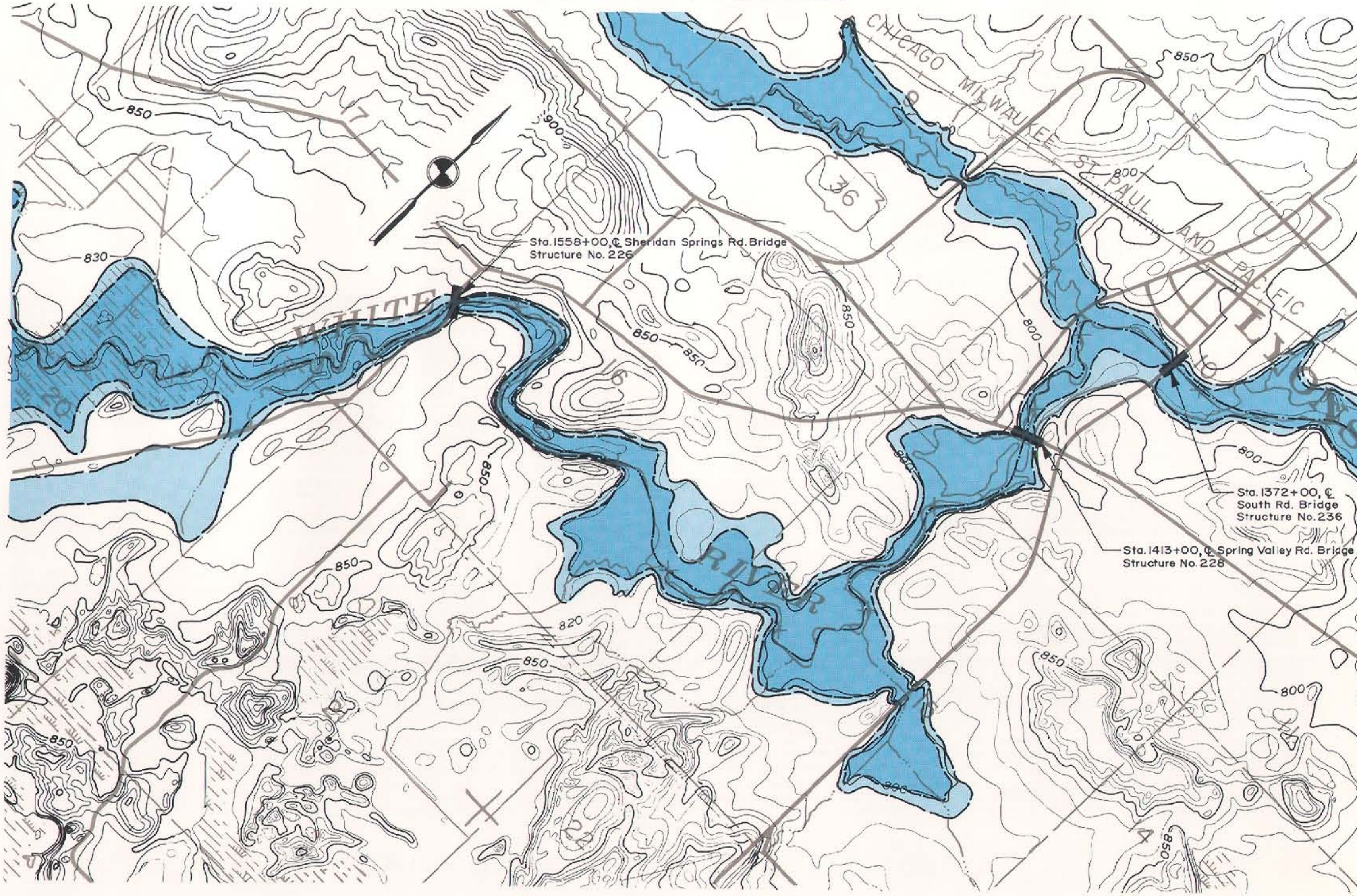
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-4 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
WHITE RIVER

FROM STA. 1440+00 TO STA. 1600+00
WALWORTH COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: SEPTEMBER 1969
CHECKED: DRB DATE: SEPTEMBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

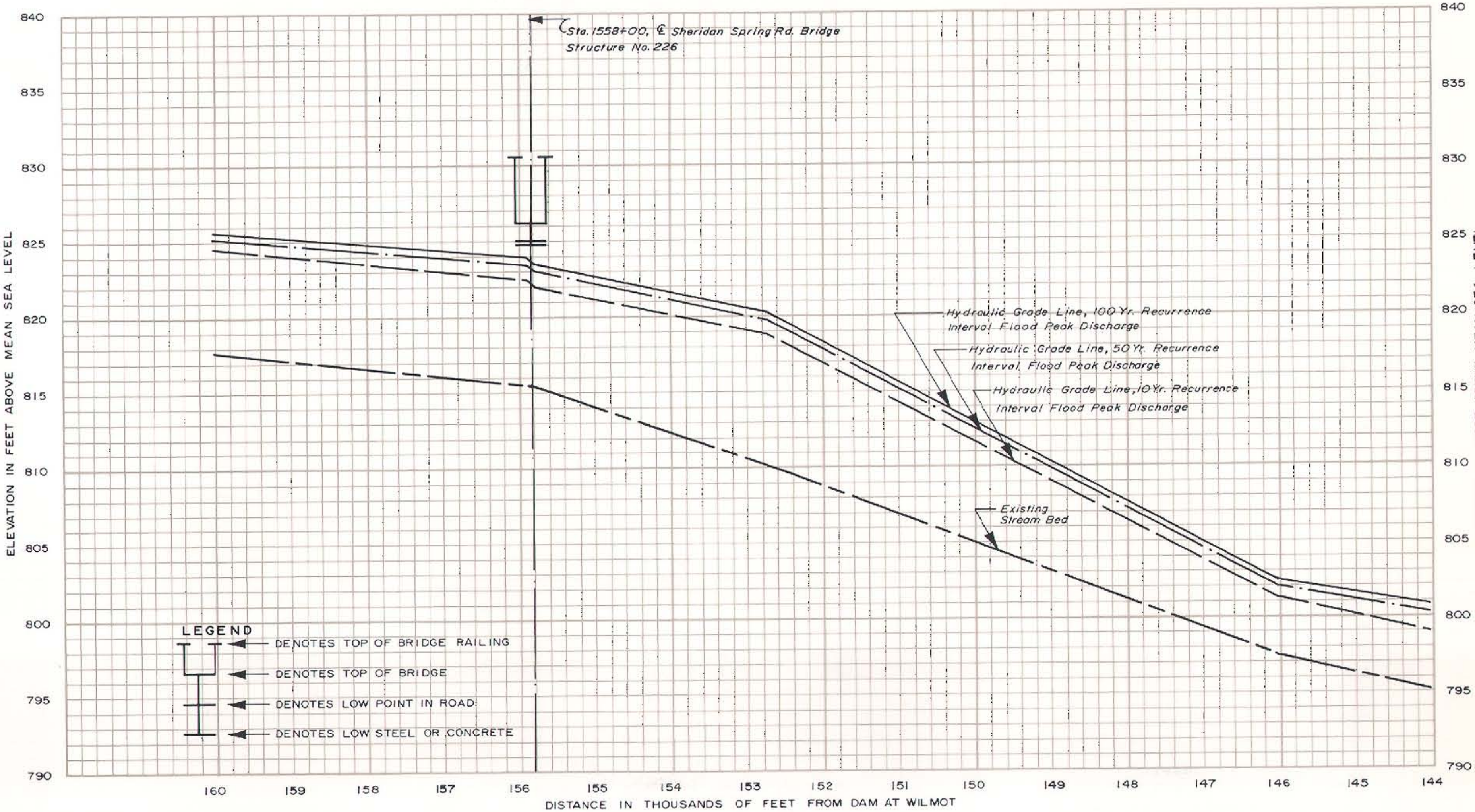
Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

DENOTES STATION TICK

Figure D-4 (continued)

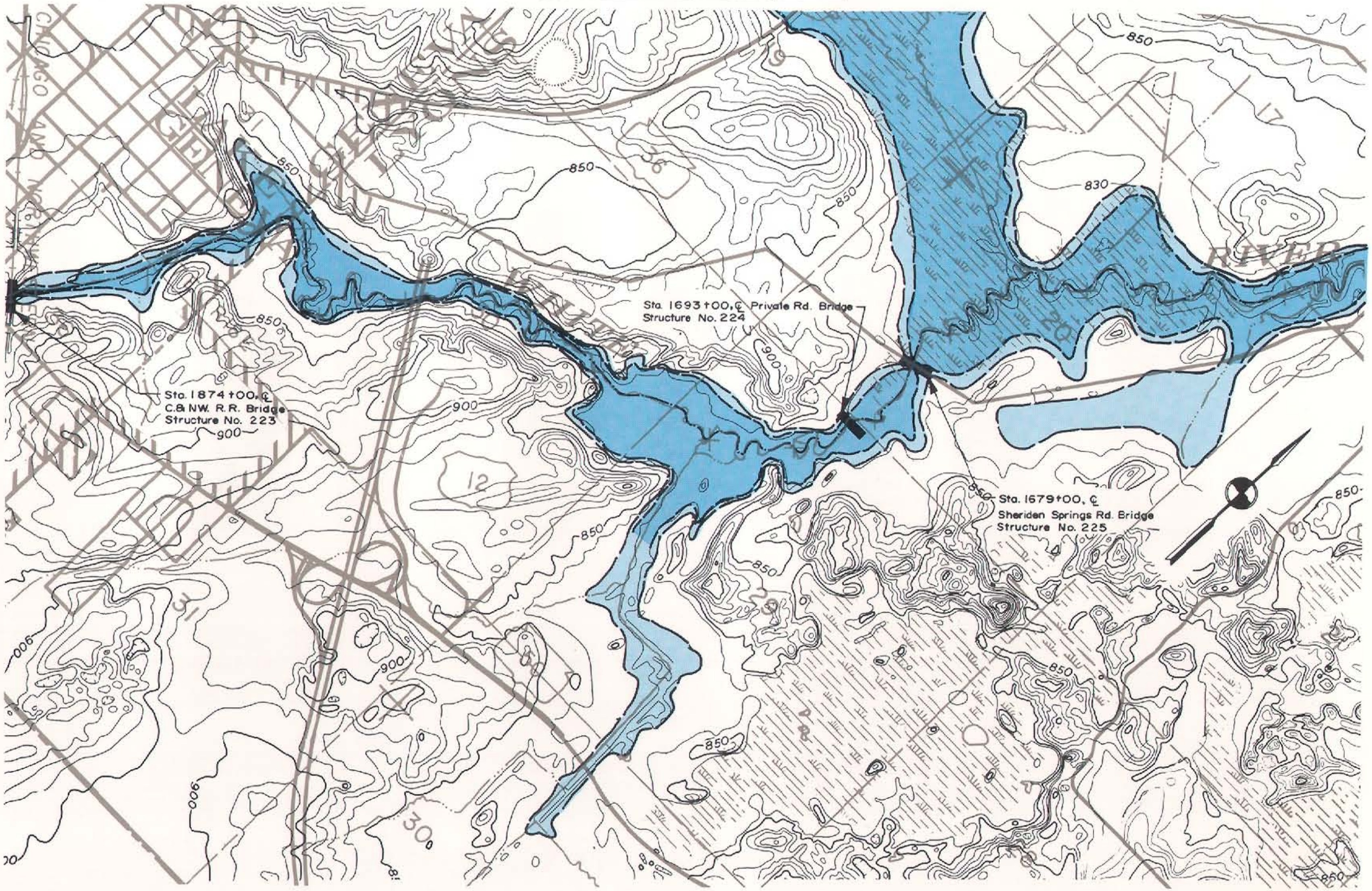
HIGH WATER AND STREAM BED PROFILES
OF THE
WHITE RIVER
FROM STA. 1440+00 TO STA. 1600+00
WALWORTH COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: LHK DATE: DECEMBER 1969
CHECKED: DRB DATE: DECEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-4 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
WHITE RIVER

FROM STA. 1600+00 TO STA. 1740+00
WALWORTH COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-4 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

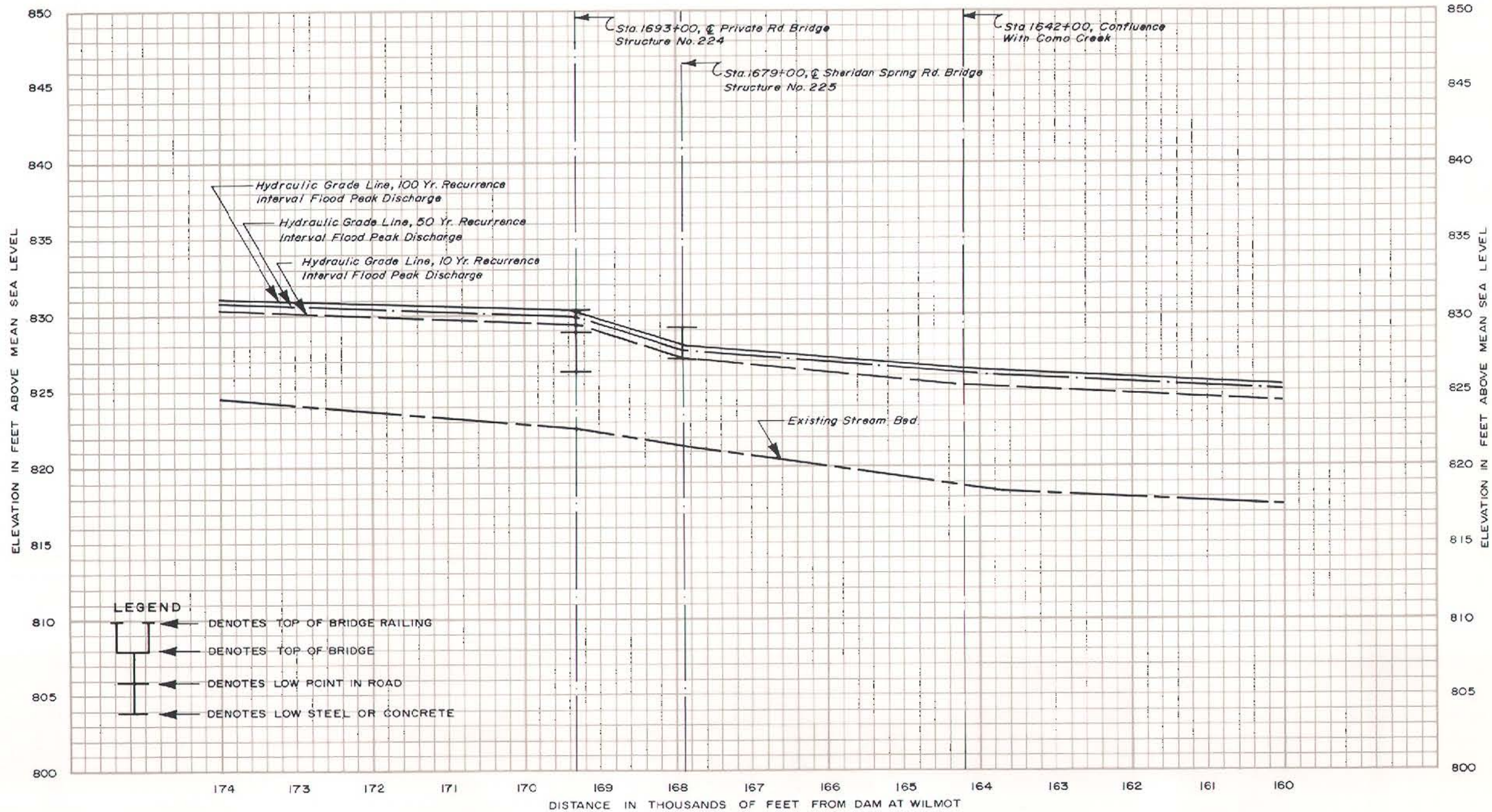
WHITE RIVER

FROM STA. 1600+00 TO STA. 1740+00
WALWORTH COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: JHW DATE: DECEMBER, 1969
CHECKED: DRB DATE: DECEMBER, 1969

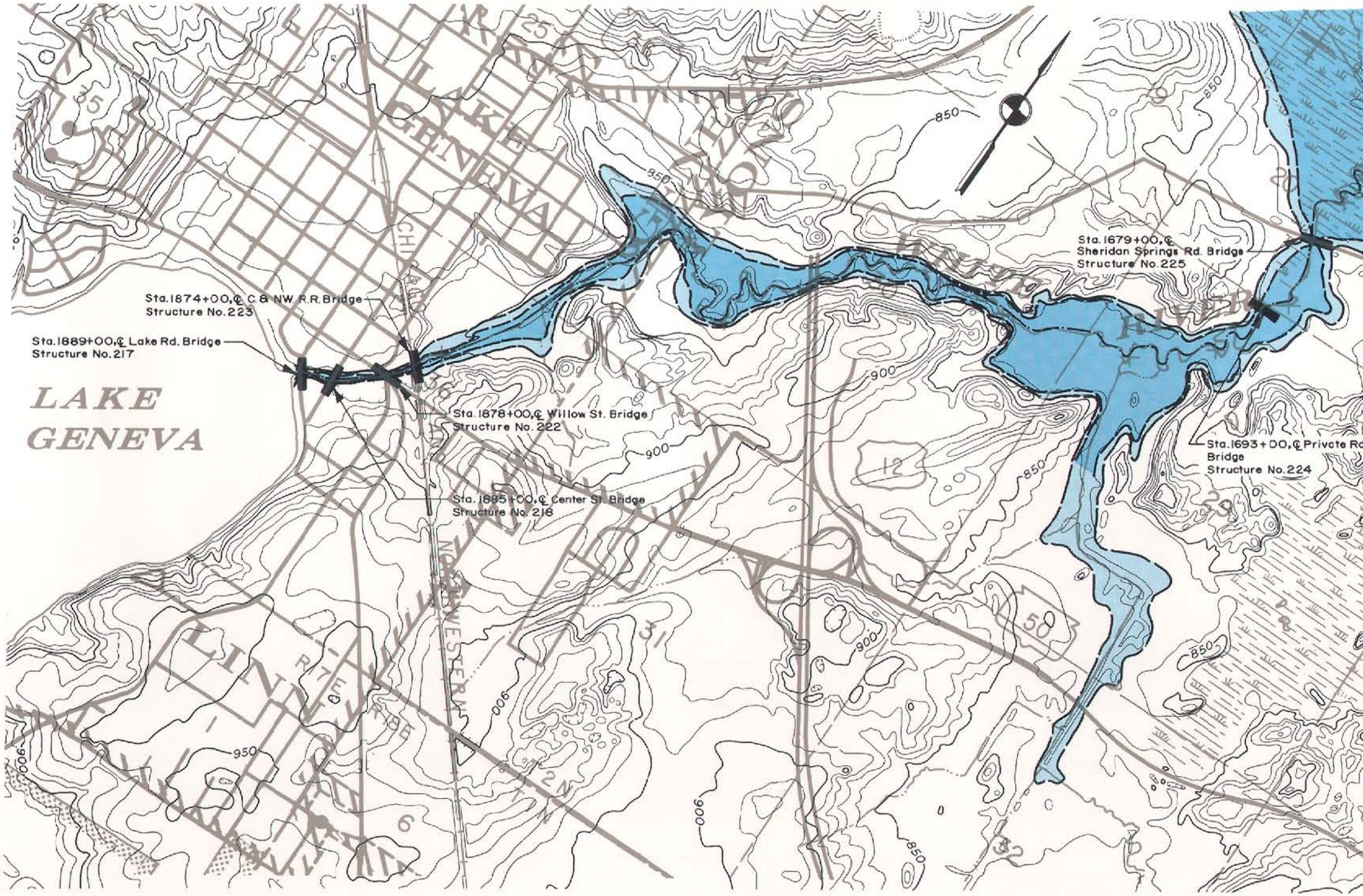
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-4 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
WHITE RIVER

FROM STA.1740+00 TO STA.1889+00
WALWORTH COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



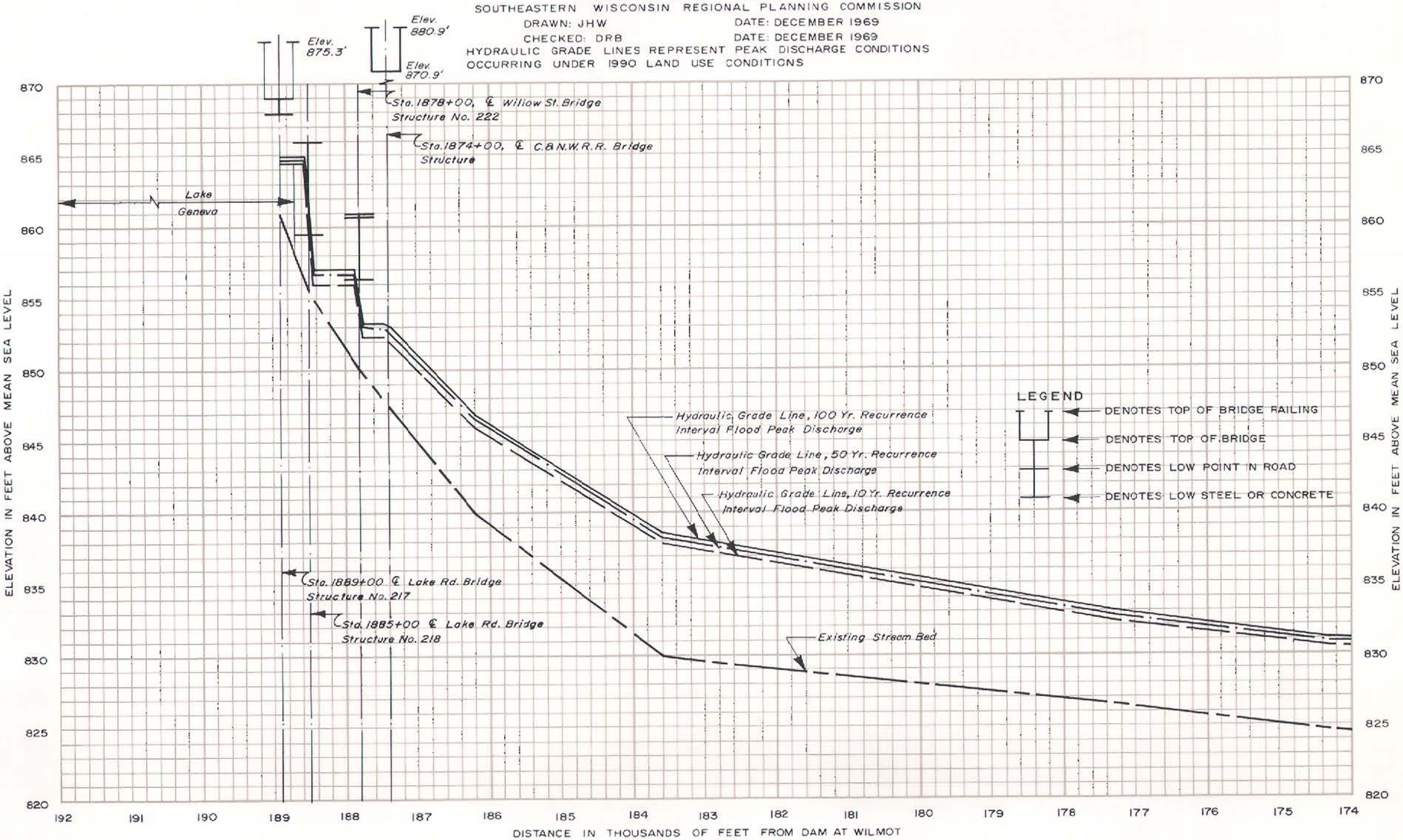
LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
+ DENOTES STATION TICK

Figure D-4 (continued)

HIGH WATER AND STREAM BED PROFILES
OF THE
WHITE RIVER
FROM STA. 1740+00 TO STA 1889+00
WALWORTH COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: JHW DATE: DECEMBER 1969
CHECKED: DRB DATE: DECEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-5
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
HONEY CREEK
FROM STA. 943+00 TO STA. 1043+00

RACINE AND WALWORTH COUNTIES, WISCONSIN

PREPARED BY

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

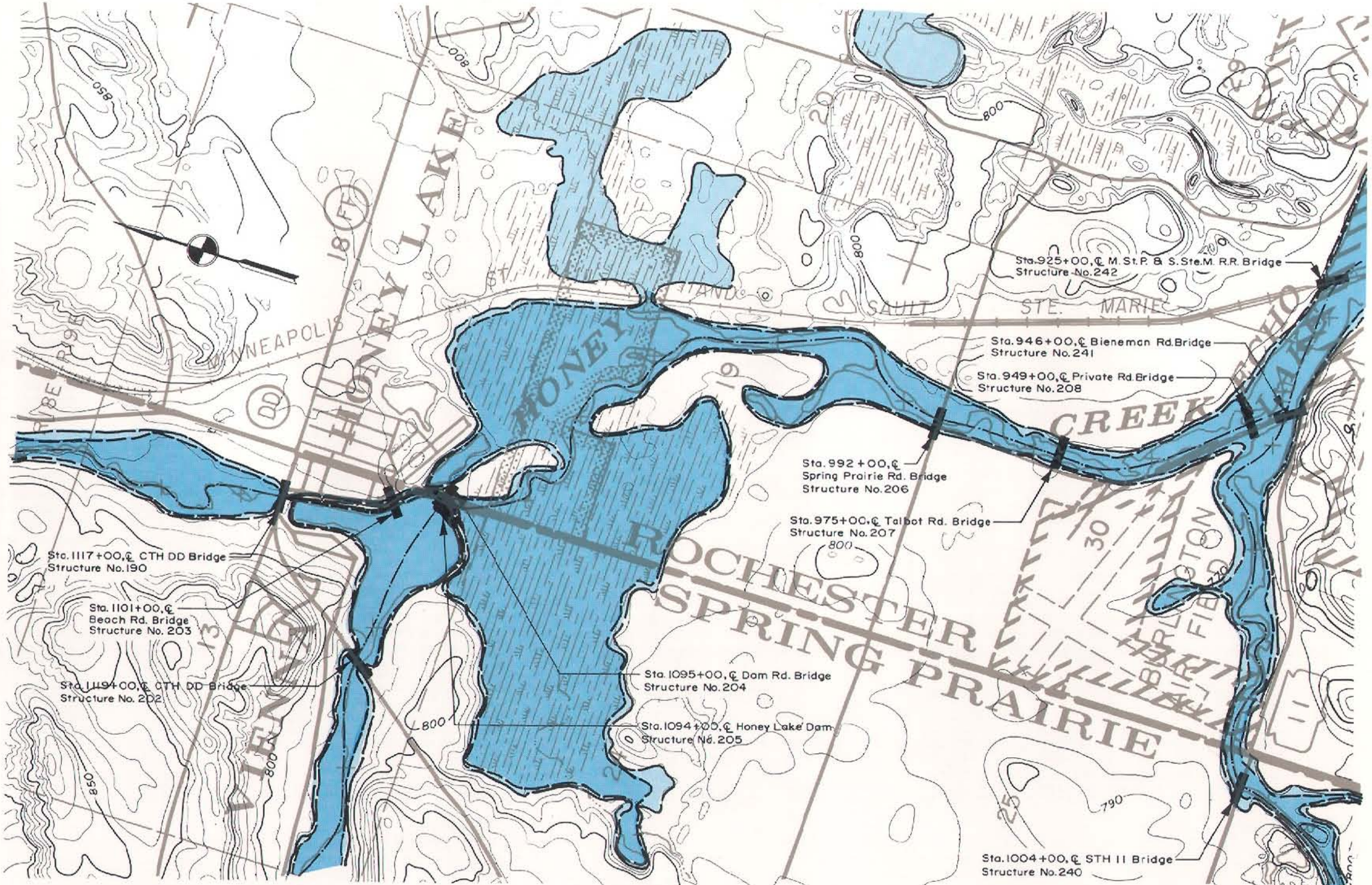
DRAWN: RHH DATE: OCTOBER 1969

CHECKED: DRB DATE: OCTOBER 1969

SCALE: 1" = 2000'

GRAPHIC SCALE

0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

DENOTES STATION TICK

Figure D-5

HIGH WATER AND STREAM BED PROFILES

OF THE

HONEY CREEK

FROM STA. 943+00 TO STA. 1043+00

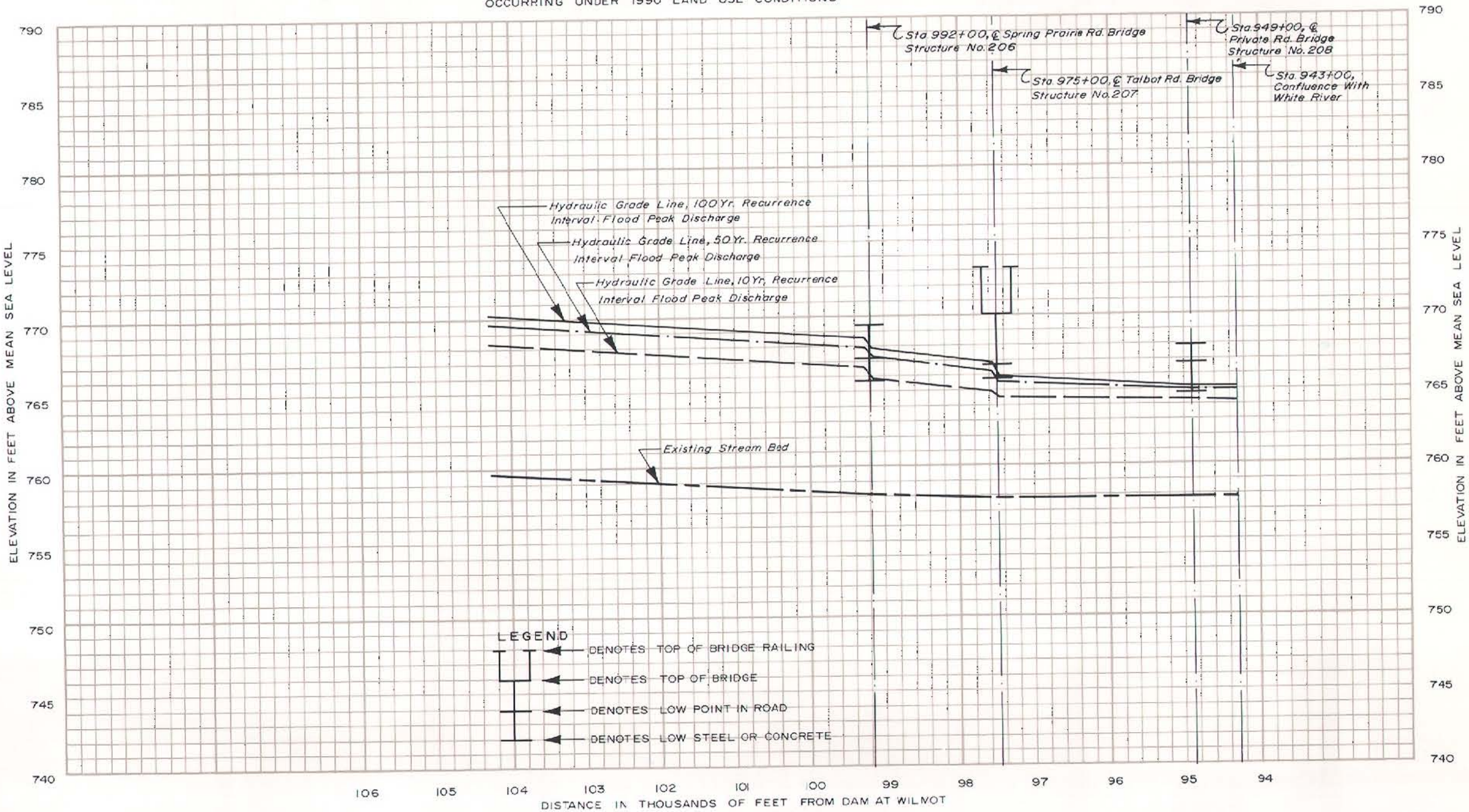
RACINE COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



NOTE: BURLINGTON CITY DATUM = MEAN SEA LEVEL DATUM, 1929 ADJUSTMENT MINUS 175.25'

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

Map D-5 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
HONEY CREEK

FROM STA. 1043+00 TO STA. 1163+00

RACINE AND WALWORTH COUNTIES, WISCONSIN

PREPARED BY

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

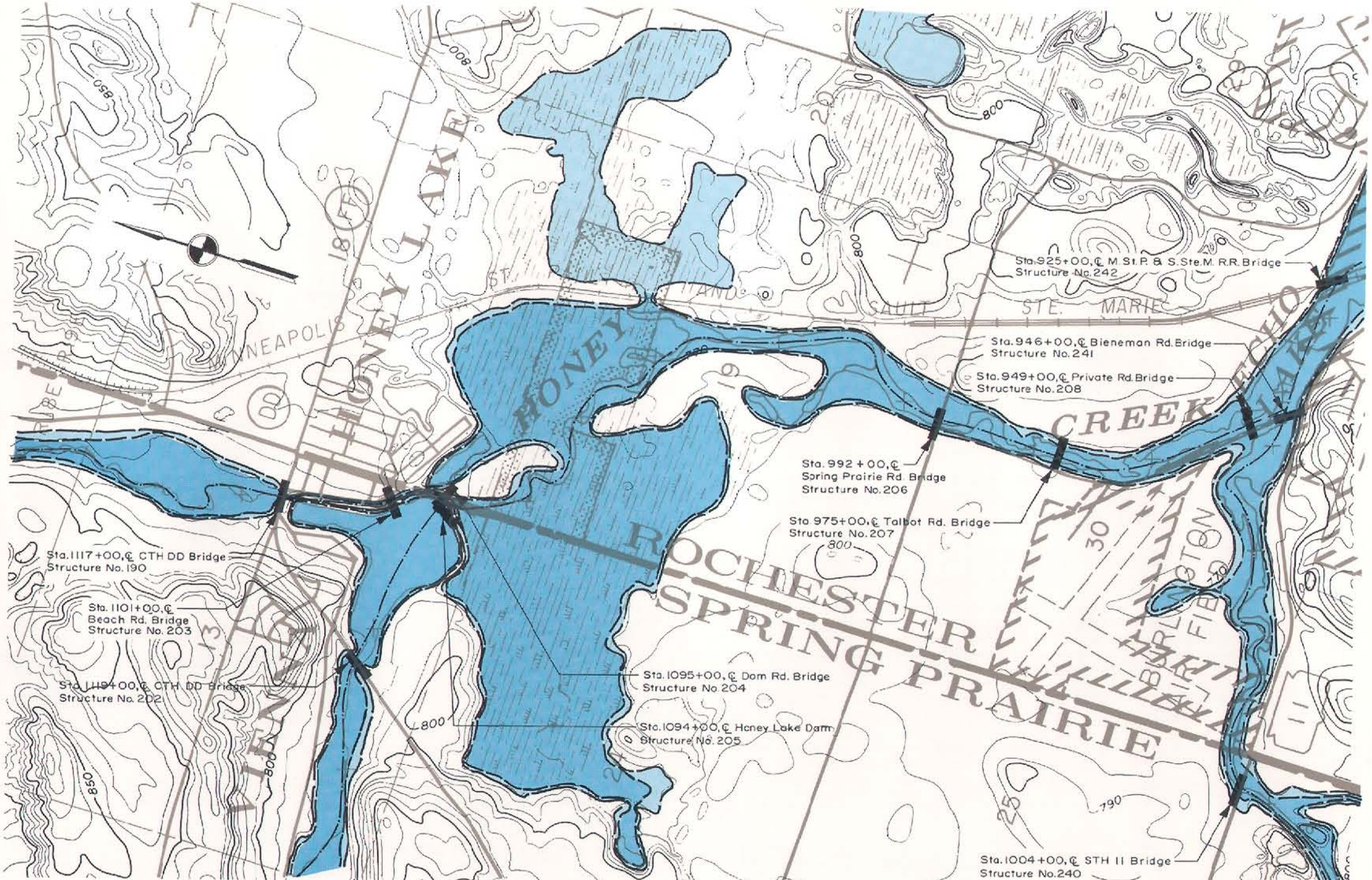
DRAWN: RHH DATE: OCTOBER 1969

CHECKED: DRB DATE: OCTOBER 1969

SCALE: 1" = 2000'

GRAPHIC SCALE

0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

\+ DENOTES STATION TICK

Figure D-5 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

HONEY CREEK

FROM STA. 1043+00 TO STA. 1163+00

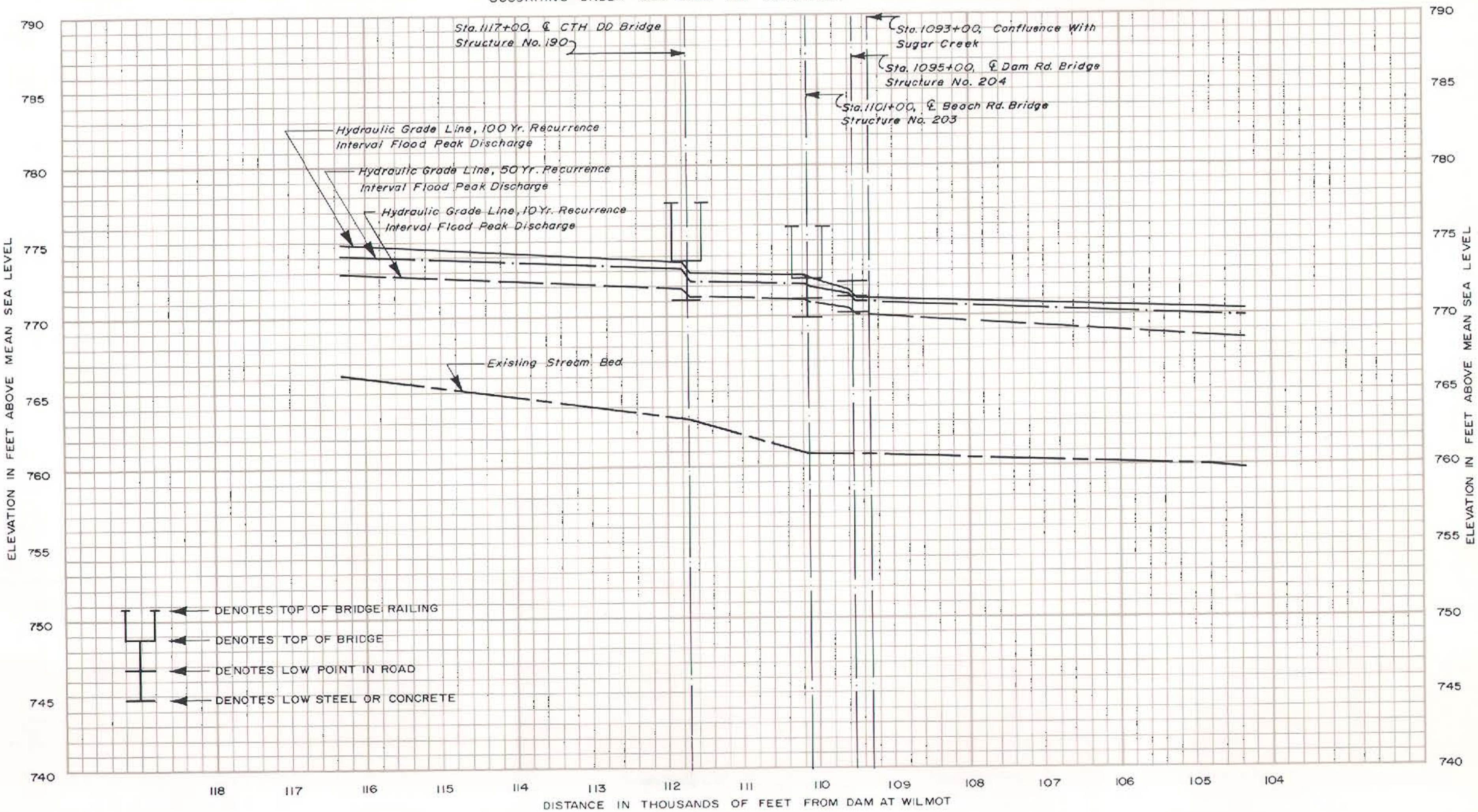
RACINE AND WALWORTH COUNTIES, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: JHW DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS

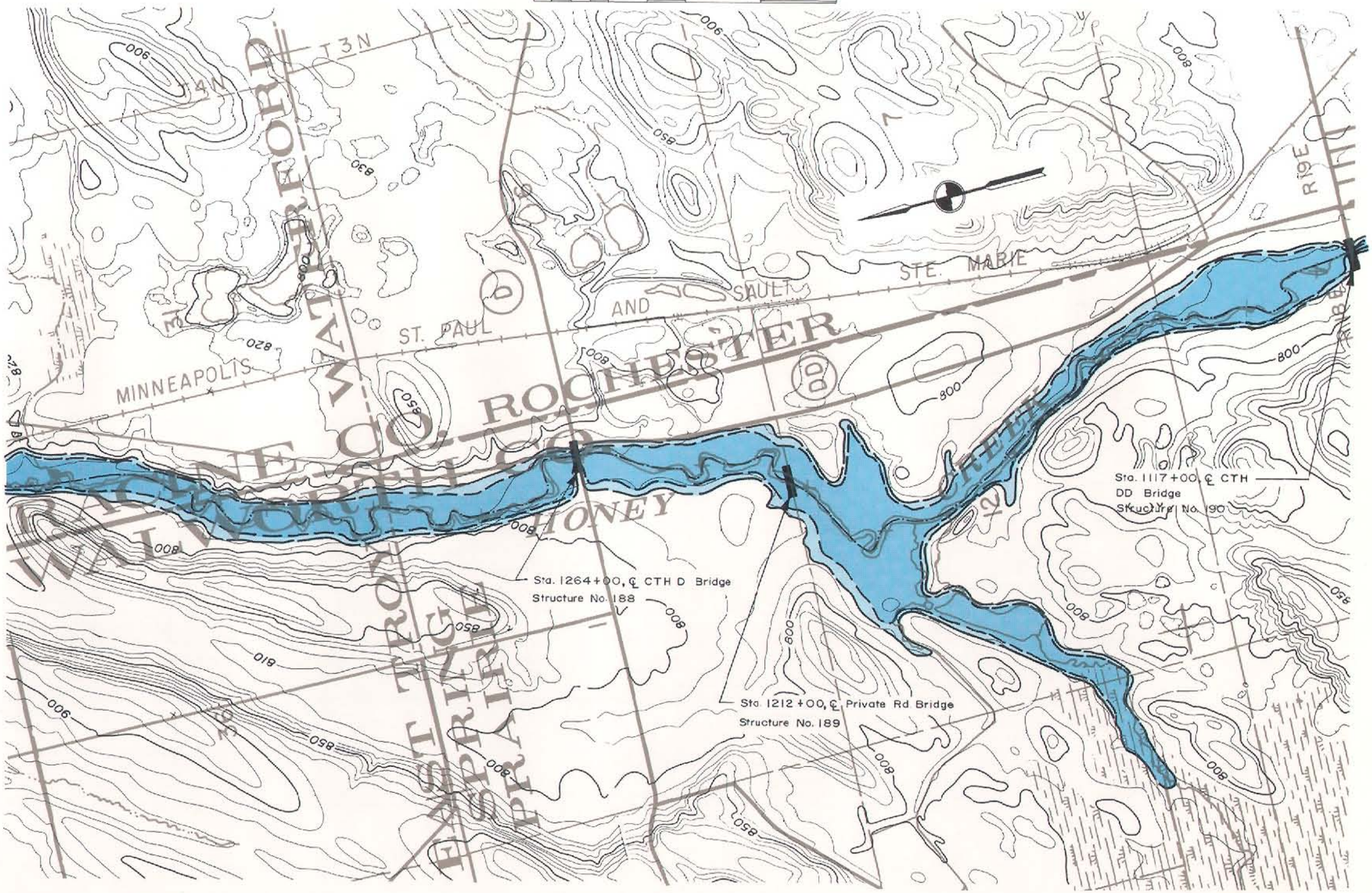


NOTE: BURLINGTON CITY DATUM = MEAN SEA LEVEL DATUM, 1929 ADJUSTMENT MINUS 175.25'

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

Map D-5 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
HONEY CREEK

FROM STA. 1163+00 TO STA. 1340+00
RACINE AND WALWORTH COUNTIES WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL, 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-5 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

HONEY CREEK

FROM STA. 1163+00 TO STA. 1340+00

WALWORTH COUNTY, WISCONSIN

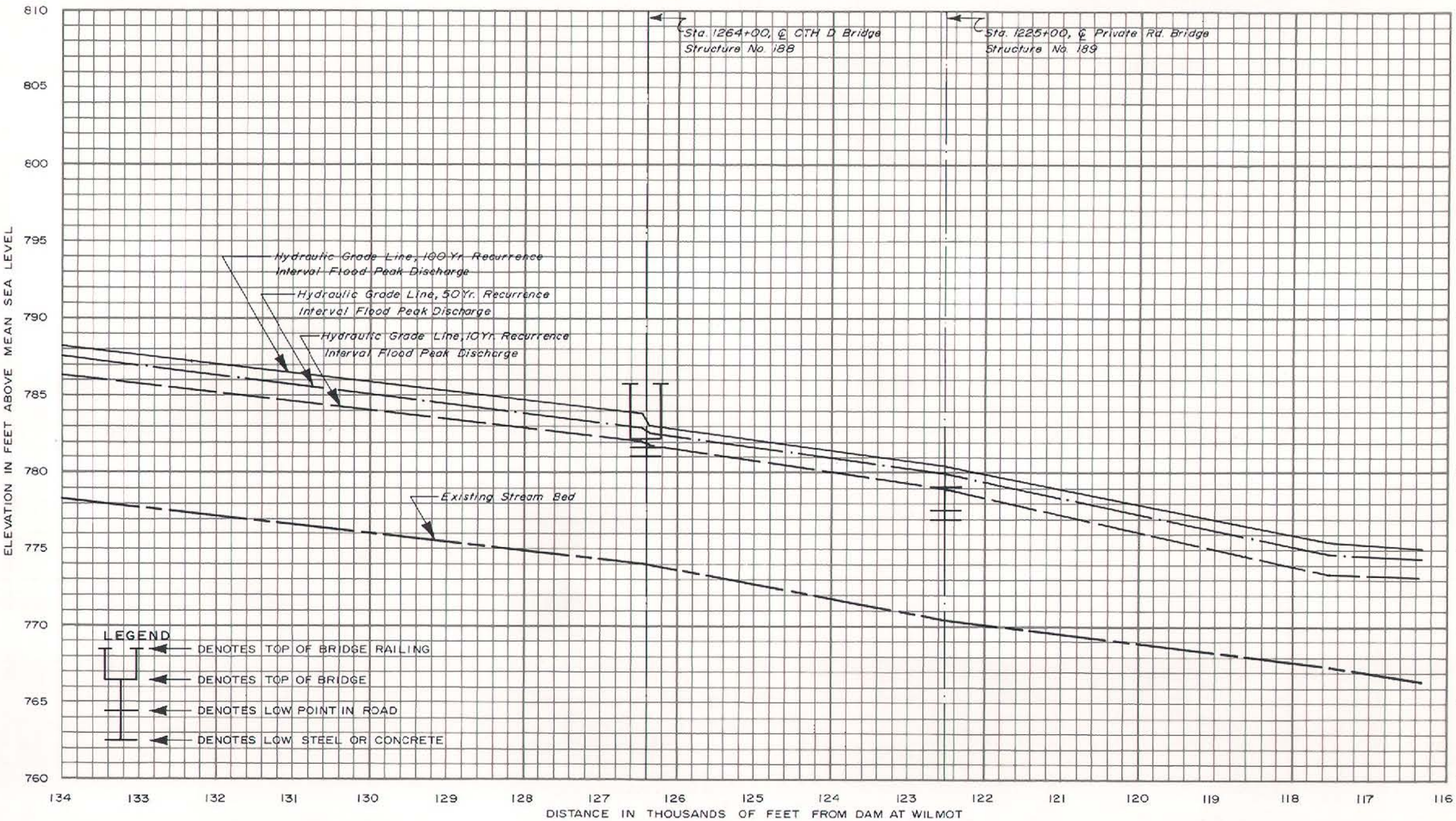
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS

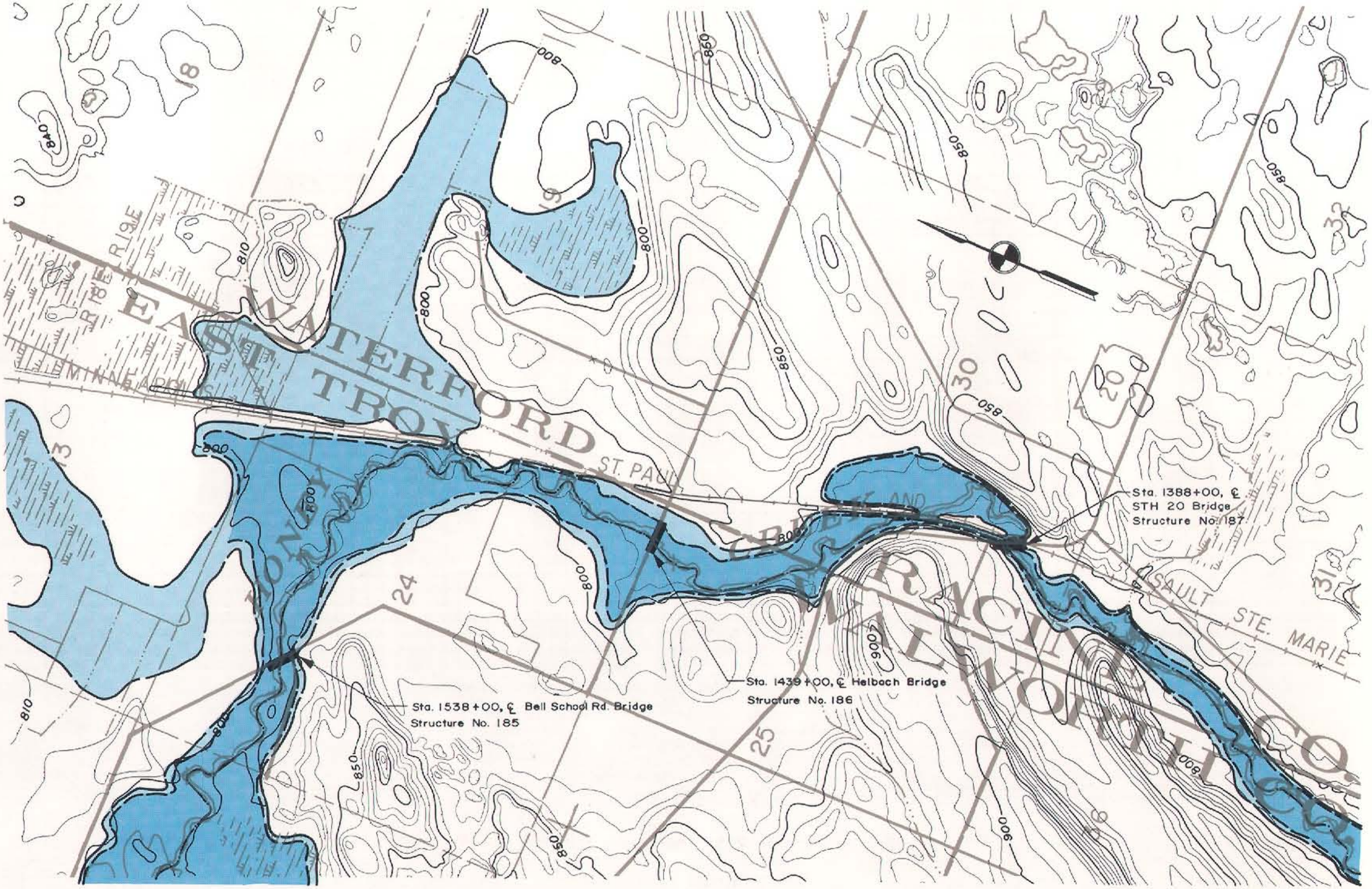
OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-5 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
HONEY CREEK

FROM STA. 1340+00 TO STA. 1520+00
RACINE AND WALWORTH COUNTIES, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-5 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

HONEY CREEK

FROM STA. 1340+00 TO STA. 1520+00

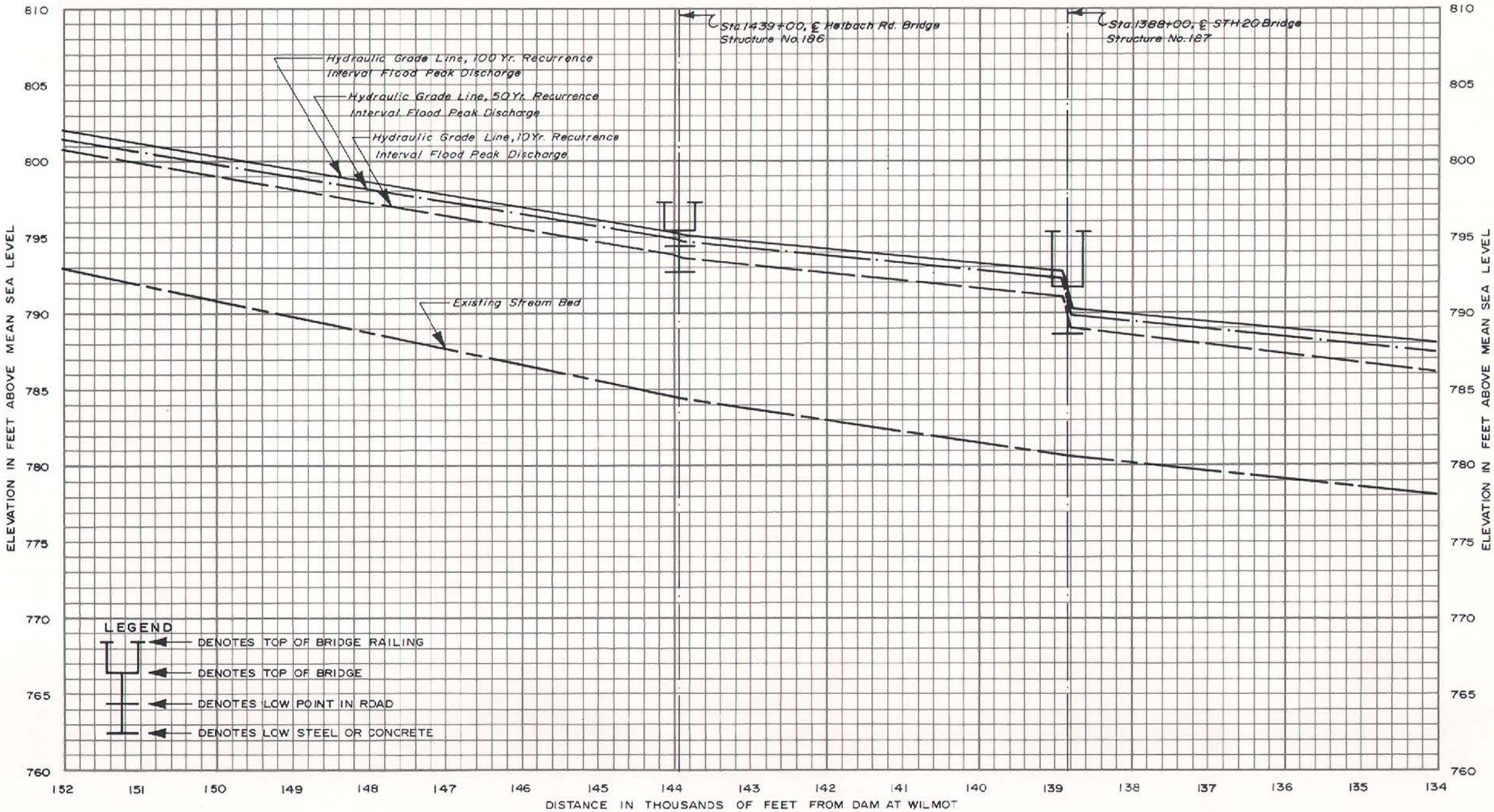
RACINE AND WALWORTH COUNTIES, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: DECEMBER 1969

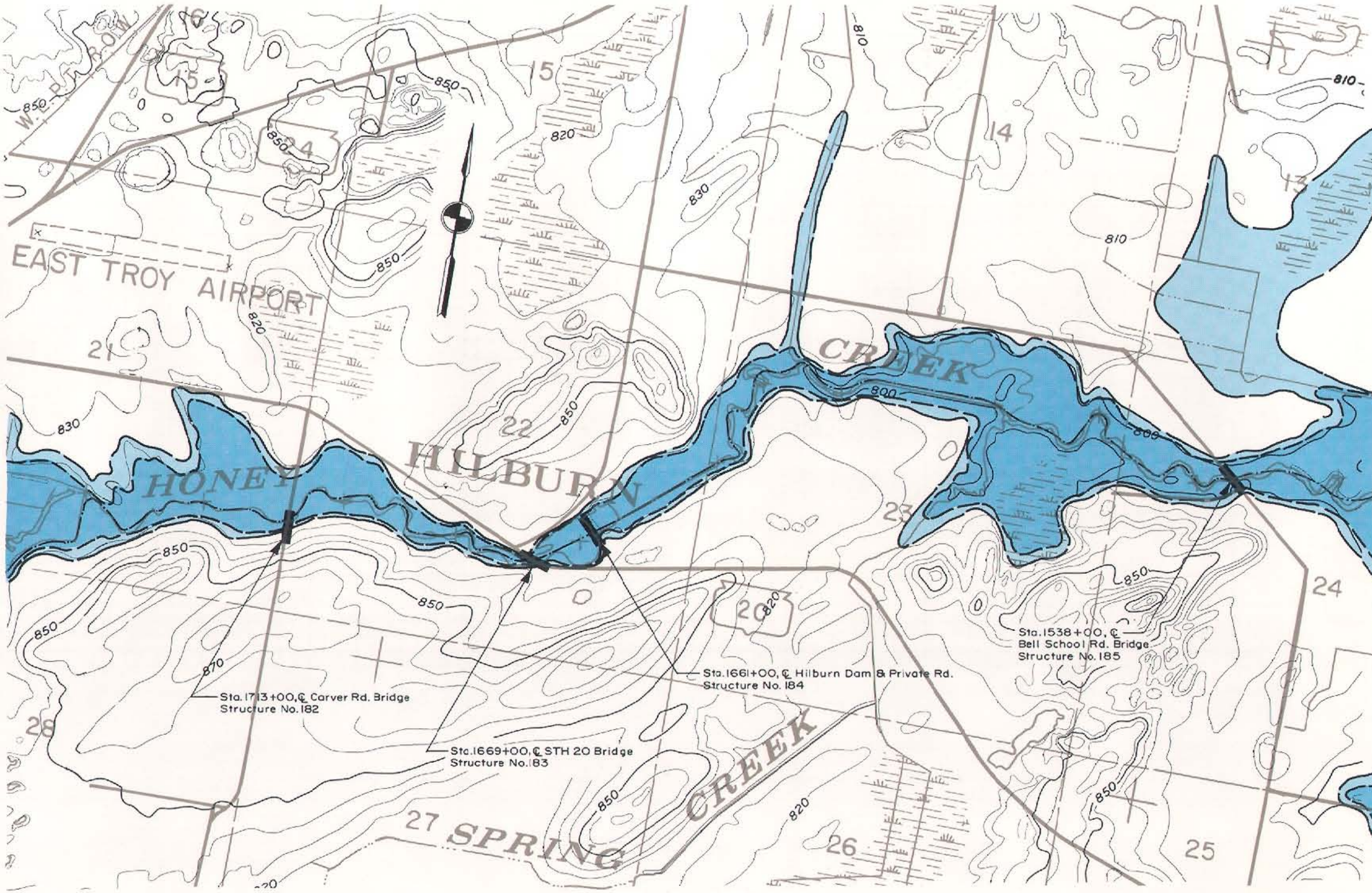
CHECKED: DRB DATE: DECEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-5 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
HONEY CREEK
FROM STA. 1520+00 TO STA. 1640+00
WALWORTH COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND
DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY
Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
+ DENOTES STATION TICK

Figure D-5 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

HONEY CREEK

FROM STA. 1520+00 TO STA. 1640+00

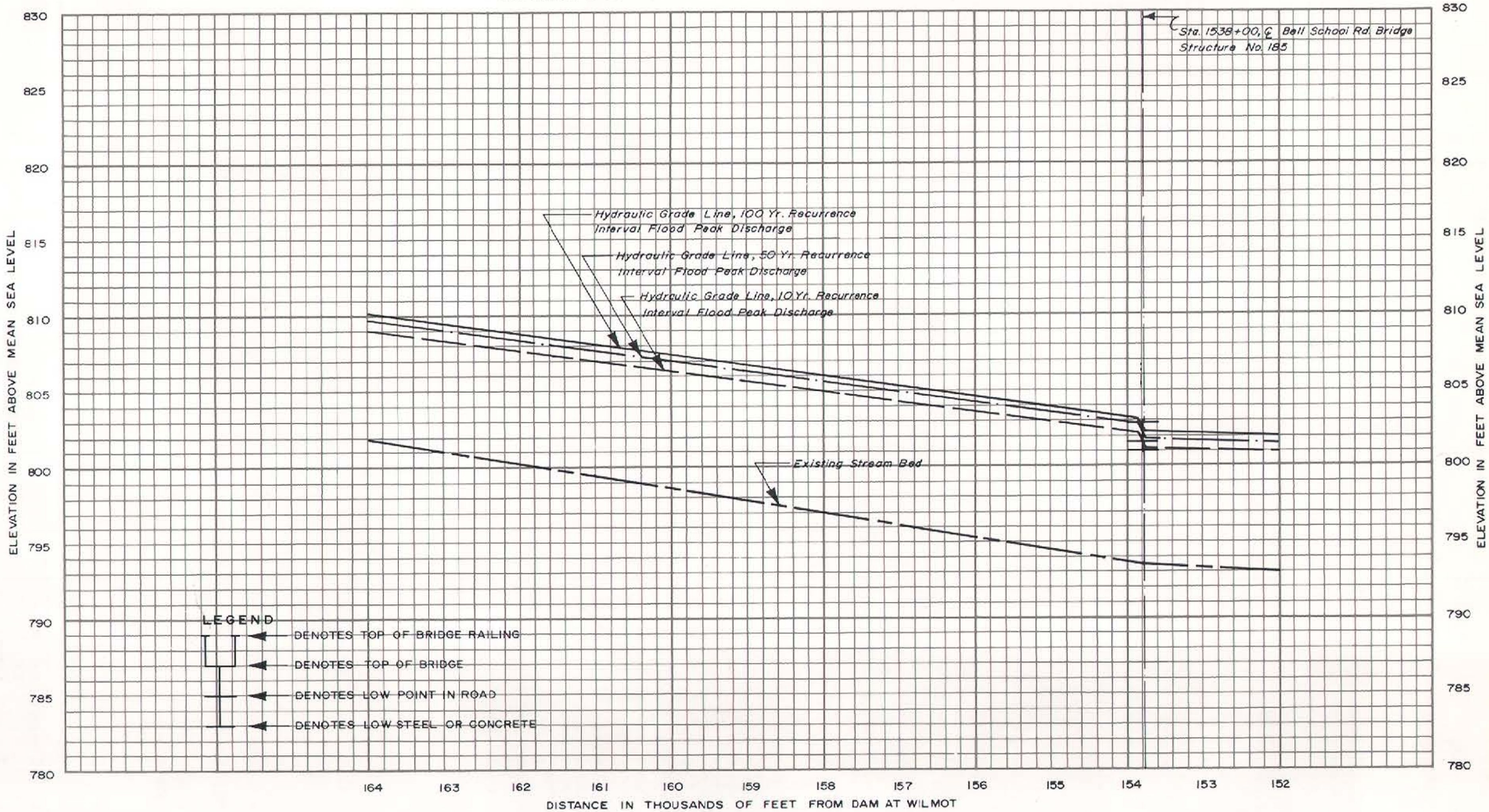
WALWORTH COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: J H W   DATE: DECEMBER 1969

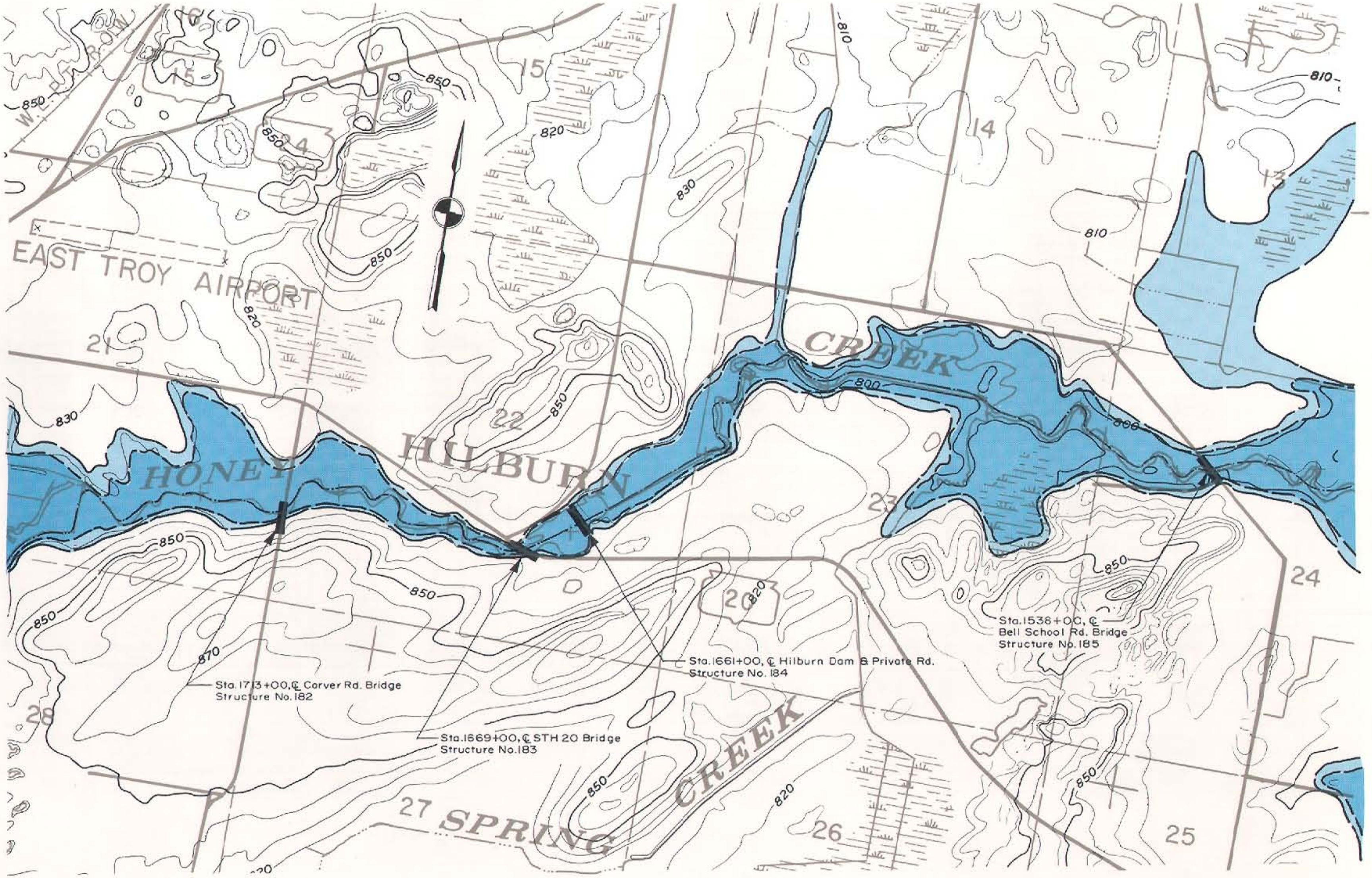
CHECKED: DRB   DATE: DECEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-5 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
HONEY CREEK
FROM STA. 1640+00 TO STA. 1740+00
WALWORTH COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

DENOTES STATION TICK

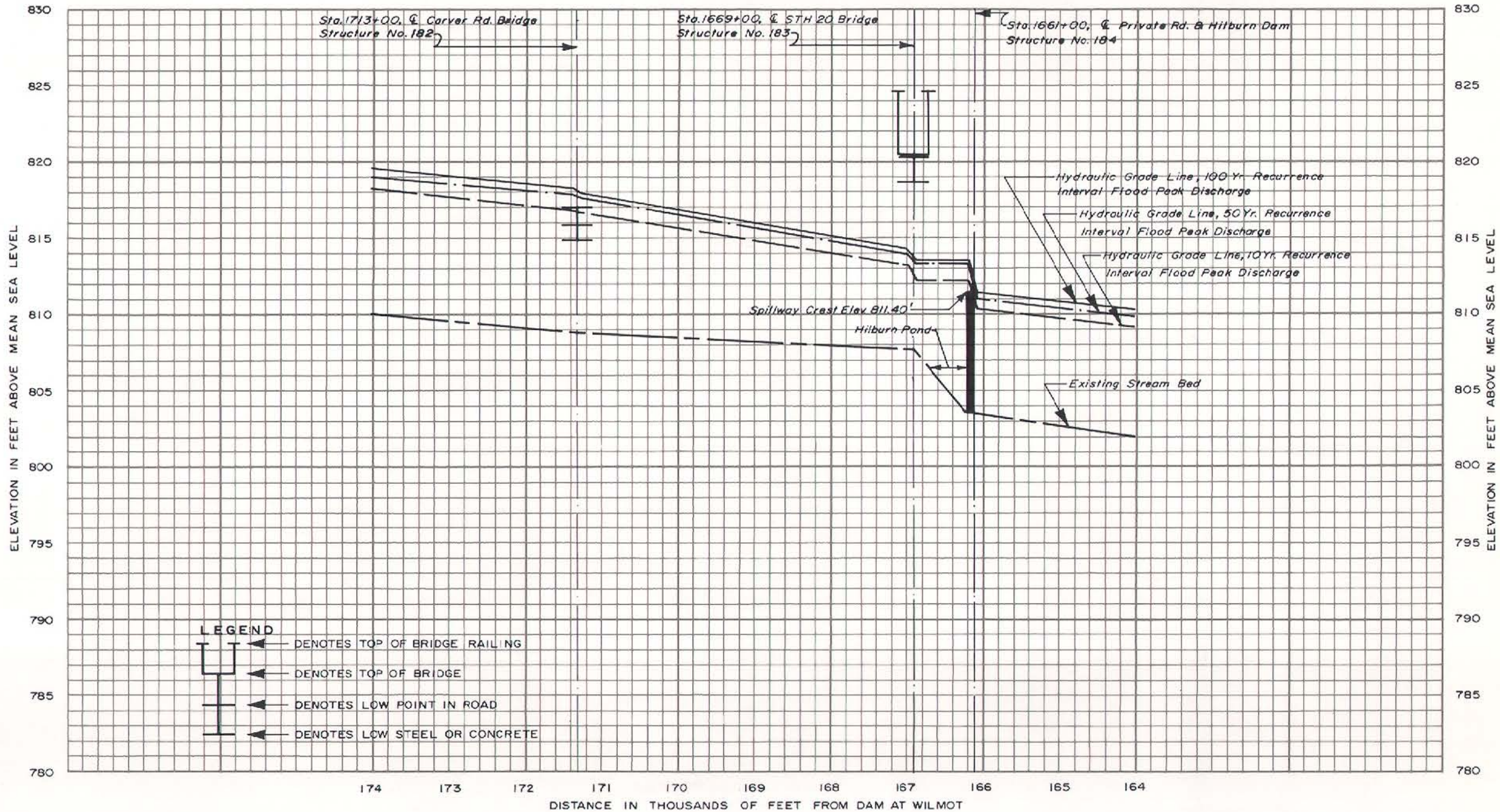
Figure D-5 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

HONEY CREEK

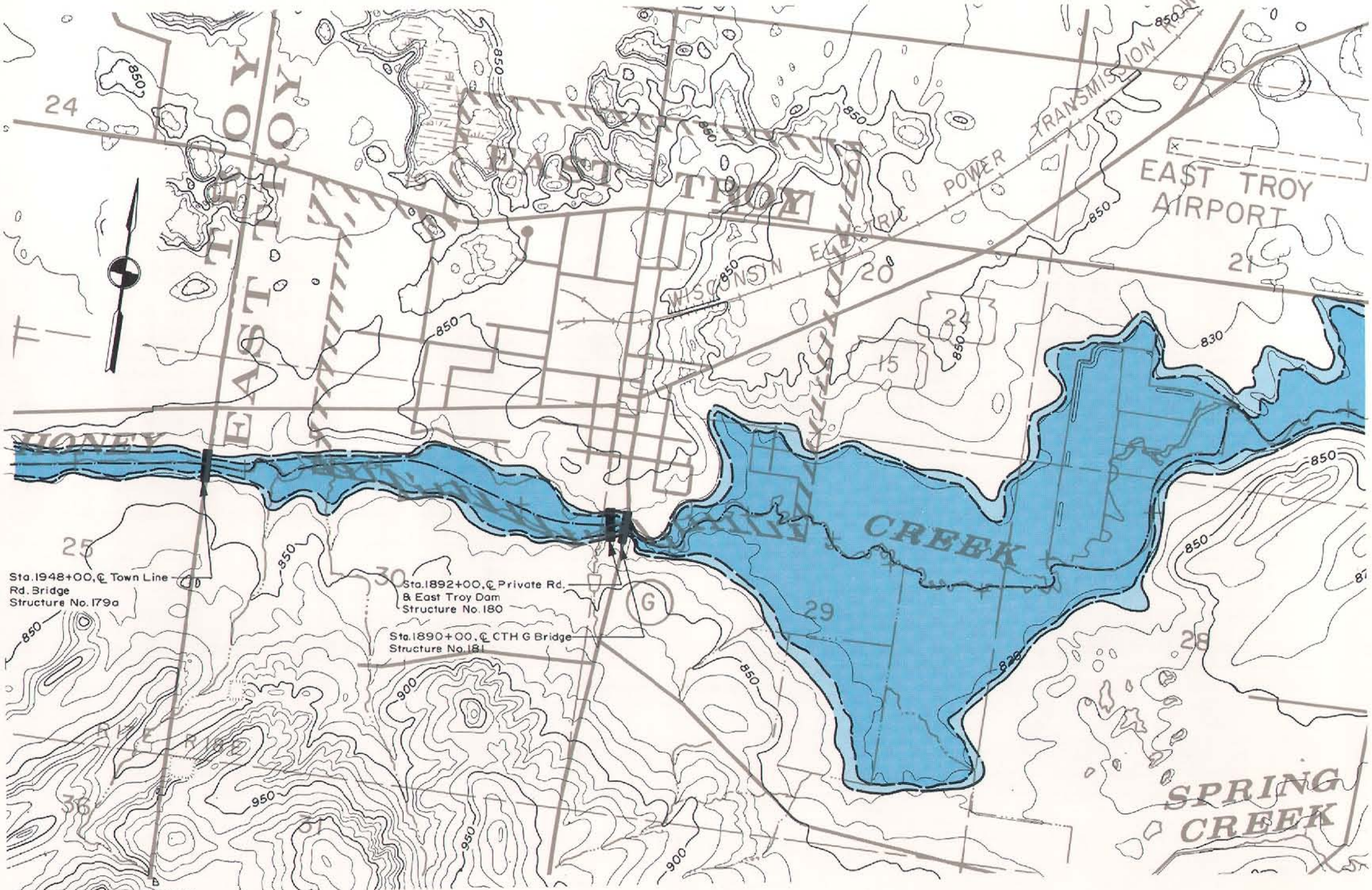
FROM STA. 1640+00 TO STA. 1740+00
WALWORTH COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: LHK DATE: DECEMBER 1969
CHECKED: DRB DATE: DECEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-5 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
HONEY CREEK

FROM STA. 1740+00 TO STA. 1860+00
WALWORTH COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 + 00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

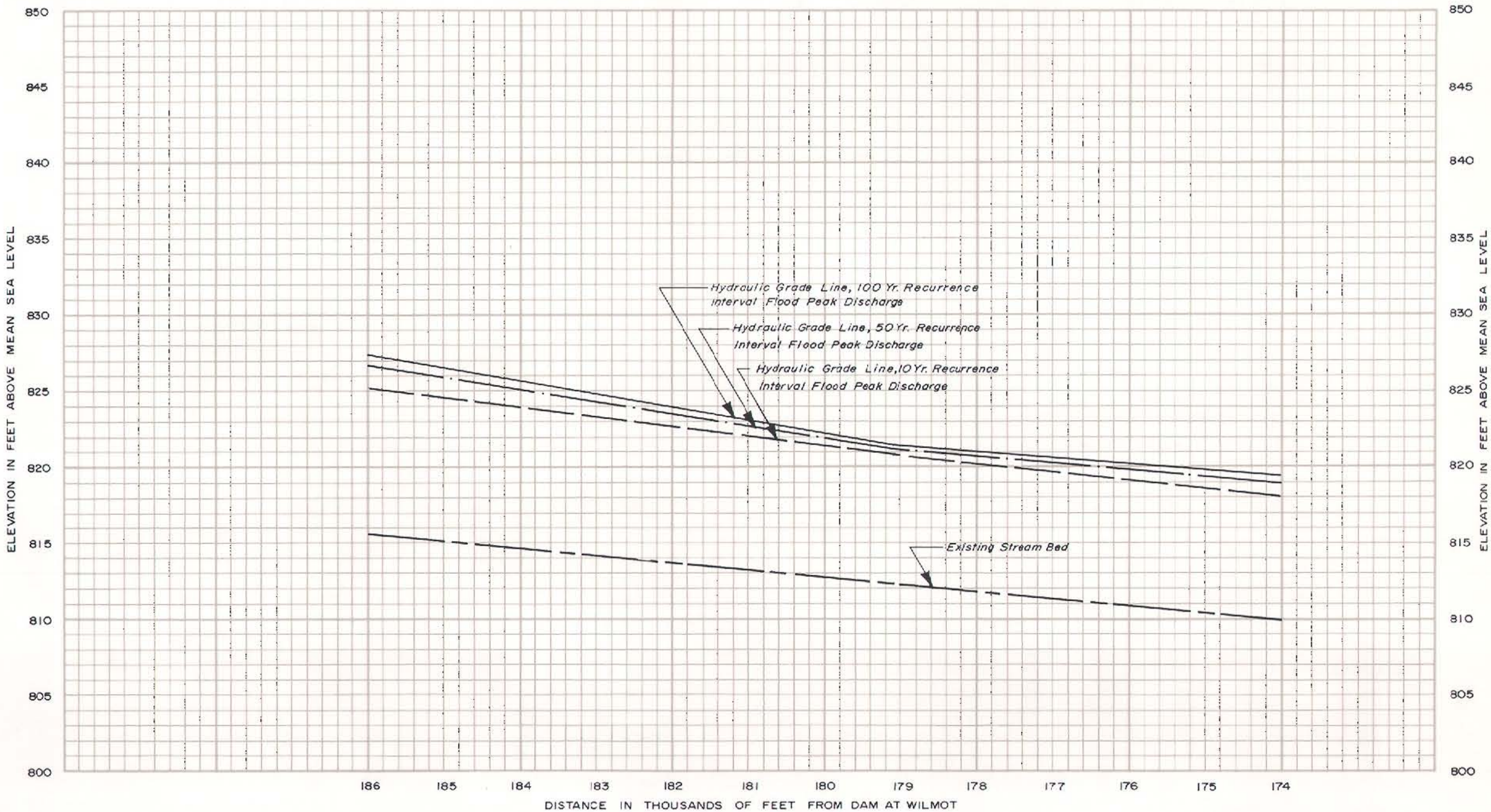
Figure D-5 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

HONEY CREEK

FROM STA. 1740+00 TO STA. 1860+00
WALWORTH COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: JHW DATE: DECEMBER 1969
CHECKED: DRB DATE: DECEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS

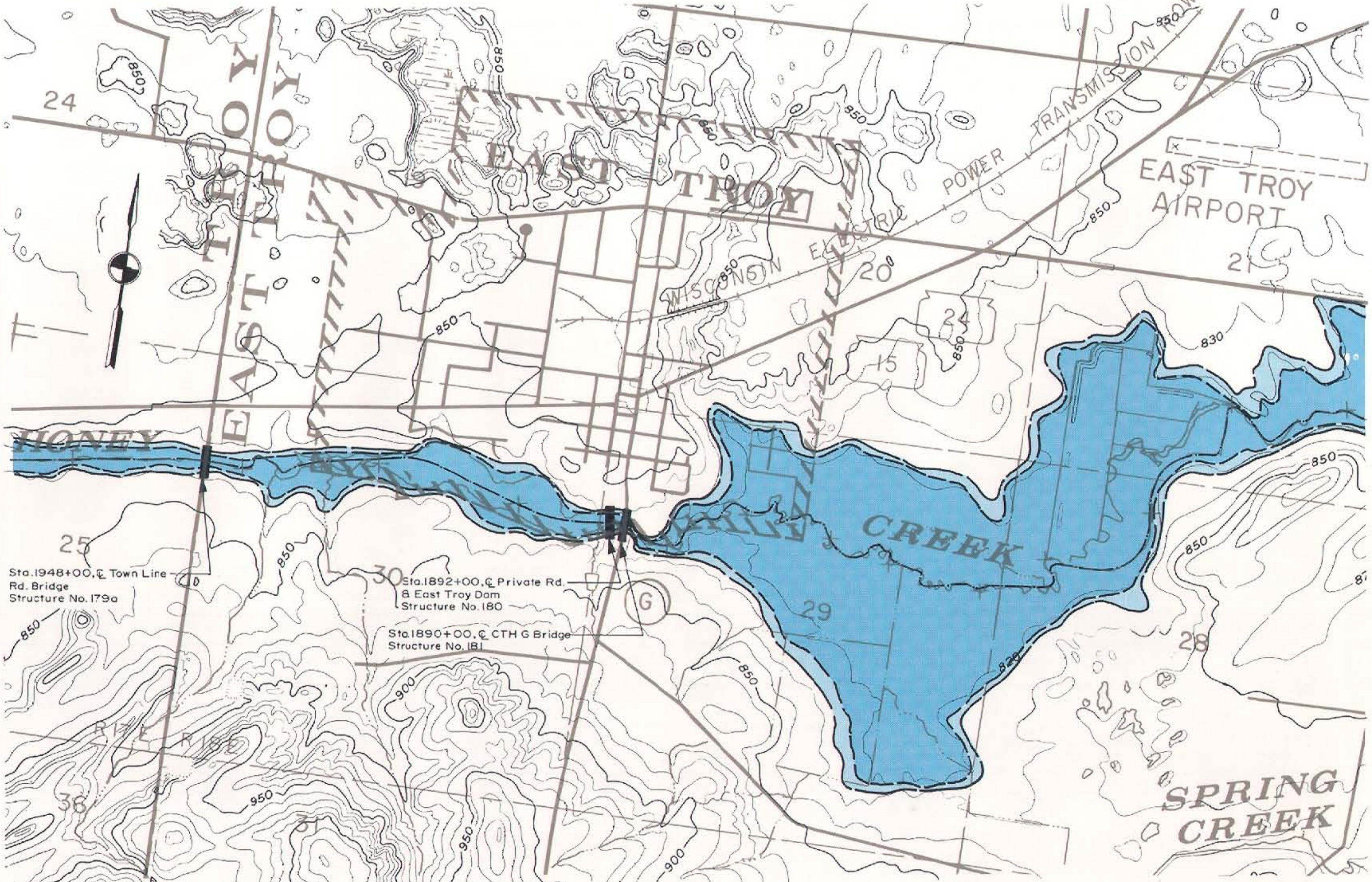


NOTE: EAST TROY VILLAGE DATUM = MEAN SEA LEVEL DATUM, 1929 ADJUSTMENT MINUS 657.43'

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

Map D-5 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
HONEY CREEK

FROM STA. 1860+00 TO STA. 1963+00
WALWORTH COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 + 00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

DENOTES STATION TICK

Figure D-5 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

HONEY CREEK

FROM STA. 1860+00 TO STA. 1963+00

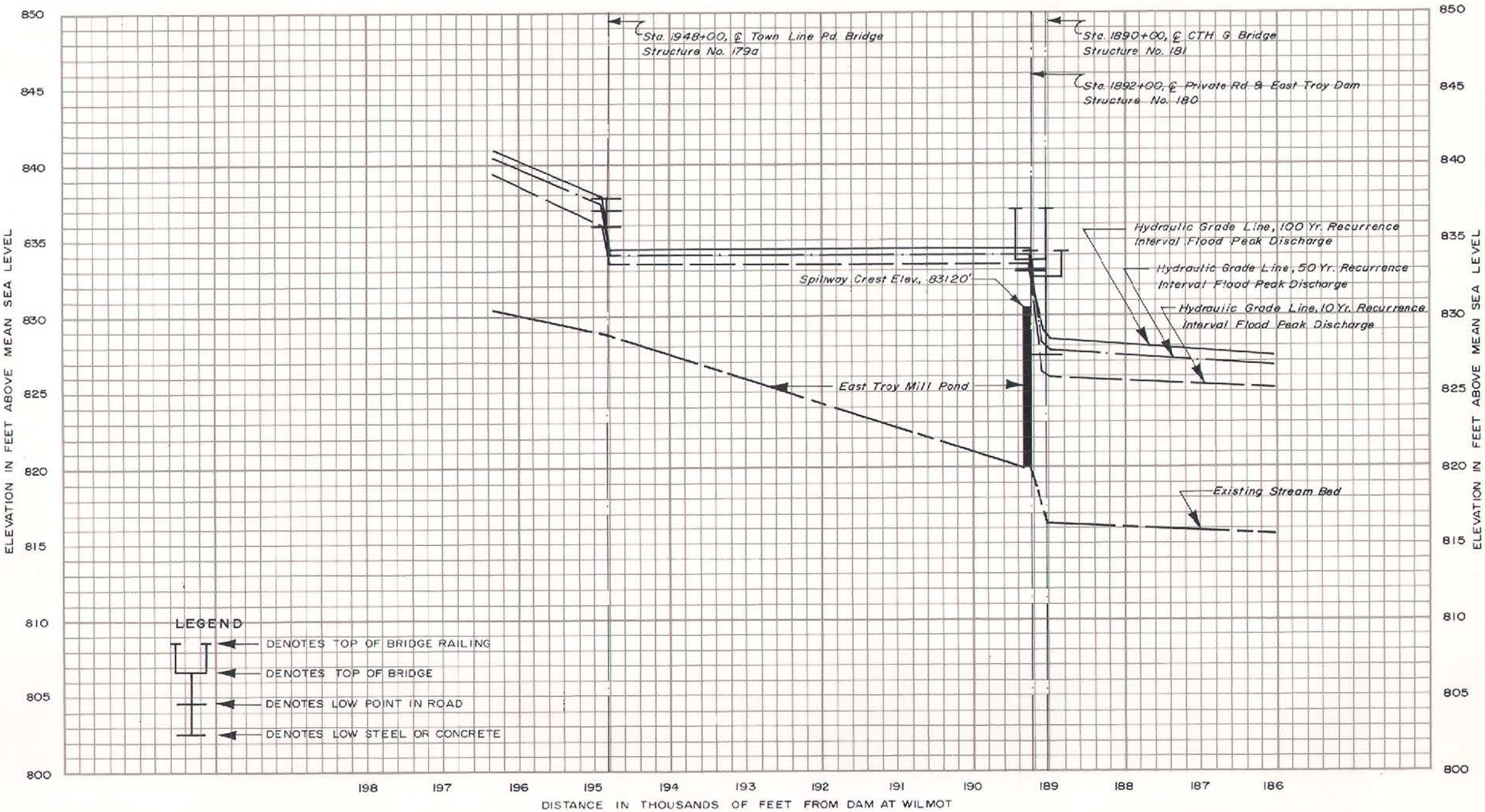
WALWORTH COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: JHW DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

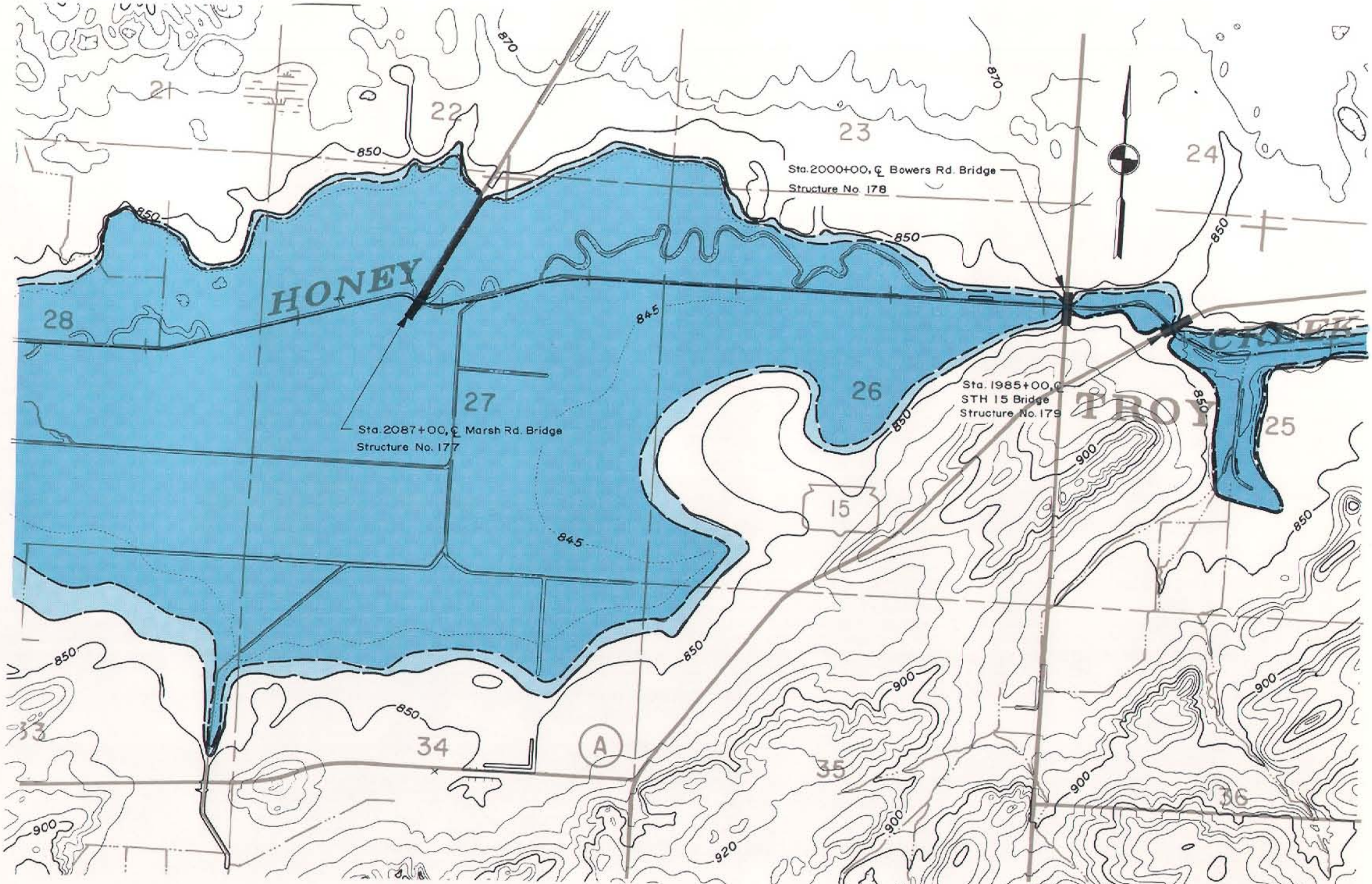
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



NOTE: EAST TROY VILLAGE DATUM = MEAN SEA LEVEL DATUM, 1929 ADJUSTMENT MINUS 752.43'

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

Map D-5 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
HONEY CREEK
FROM STA. 1963+00 TO STA. 2123+00
WALWORTH COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND
DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-5 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

HONEY CREEK

FROM STA. 1963+00 TO STA. 2123+00

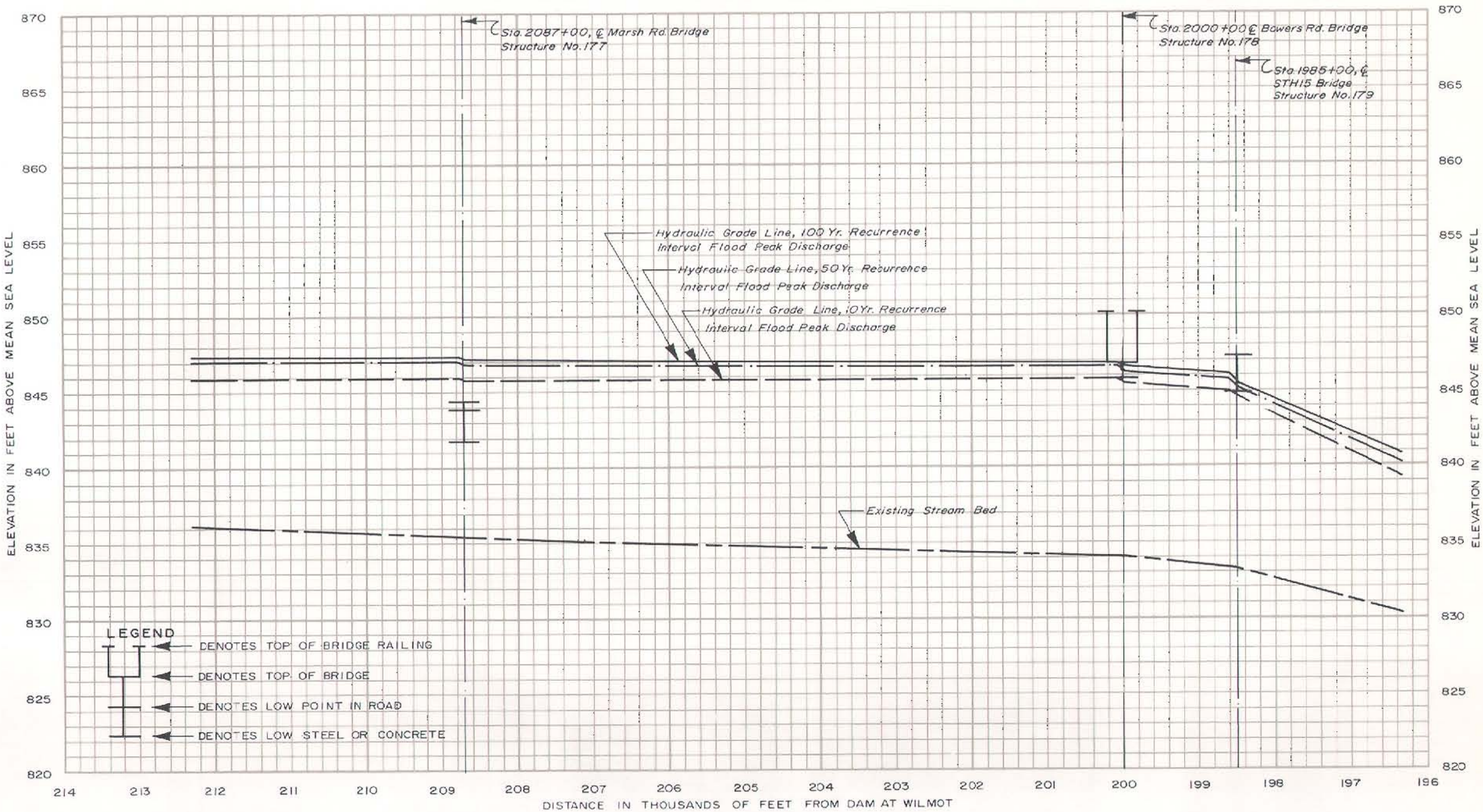
WALWORTH COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-5 (continued)

TOPOGRAPHIC MAP

SHOWING

AREAS SUBJECT TO FLOODING

ALONG THE

HONEY CREEK

FROM STA. 2123+00 TO STA. 2300+00

WALWORTH COUNTY, WISCONSIN

PREPARED BY

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

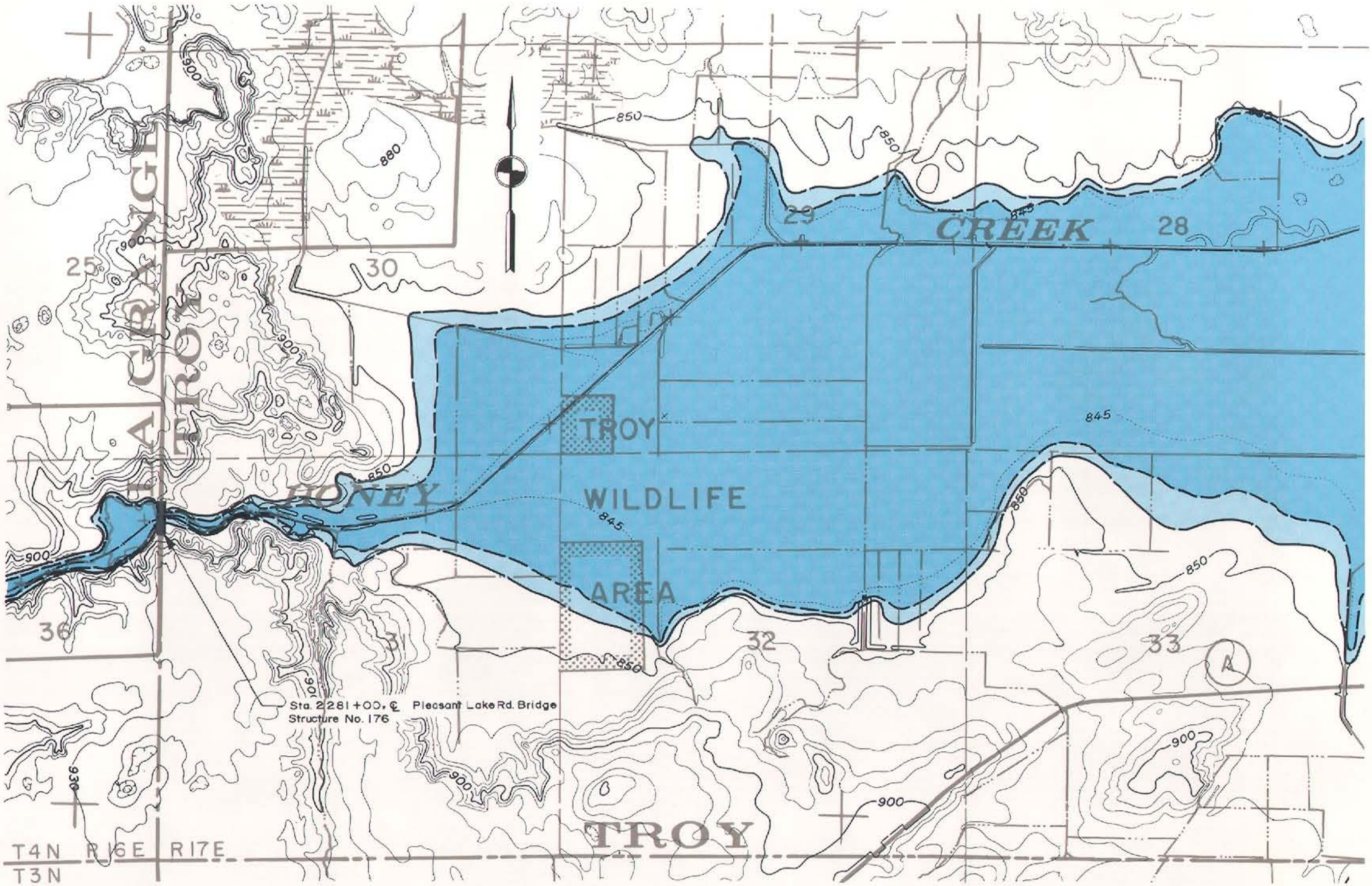
DRAWN: RHH DATE: OCTOBER 1969

CHECKED: DRB DATE: OCTOBER 1969

SCALE: 1" = 2000'

GRAPHIC SCALE

0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

DENOTES STATION TICK

Figure D-4 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

HONEY CREEK

FROM STA. 2123+00 TO STA. 2300+00

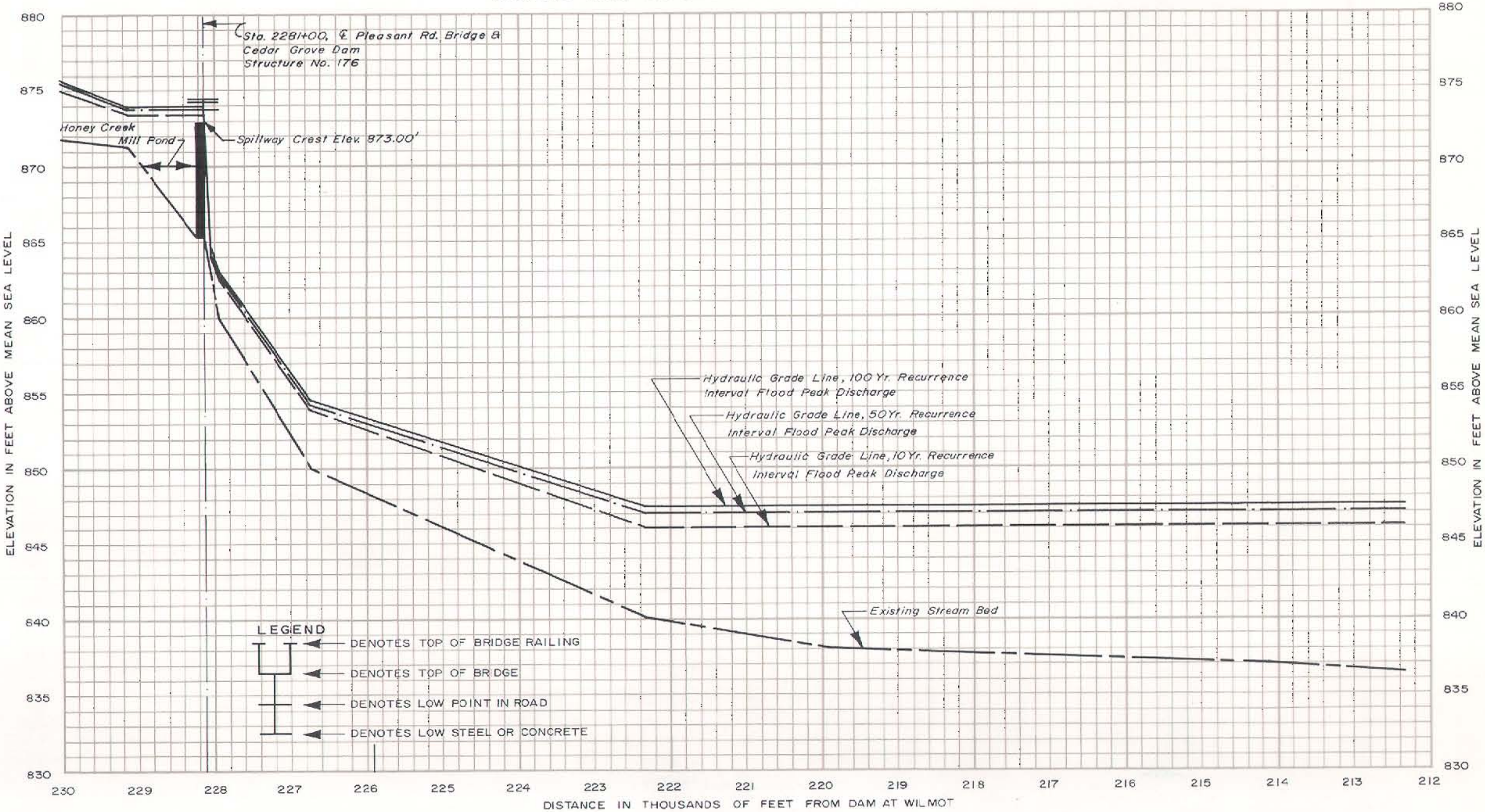
WALWORTH COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

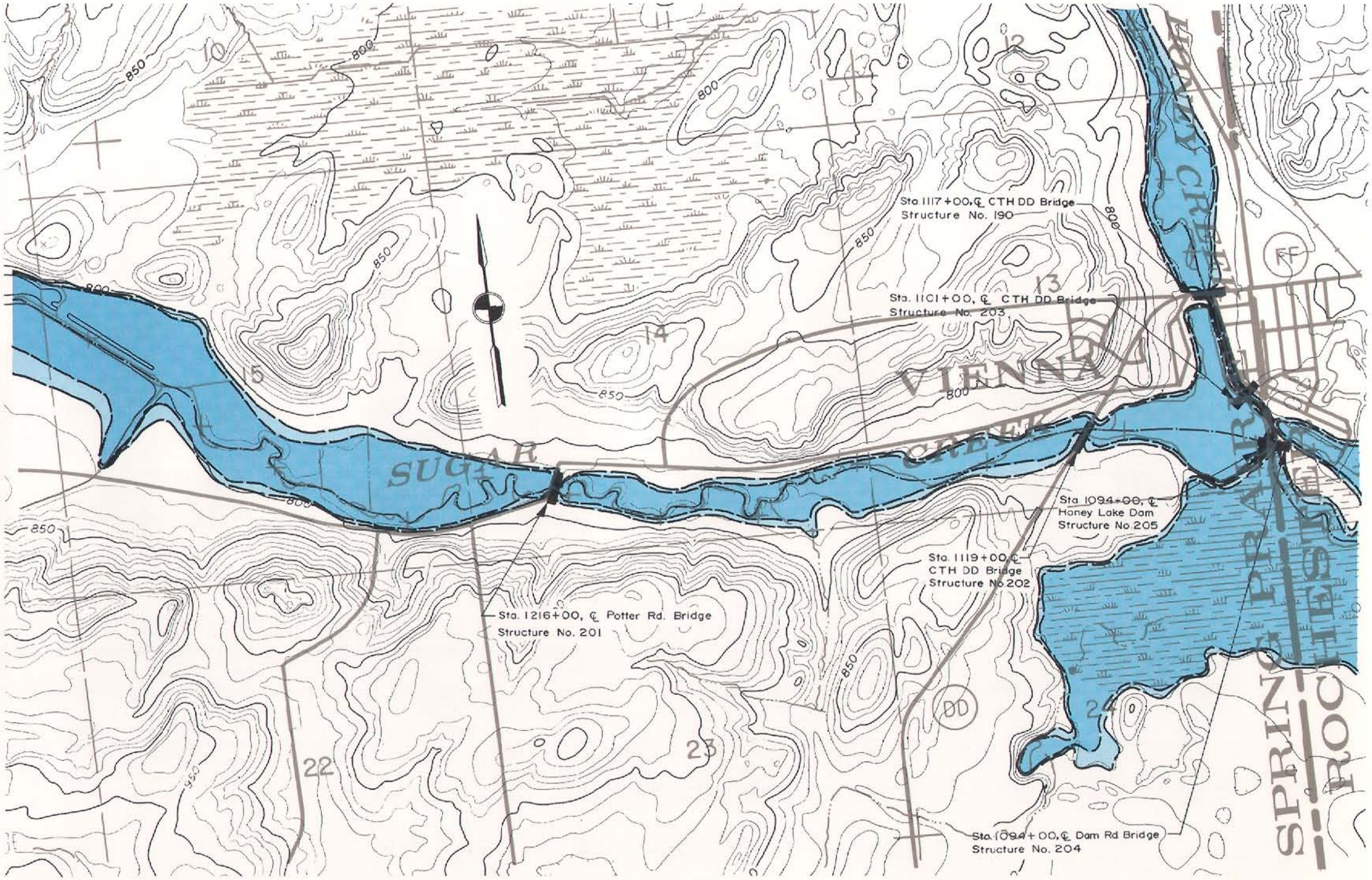
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-6
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
SUGAR CREEK

FROM STA. 1093+00 TO STA. 1193+00
RACINE AND WALWORTH COUNTIES, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM. ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

\+ DENOTES STATION TICK

Figure D-6

HIGH WATER AND STREAM BED PROFILES

OF THE

SUGAR CREEK

FROM STA. 1093+00 TO STA. 1193+00

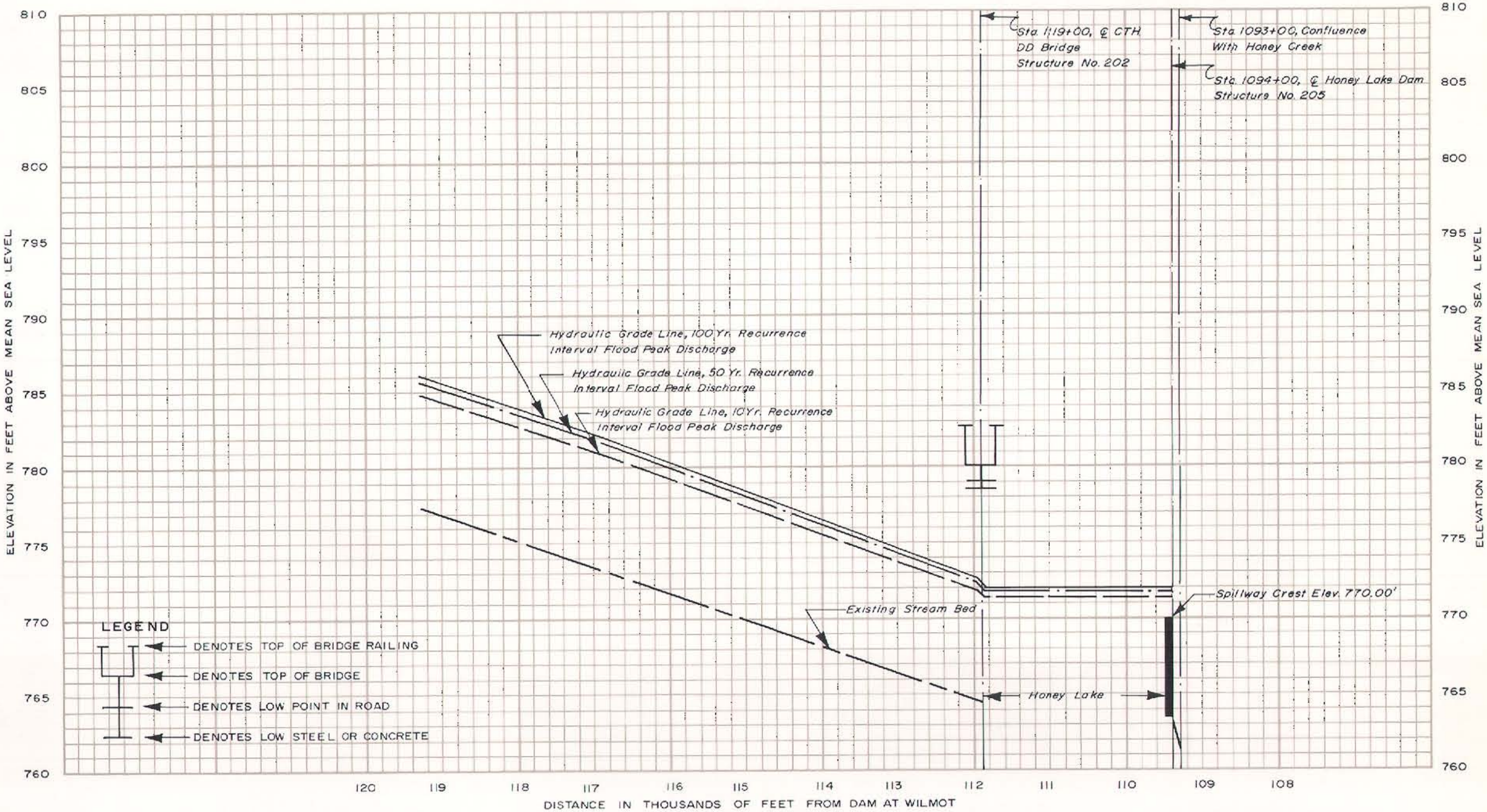
RACINE AND WALWORTH COUNTIES, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: BLR DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



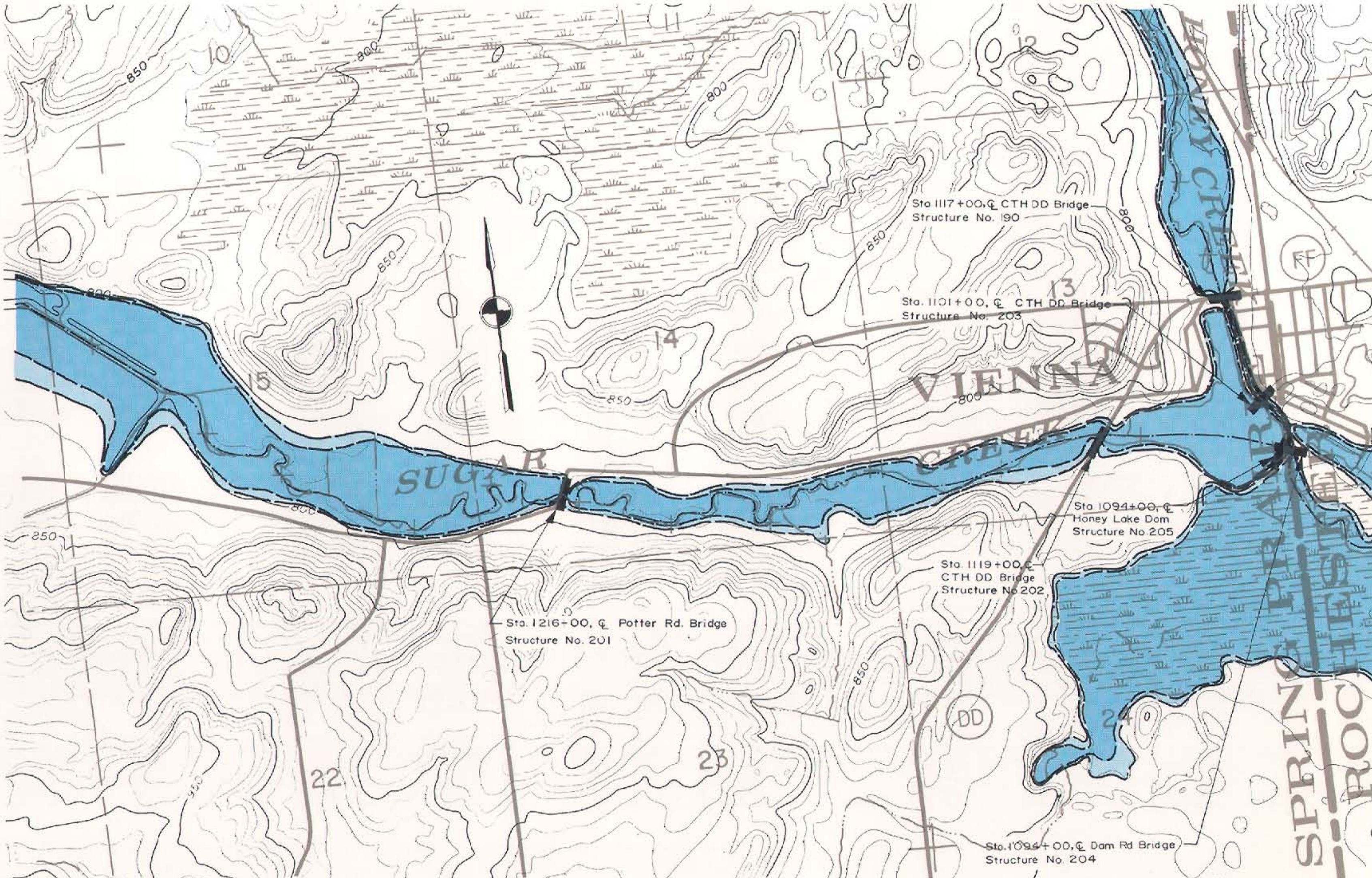
Source: U.S. Soil Conservation Service; SEWRPC.

Map D-6 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
SUGAR CREEK

FROM STA. 1193+00 TO STA. 1313+00
RACINE AND WALWORTH COUNTIES, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969

SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL, 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-6 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

SUGAR CREEK

FROM STA. 1193+00 TO STA. 1313+00

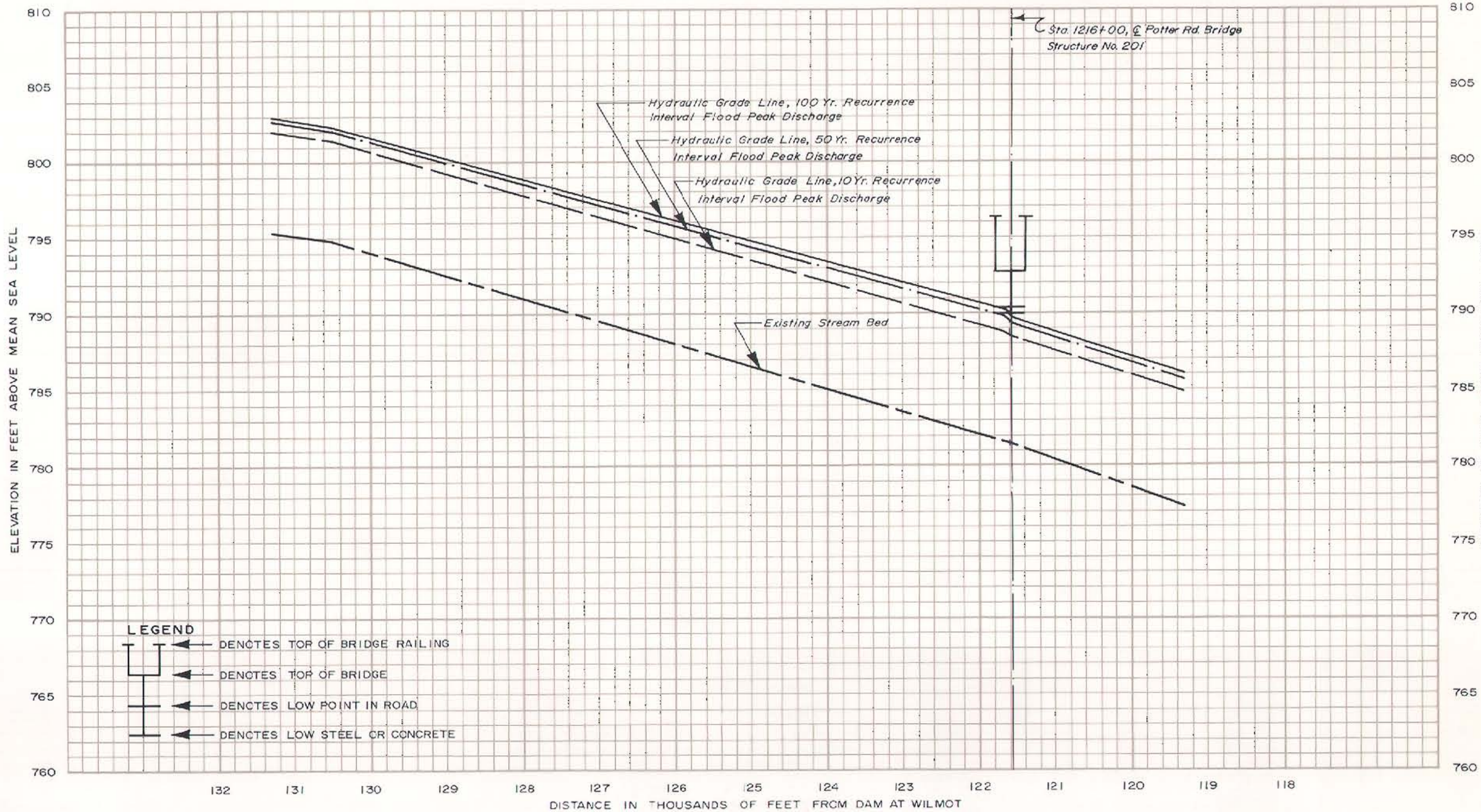
WALWORTH COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: DECEMBER 1969

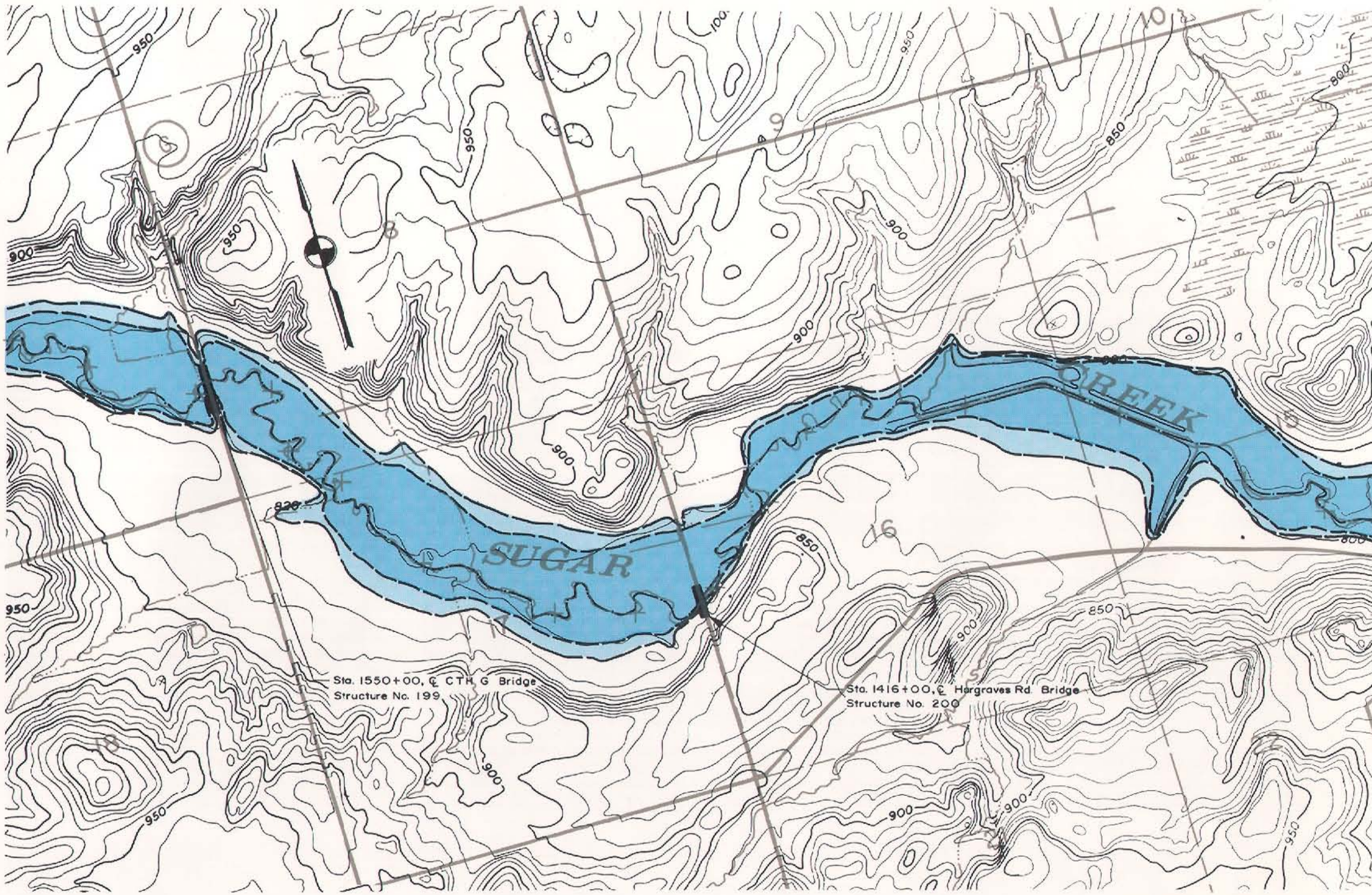
CHECKED: DRB DATE: DECEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

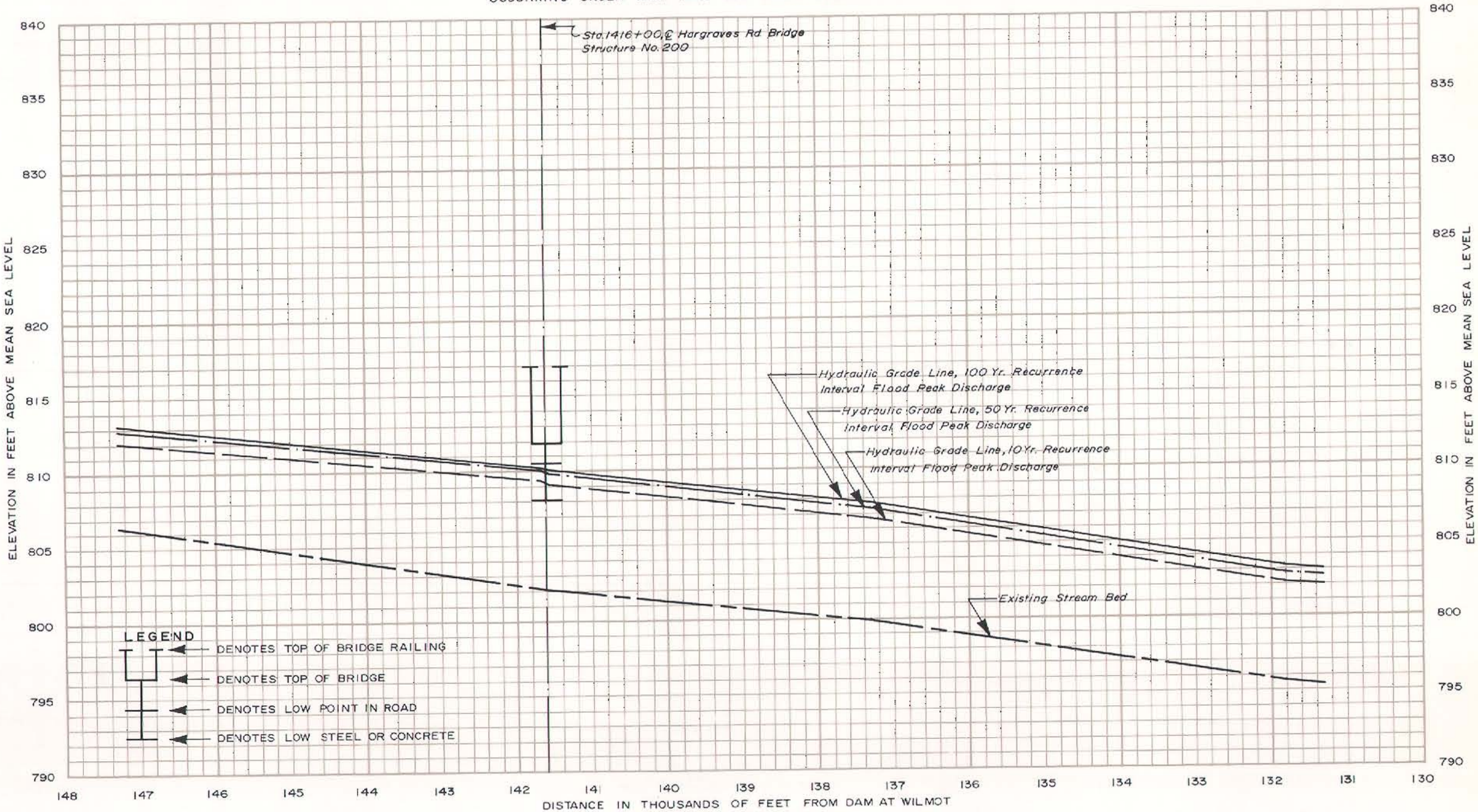
Map D-6 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
SUGAR CREEK
FROM STA. 1313+00 TO STA. 1473+00
WALWORTH COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND
DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY
Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-6 (continued)

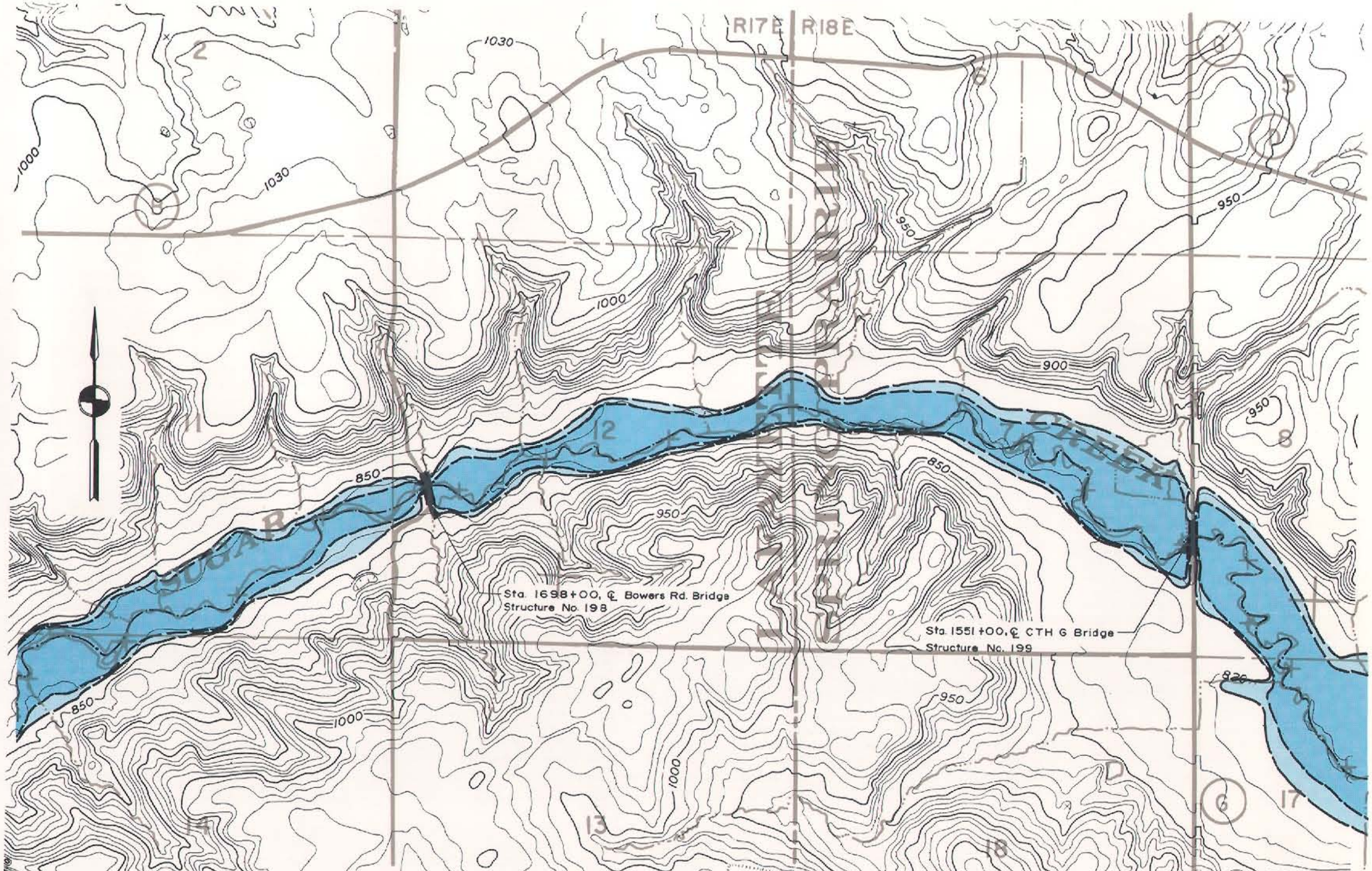
HIGH WATER AND STREAM BED PROFILES
OF THE
SUGAR CREEK
FROM STA. 1313+00 TO STA. 1473+00
WALWORTH COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: LHK DATE: DECEMBER 1969
CHECKED: DRB DATE: DECEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-6 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
SUGAR CREEK
FROM STA. 1473+00 TO STA. 1633+00
WALWORTH COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



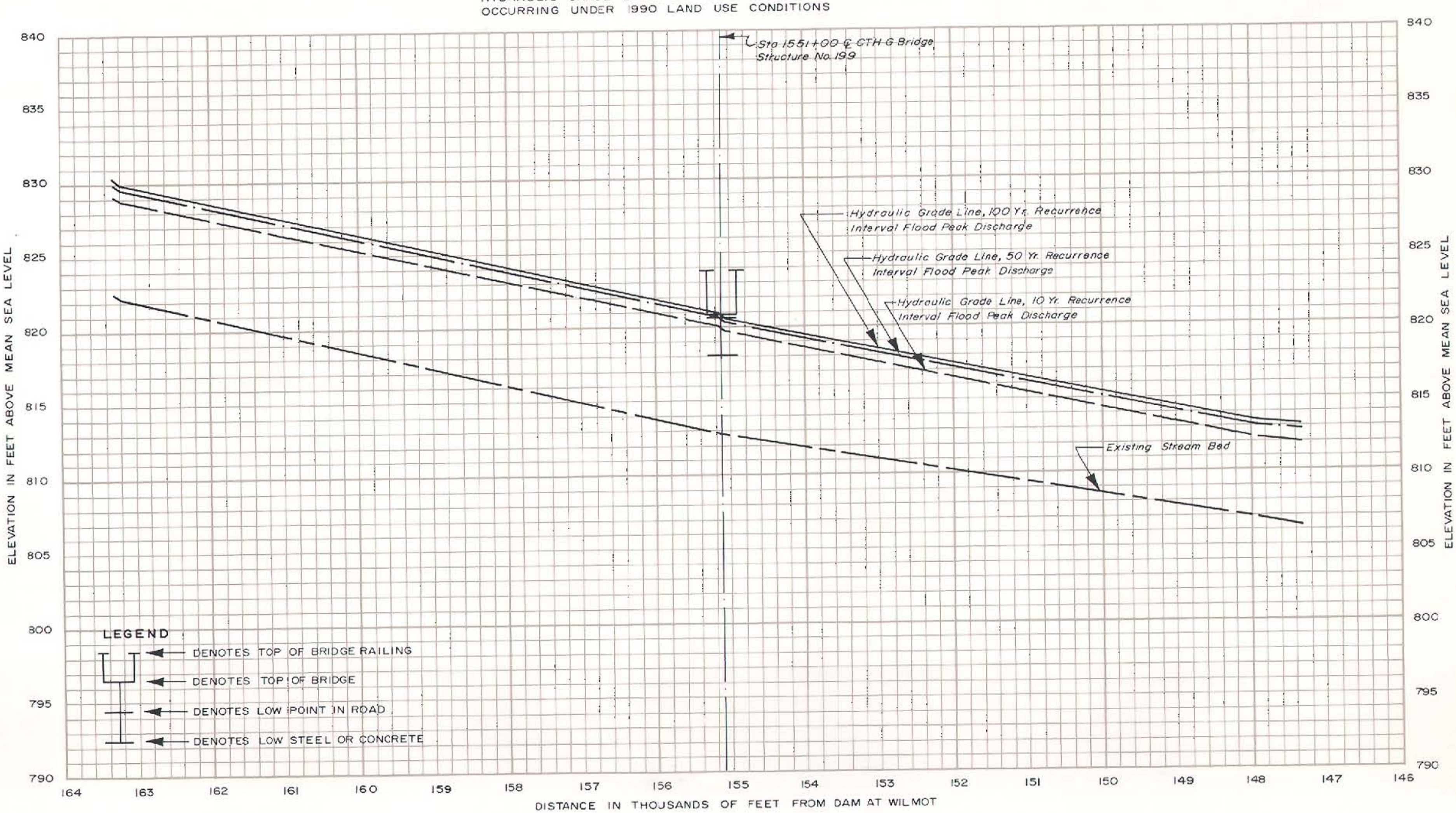
LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
\+ DENOTES STATION TICK

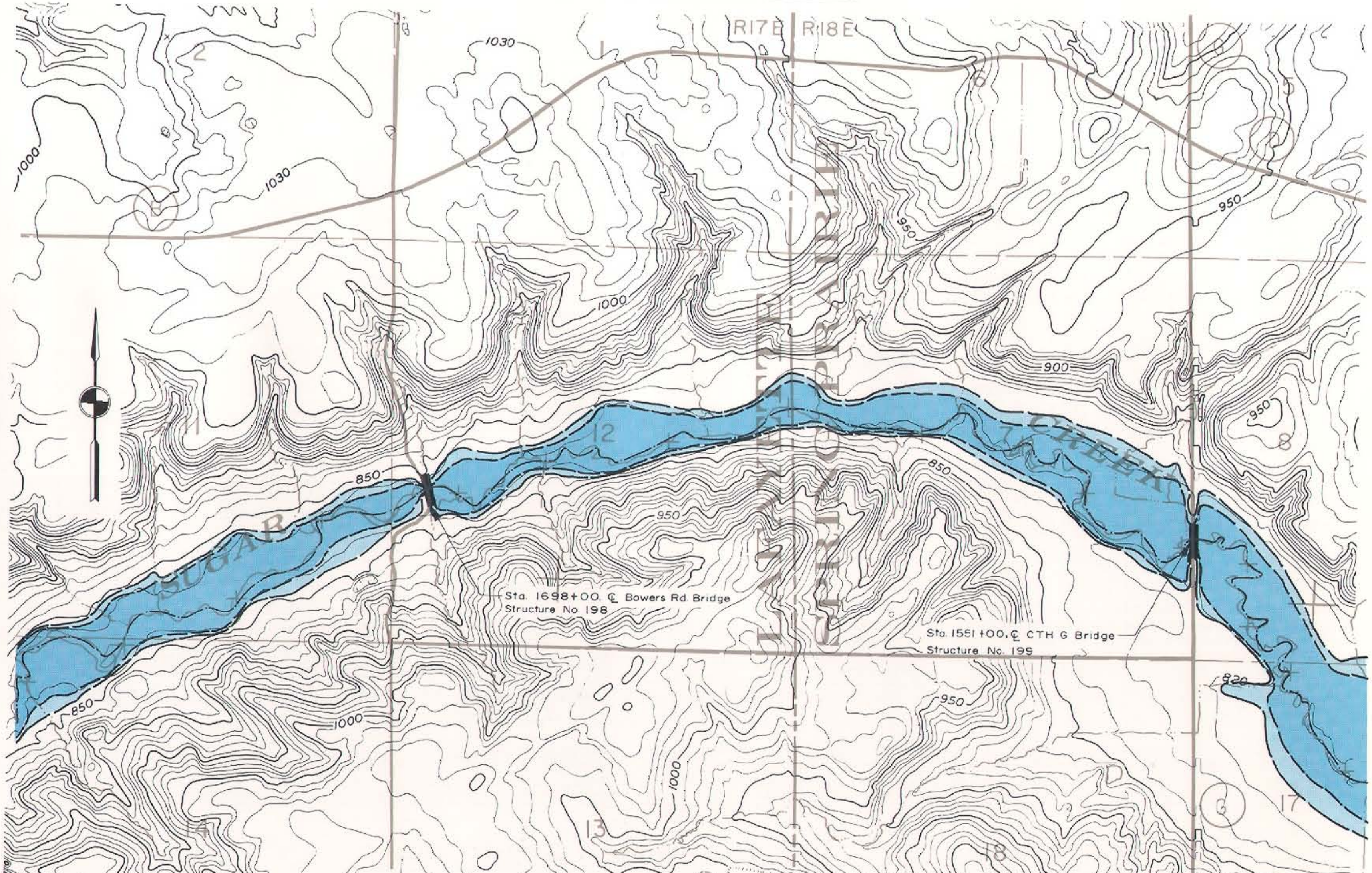
Figure D-6 (continued)

HIGH WATER AND STREAM BED PROFILES
OF THE
SUGAR CREEK
FROM STA. 1473+00 TO STA. 1633+00
WALWORTH COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: BLR DATE: DECEMBER 1969
CHECKED: DRB DATE: DECEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-6 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
SUGAR CREEK
FROM STA. 1633+00 TO STA. 1773+00
WALWORTH COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND
DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL, 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-6 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

SUGAR CREEK

FROM STA. 1633+00 TO STA 1773+00

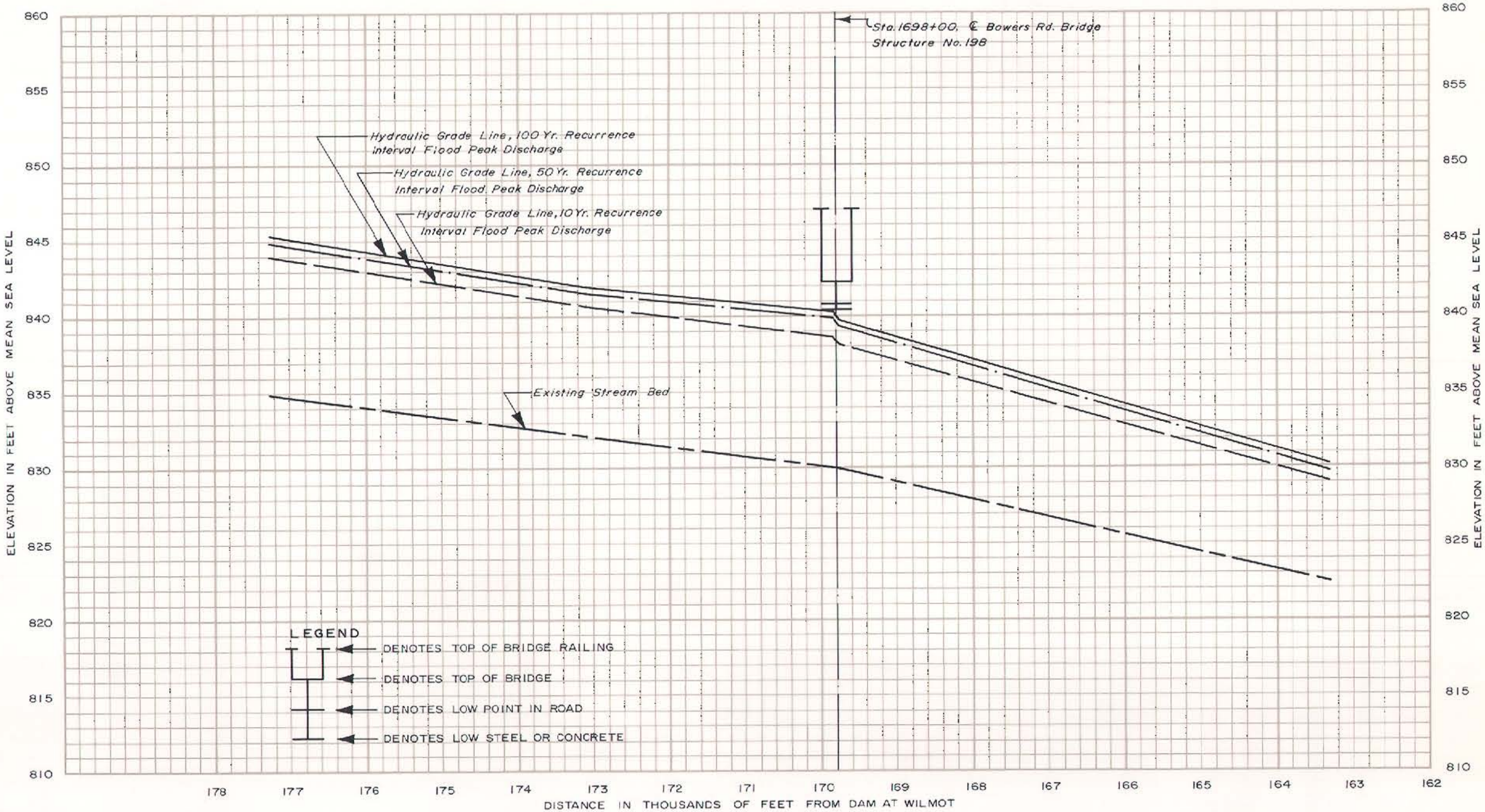
WALWORTH COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

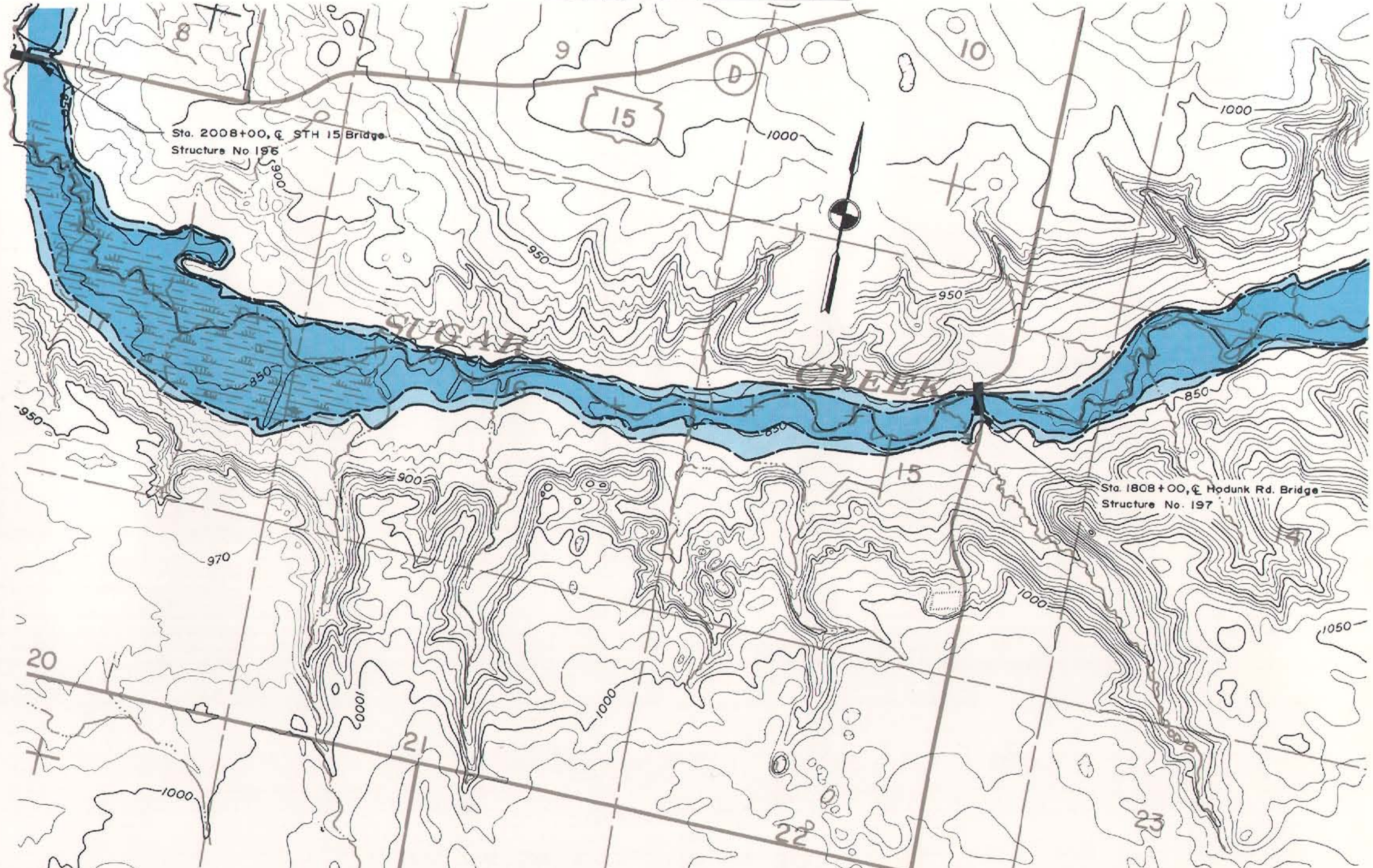
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-6 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
SUGAR CREEK

FROM STA. 1773+00 TO STA. 1933+00
WALWORTH COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND
DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
+ DENOTES STATION TICK

Figure D-6 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

SUGAR CREEK

FROM STA. 1773+00 TO STA. 1933+00

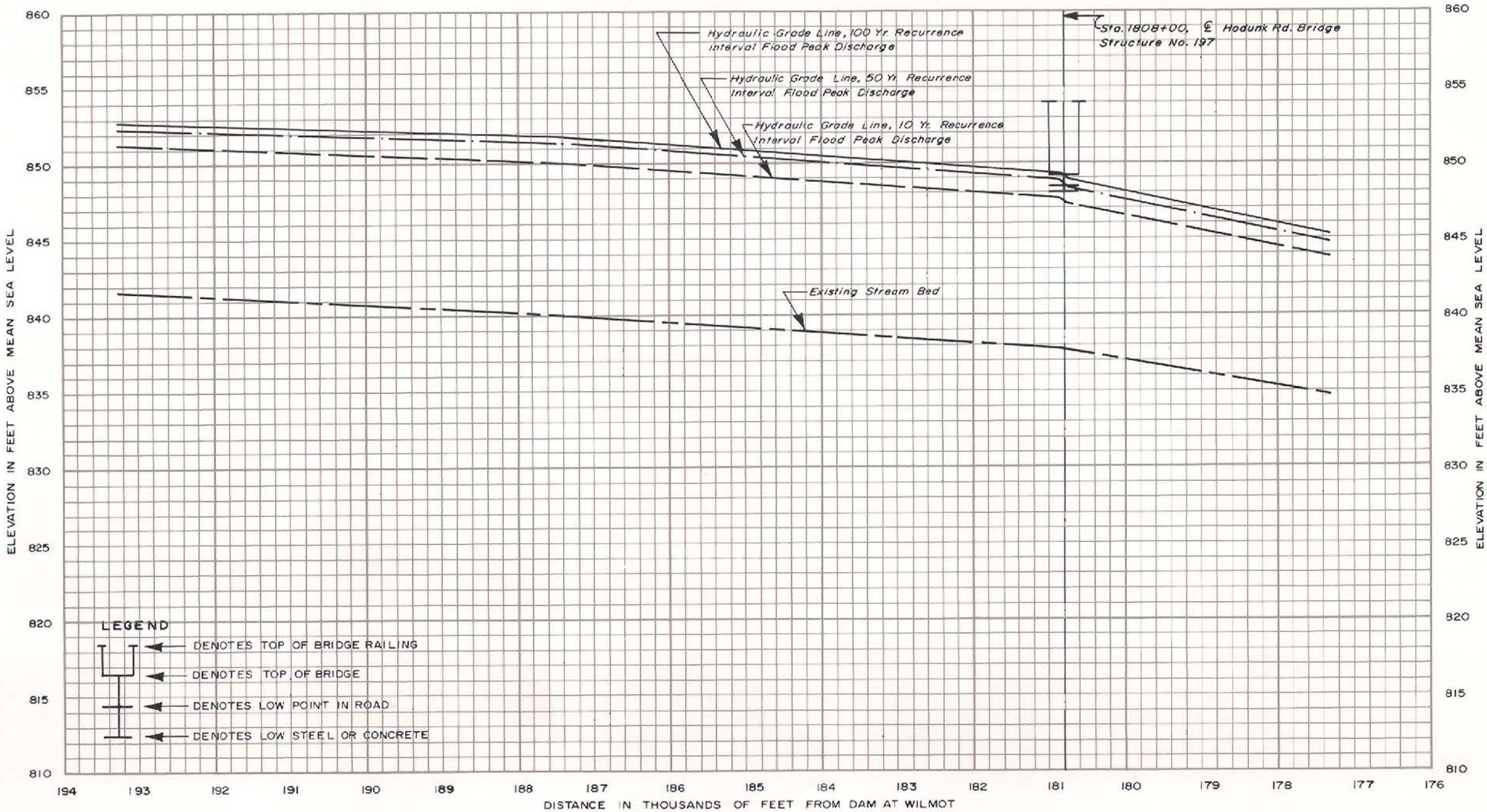
WALWORTH COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: BLR DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

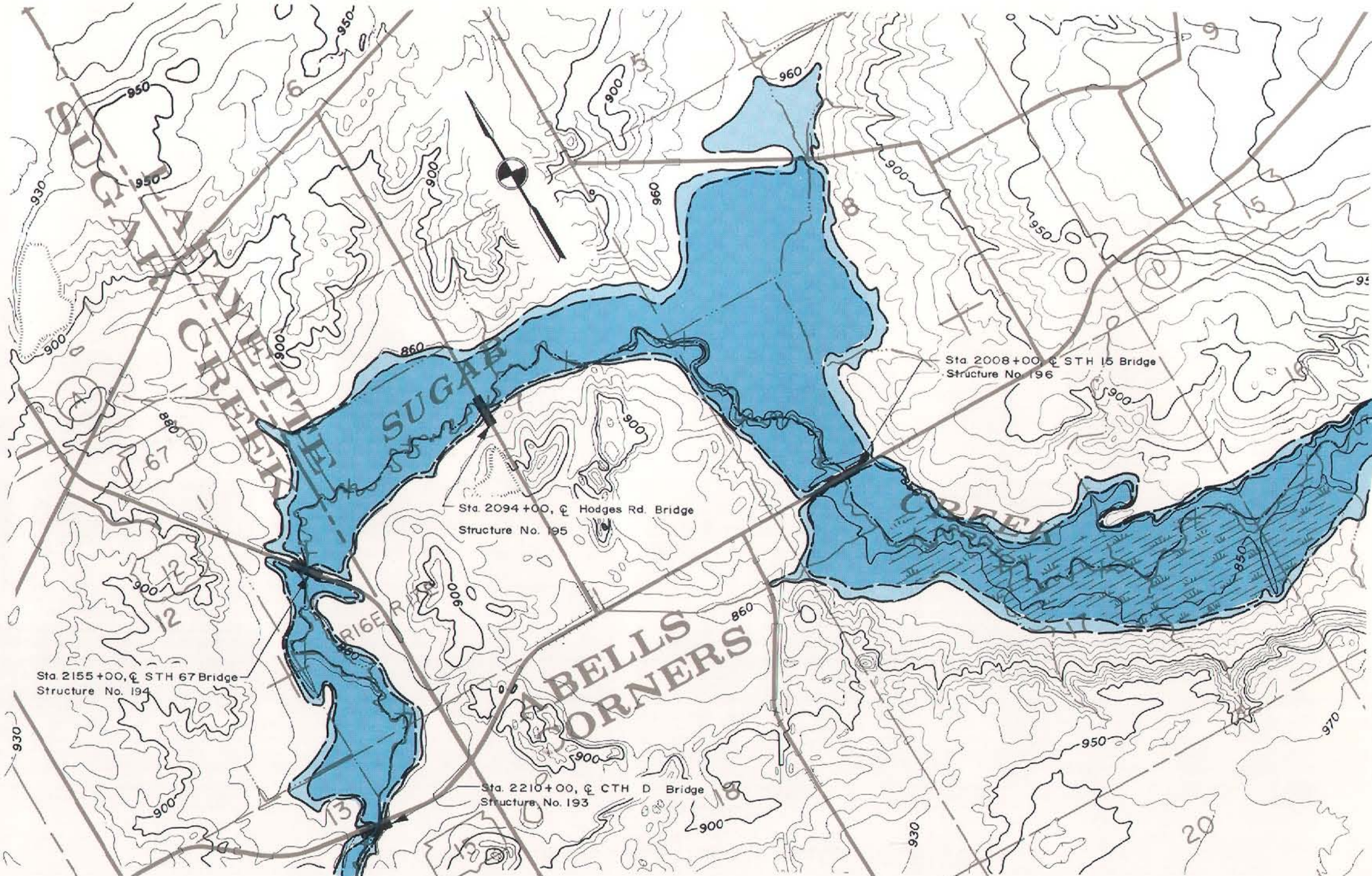
Map D-6 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
SUGAR CREEK

FROM STA. 1933+00 TO STA. 2073+00
WALWORTH COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969

SCALE: 1" = 2000'

GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-6 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

SUGAR CREEK

FROM STA. 1933+00 TO STA. 2073+00

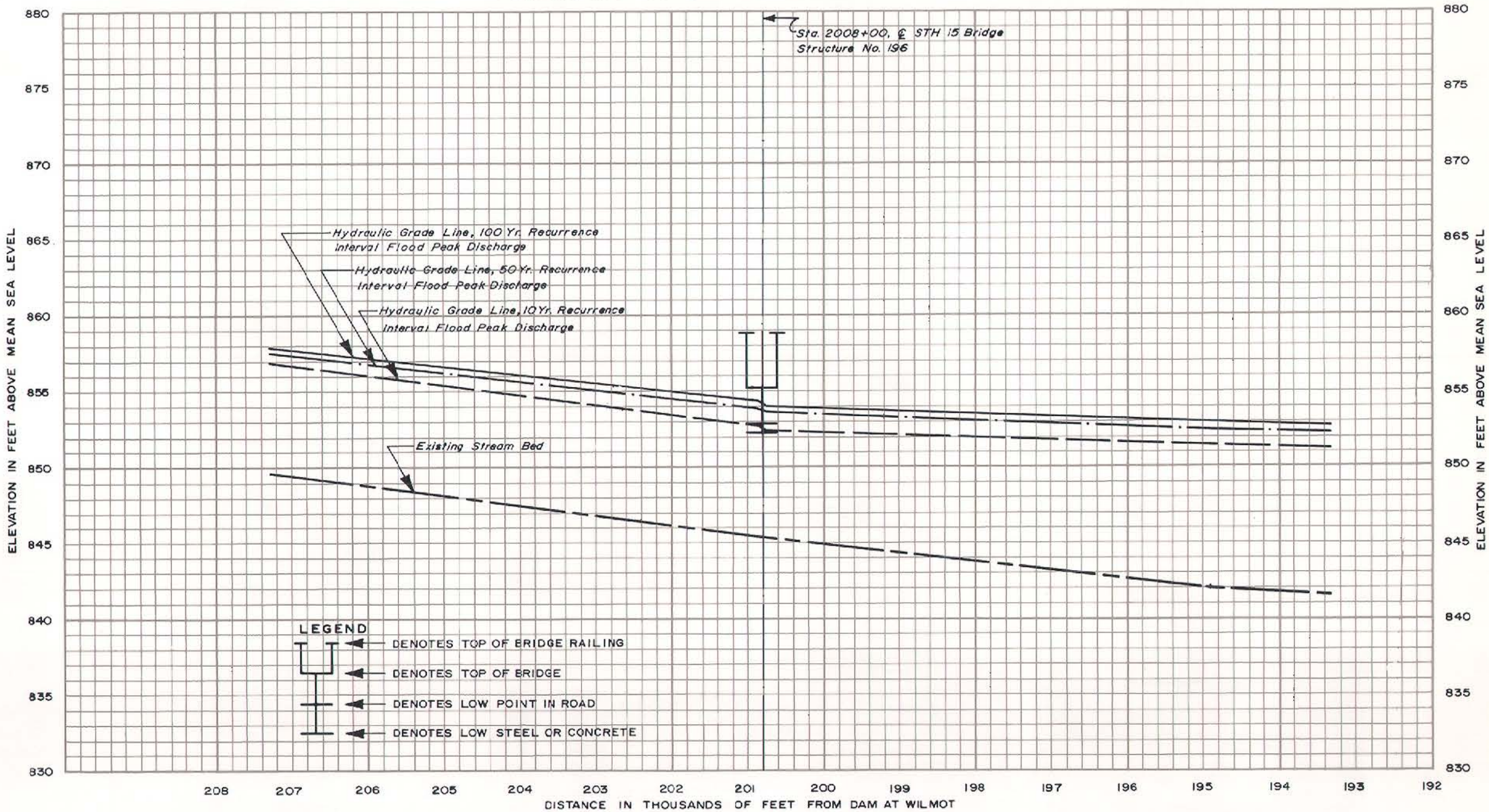
WALWORTH COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS

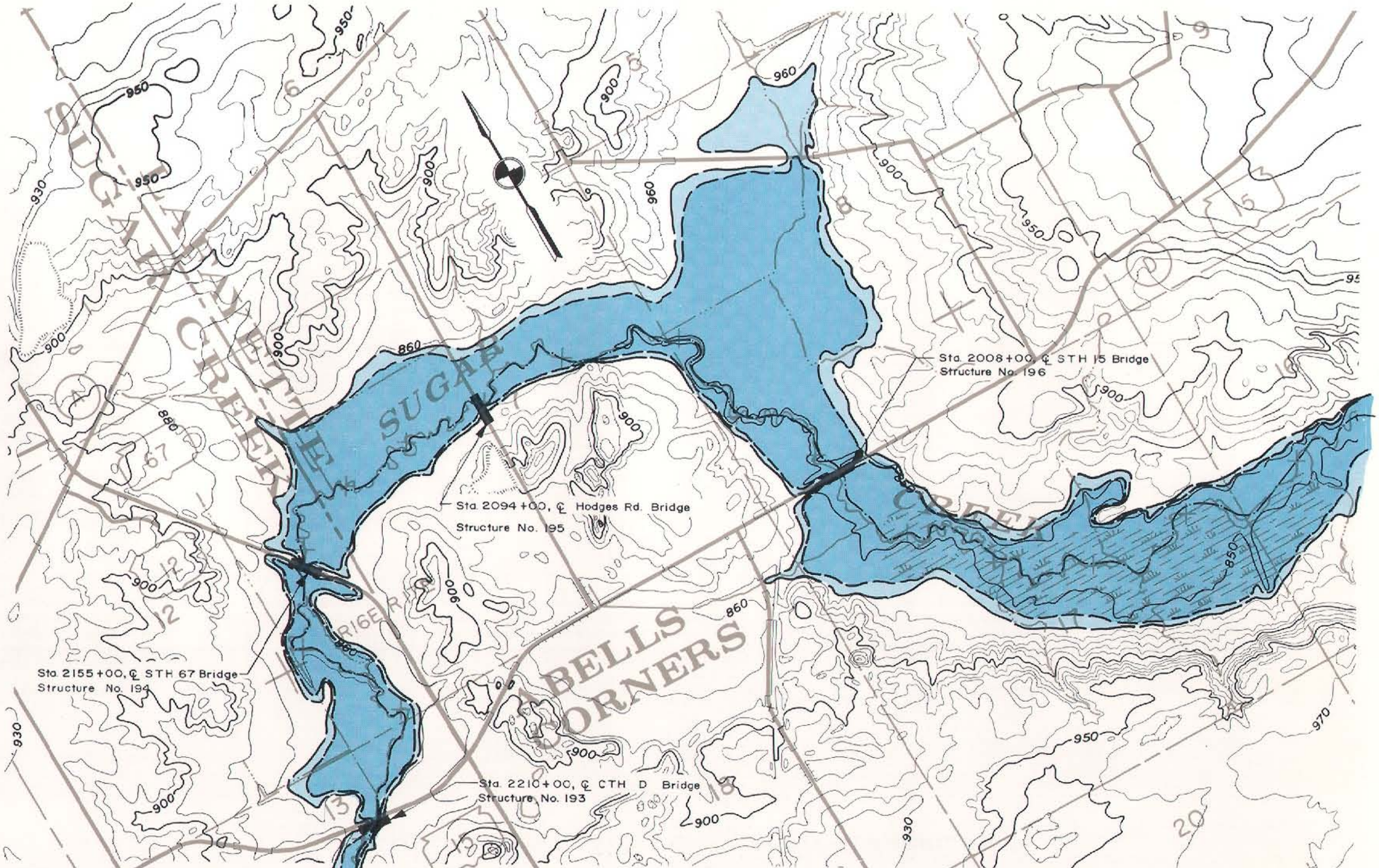


Source: U.S. Soil Conservation Service; SEWRPC.

Map D-6 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
SUGAR CREEK
FROM STA. 2073+00 TO STA. 2213+00
WALWORTH COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969

SCALE 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-6 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

SUGAR CREEK

FROM STA. 2073+00 TO STA. 2213+00

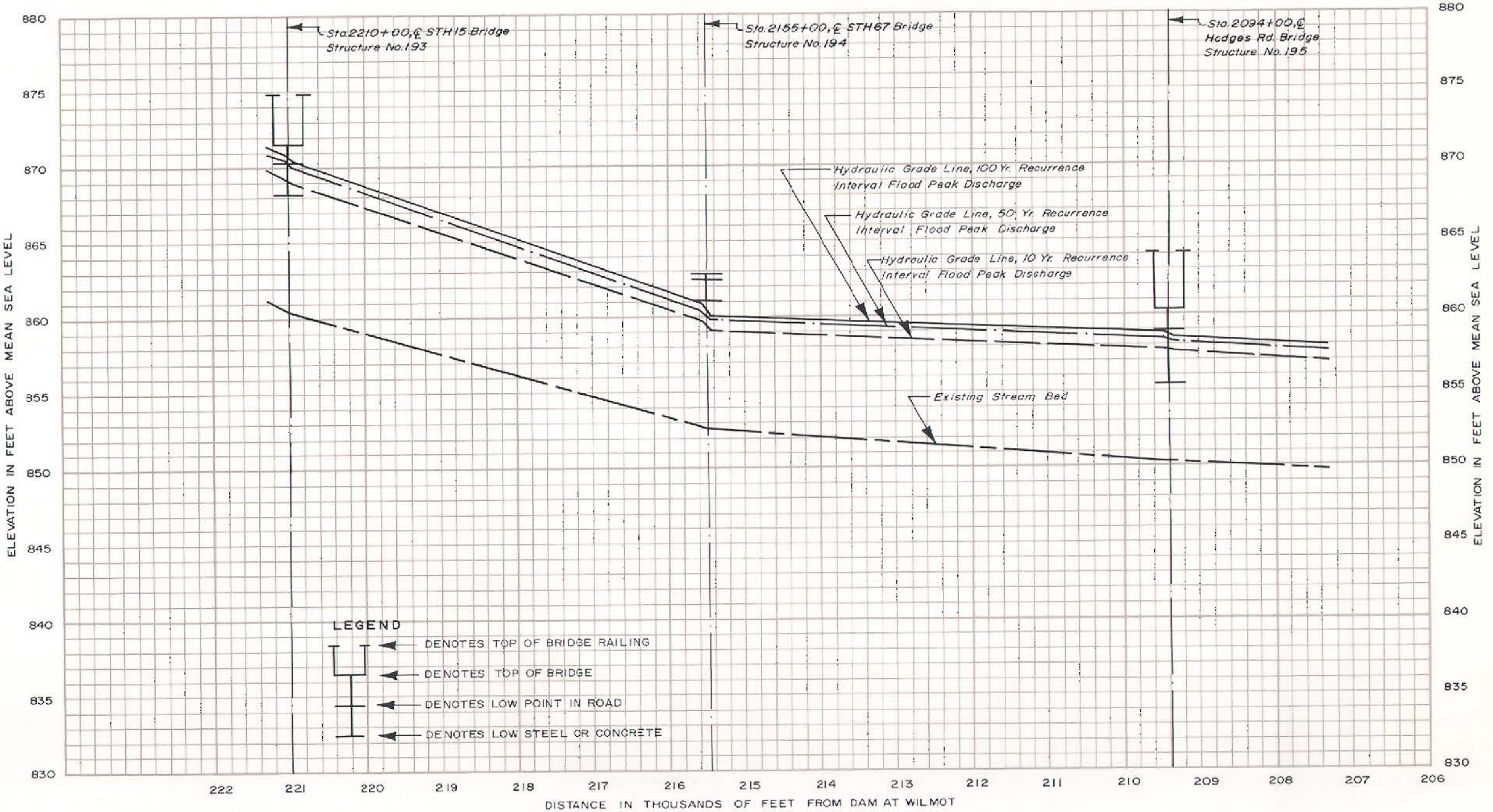
WALWORTH COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: BLR DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

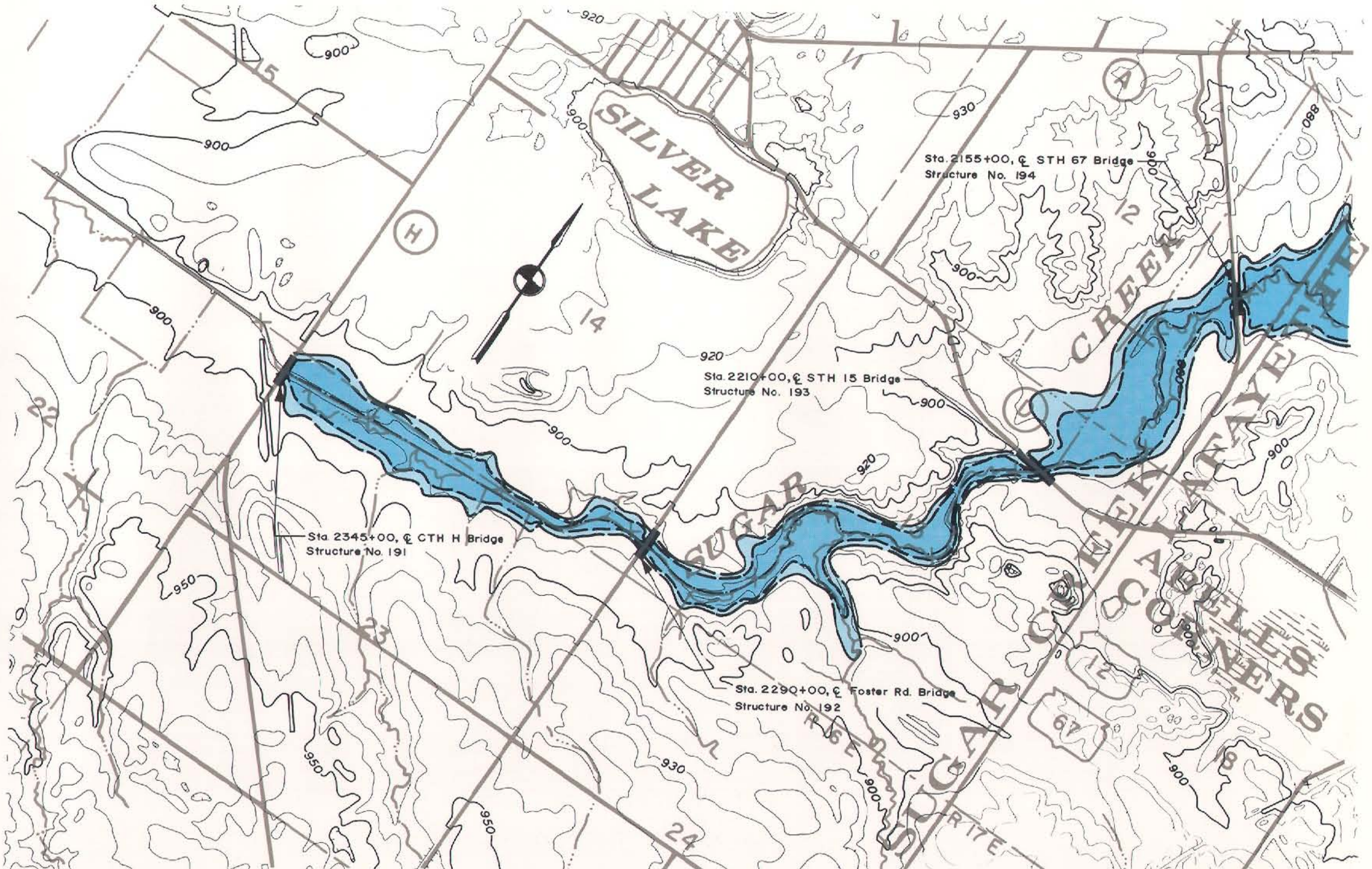
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-6 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
SUGAR CREEK

FROM STA. 2213+00 TO STA. 2345+00
WALWORTH COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-6 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

SUGAR CREEK

FROM STA. 2213+00 TO STA. 2345+00

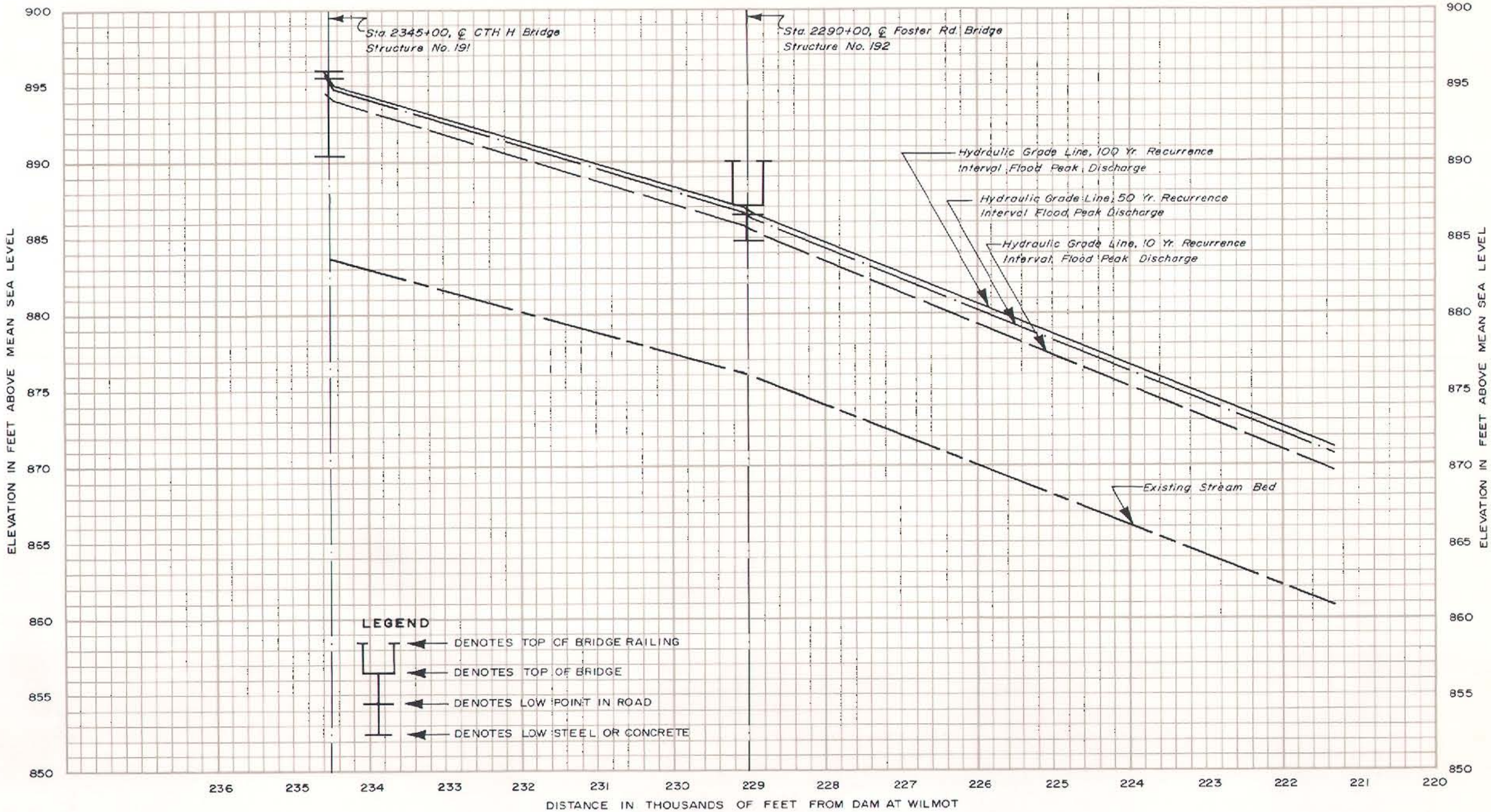
WALWORTH COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: BLR DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



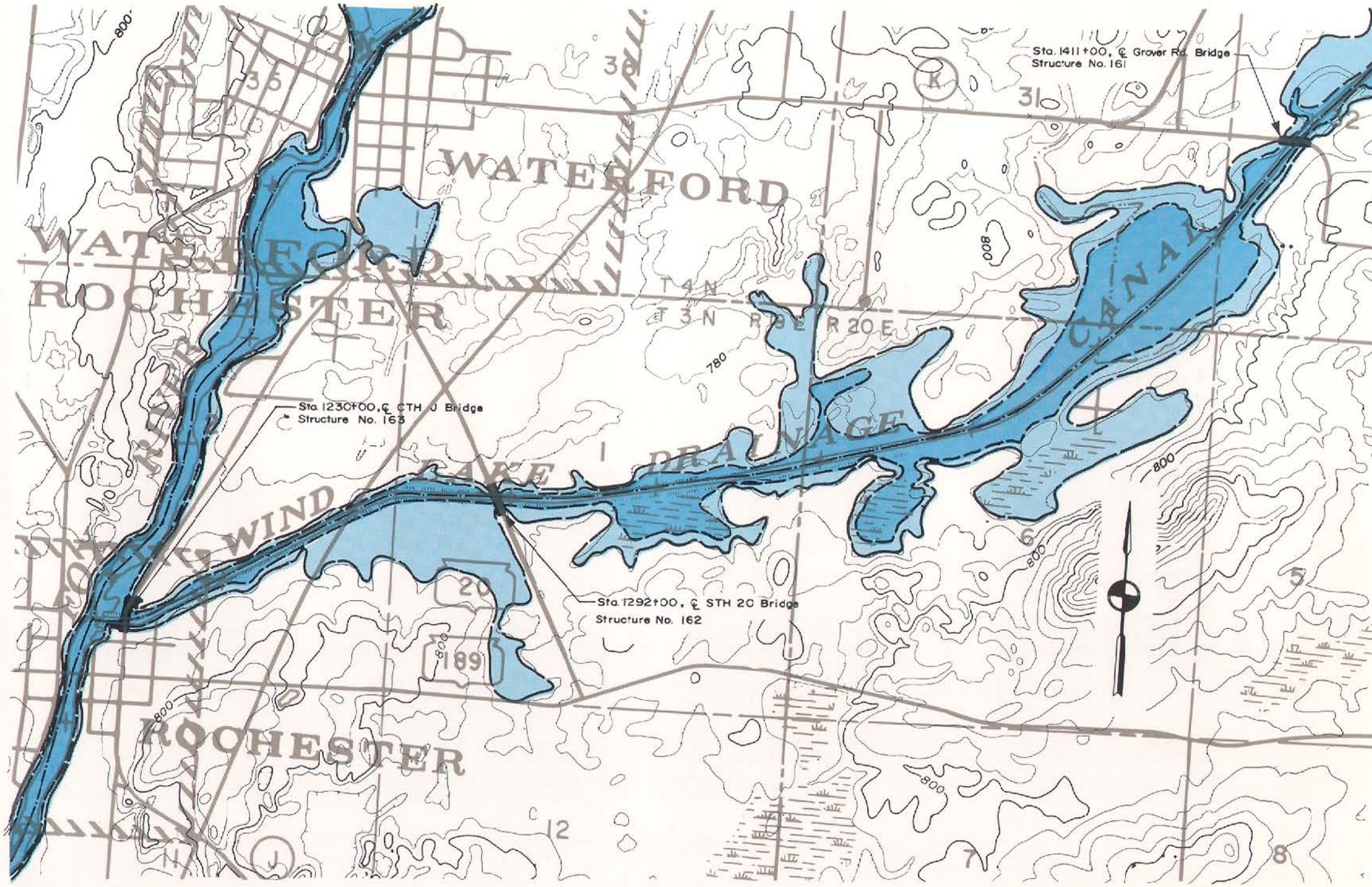
Source: U.S. Soil Conservation Service; SEWRPC.

Map D-7
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
WIND LAKE DRAINAGE CANAL

FROM STA. 1234+00 TO STA. 1320+00
RACINE COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969

SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-7

HIGH WATER AND STREAM BED PROFILES

OF THE

WIND LAKE DRAINAGE CANAL

FROM STA. 1234+00 TO STA. 1320+00

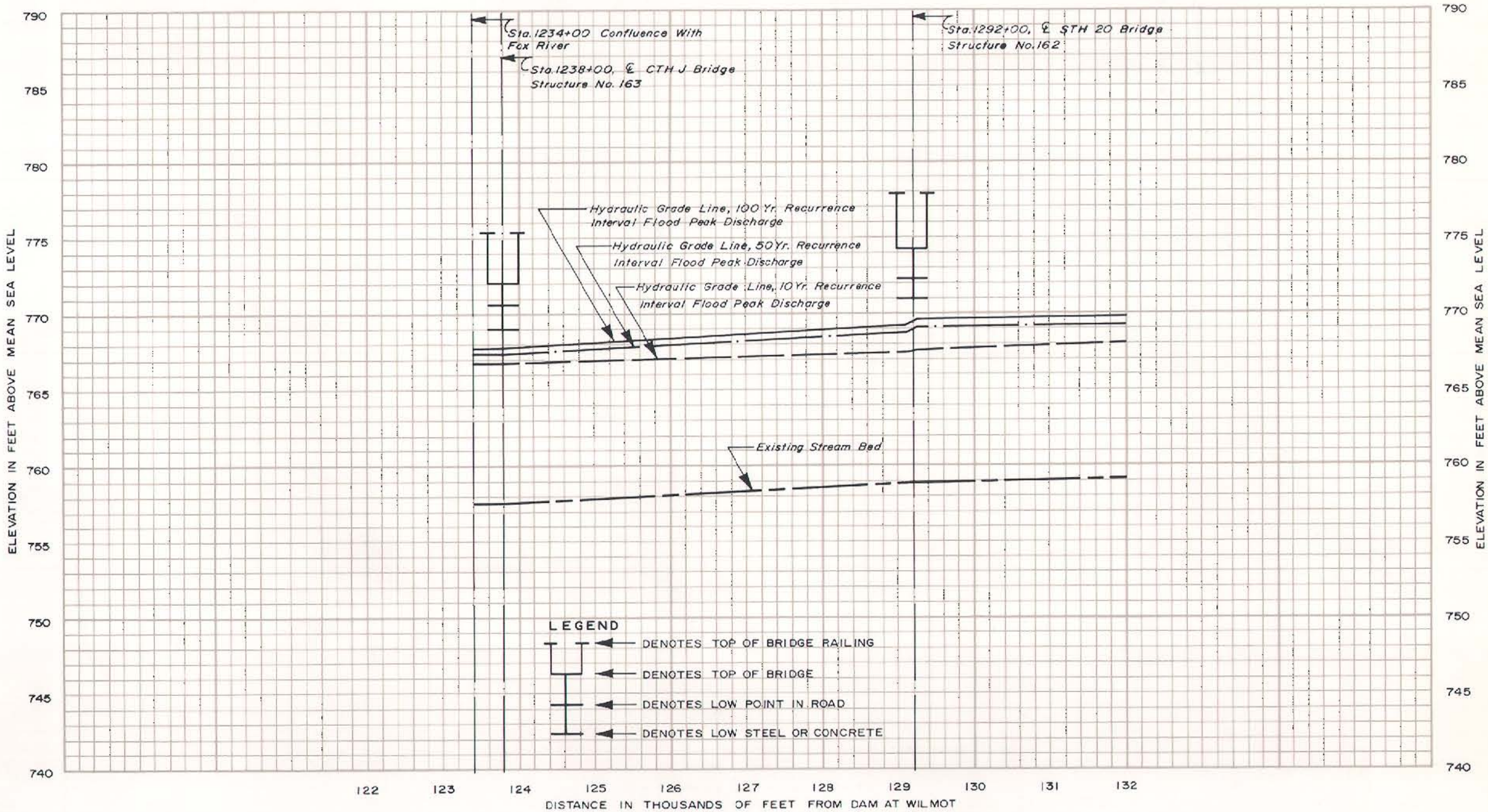
RACINE COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS

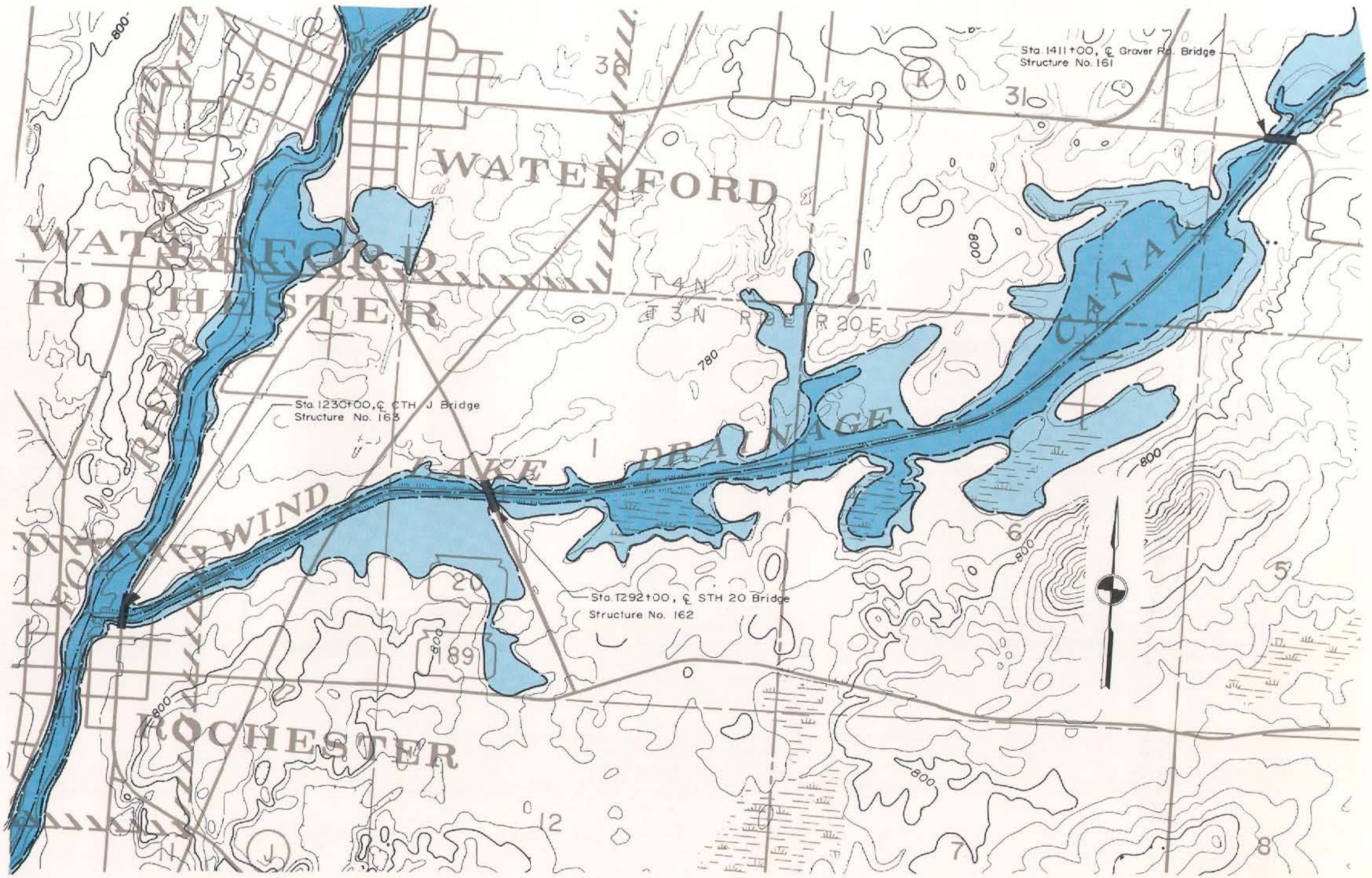


NOTE: WATERFORD VILLAGE DATUM = MEAN SEA LEVEL DATUM, 1929 ADJUSTMENT MINUS 580.38'

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

Map D-7 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
WIND LAKE DRAINAGE CANAL

FROM STA. 1320+00 TO STA. 1414+00
RACINE COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

DENOTES STATION TICK

Figure D-7 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

WIND LAKE DRAINAGE CANAL

FROM STA. 1320+00 TO STA. 1414+00

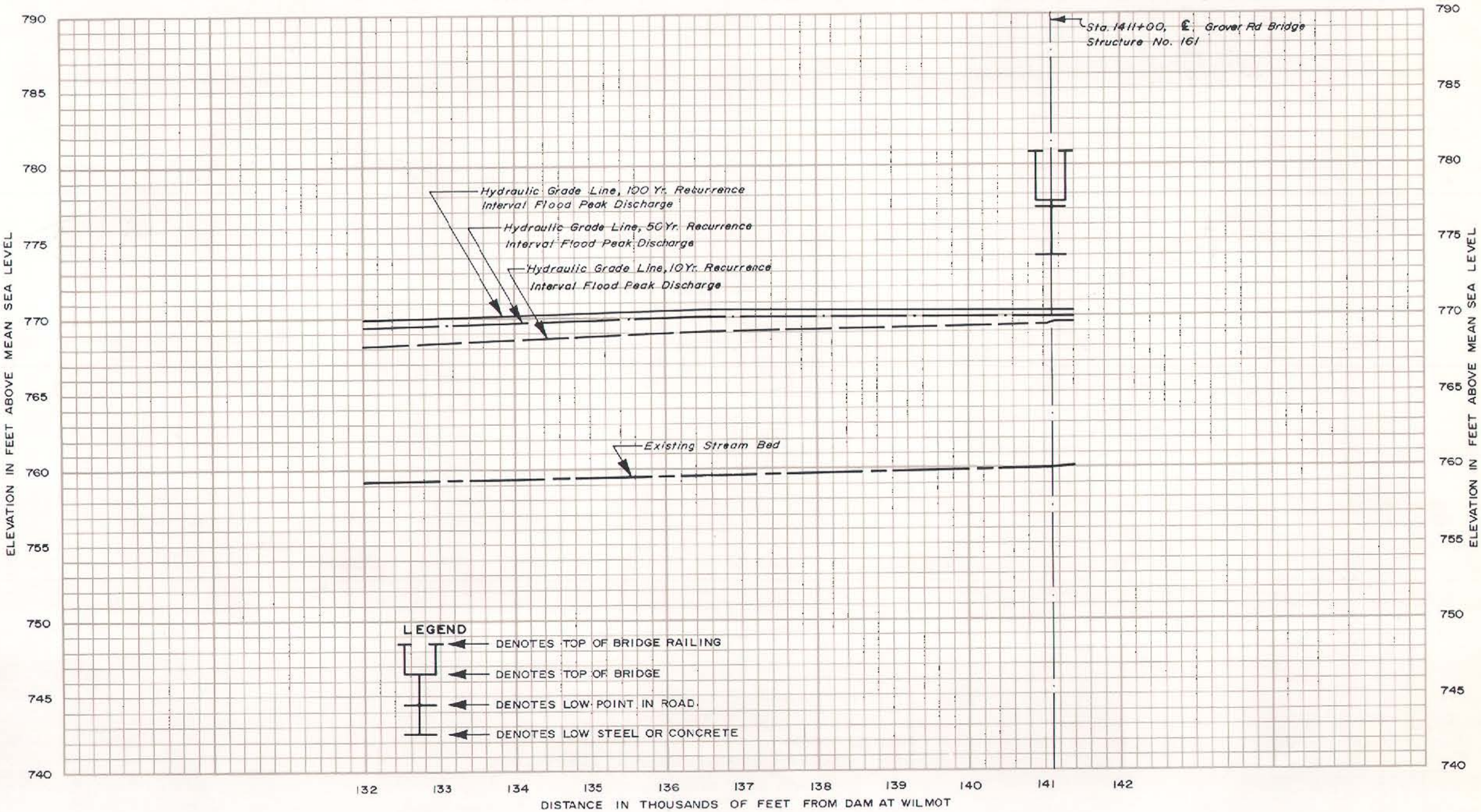
RACINE COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS

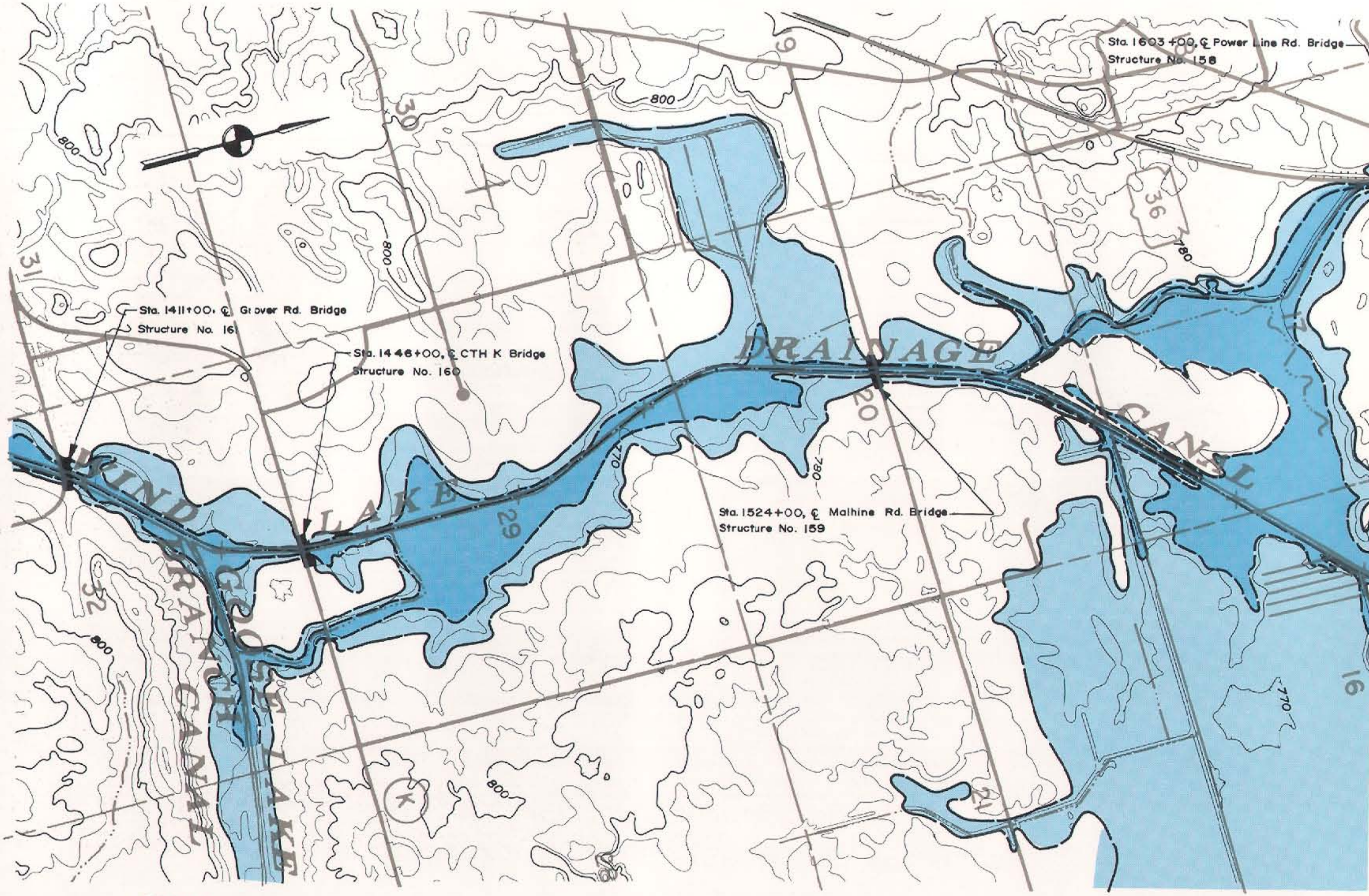


NOTE: WATERFORD VILLAGE DATUM = MEAN SEA LEVEL DATUM, 1929 ADJUSTMENT MINUS 580.38'

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

Map D-7 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
WIND LAKE DRAINAGE CANAL

FROM STA. 1414+00 TO STA. 1500+00
RACINE COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND
DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
+ DENOTES STATION TICK

Figure D-7 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

WIND LAKE DRAINAGE CANAL

FROM STA. 1414+00 TO STA.1500+00

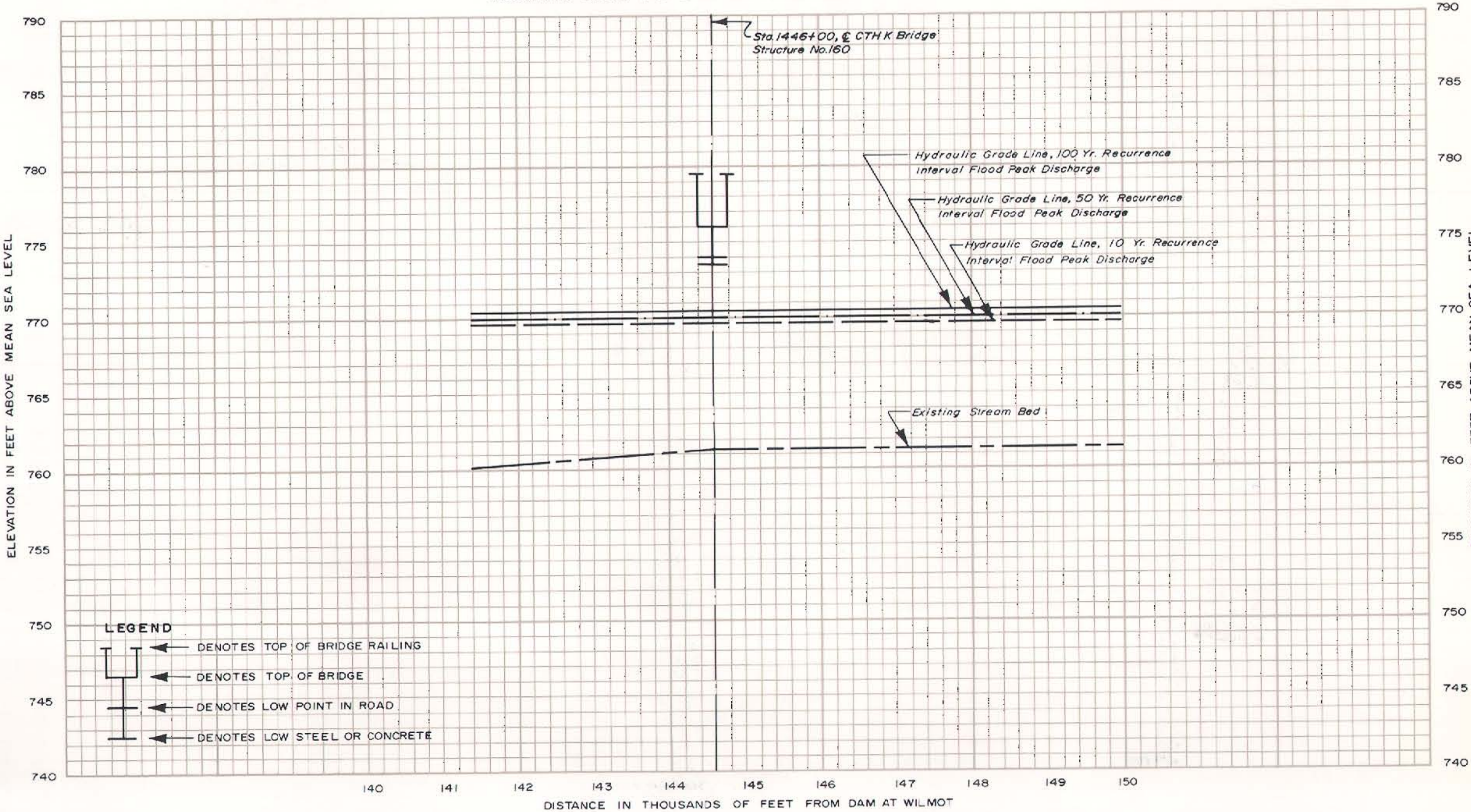
RACINE COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: BLR DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



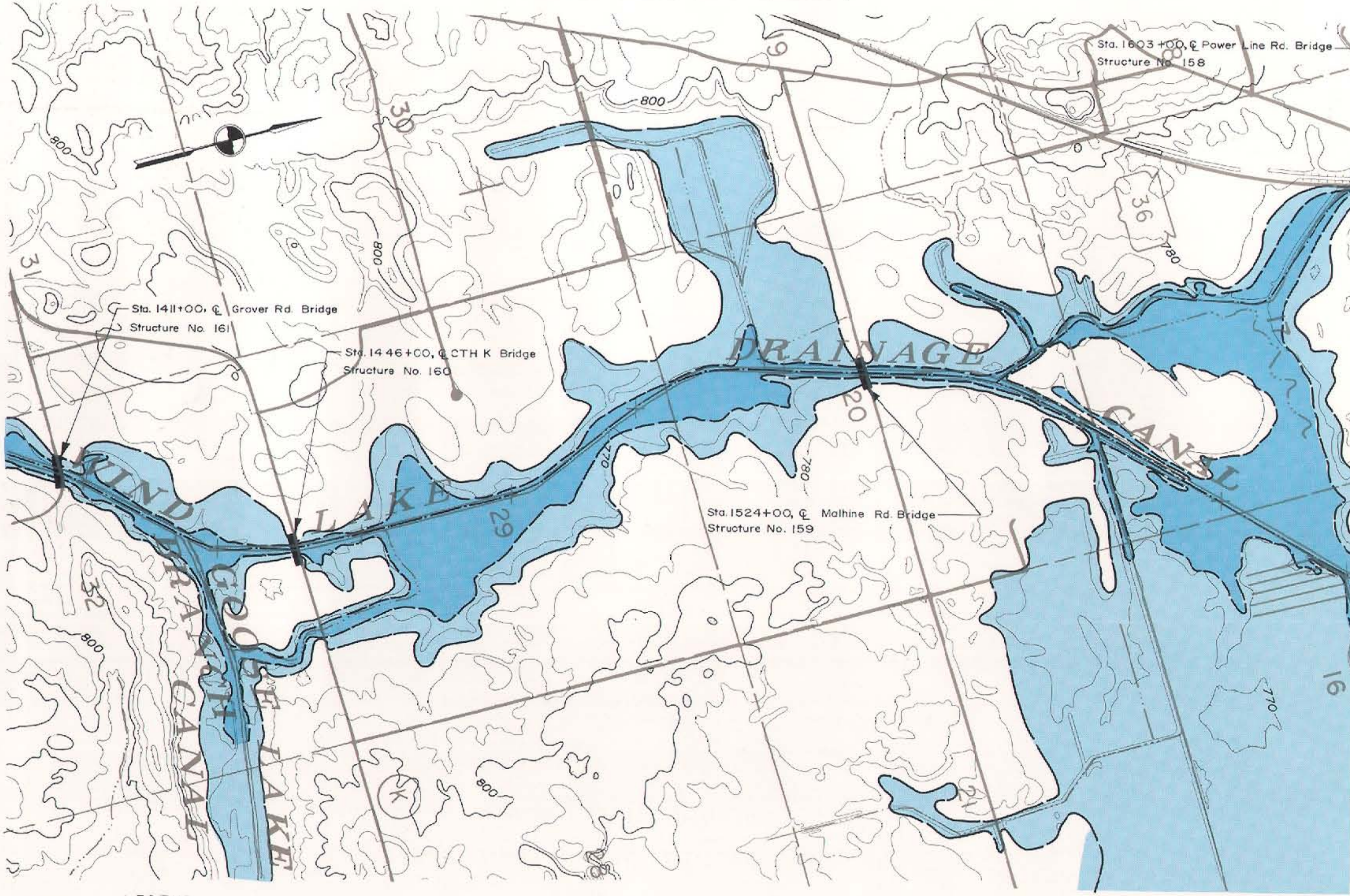
Source: U.S. Soil Conservation Service; SEWRPC.

Map D-7 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
WIND LAKE DRAINAGE CANAL

FROM STA.1500+00 TO STA.1594+00
RACINE COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969

SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

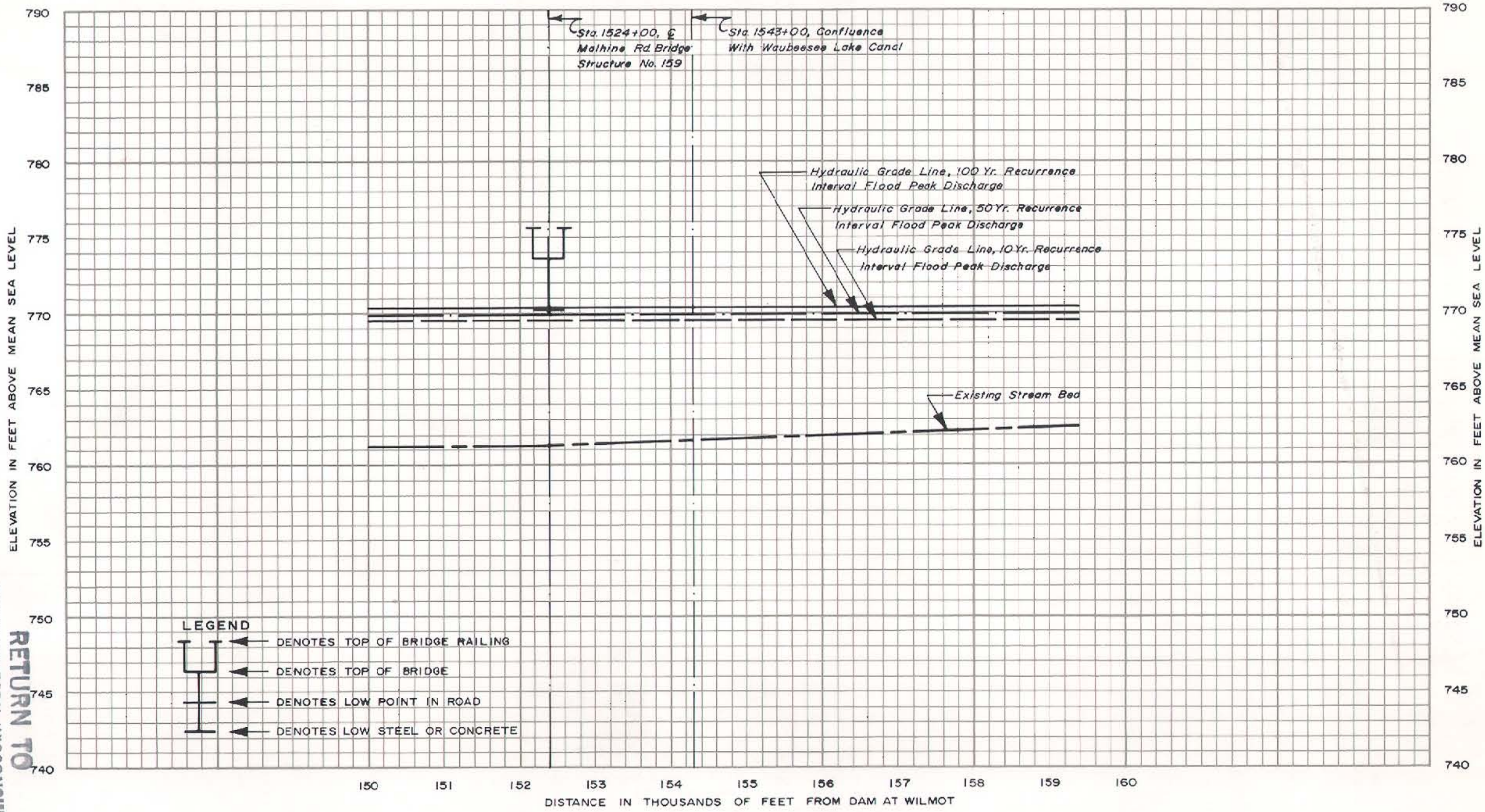
Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

DENOTES STATION TICK

Figure D-7 (continued)

HIGH WATER AND STREAM BED PROFILES
OF THE
WIND LAKE DRAINAGE CANAL
FROM STA. 1500+00 TO STA. 1594+00
RACINE COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: LHK DATE: DECEMBER 1969
CHECKED: DRB DATE: DECEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-7 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
WIND LAKE DRAINAGE CANAL

FROM STA.1594+00 TO STA. 1694+00

RACINE AND WAUKESHA COUNTIES, WISCONSIN

PREPARED BY

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

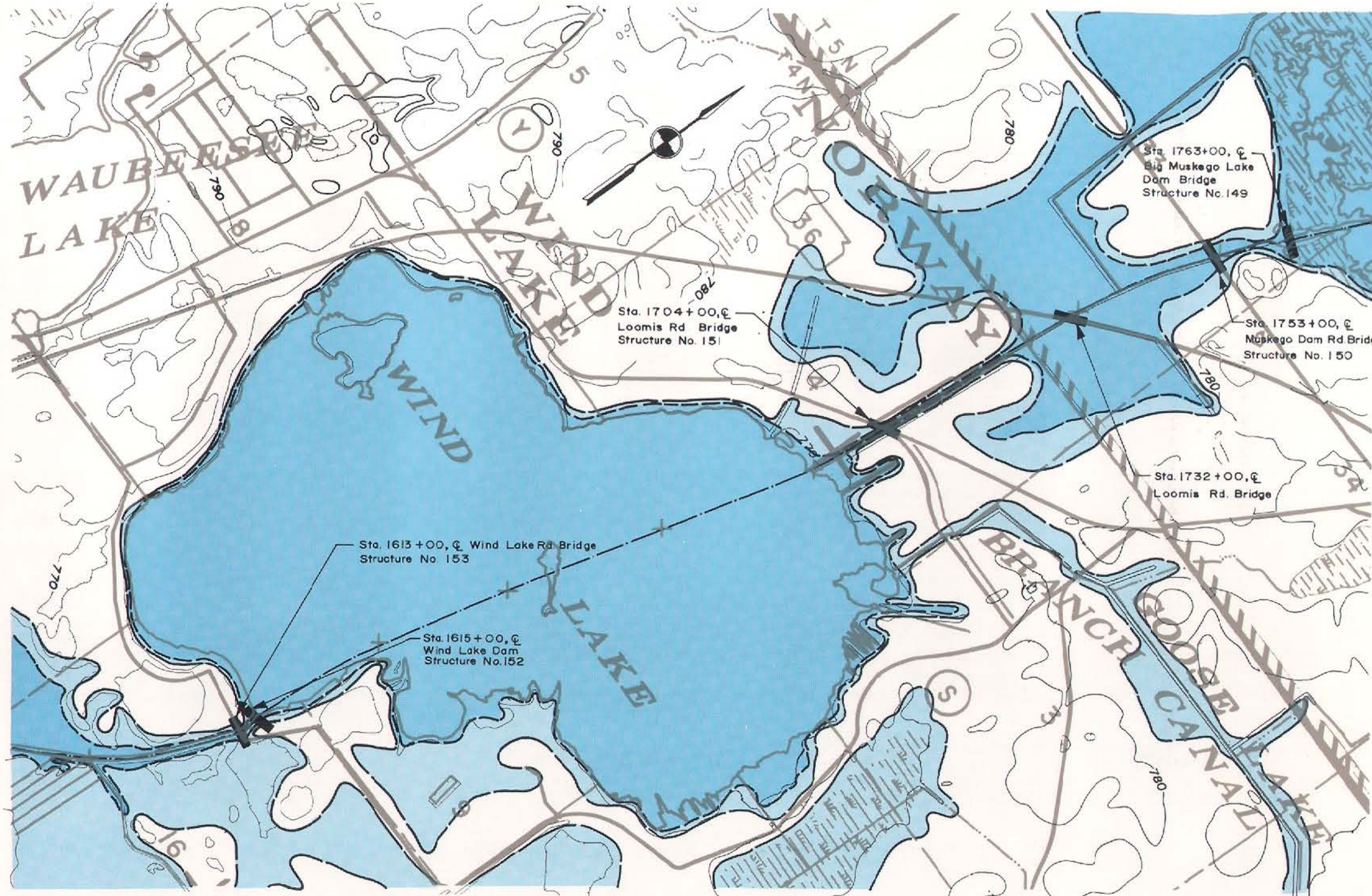
DRAWN: RHH DATE: OCTOBER 1969

CHECKED: DRB DATE: OCTOBER 1969

SCALE: 1" = 2000'

GRAPHIC SCALE

0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

DENOTES STATION TICK

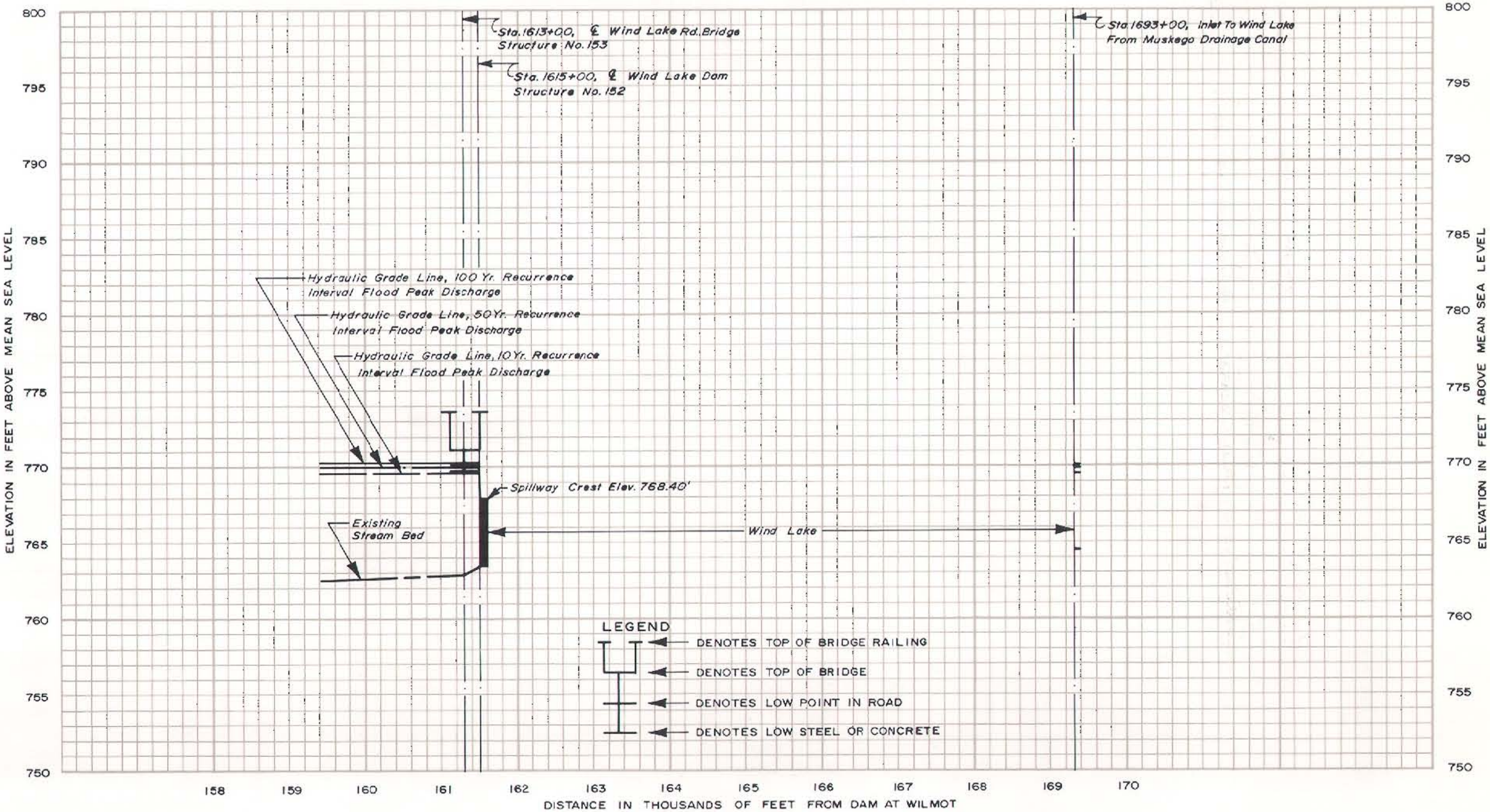
Figure D-7 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

WIND LAKE DRAINAGE CANAL

FROM STA. 1594+00 TO STA. 1694+00
RACINE COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: LHK DATE: DECEMBER 1969
CHECKED: DRB DATE: DECEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-8
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
MUSKEGO DRAINAGE CANAL
FROM STA.1694+00 TO STA.1774+00

RACINE AND WAUKESHA COUNTIES, WISCONSIN

PREPARED BY

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

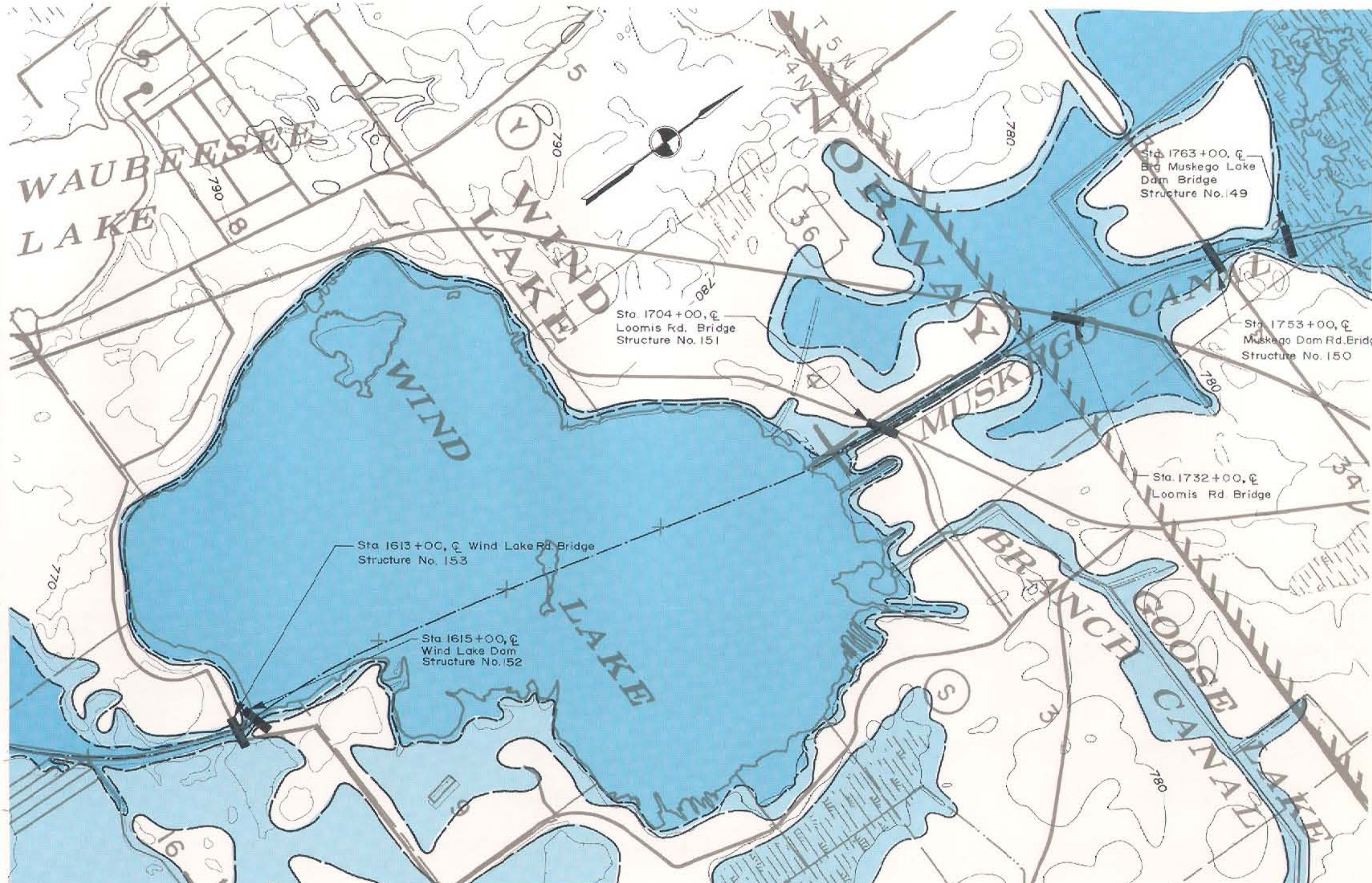
DRAWN: RHH DATE: OCTOBER 1969

CHECKED: DRB DATE: OCTOBER 1969

SCALE: 1" = 2000'

GRAPHIC SCALE

0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

DENOTES STATION TICK

Figure D-8

HIGH WATER AND STREAM BED PROFILES

OF THE

MUSKEGO DRAINAGE CANAL

FROM STA. 1694+00 TO STA. 1774+00

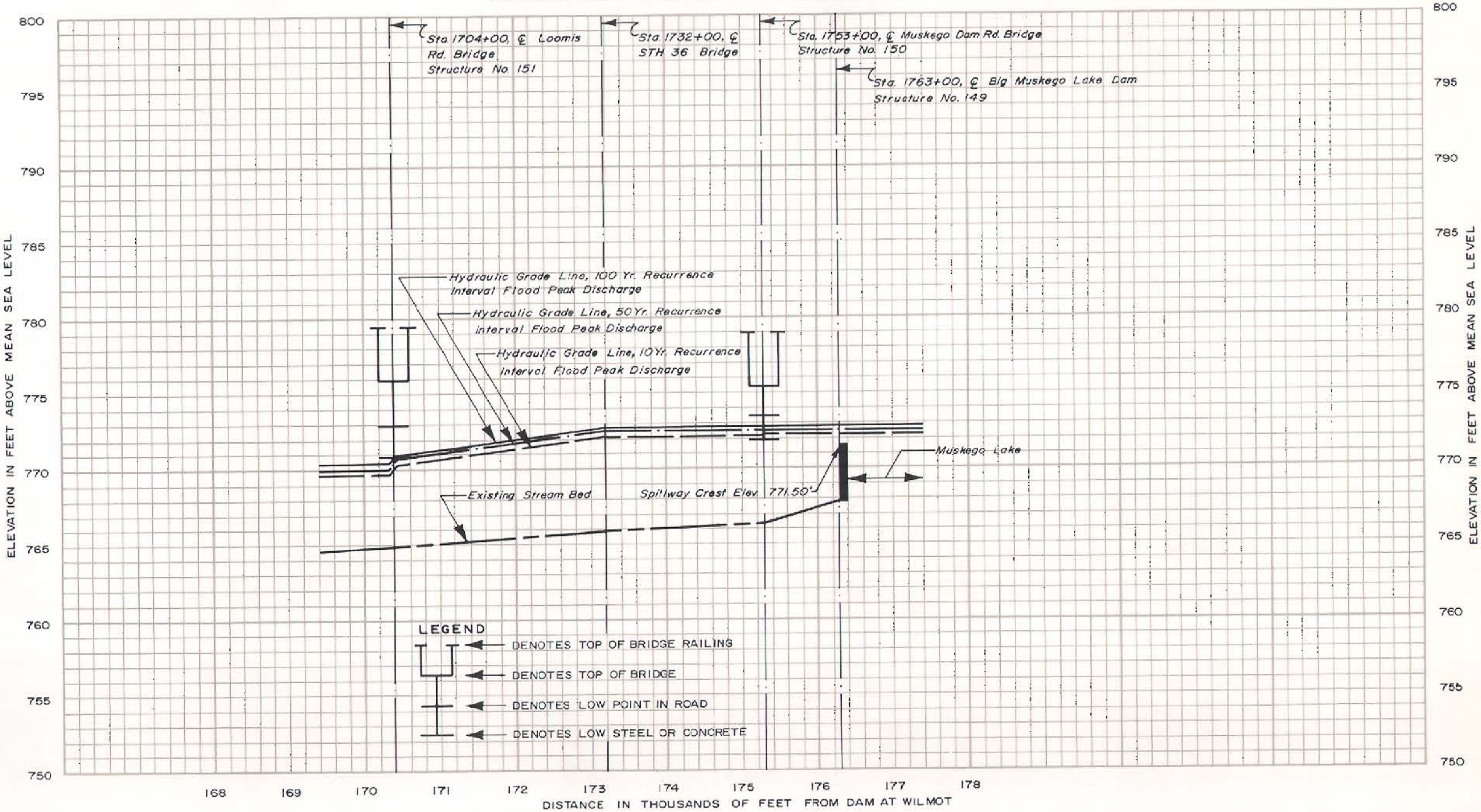
RACINE AND WAUKESHA COUNTIES, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-8 (continued)

TOPOGRAPHIC MAP

SHOWING

AREAS SUBJECT TO FLOODING

ALONG THE

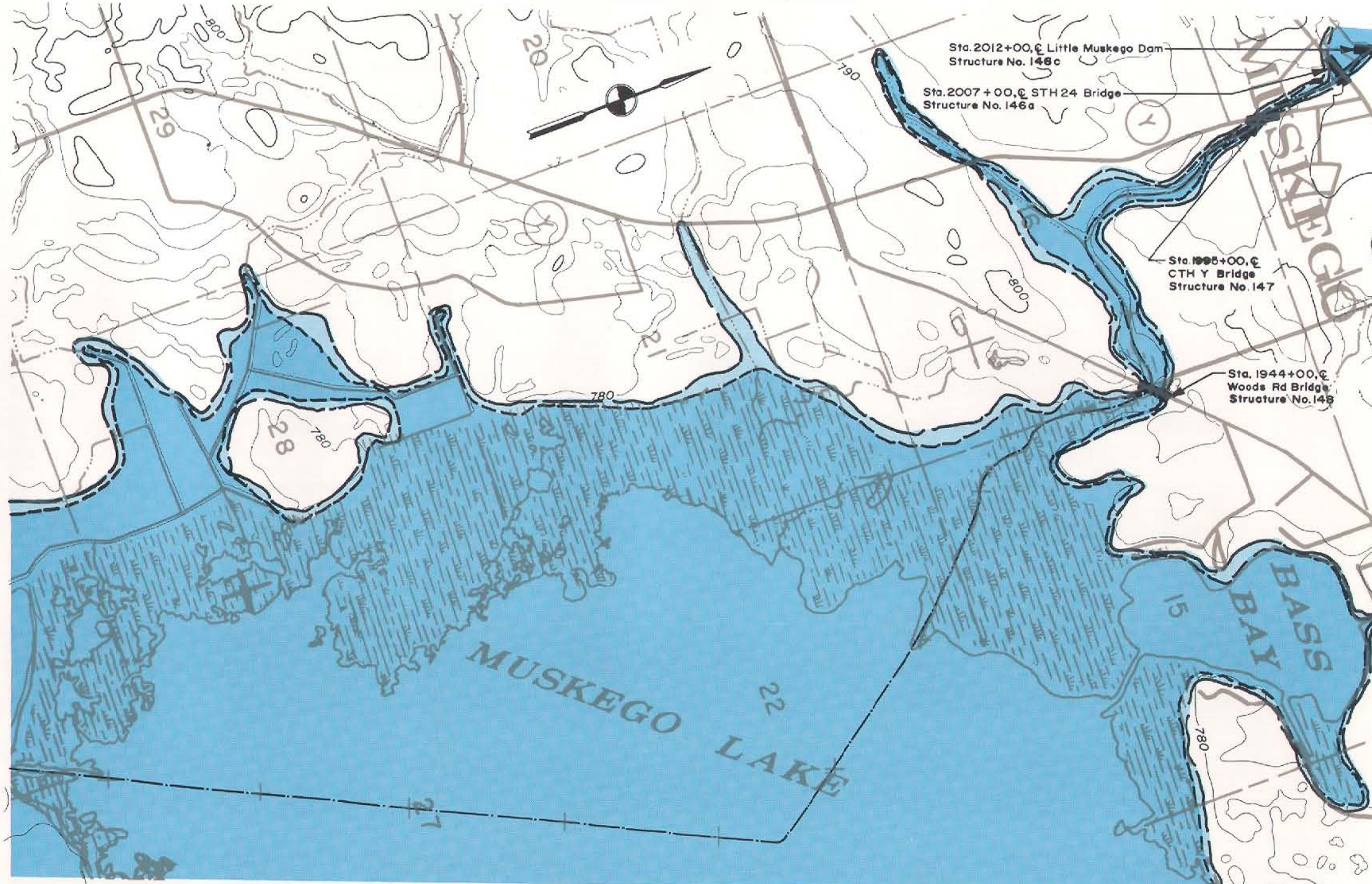
MUSKEGO DRAINAGE CANAL

FROM STA. 1774+00 TO STA. 1894+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: RMW — DATE: NOVEMBER 1969
CHECKED: DRB — DATE: NOVEMBER 1969

SCALE: 1" = 2000'

GRAPHIC SCALE
0 — 2000 — 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

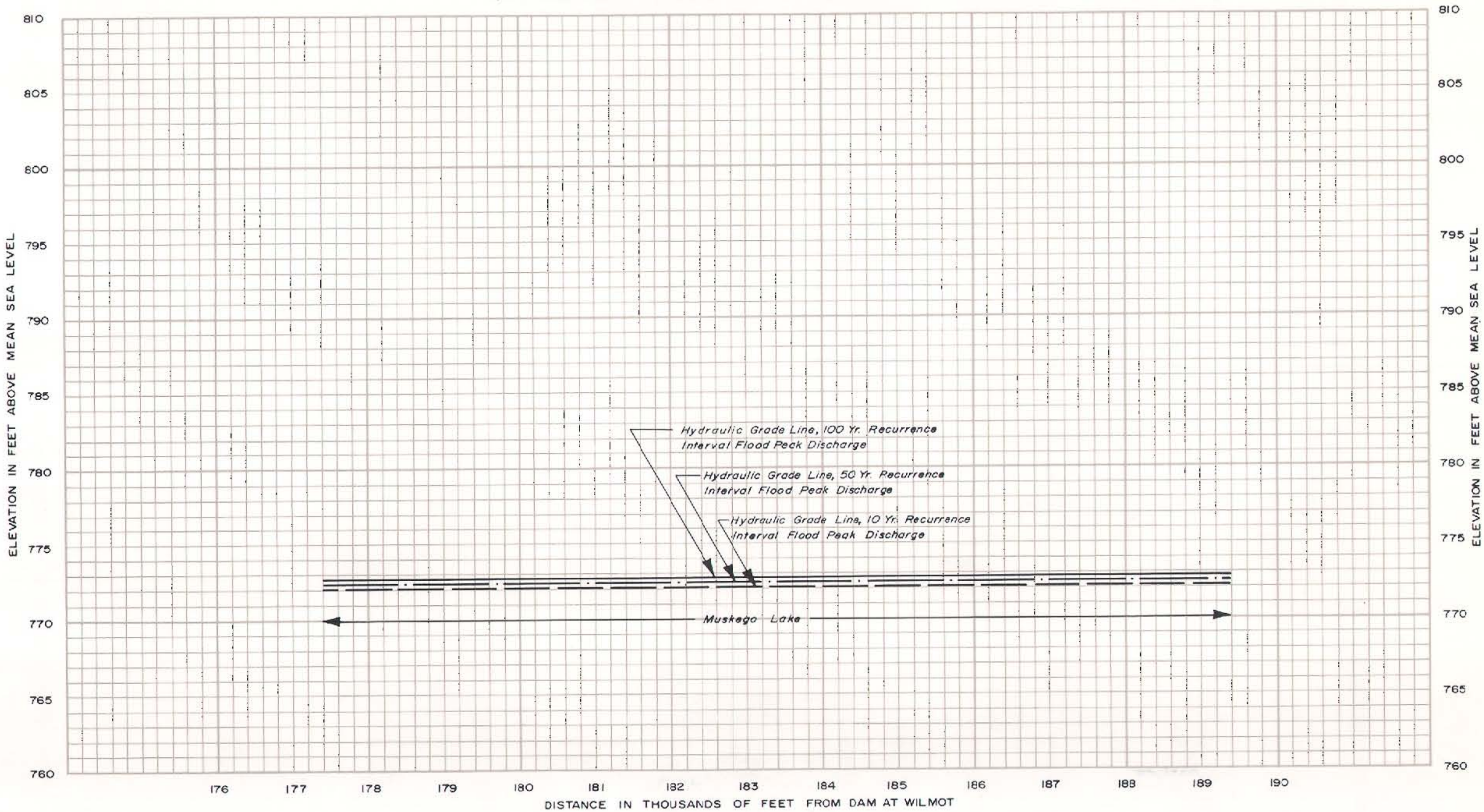
Sta. 131 +00 — DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

+ — DENOTES STATION TICK

Figure D-8 (continued)

HIGH WATER AND STREAM BED PROFILES
OF THE
MUSKEGO DRAINAGE CANAL
FROM STA. 1774+00 TO STA. 1894+00
RACINE COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: BLR DATE: DECEMBER 1969
CHECKED: DRB DATE: DECEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS



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

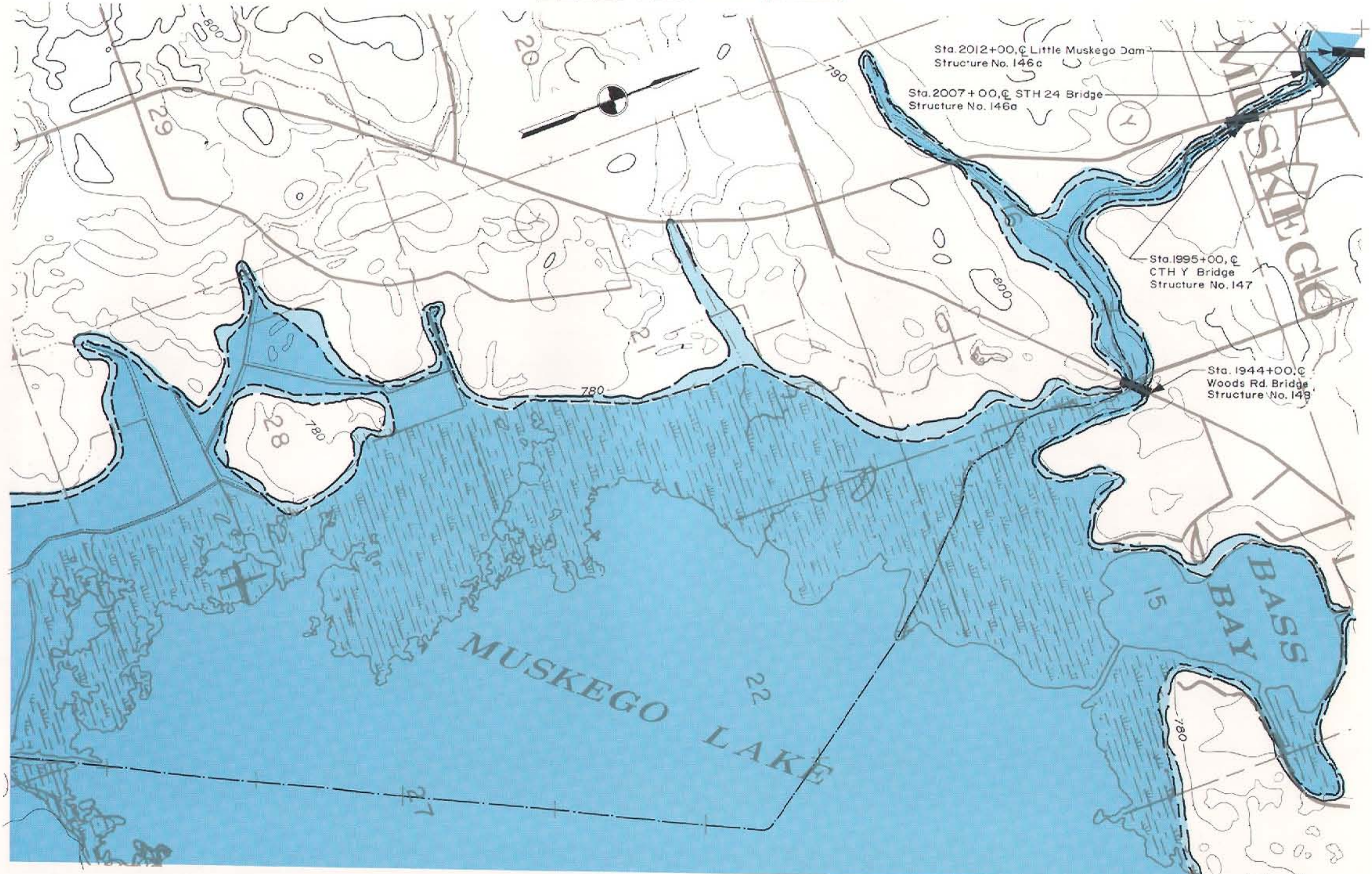
Map D-8 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
MUSKEGO DRAINAGE CANAL

FROM STA. 1894+00 TO STA. 2012+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: RMW — DATE: NOVEMBER 1969
CHECKED: DRB — DATE: NOVEMBER 1969

SCALE: 1" = 2000'

GRAPHIC SCALE
0 — 2000 — 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

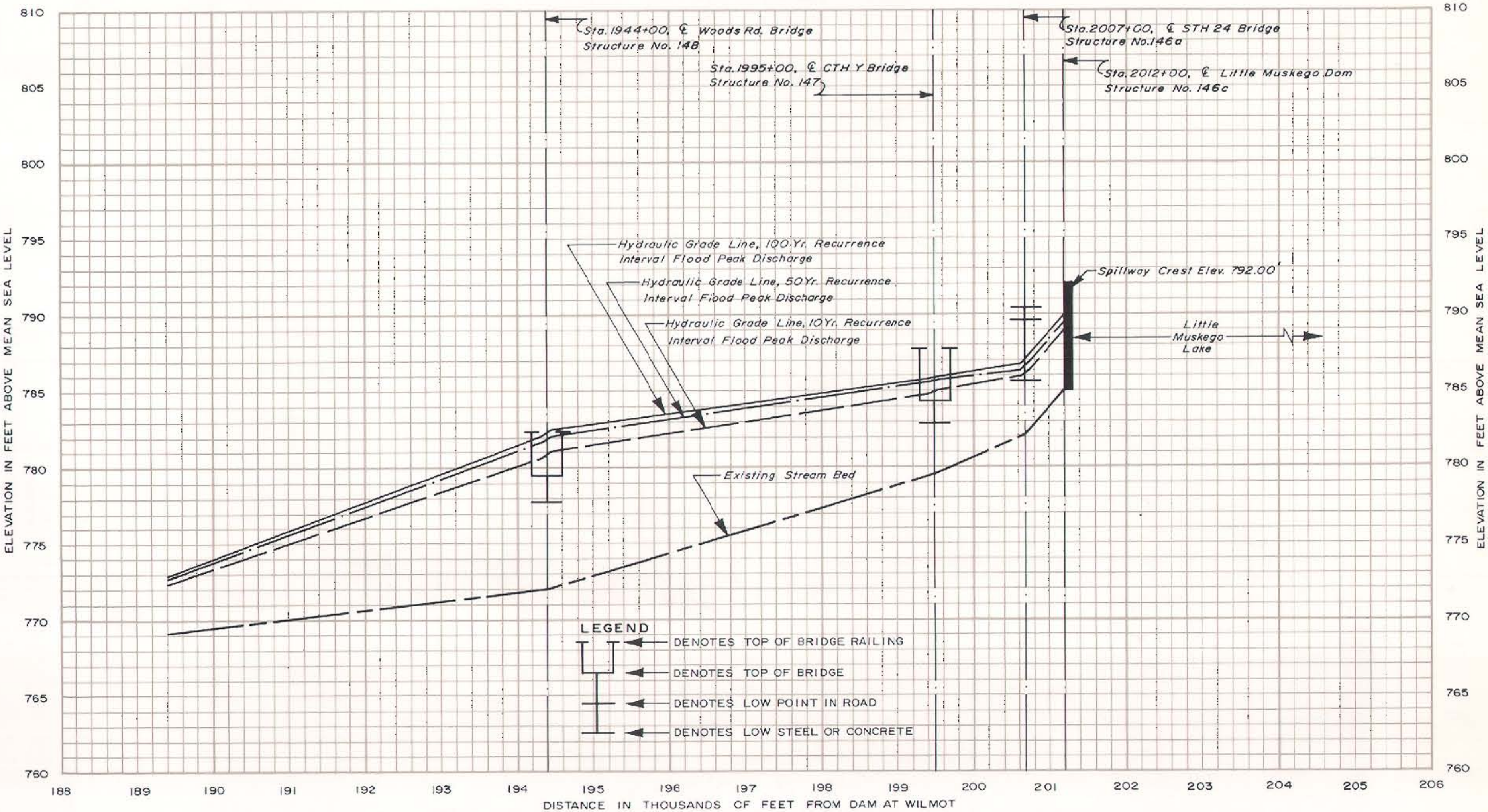
Sta. 131+00 — DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

+ DENOTES STATION TICK

Figure D-8 (continued)

HIGH WATER AND STREAM BED PROFILES
OF THE
MUSKEGO DRAINAGE CANAL
FROM STA. 1894+00 TO STA. 2012+00
WAUKESHA COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: LHK DATE: DECEMBER 1969
CHECKED: DRB DATE: DECEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS



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

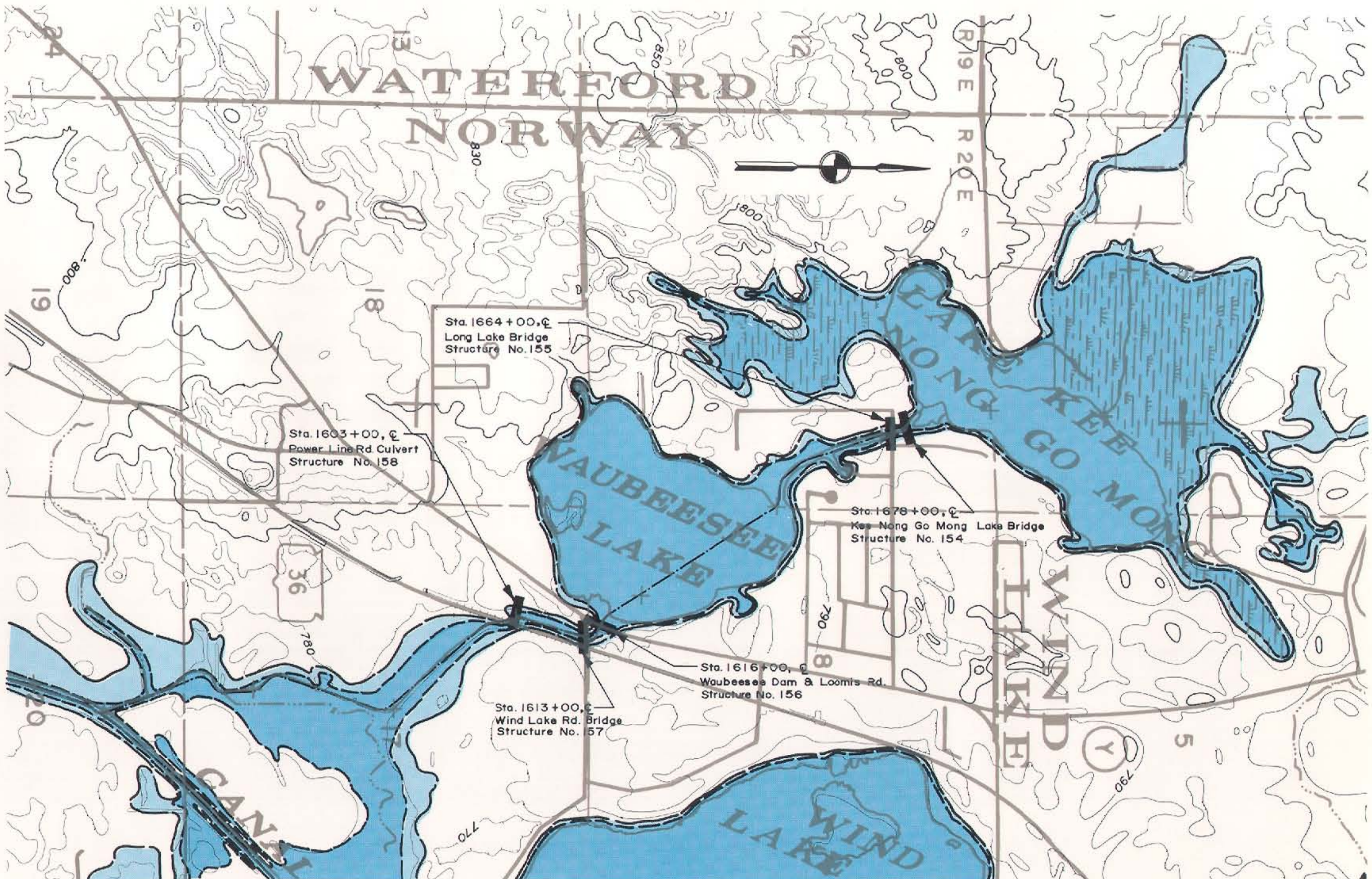
Map D-9
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
KEE NONG GO MONG AND WAUBEESEE LAKE CANALS

FROM STA. 1543+00 TO STA. 1665+00
RACINE COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969

SCALE: 1" = 2000'

GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

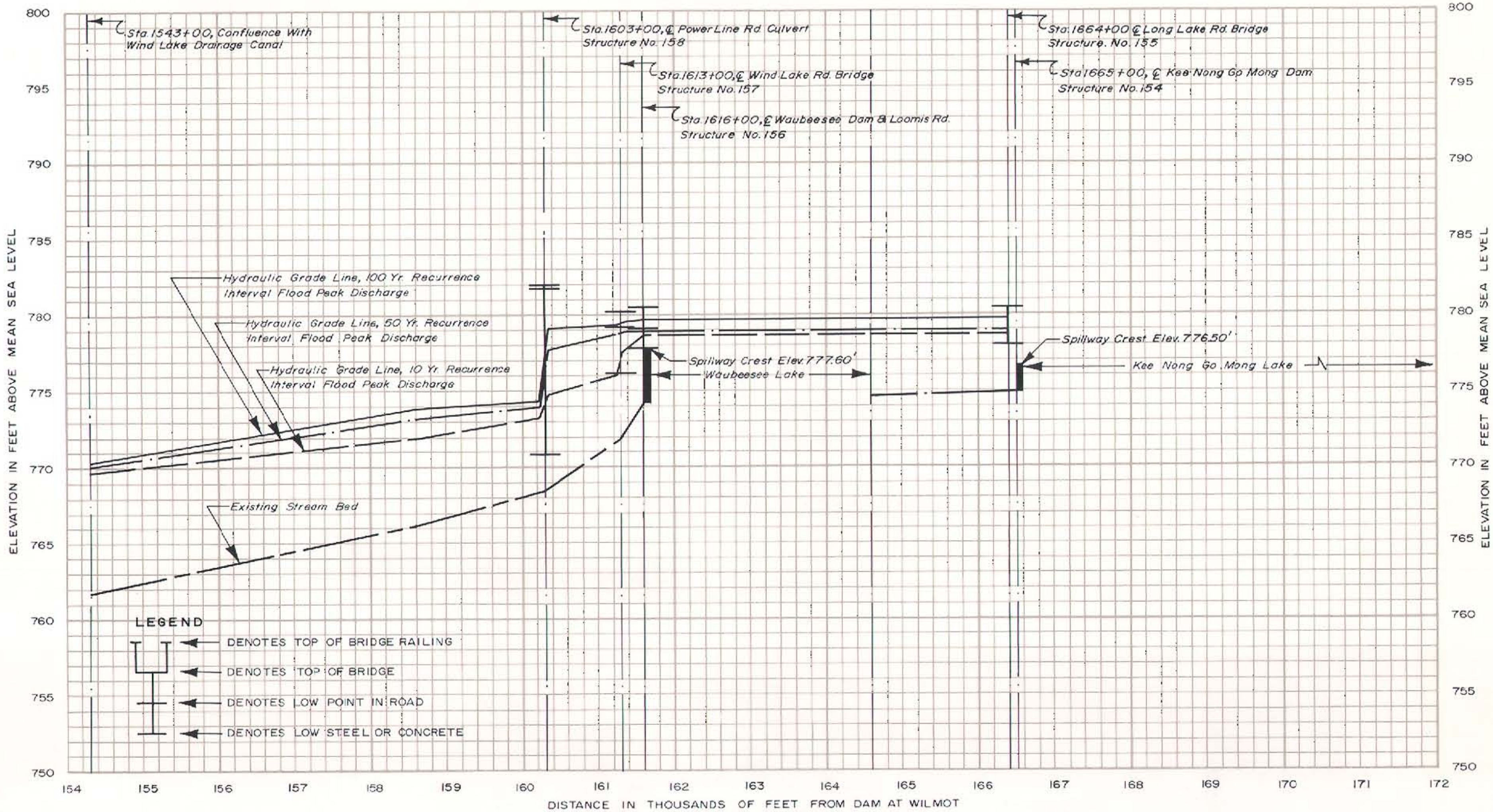
Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

DENOTES STATION TICK

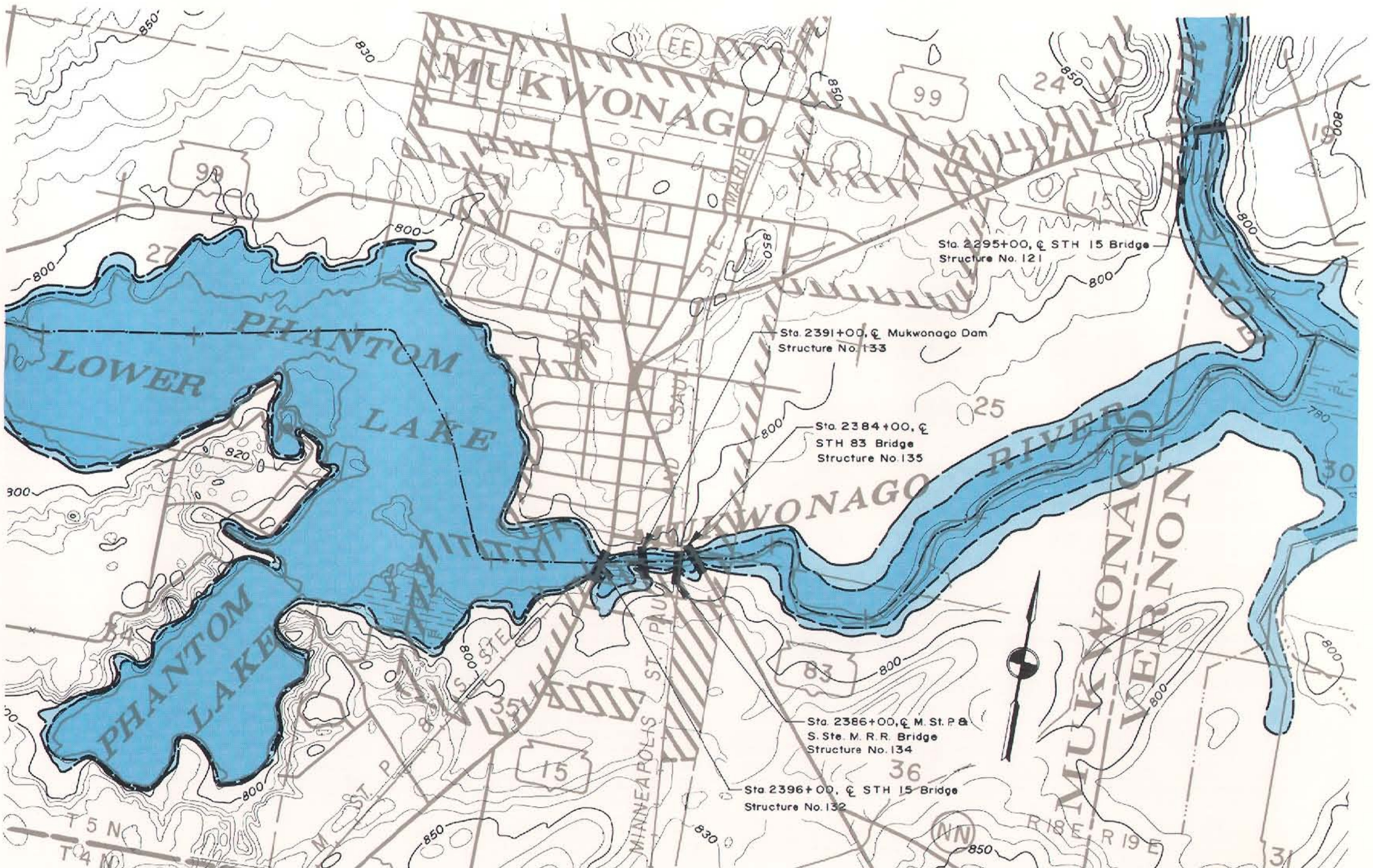
Figure D-9

HIGH WATER AND STREAM BED PROFILES
OF THE
KEE NONG GO MONG AND WAUBEESEE LAKE CANALS
FROM STA. 1543+00 TO STA. 1665+00
WAUKESHA COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: BLR DATE: DECEMBER 1969
CHECKED: DRB DATE: DECEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-10
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
MUKWONAGO RIVER
FROM STA. 2272+00 TO STA. 2372+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

+ DENOTES STATION TICK

Figure D-10

HIGH WATER AND STREAM BED PROFILES

OF THE

MUKWONAGO RIVER

FROM STA. 2272+00 TO STA. 2372+00

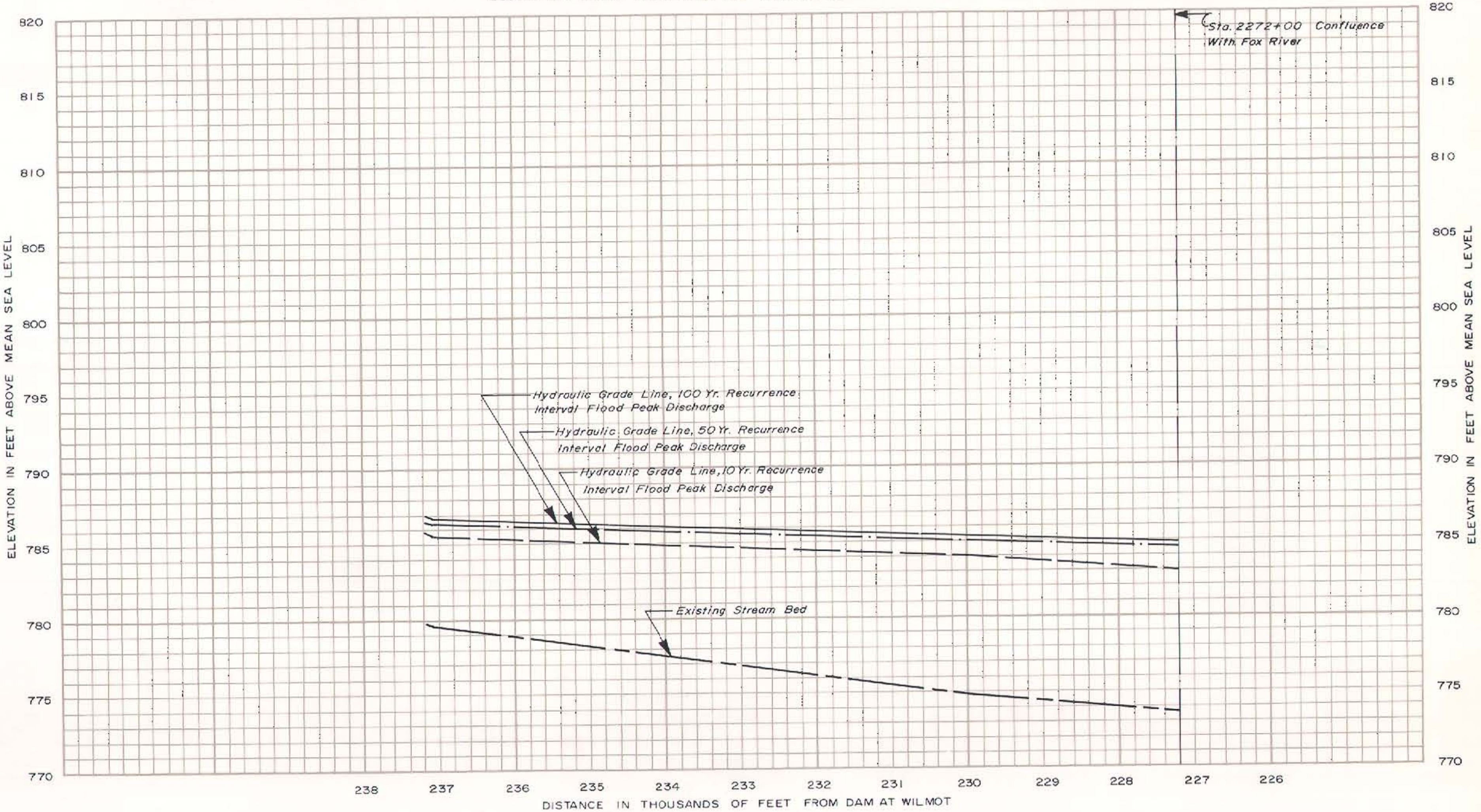
WAUKESHA COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

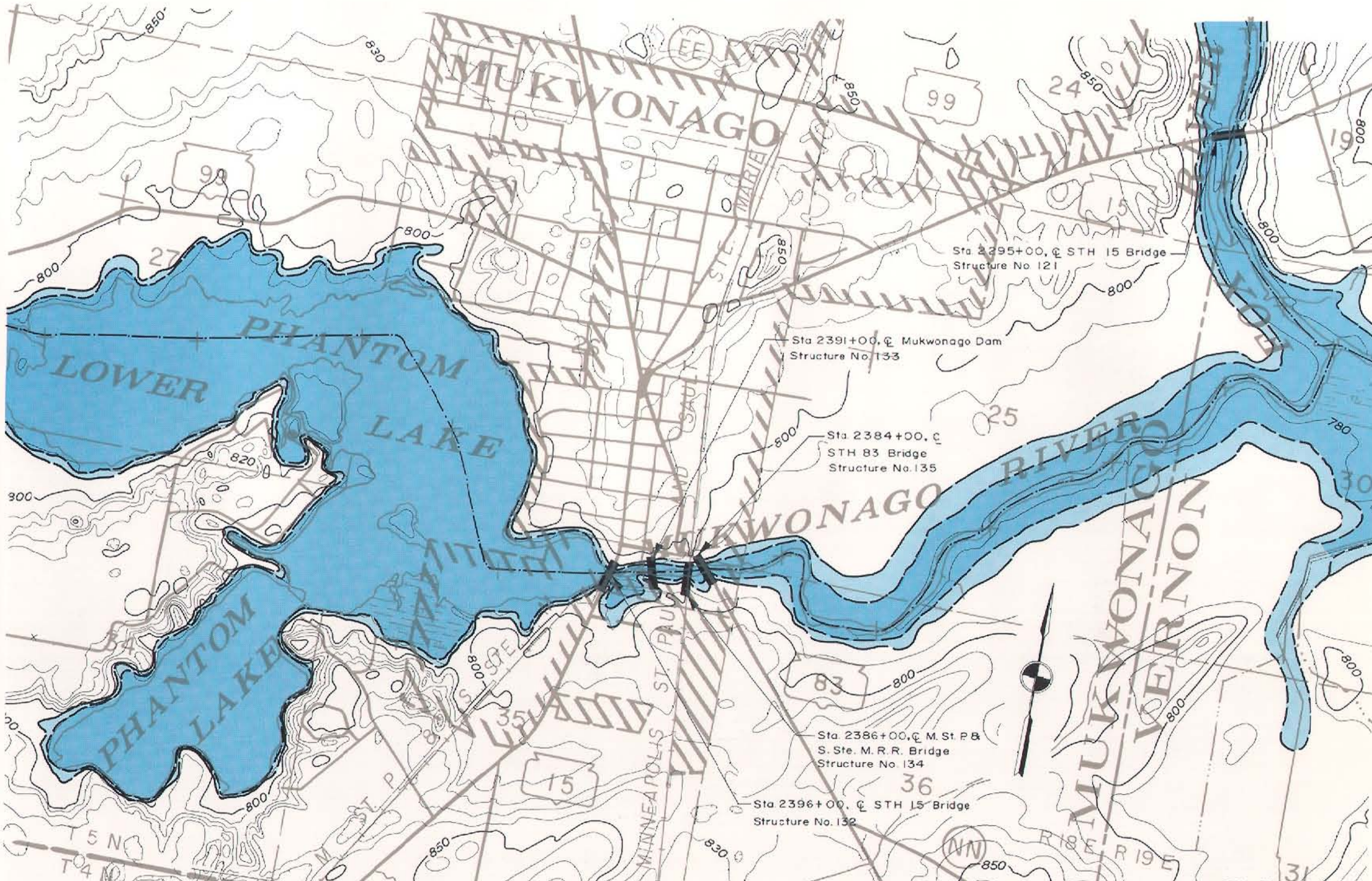
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



NOTE: MUKWONAGO VILLAGE DATUM = MEAN SEA LEVEL DATUM, 1929 ADJUSTMENT MINUS 752.55'

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

Map D-10 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
MUKWONAGO RIVER
FROM STA. 2372+00 TO STA. 2492+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET

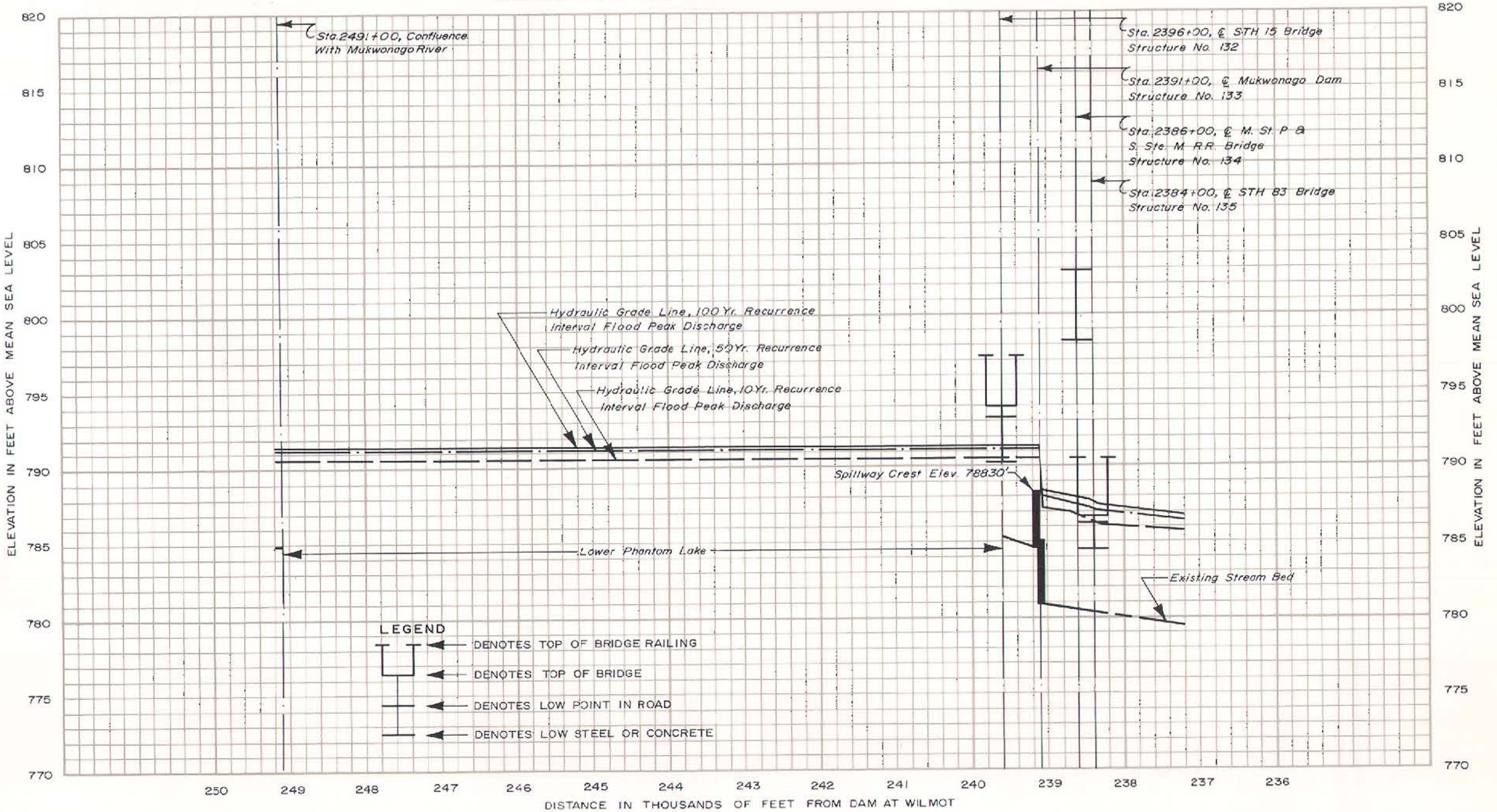


LEGEND
DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL: 1929 ADJUSTMENT
\+ DENOTES STATION TICK

Figure D-10 (continued)

HIGH WATER AND STREAM BED PROFILES
OF THE
MUKWONAGO RIVER
FROM STA. 2372+00 TO STA. 2492+00
WAUKESHA COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: LHK DATE: DECEMBER 1969
CHECKED: DRB DATE: DECEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS

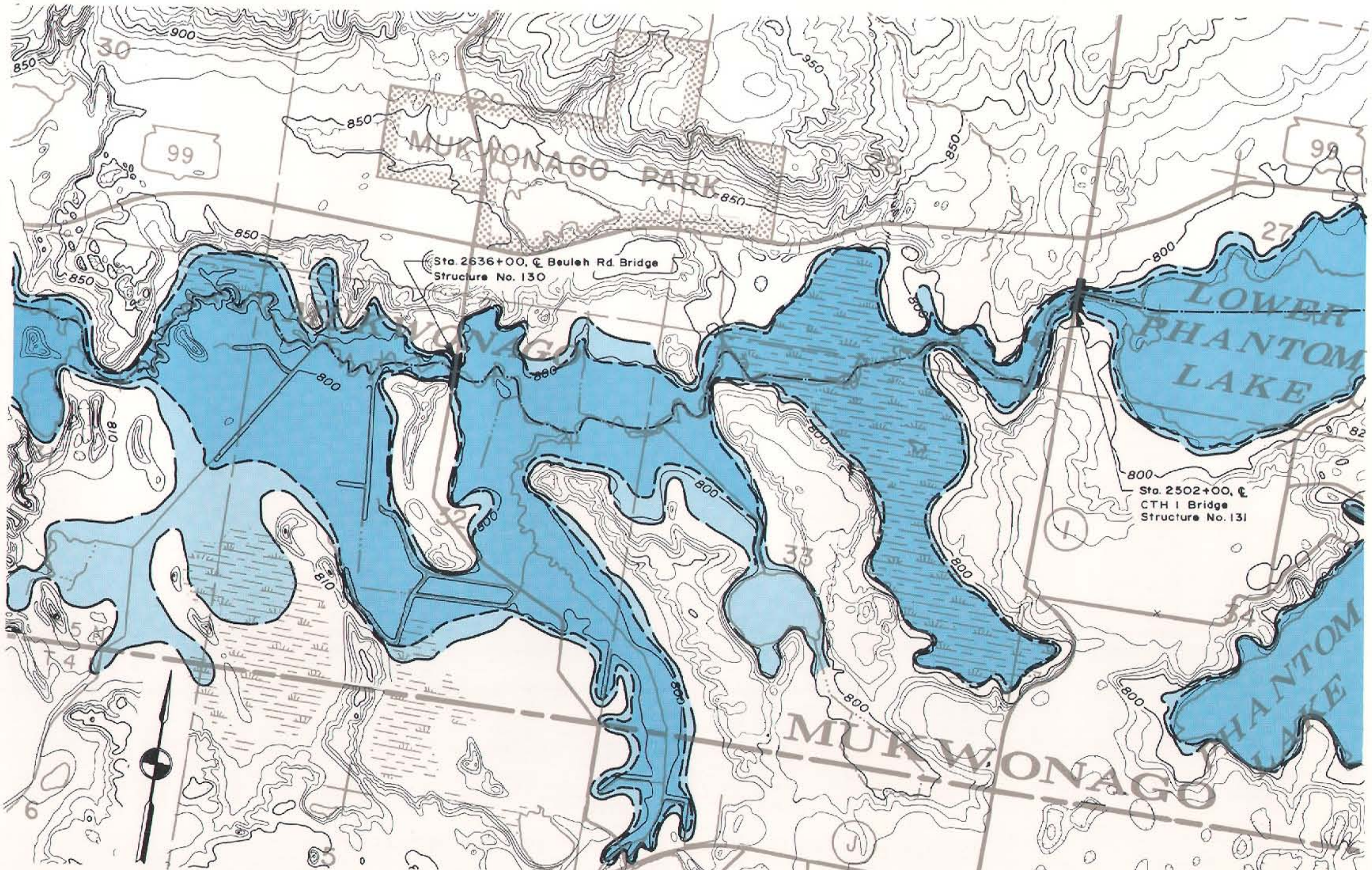


NOTE: MUKWONAGO VILLAGE DATUM = MEAN SEA LEVEL DATUM, 1929 ADJUSTMENT MINUS 752.55'

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

Map D-10 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
MUKWONAGO RIVER

FROM STA. 2492+00 TO STA. 2612+00
WALWORTH AND WAUKESHA COUNTIES, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET

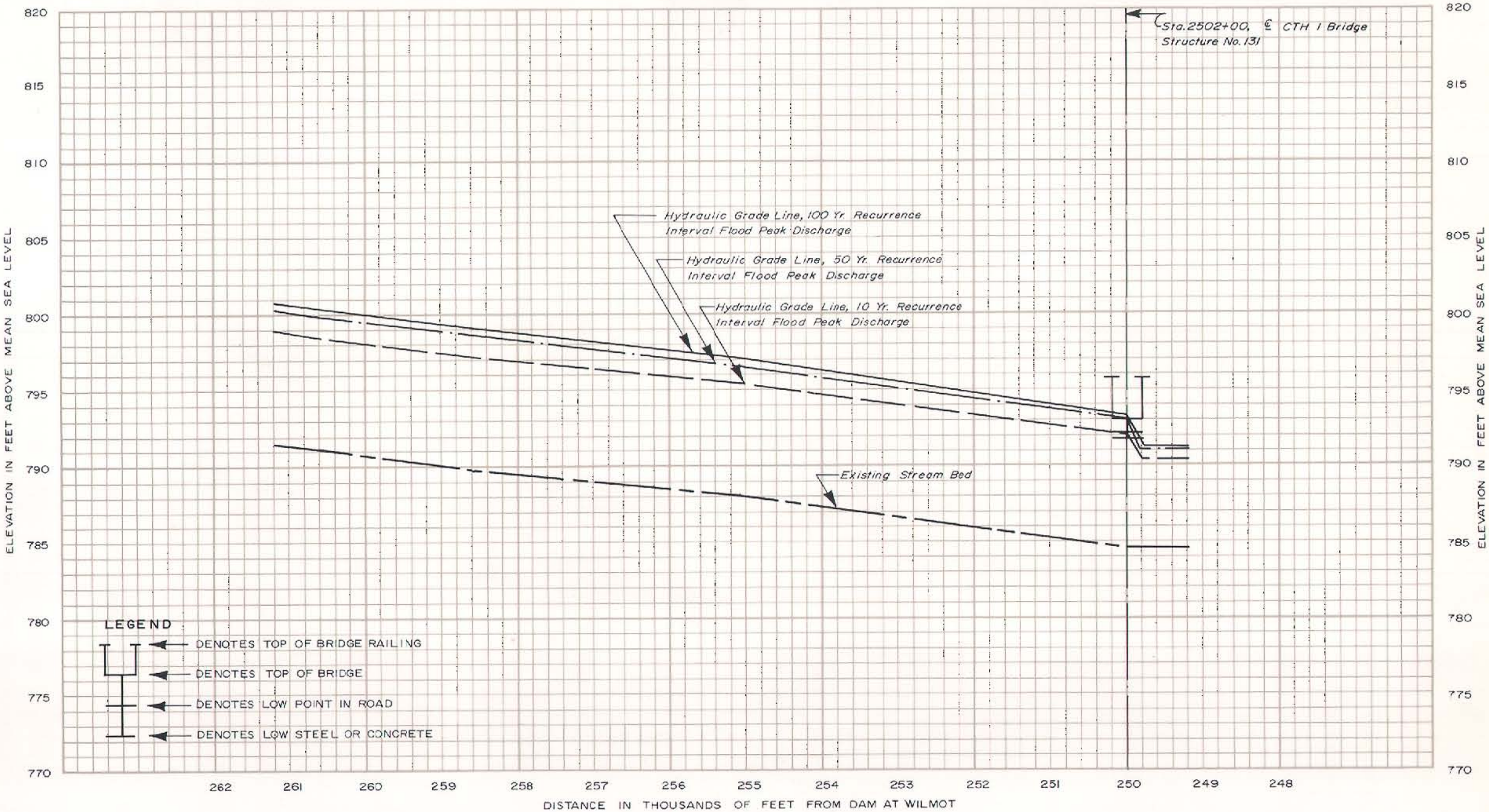


LEGEND
DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 + 00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
+ DENOTES STATION TICK

Figure D-10 (continued)

HIGH WATER AND STREAM BED PROFILES
OF THE
MUKWONAGO RIVER
FROM STA. 2492+00 TO STA. 2612+00
WAUKESHA COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: BLR DATE: DECEMBER 1969
CHECKED: DRB DATE: DECEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS



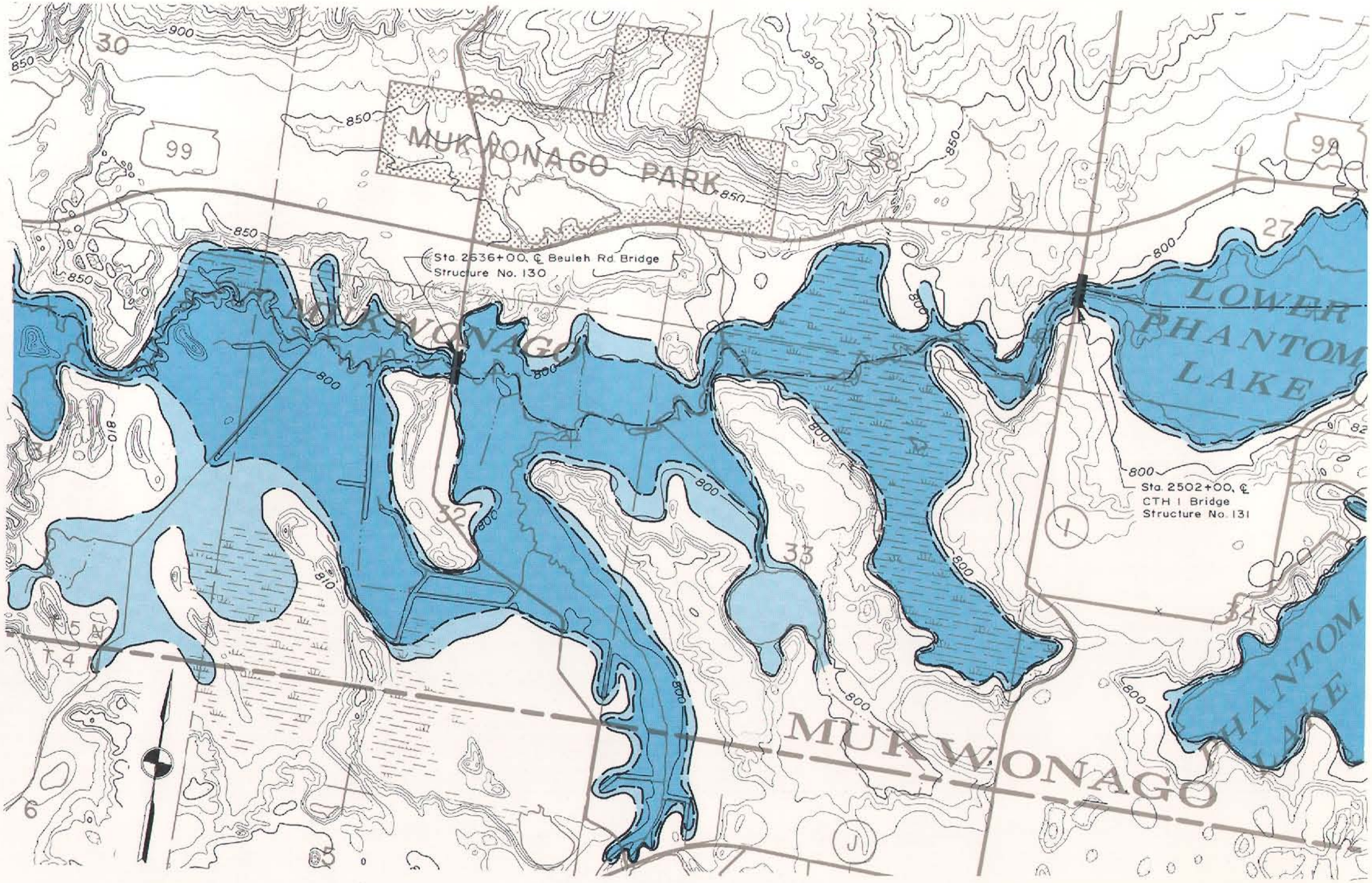
Source: U. S. Soil Conservation Service; SEWRPC.

Map D-10 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
MUKWONAGO RIVER

FROM STA. 2612+00 TO STA. 2752+00
WALWORTH AND WAUKESHA COUNTIES, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969

SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-10 (continued)

HIGH WATER AND STREAM BED PROFILES
OF THE
MUKWONAGO RIVER

FROM STA. 2612+00 TO STA. 2752+00

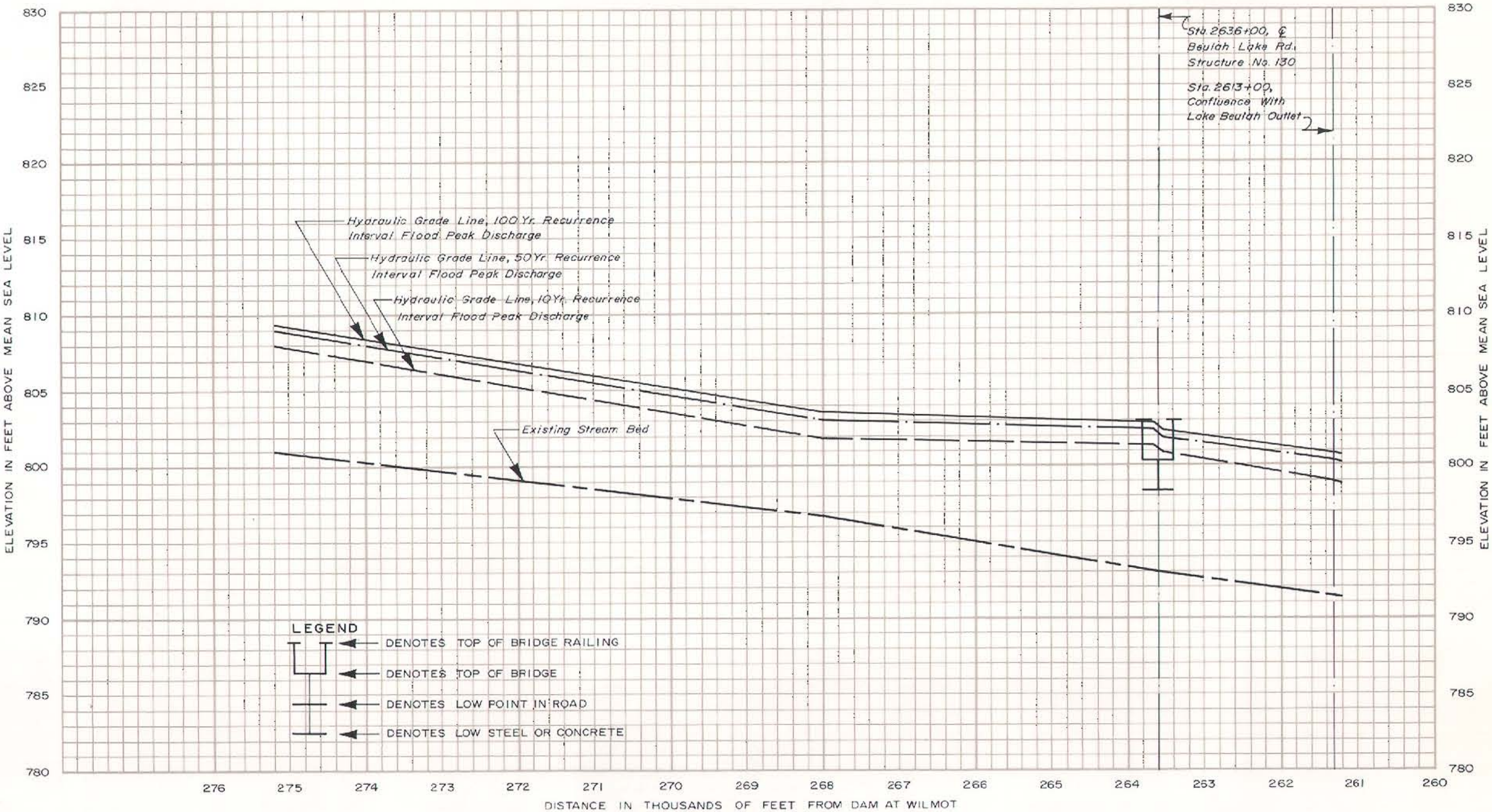
WAUKESHA COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: DECEMBER 1969

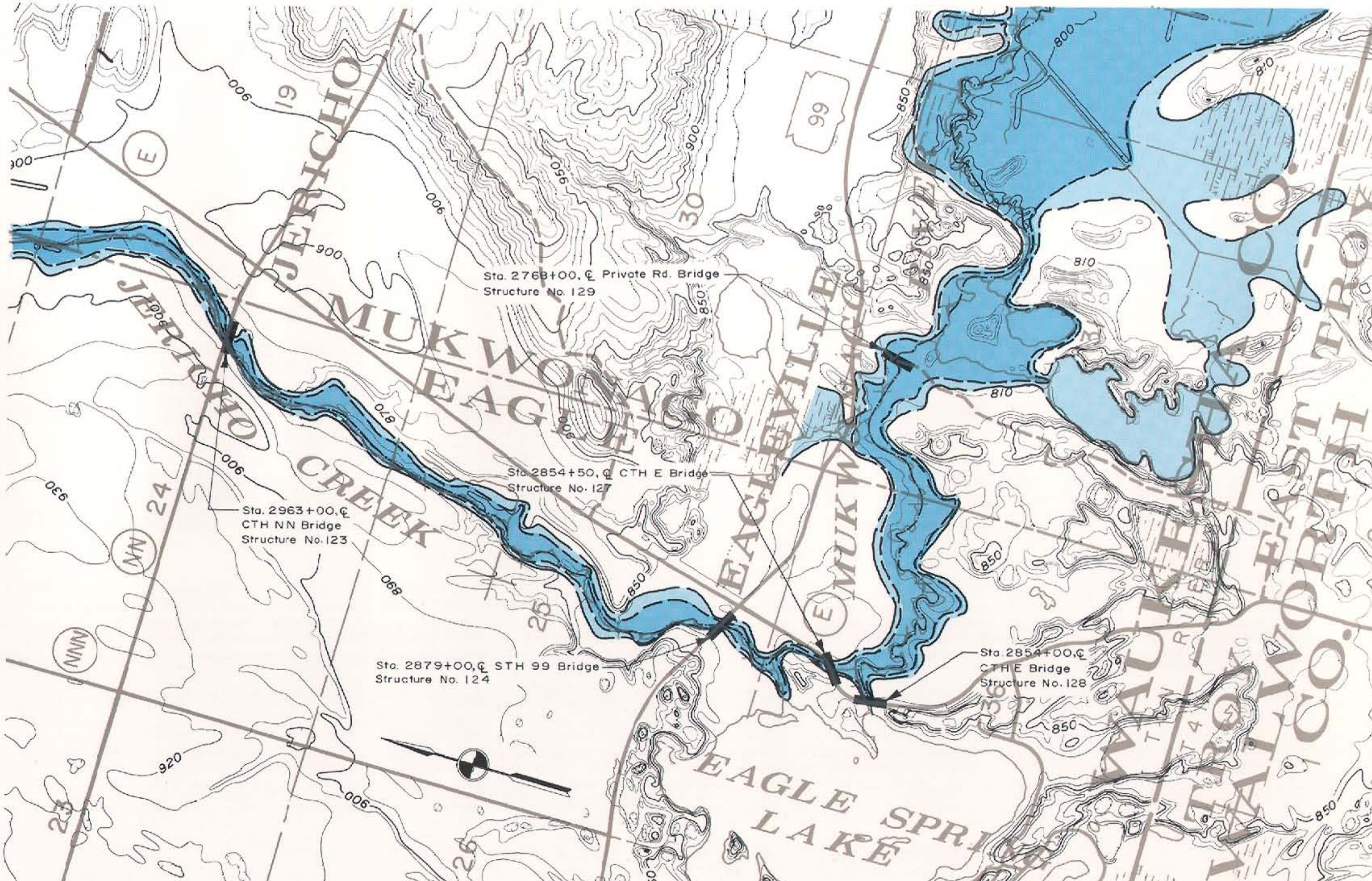
CHECKED: DRB DATE: DECEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-10 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
MUKWONAGO RIVER
FROM STA. 2752+00 TO STA. 2857+00
WALWORTH AND WAUKESHA COUNTIES, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

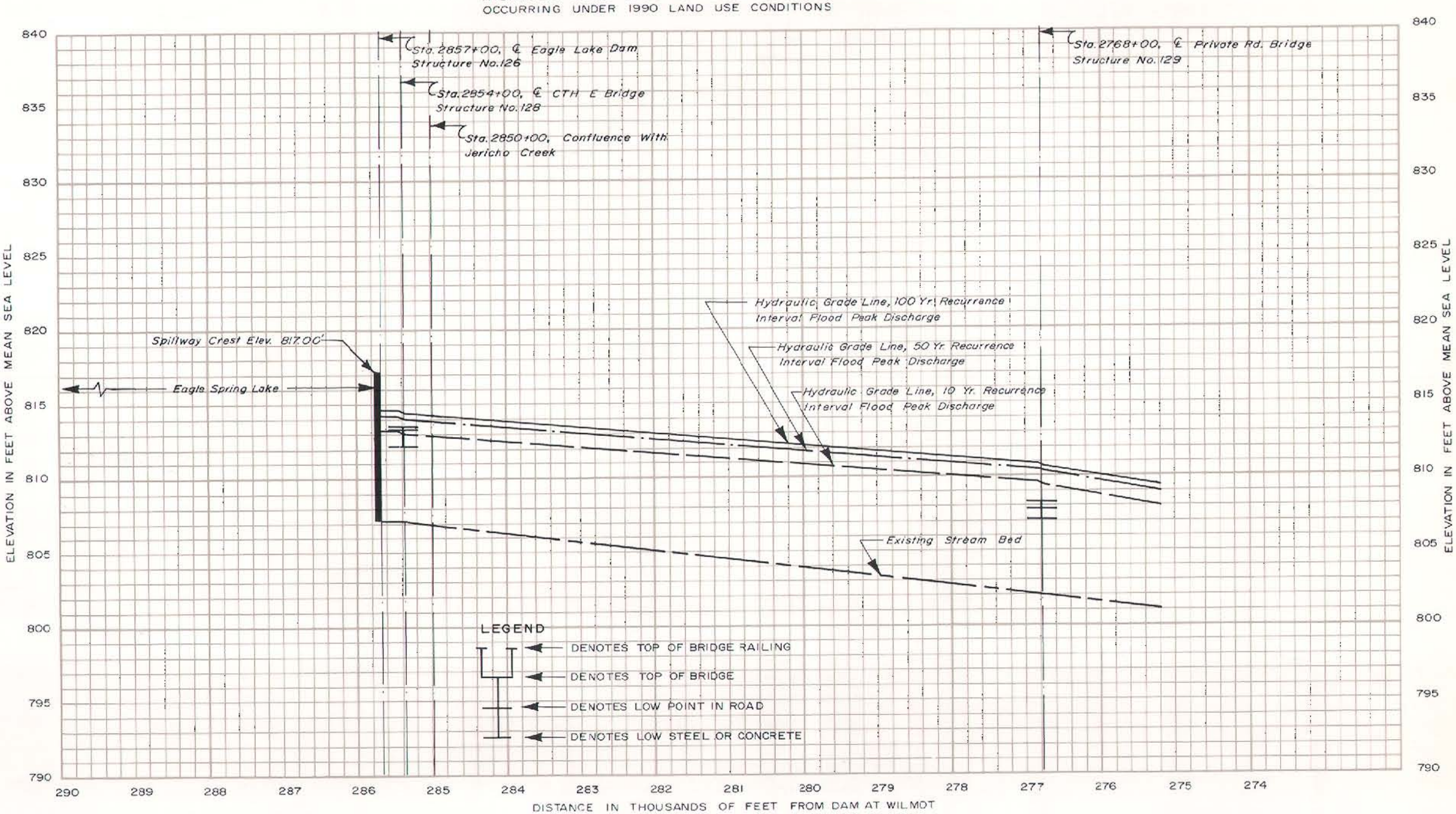
Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

DENOTES STATION TICK

Figure D-10 (continued)

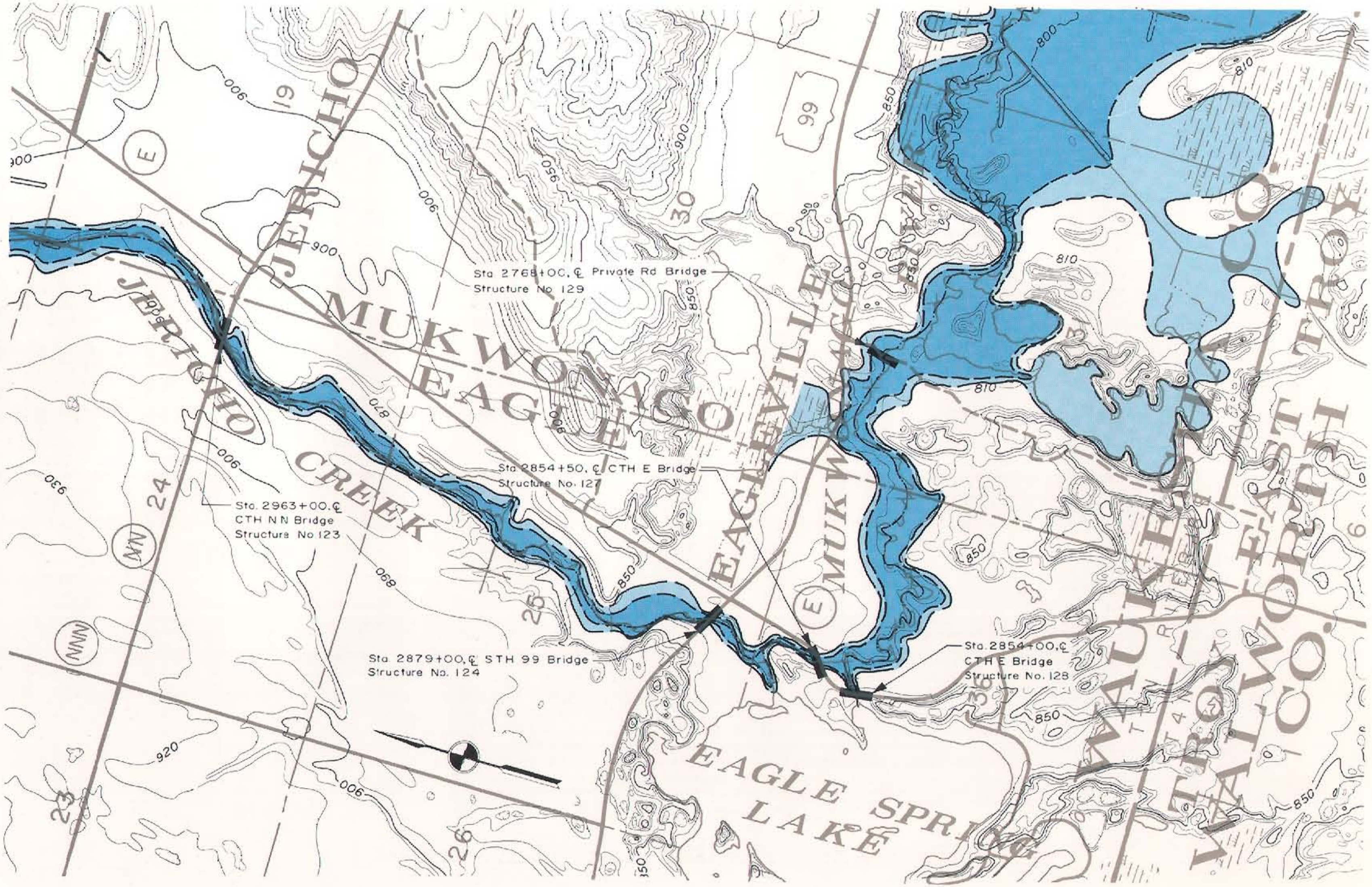
HIGH WATER AND STREAM BED PROFILES
OF THE
MUKWONAGO RIVER
FROM STA. 2752+00 TO STA. 2857+00
WAUKESHA COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: BLR DATE: DECEMBER 1969
CHECKED: DRB DATE: DECEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-11
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
JERICHO CREEK

FROM STA. 2850+00 TO STA. 2990+00
WALWORTH AND WAUKESHA COUNTIES, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND
DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY
Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-11

HIGH WATER AND STREAM BED PROFILES

OF THE

JERICHO CREEK

FROM STA. 2850+00 TO STA. 2990+00

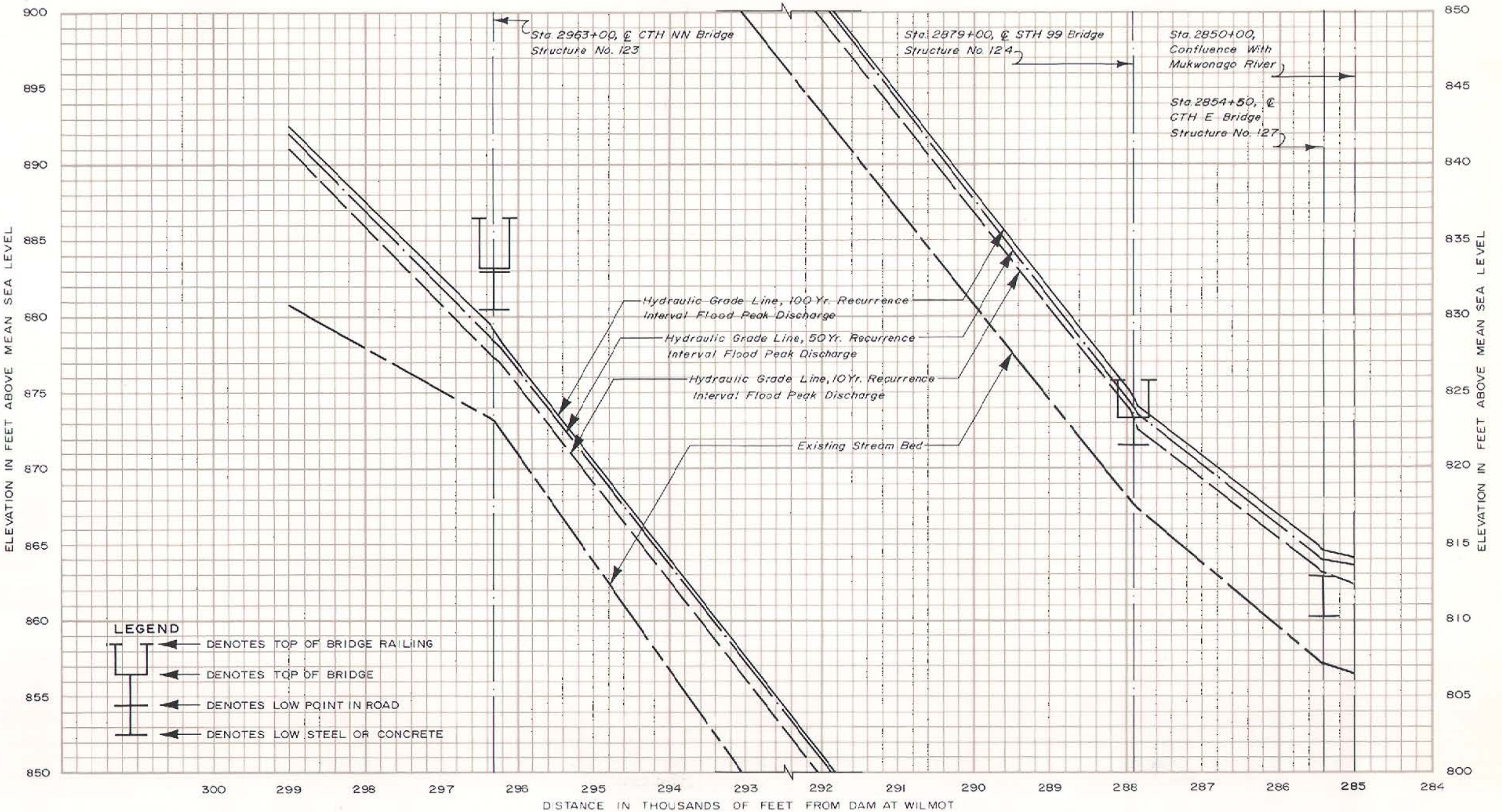
WAUKESHA COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS

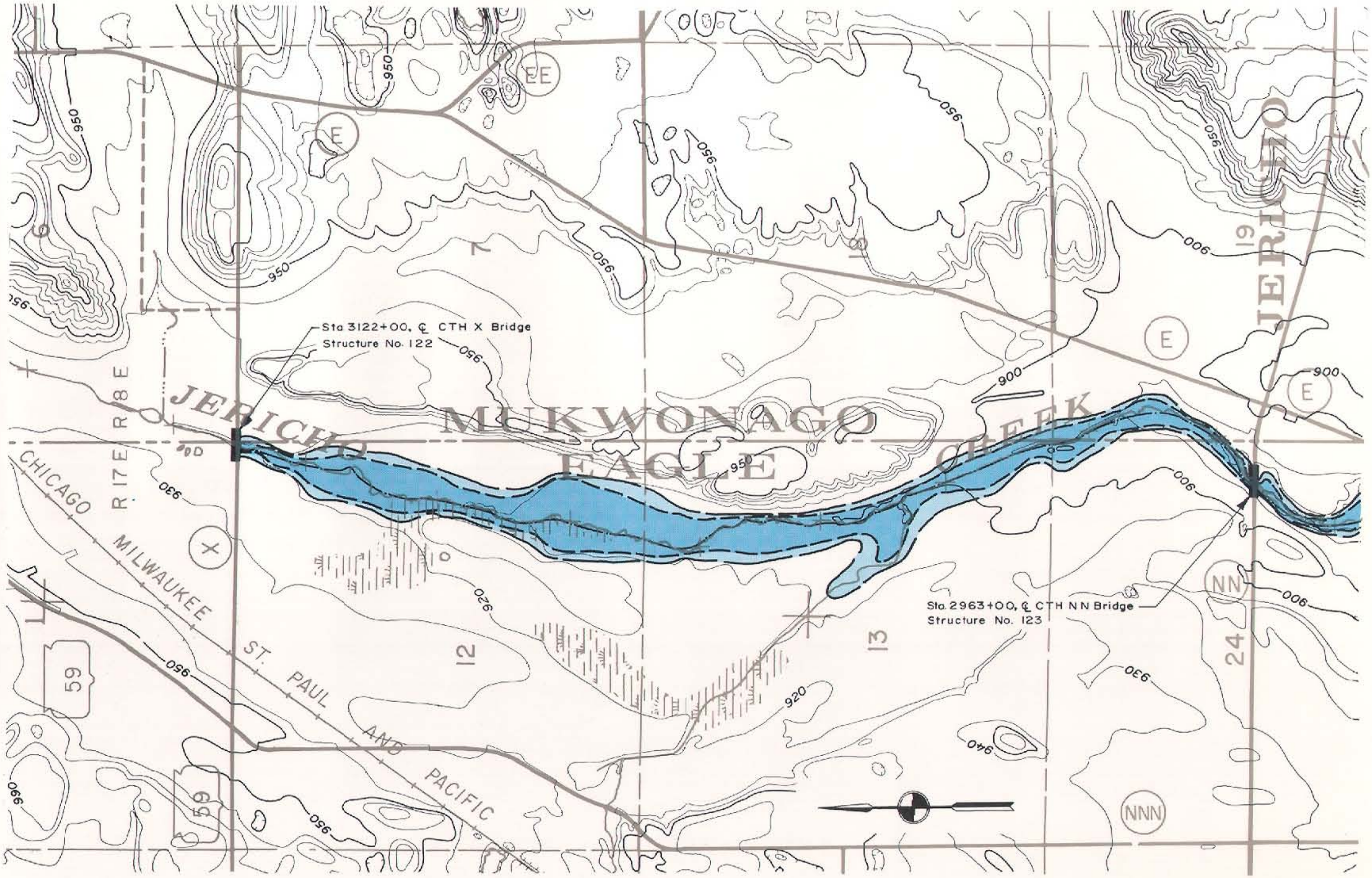


Source: U. S. Soil Conservation Service; SEWRPC.

Map D-11 (continued)

TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
JERICHO CREEK

FROM STA.2990+00 TO STA.3122 +00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

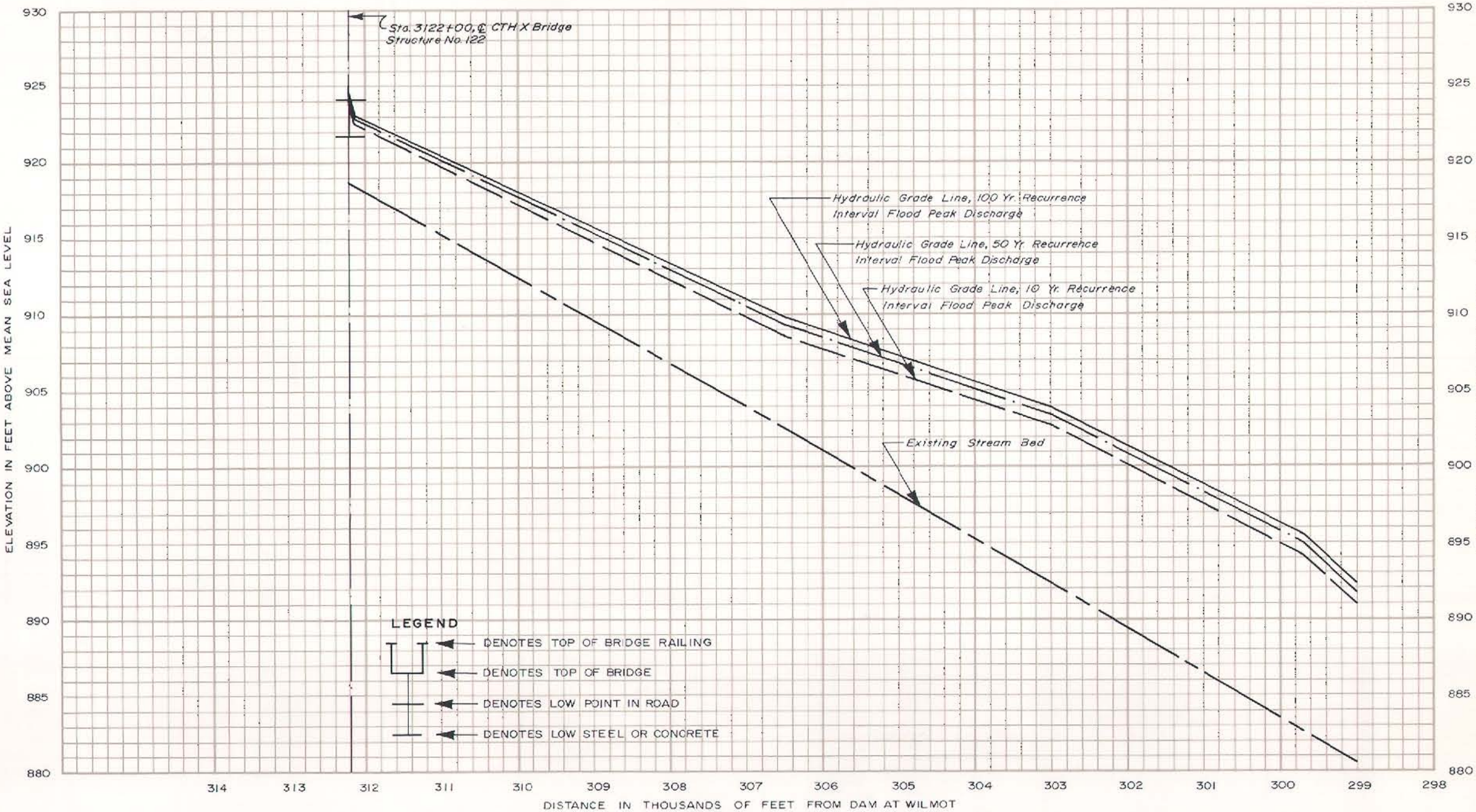
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

DENOTES STATION TICK

Figure D-11 (continued)

HIGH WATER AND STREAM BED PROFILES
OF THE
JERICHO CREEK

FROM STA. 2990+00 TO STA. 3122+00
WAUKESHA COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: BLR DATE: DECEMBER 1969
CHECKED: DRB DATE: DECEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

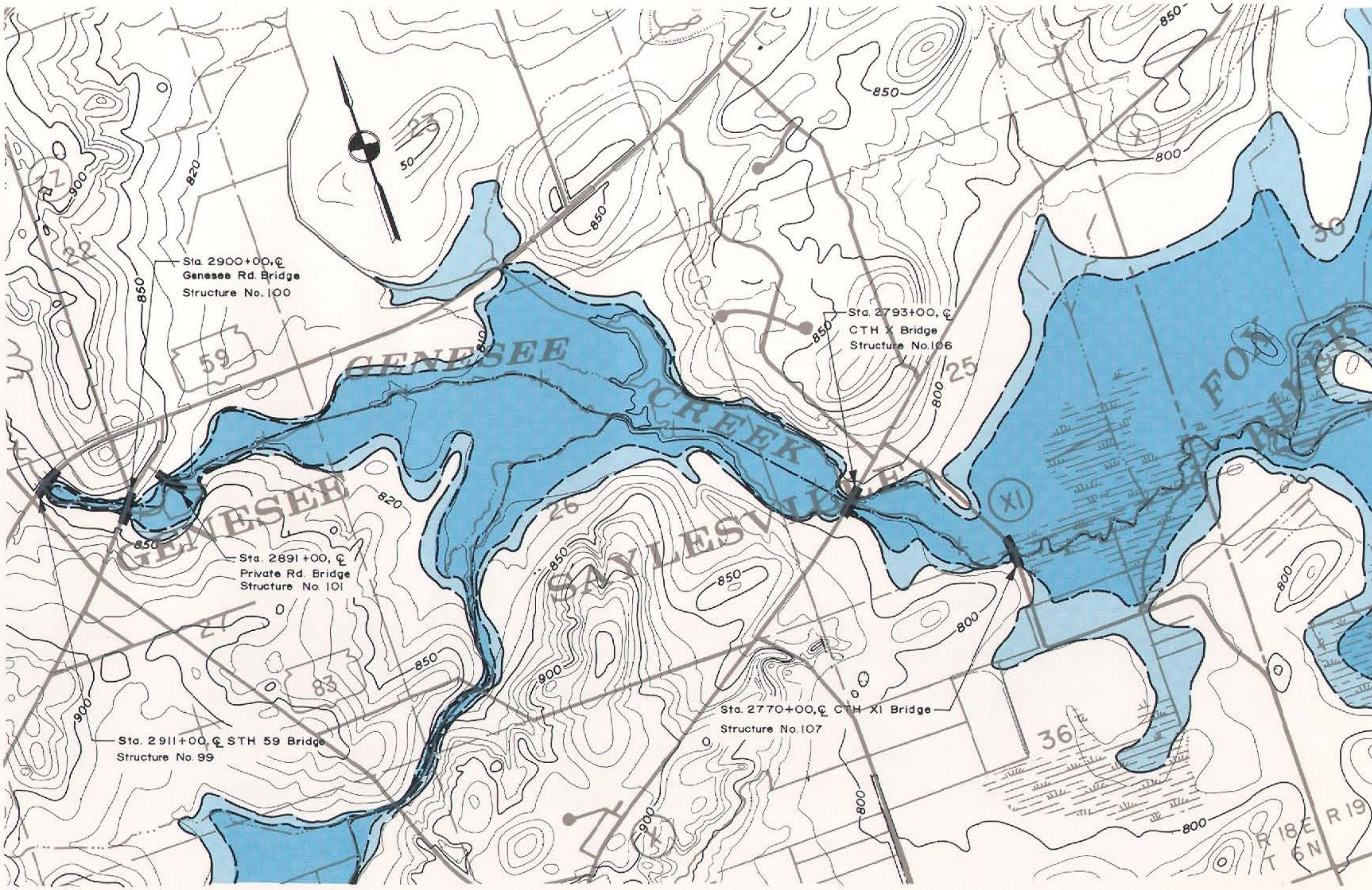
Map D-12
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
GENESEE CREEK

FROM STA. 2718+00 TO STA. 2875+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: RMW DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969

SCALE: 1" = 2000'

GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

DENOTES STATION TICK

Figure D-12

HIGH WATER AND STREAM BED PROFILES

OF THE

GENESEE CREEK

FROM STA. 2718+00 TO STA. 2875+00

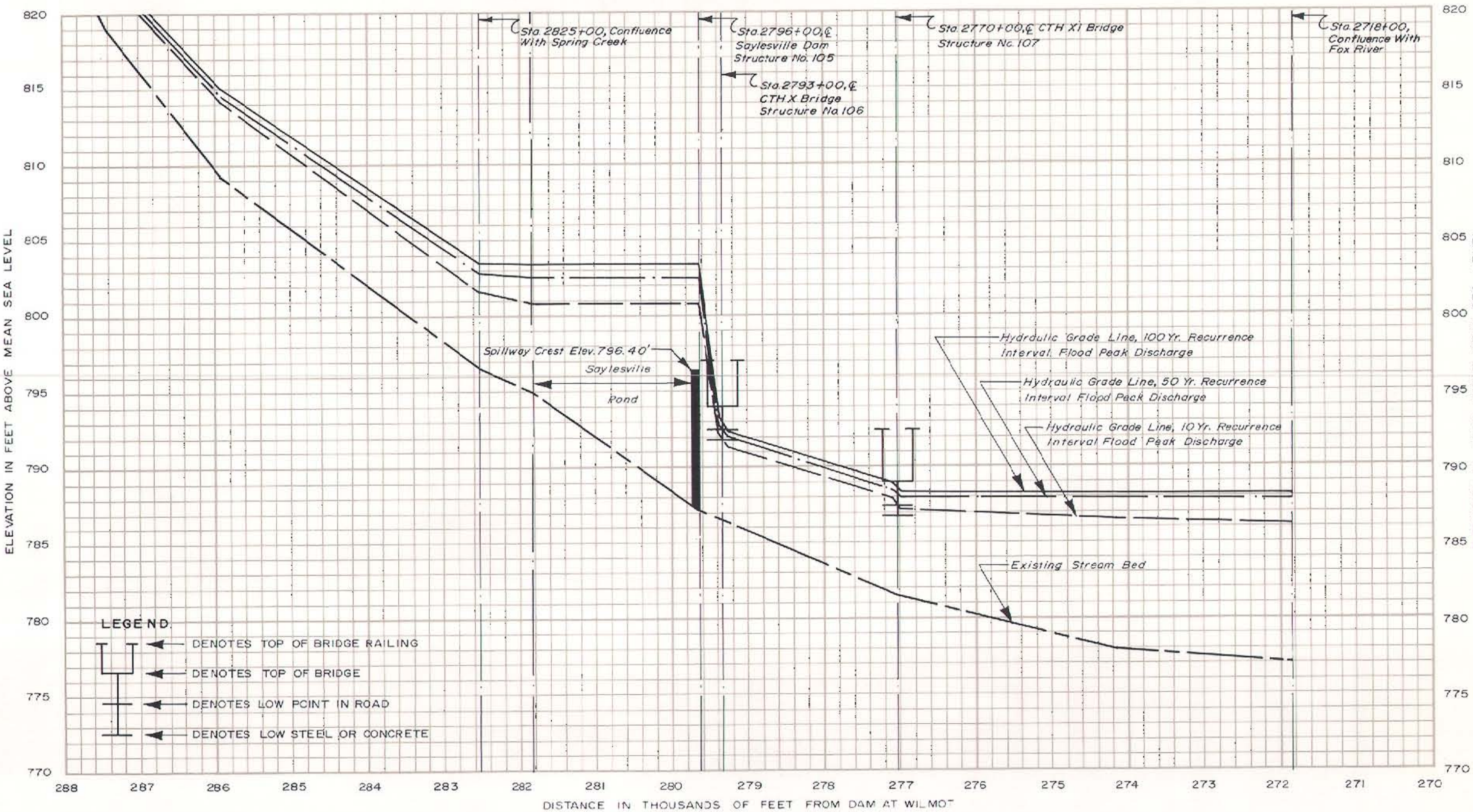
WAUKESHA COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: BLR DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS

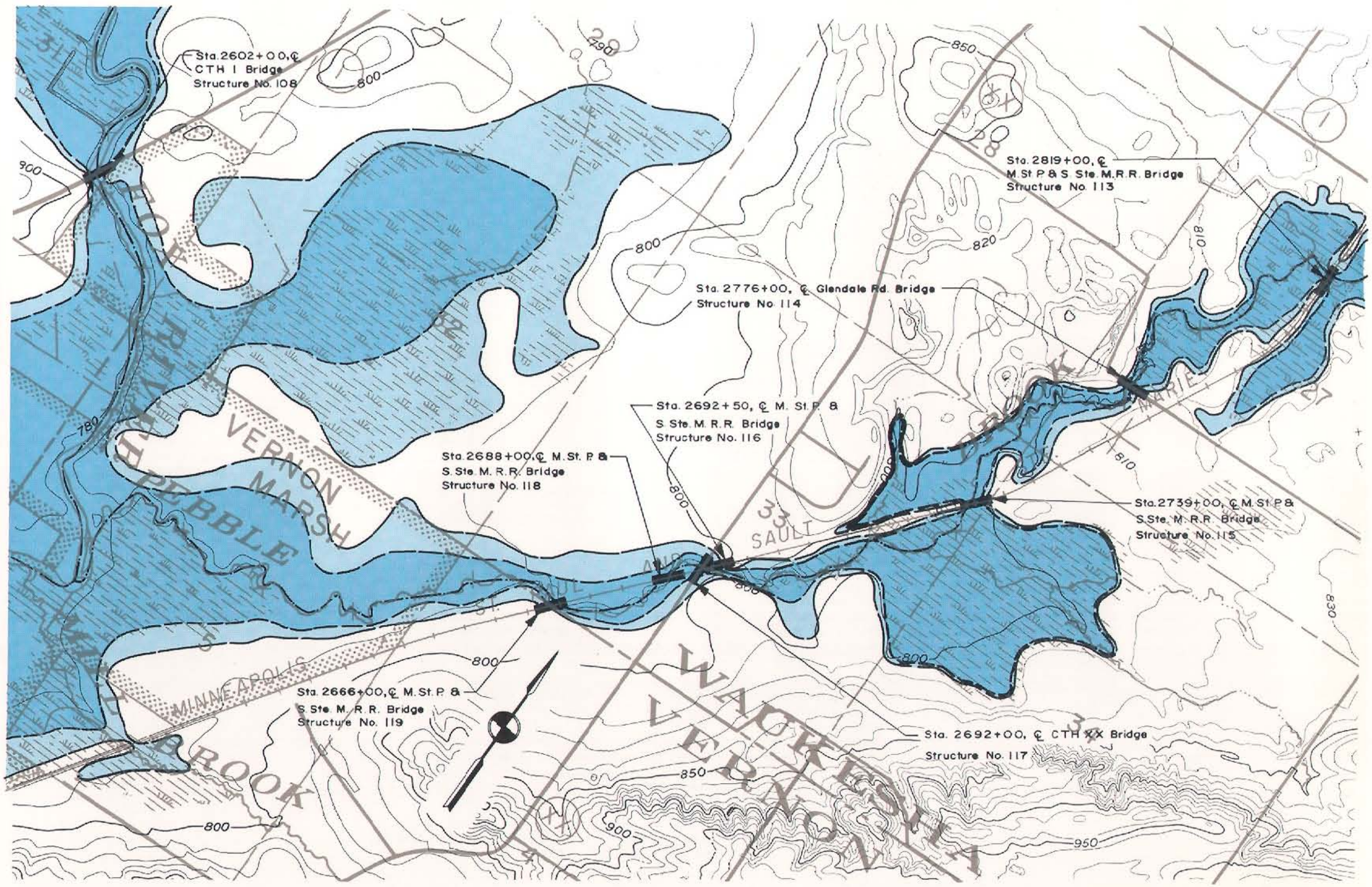


NOTE: Vertical Datum = Mean Sea Level, 1929 Adjustment.

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

Map D-13
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
PEBBLE BROOK

FROM STA. 2574+00 TO STA. 2694+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY
Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-13

HIGH WATER AND STREAM BED PROFILES

OF THE

PEBBLE BROOK

FROM STA. 2574+00 TO STA. 2694+00

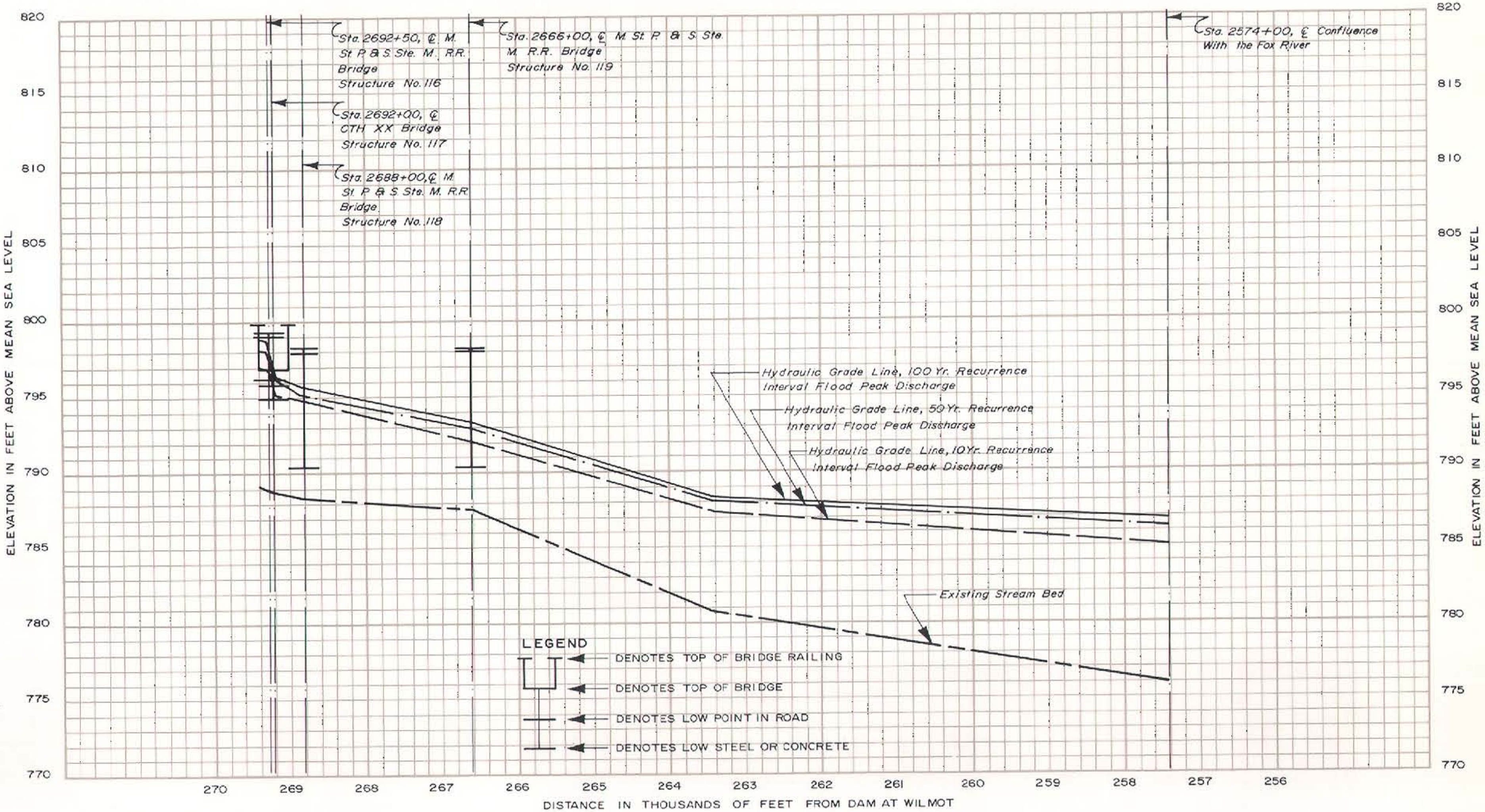
WAUKESHA COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

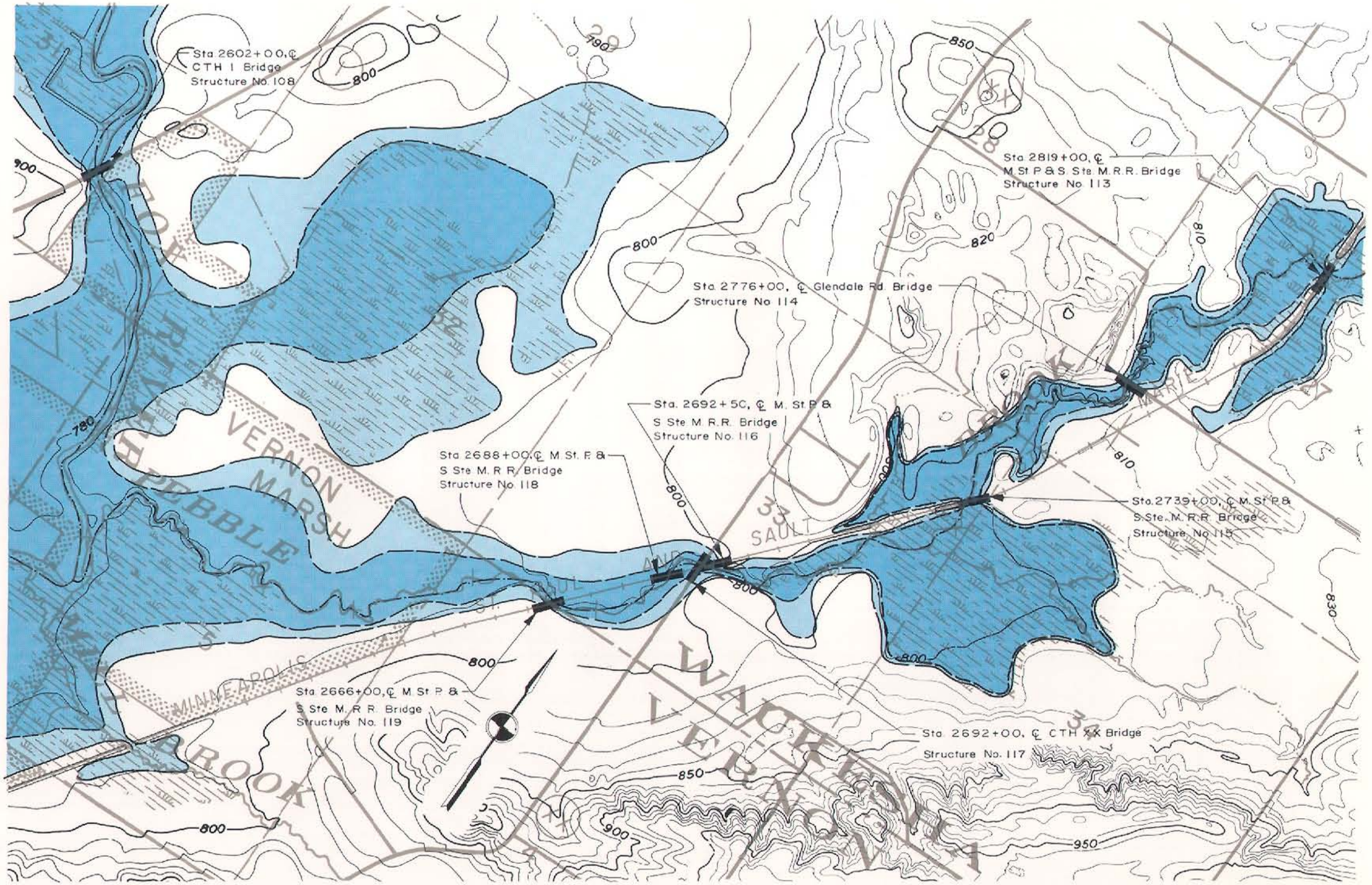
Map D-13 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
PEBBLE BROOK

FROM STA.2694+00 TO STA.2814+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969

SCALE: 1" = 2000'

GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-13 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

PEBBLE BROOK

FROM STA. 2694+00 TO STA. 2814+00

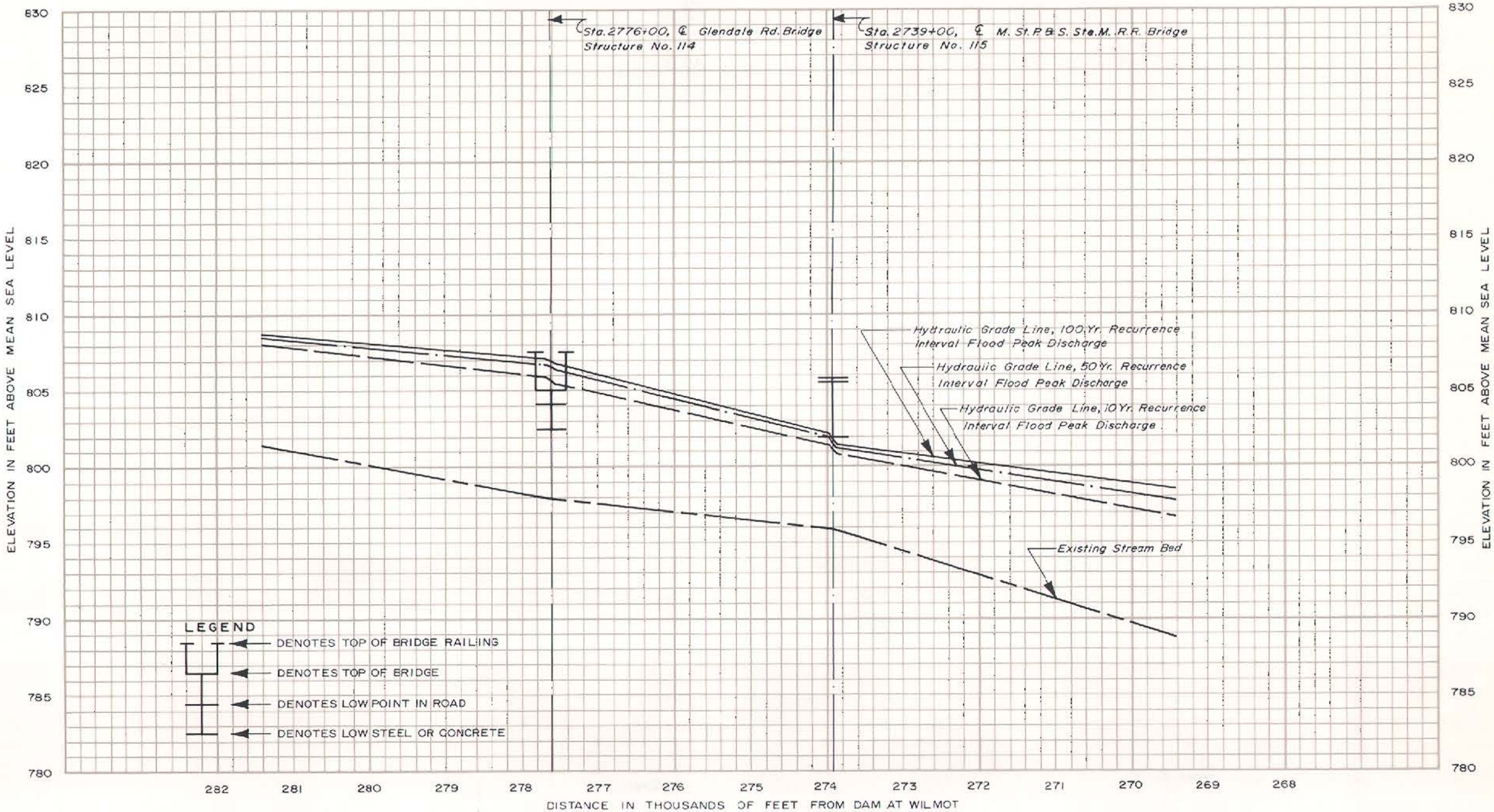
WAUKESHA COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



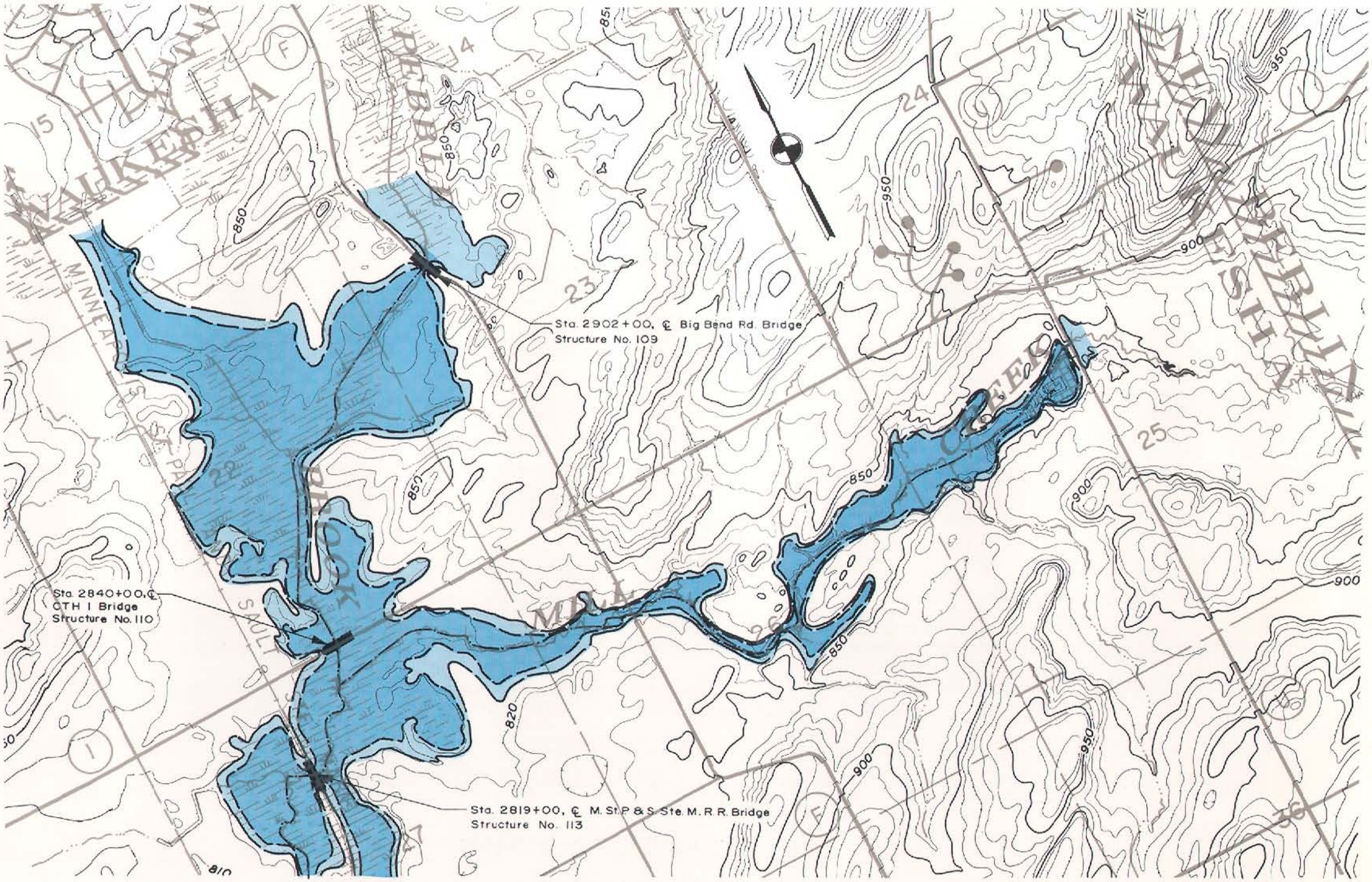
Source: U.S. Soil Conservation Service; SEWRPC.

Map D-13 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
PEBBLE BROOK

FROM STA.2814+00 TO STA.2902+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969

SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND
DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-13 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

PEBBLE BROOK

FROM STA. 2814+00 TO STA. 2902+00

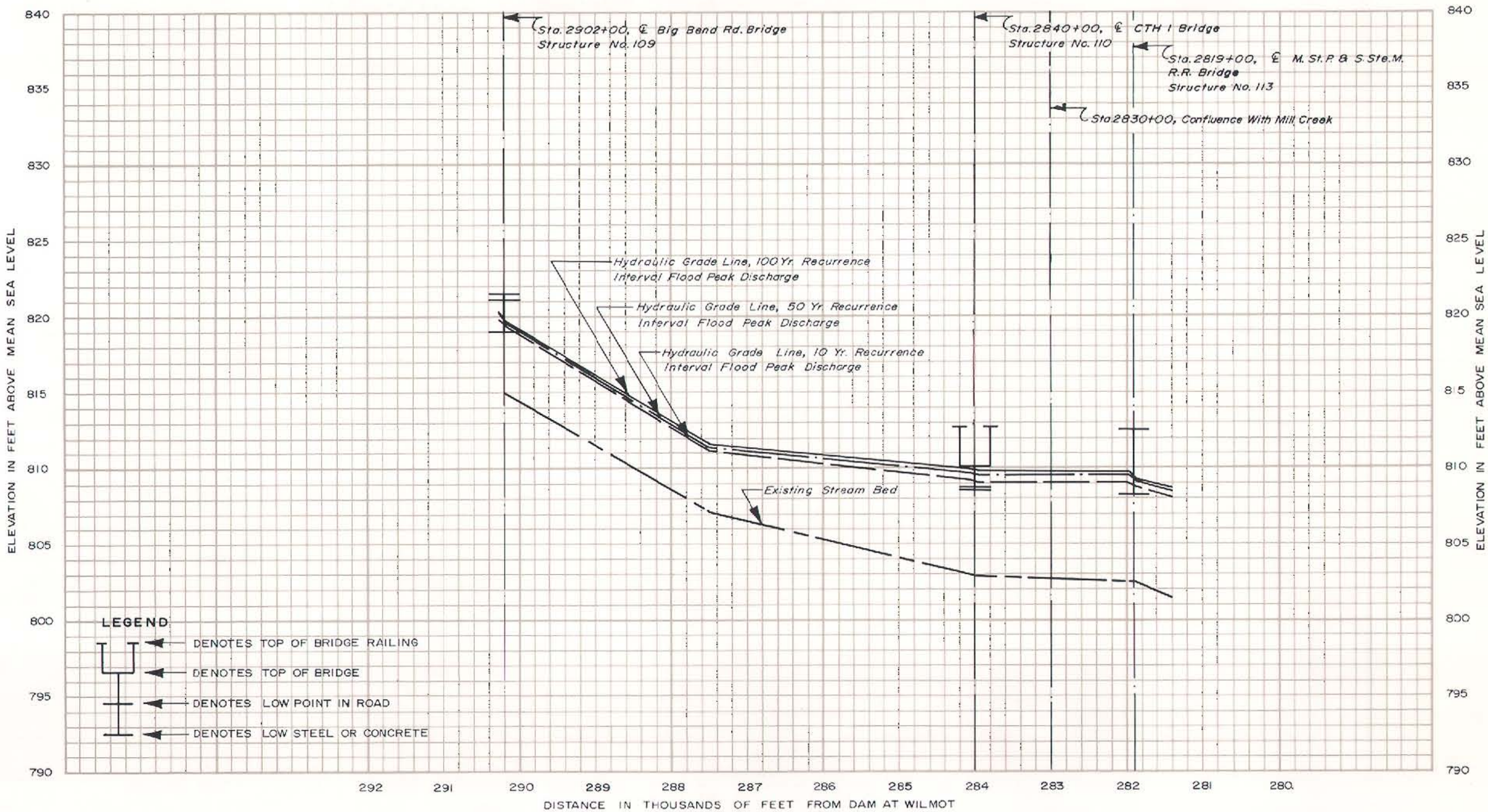
WAUKESHA COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: BLR DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

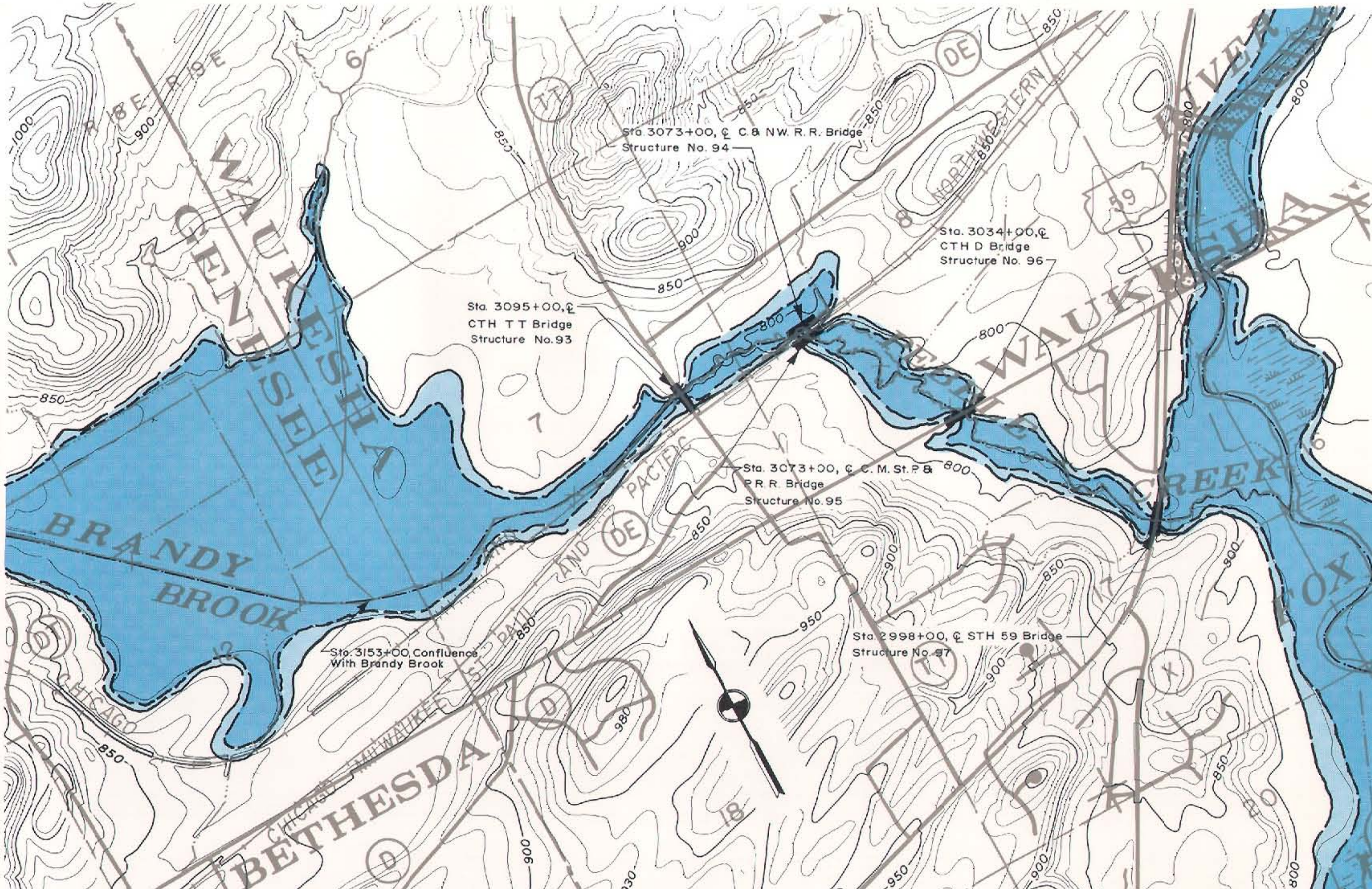
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-14 and D-15
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
PEBBLE CREEK AND BRANDY BROOK

FROM STA.2976+00 TO STA.3136+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RMW DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
DENOTES STATION TICK

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

Figure D-14

HIGH WATER AND STREAM BED PROFILES

OF THE

PEBBLE CREEK

FROM STA. 2976+00 TO STA. 3136+00

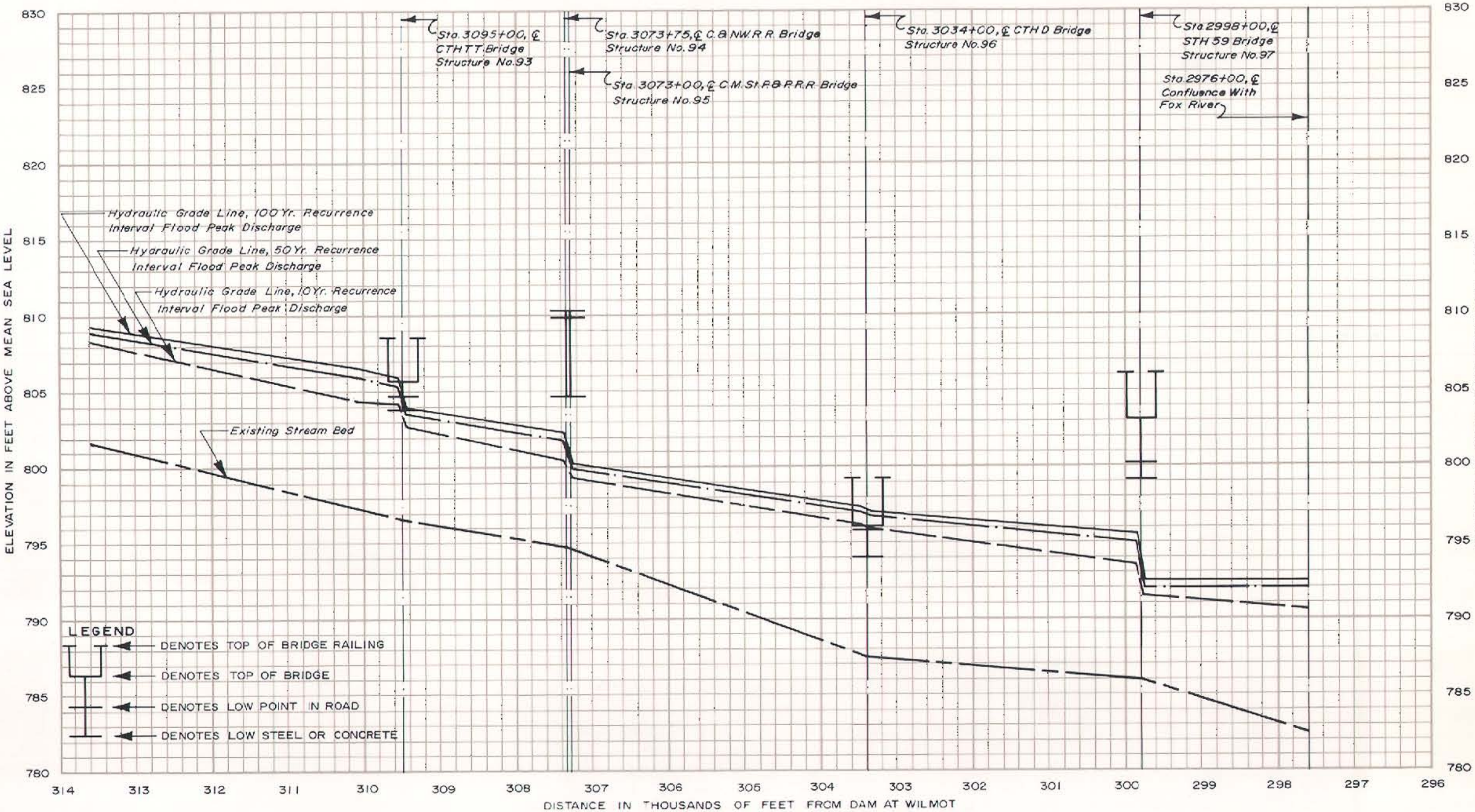
WAUKESHA COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

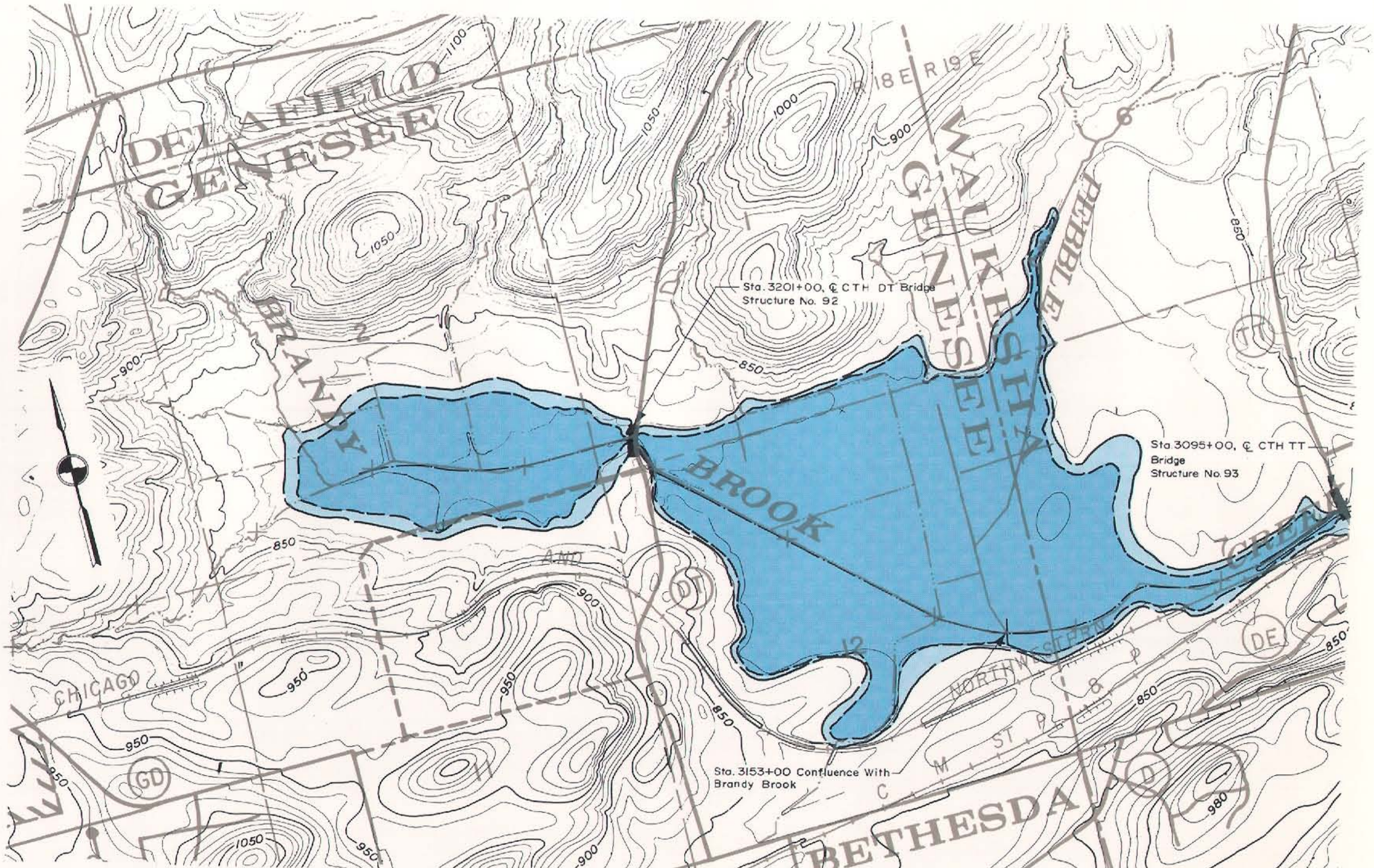
Map D-14 and D-15 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
PEBBLE CREEK AND BRANDY BROOK

FROM STA.3136+00 TO STA.3238+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969

SCALE: 1" = 2000'

GRAPHIC SCALE
0 2000 4000 FEET



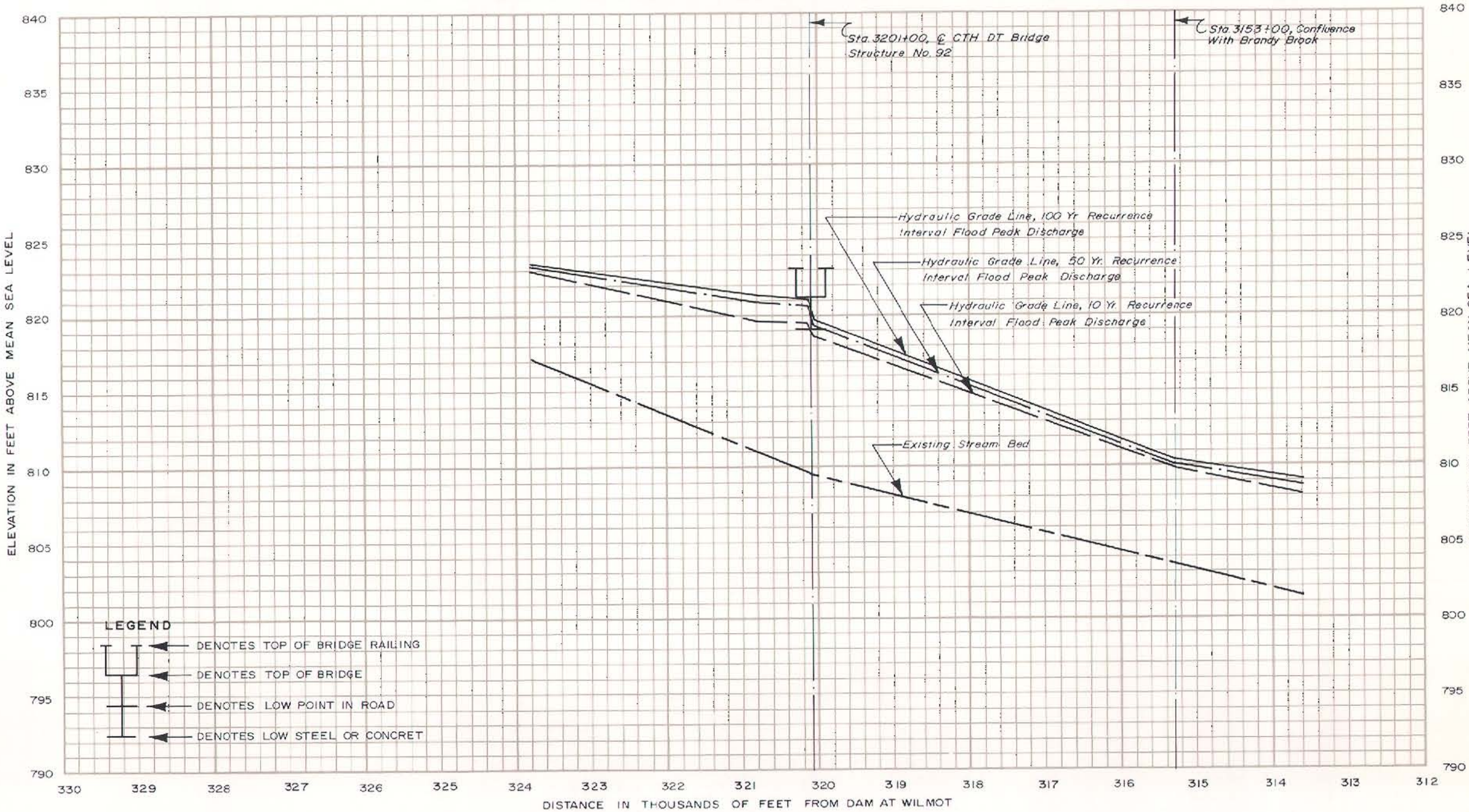
LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1969 ADJUSTMENT
+ DENOTES STATION TICK

Figure D-14 and D-15

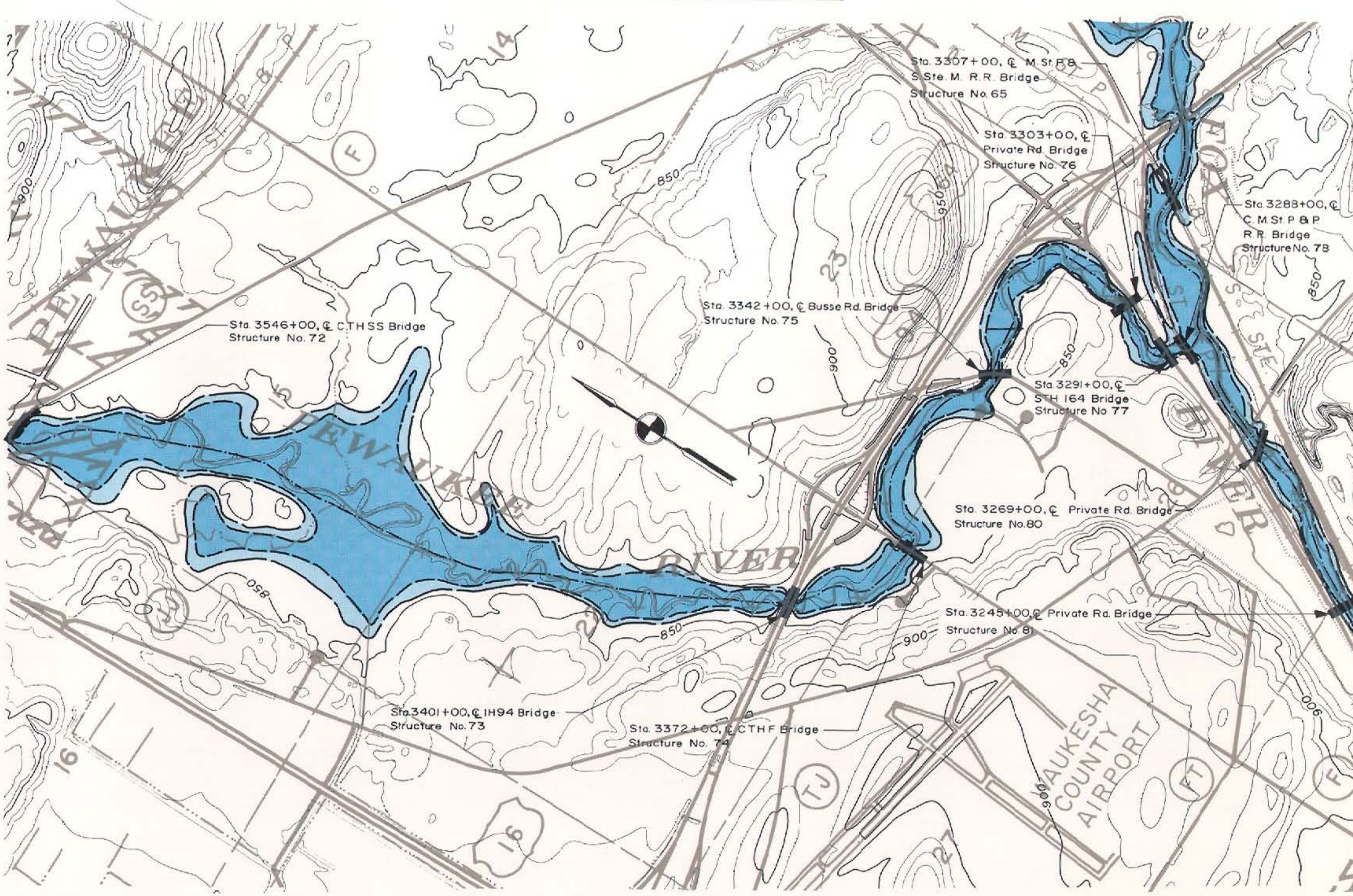
HIGH WATER AND STREAM BED PROFILES
OF THE
PEBBLE CREEK AND BRANDY BROOK
FROM STA. 3136+00 TO STA. 3238+00
WAUKESHA COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: BLR DATE: DECEMBER 1969
CHECKED: DRB DATE: DECEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-16
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
PEWAUKEE RIVER

FROM STA.3285+00 TO STA.3400+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RMW DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL, 1929 ADJUSTMENT

+ DENOTES STATION TICK

Figure D-16

HIGH WATER AND STREAM BED PROFILES

OF THE

PEWAUKEE RIVER

FROM STA. 3285+00 TO STA. 3400+00

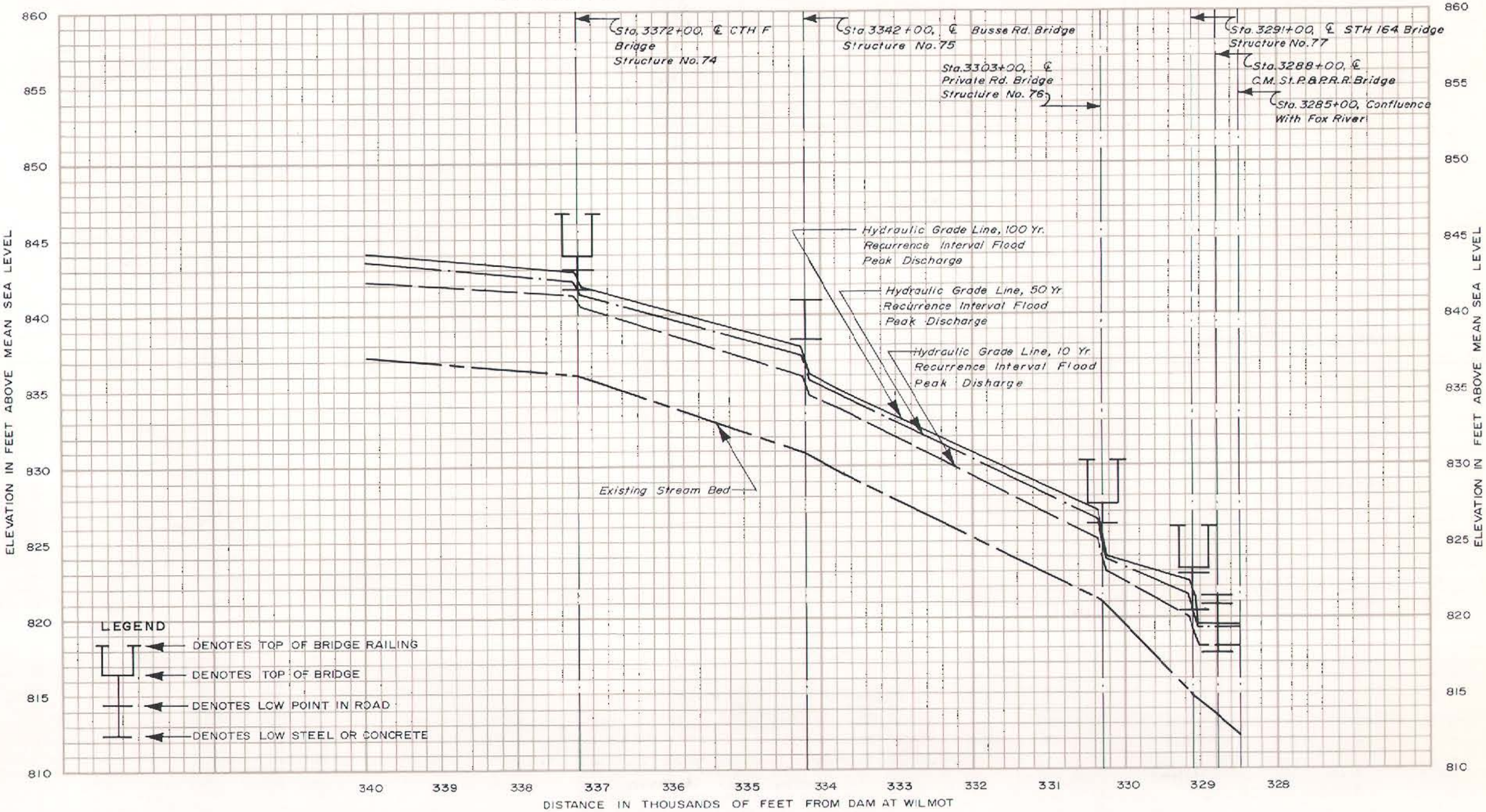
WAUKESHA COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: BLR DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



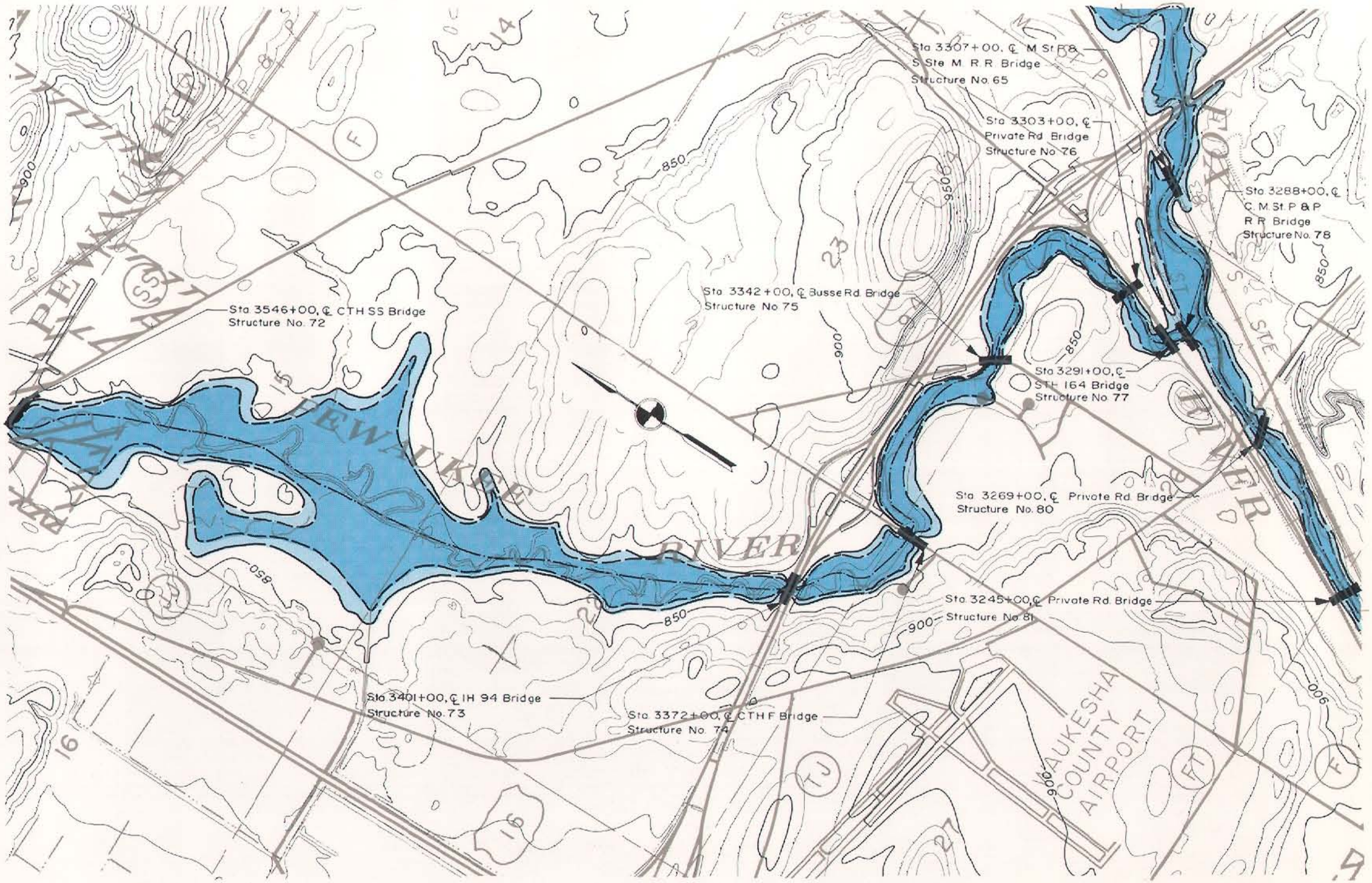
Source: U.S. Soil Conservation Service; SEWRPC.

Map D-16 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
PEWAUKEE RIVER

FROM STA.3385+00 TO STA.3485+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: RMW DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969

SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-16 (continued)

HIGH WATER AND STREAM BED PROFILES
OF THE
PEWAUKEE RIVER

FROM STA. 3385+00 TO STA. 3485+00

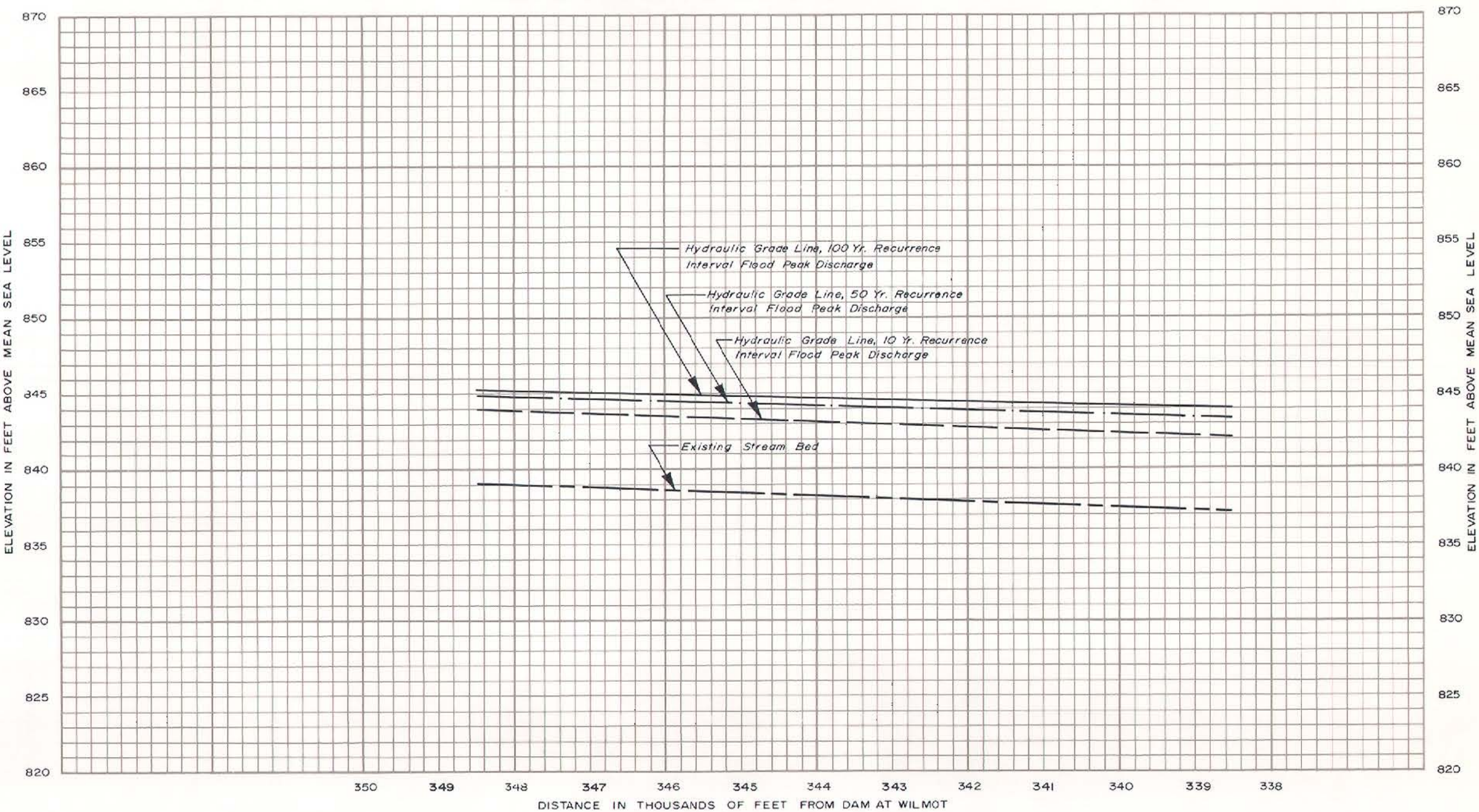
WAUKESHA COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: BLR DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

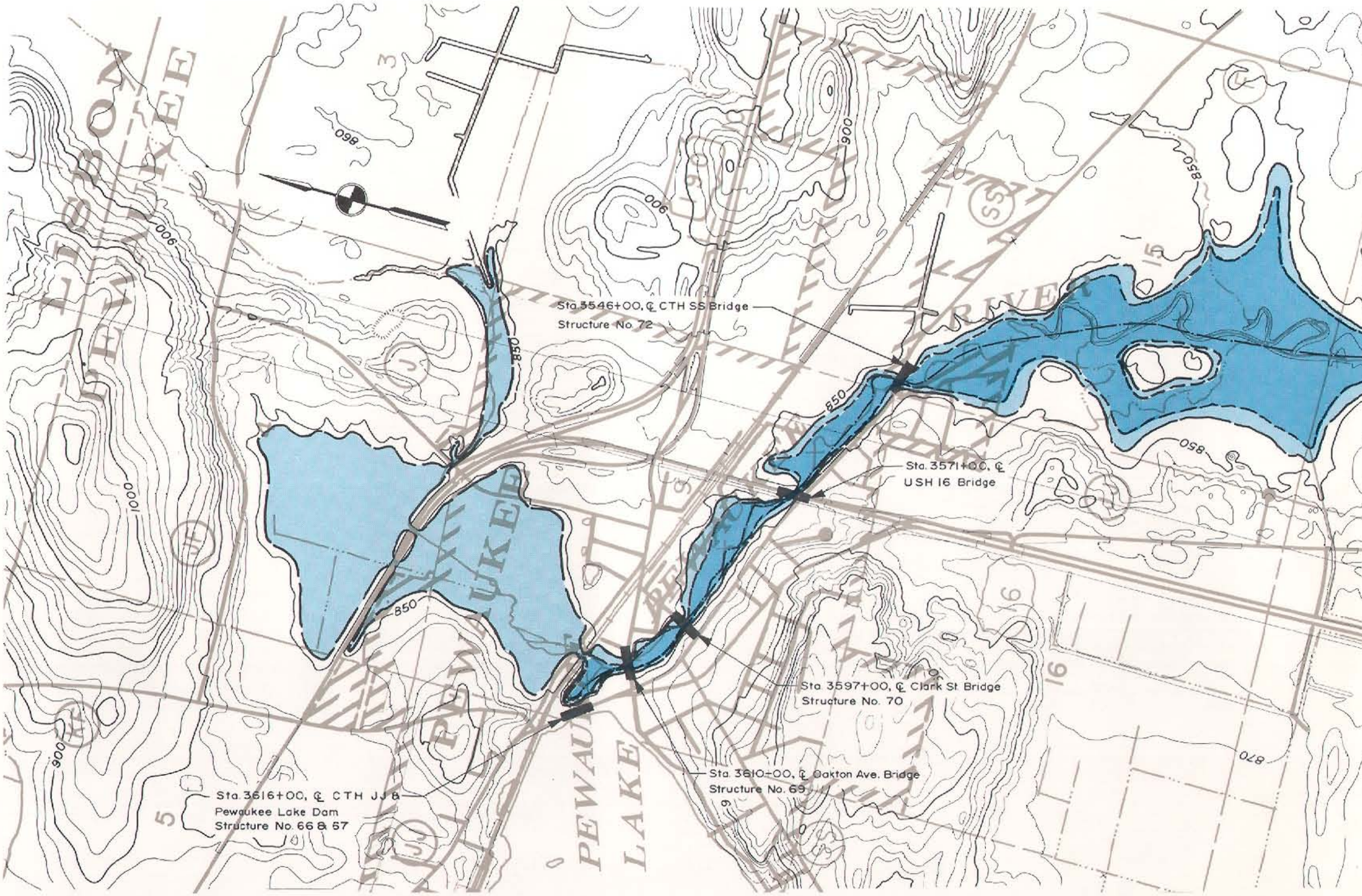
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-16 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
PEWAUKEE RIVER

FROM STA.3485+00 TO STA.3616+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET

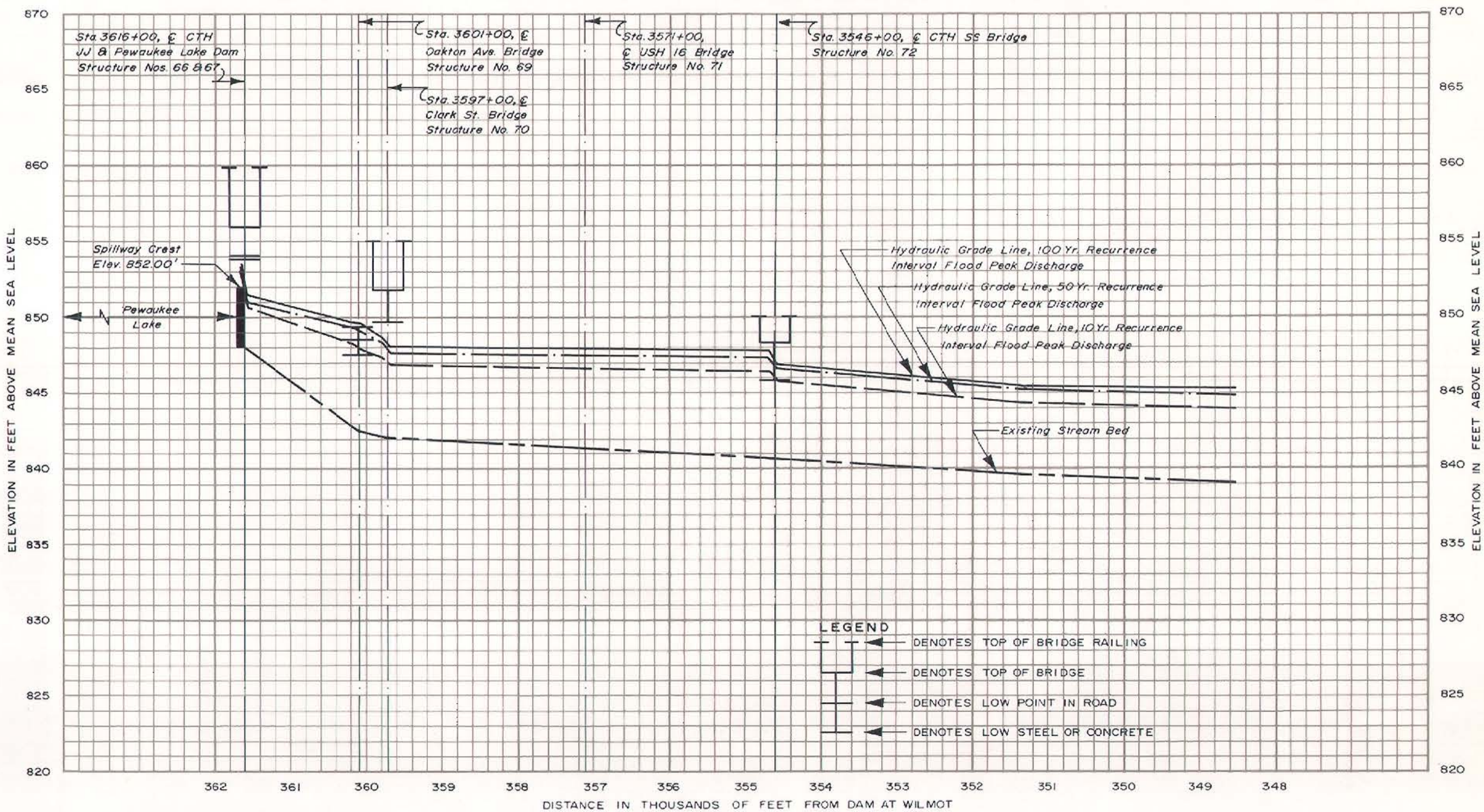


LEGEND
DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta.131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL, 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-16 (continued)

HIGH WATER AND STREAM BED PROFILES
OF THE
PEWAUKEE RIVER
FROM STA. 3485+00 TO STA. 3616+00
WAUKESHA COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: LHK DATE: DECEMBER 1969
CHECKED: DRB DATE: DECEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS

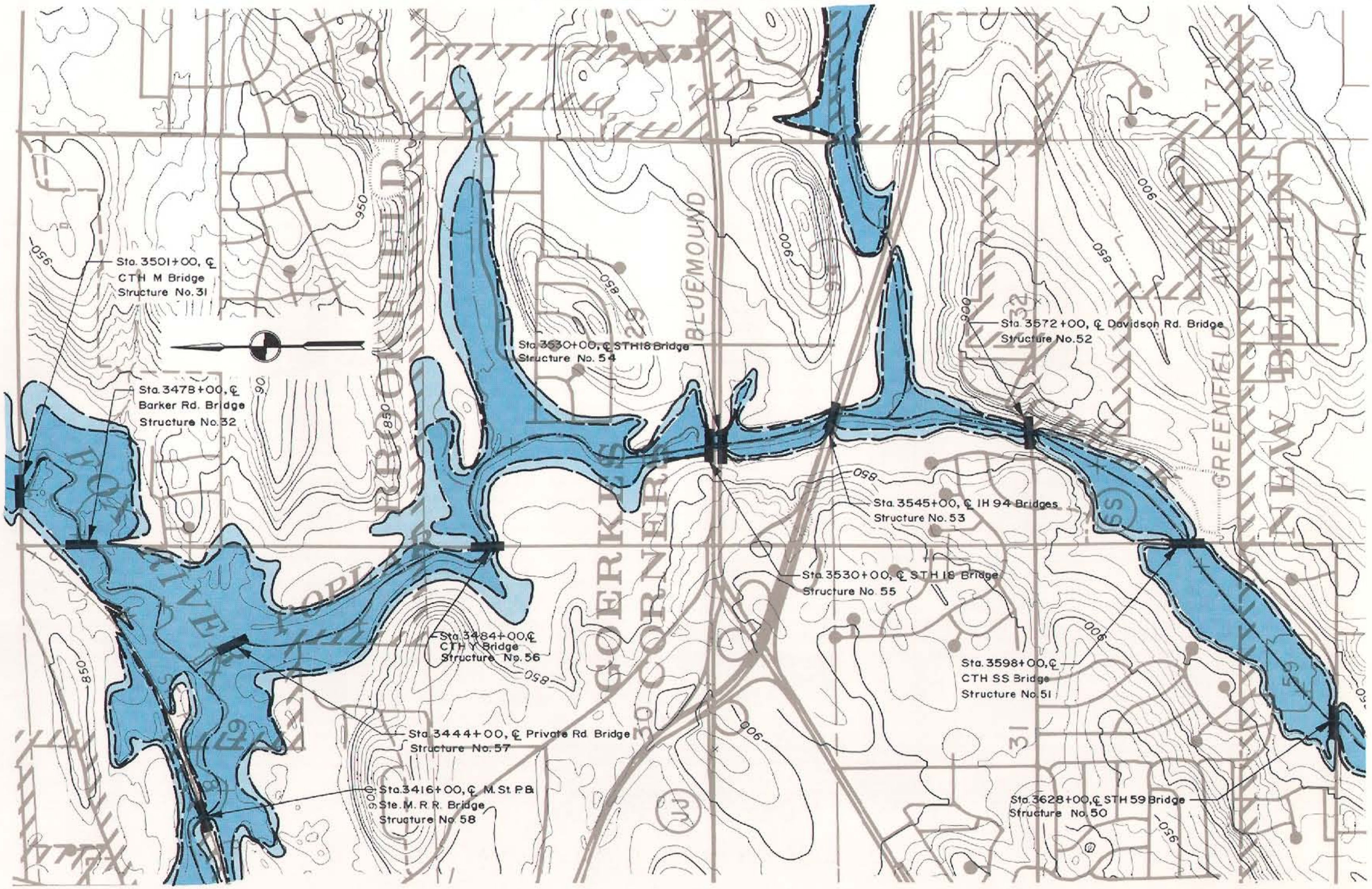


Source: U.S. Soil Conservation Service; SEWRPC.

Map D-17
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
POPLAR CREEK

FROM STA.3442+00 TO STA.3602+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RMW DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'

GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

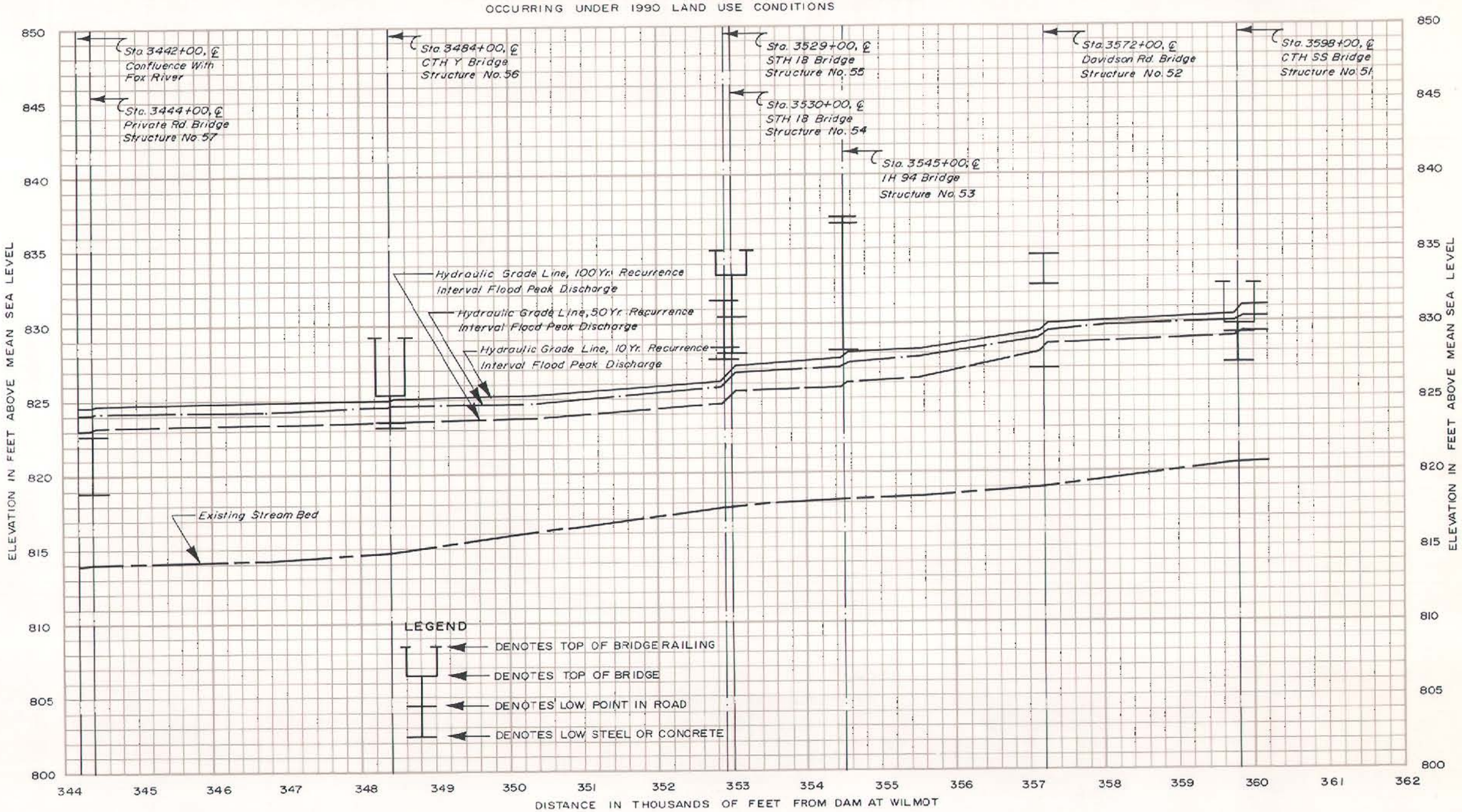
Figure D-17

HIGH WATER AND STREAM BED PROFILES

OF THE

POPLAR CREEK

FROM STA. 3442+00 TO STA. 3602+00
WAUKESHA COUNTY, WISCONSIN
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: BLR DATE: DECEMBER 1969
CHECKED: DRB DATE: DECEMBER 1969
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS
OCCURRING UNDER 1990 LAND USE CONDITIONS

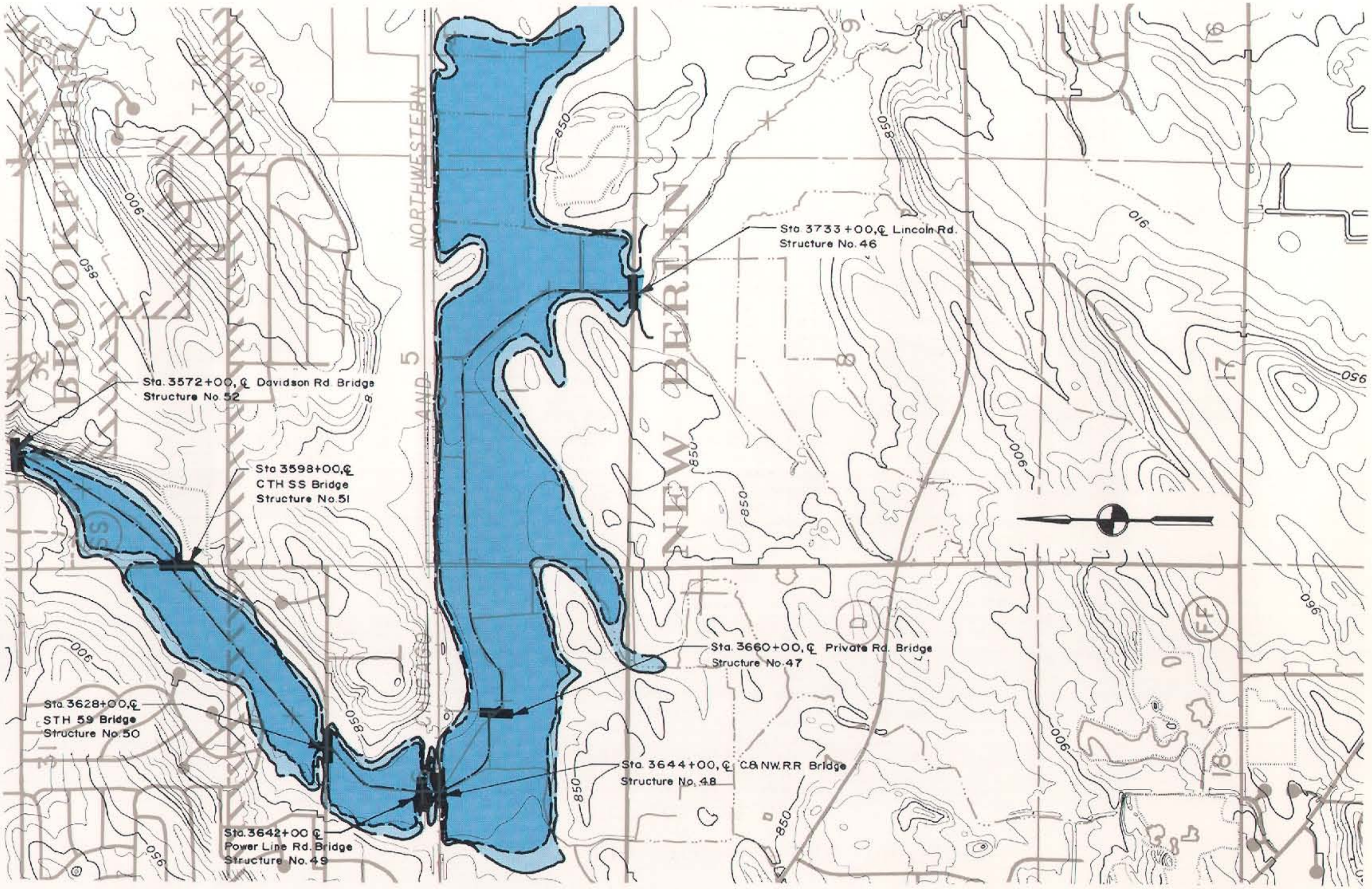


NOTE:

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

Map D-17 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
POPLAR CREEK

FROM STA.3602+00 TO STA3733+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
DENOTES STATION TICK

Figure D-17 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

POPLAR CREEK

FROM STA. 3602+00 TO STA. 3733+00

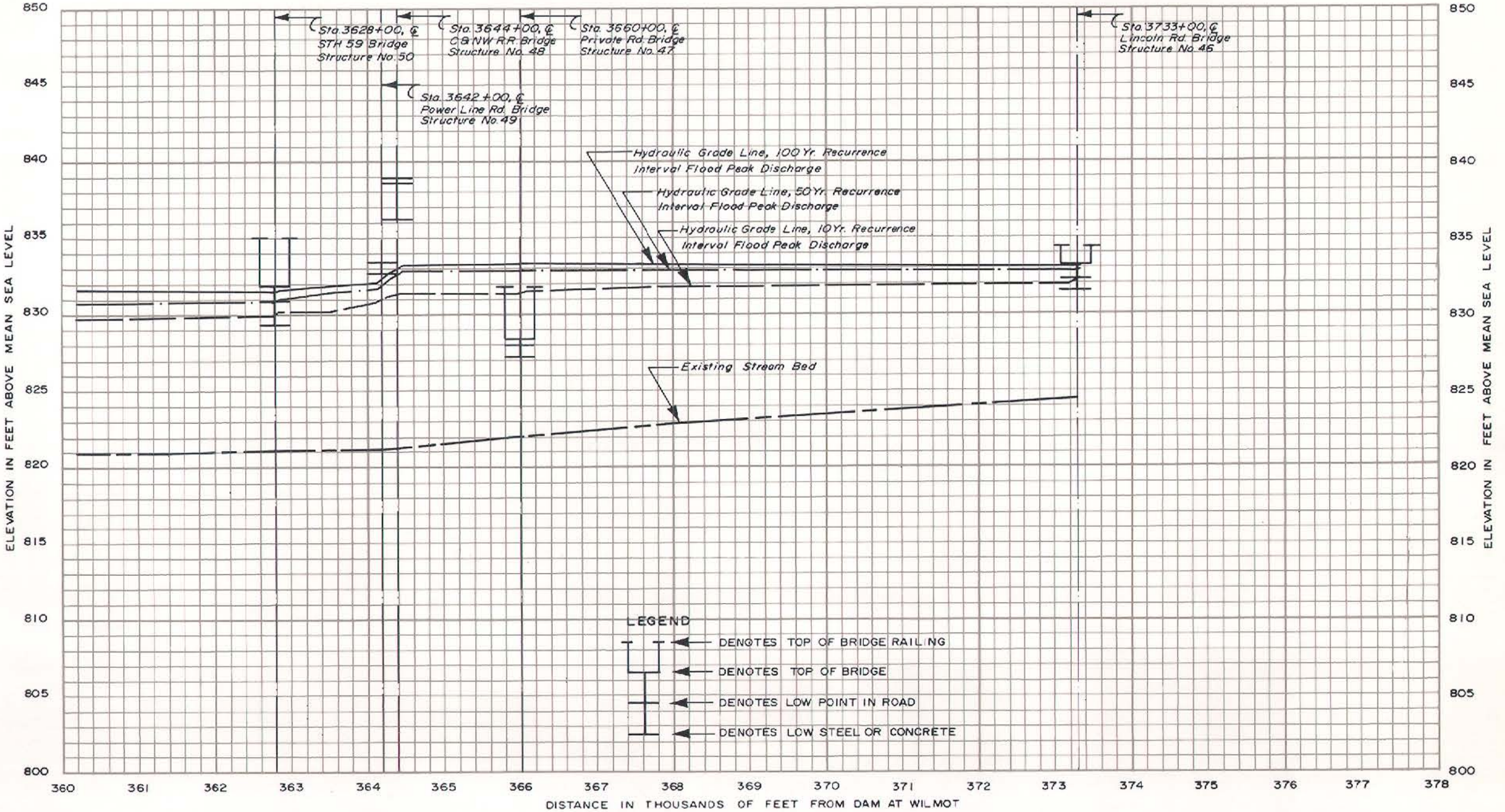
WAUKESHA COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

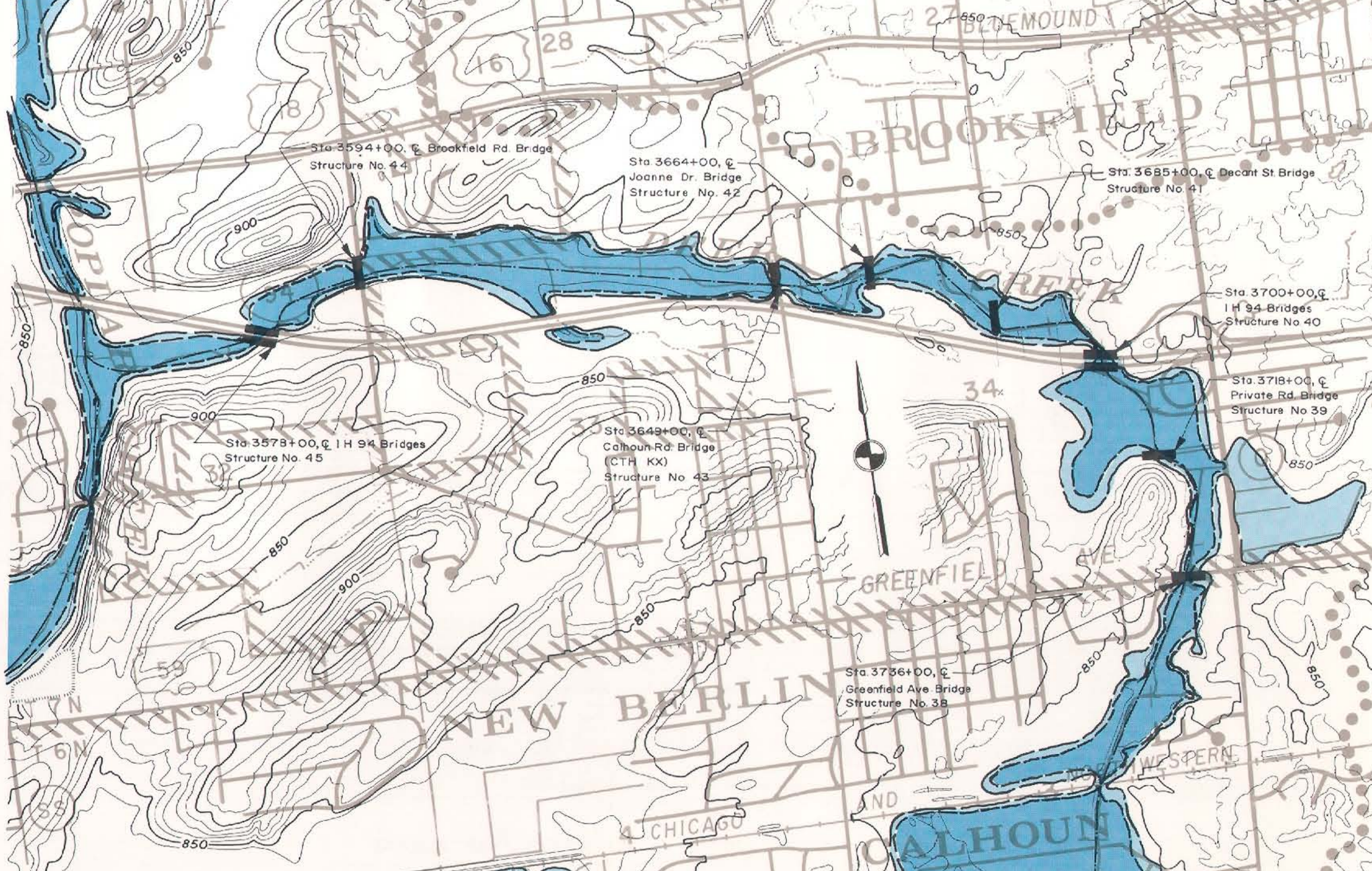
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-18
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
DEER CREEK

FROM STA.3552+00 TO STA.3652+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RMW DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
+ DENOTES STATION TICK

Figure D-18

HIGH WATER AND STREAM BED PROFILES

OF THE

DEER CREEK

FROM STA. 3552+00 TO STA. 3652+00

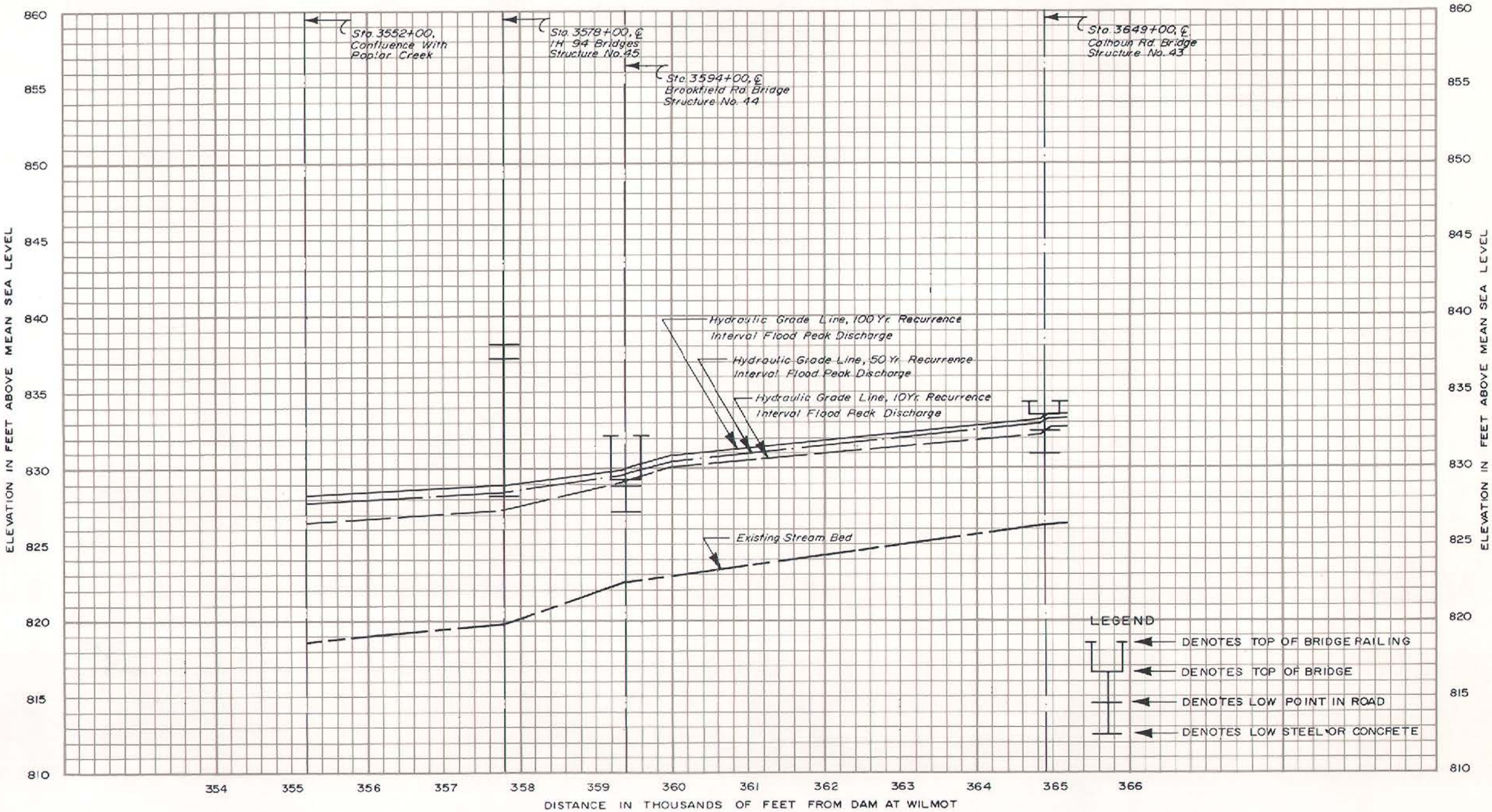
WAUKESHA COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: RHH DATE: DECEMBER 1969

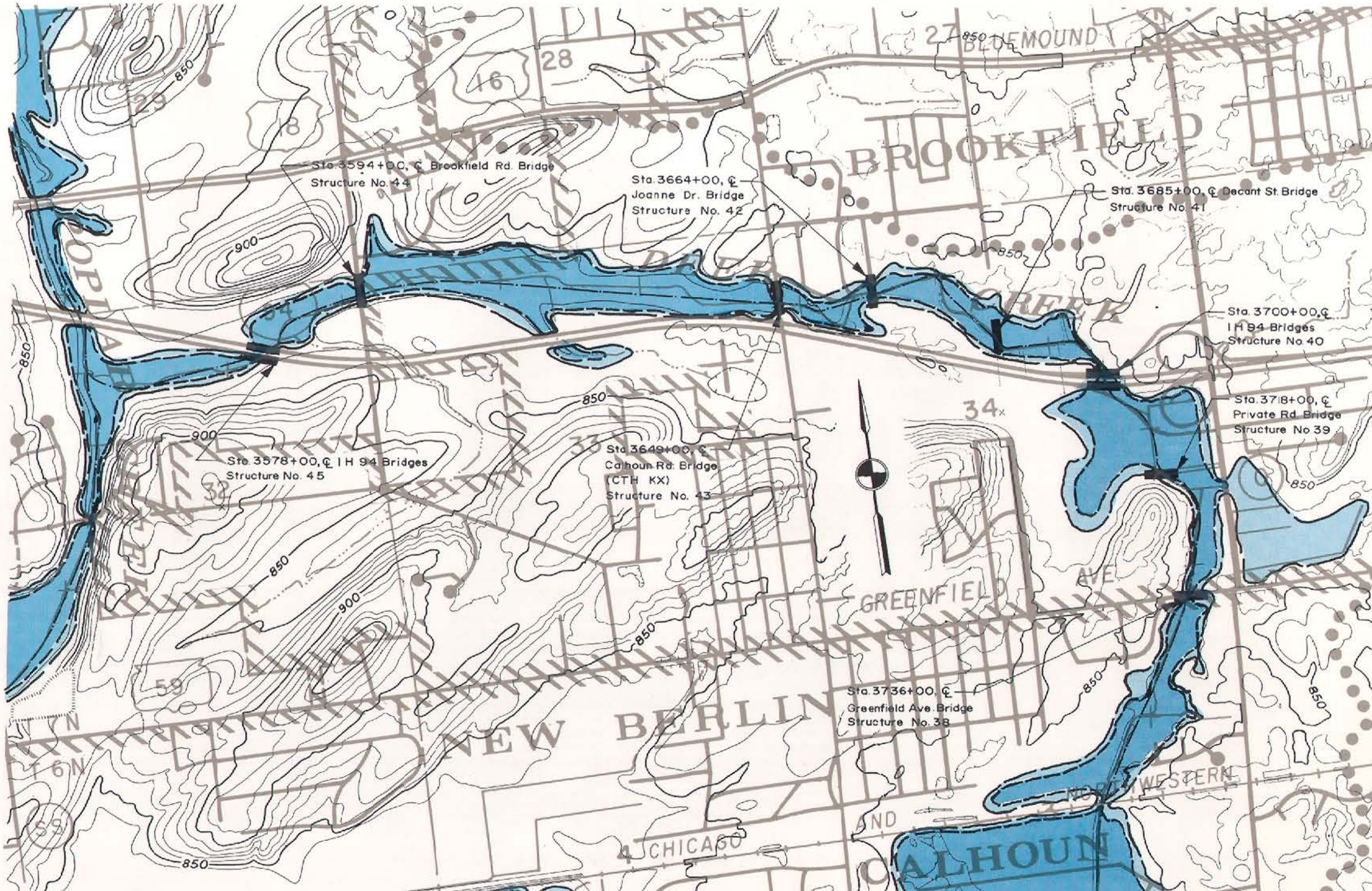
CHECKED: DRB DATE: DECEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-18 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
DEER CREEK
FROM STA.3652+00 TO STA.3772+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RMW DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT
+ DENOTES STATION TICK

Figure D-18 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

DEER CREEK

FROM STA 3652+00 TO STA. 3772+00

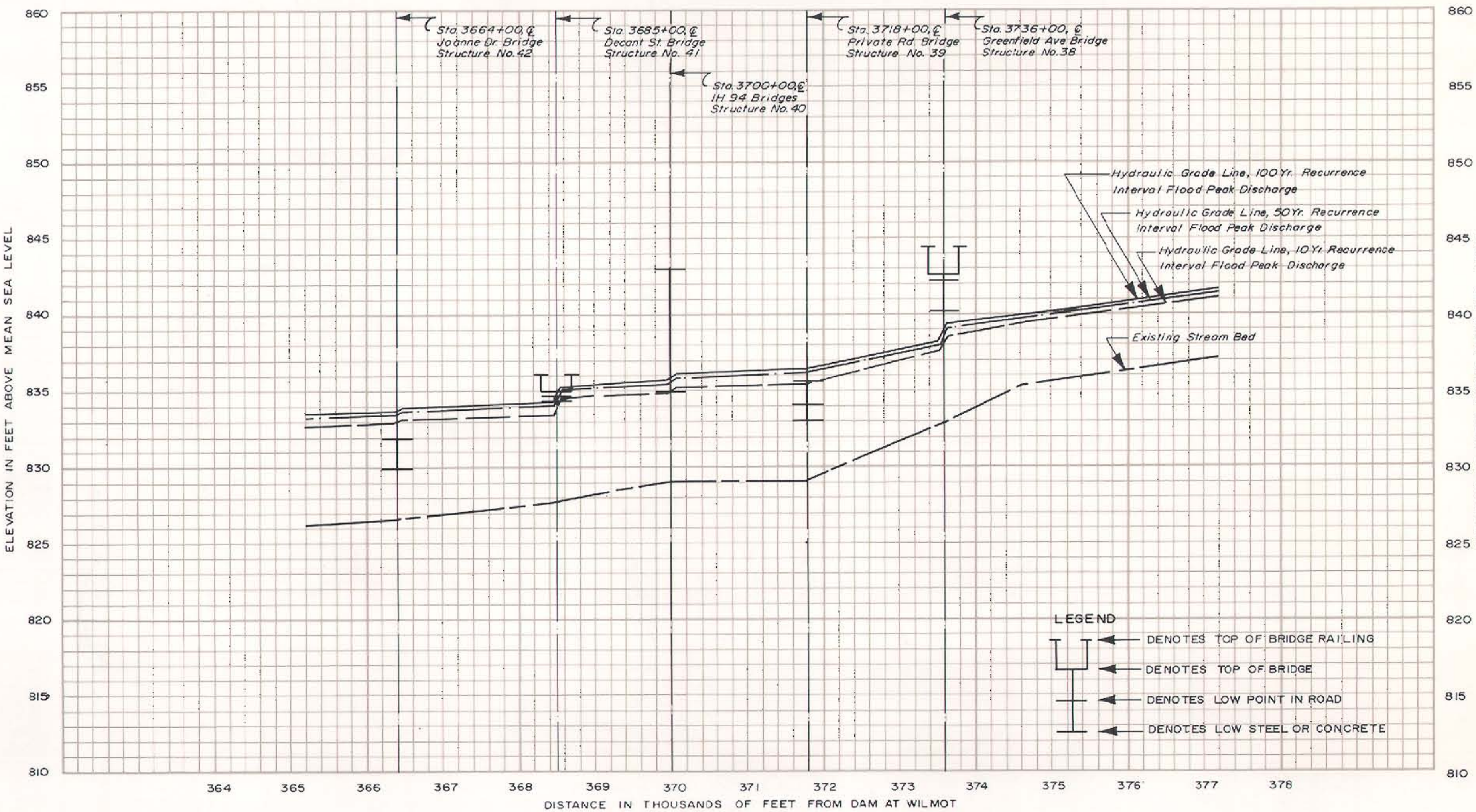
WAUKESHA COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: BLR DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



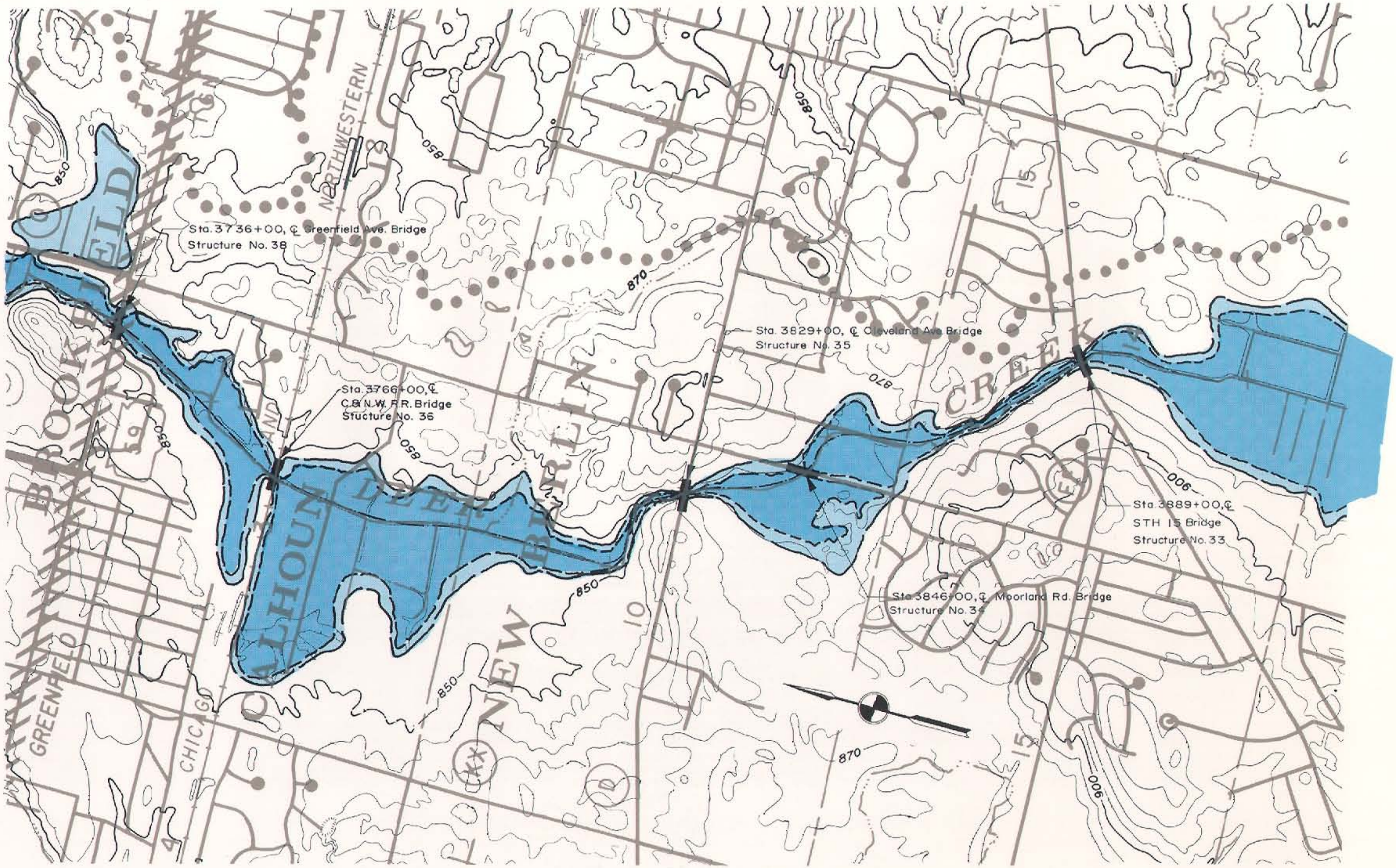
Source: U. S. Soil Conservation Service; SEWRPC.

Map D-18 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
DEER CREEK

FROM STA.3772+00 TO STA.3909+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: RMW DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969

SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE

DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

DENOTES STATION TICK

Figure D-18 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

DEER CREEK

FROM STA. 3772+00 TO STA. 3909+00

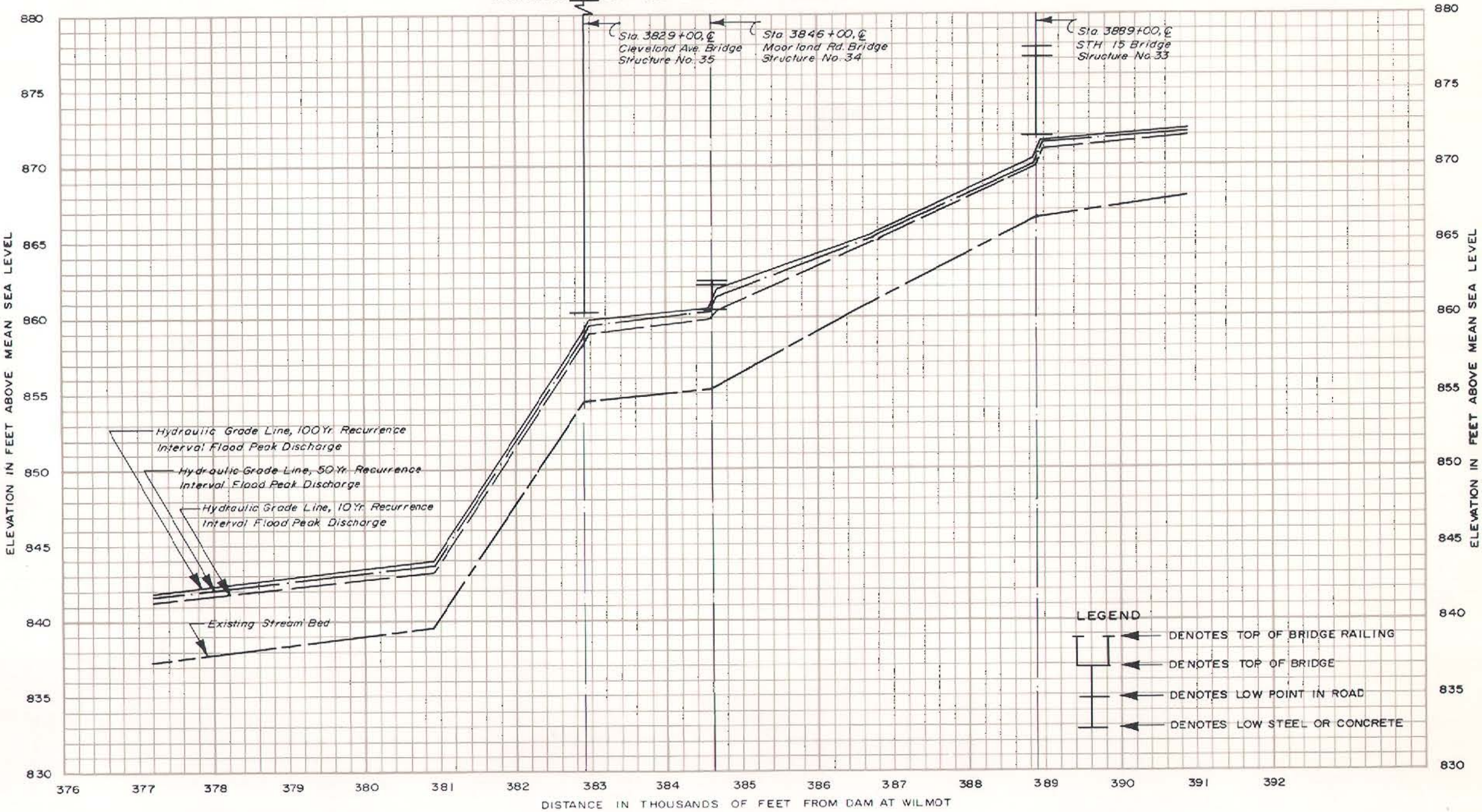
WAUKESHA COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: LHK DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

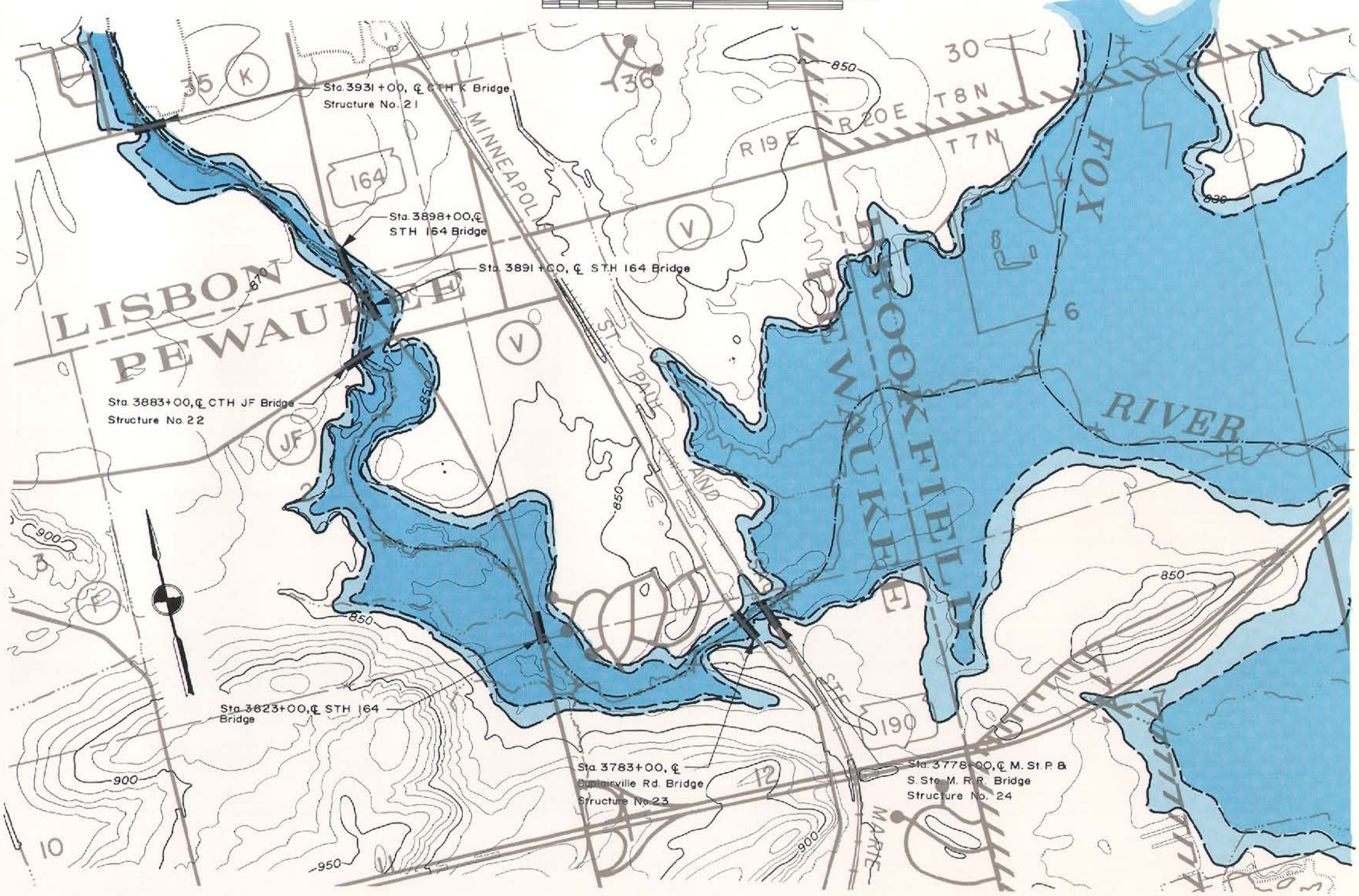
Map D-19
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
SUSSEX CREEK

FROM STA. 3713+00 TO STA. 3873+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: RHH — DATE: OCTOBER 1969
CHECKED: DRB — DATE: OCTOBER 1969

SCALE 1" = 2000'

GRAPHIC SCALE
0 — 2000 — 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 — DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM
ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1969 ADJUSTMENT
DENOTES STATION TICK

Figure D-19

HIGH WATER AND STREAM BED PROFILES

OF THE

SUSSEX CREEK

FROM STA. 3713+00 TO STA. 3873+00

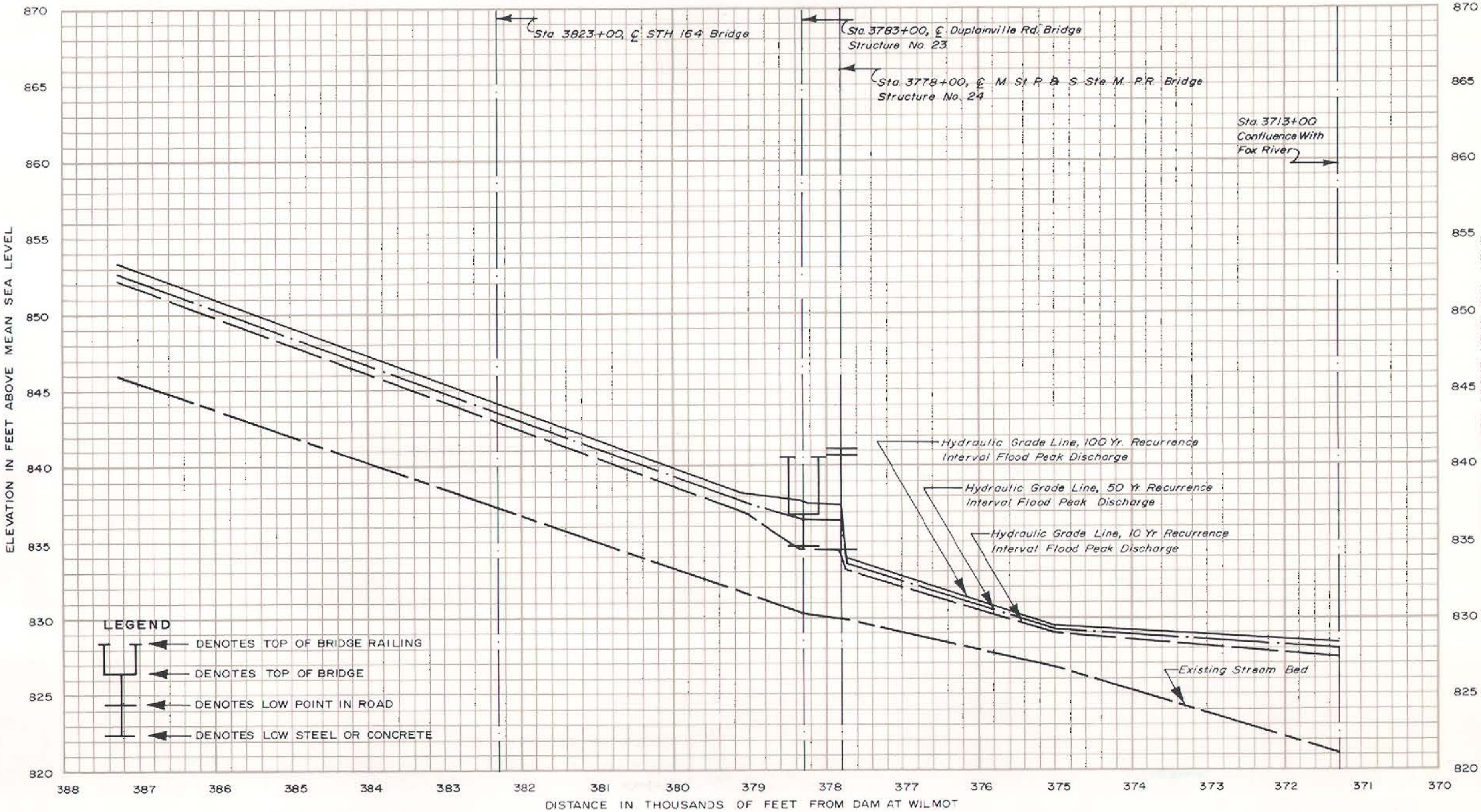
WAUKESHA COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: BLR DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

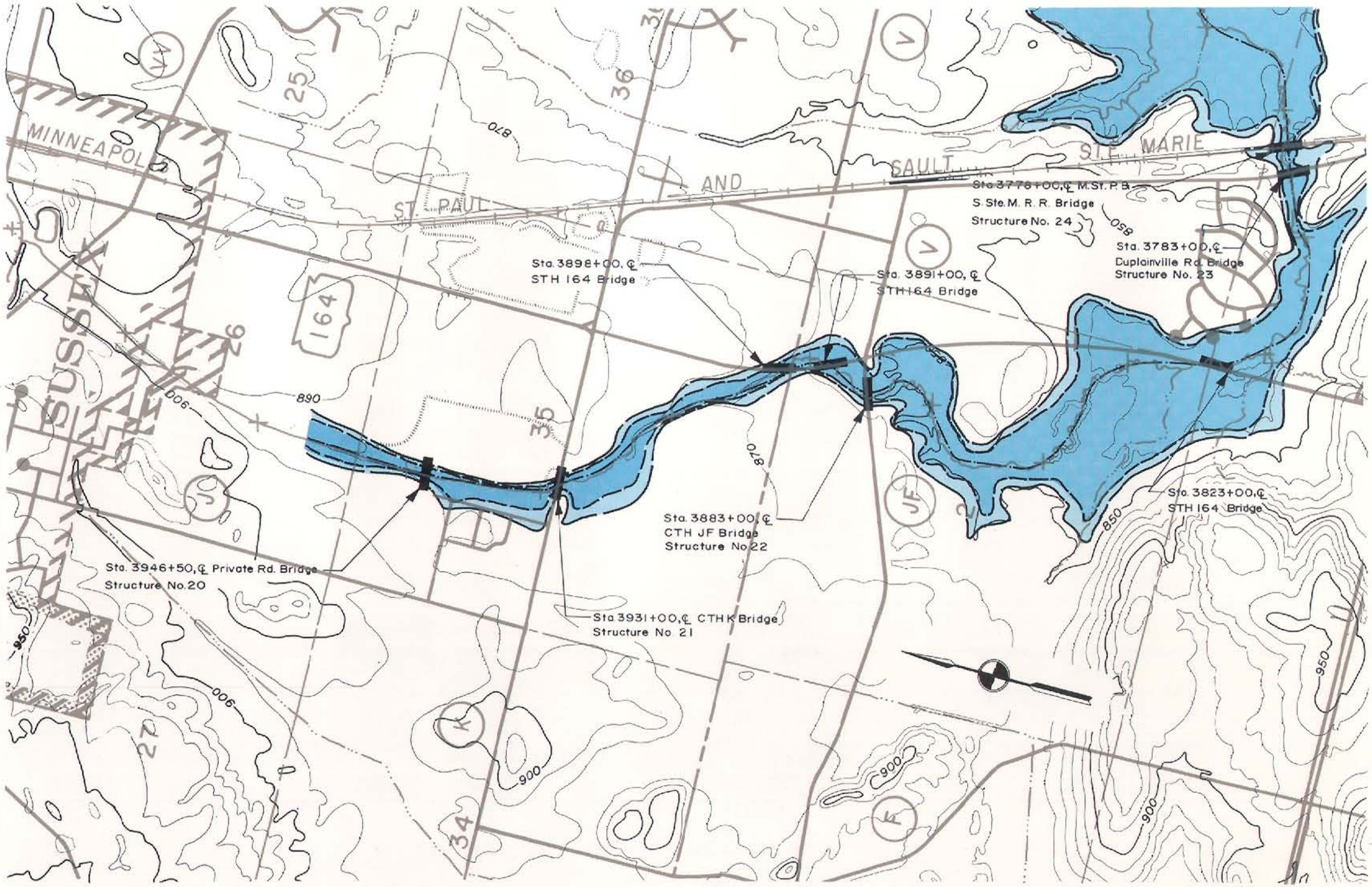
Map D-19 (continued)
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
SUSSEX CREEK

FROM STA.3873+00 TO STA.3966+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969

SCALE: 1" = 2000'

GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131 +00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

DENOTES STATION TICK

Figure D-19 (continued)

HIGH WATER AND STREAM BED PROFILES

OF THE

SUSSEX CREEK

FROM STA. 3873+00 TO STA. 3966+00

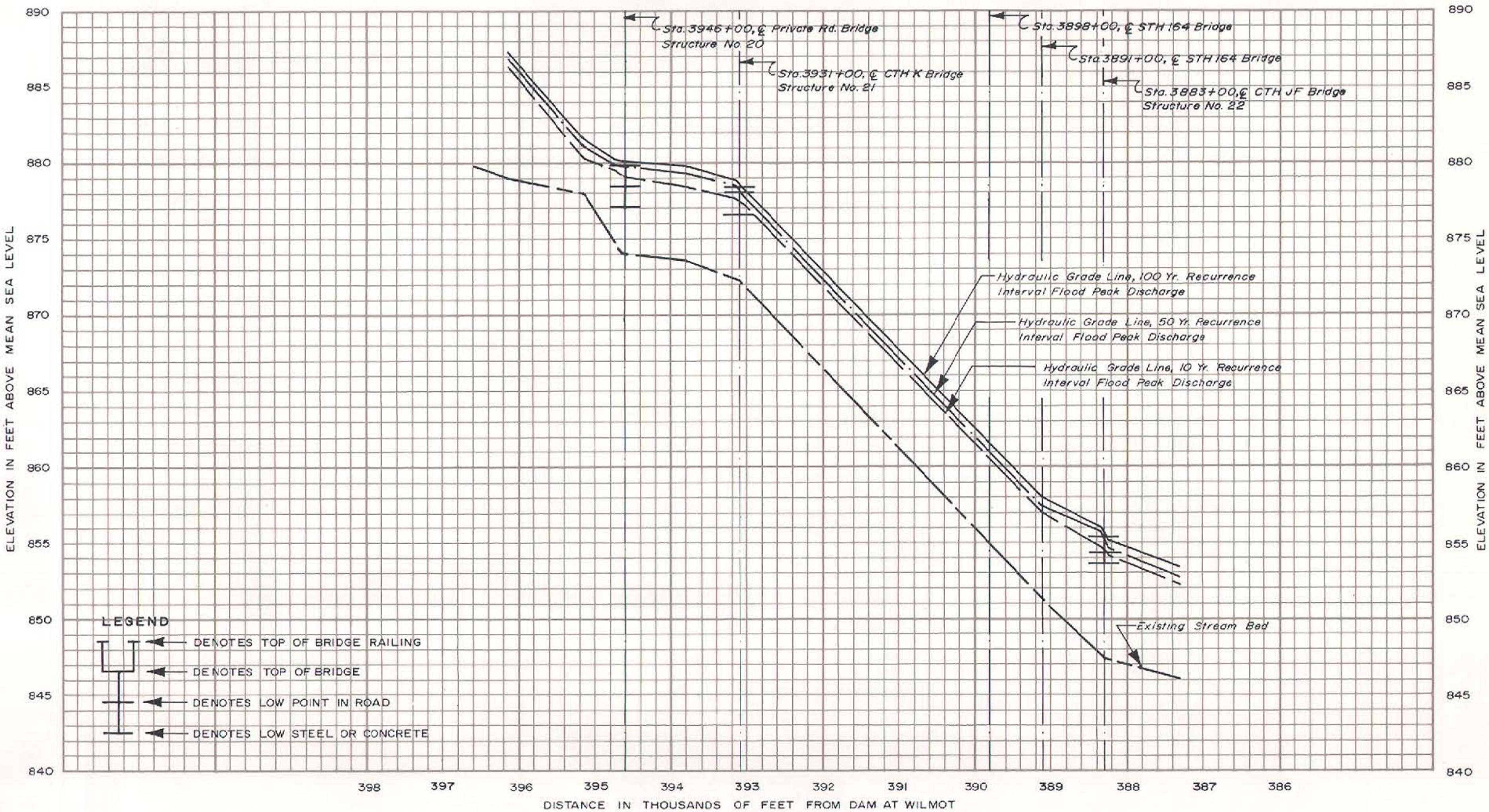
WAUKESHA COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: BLR DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

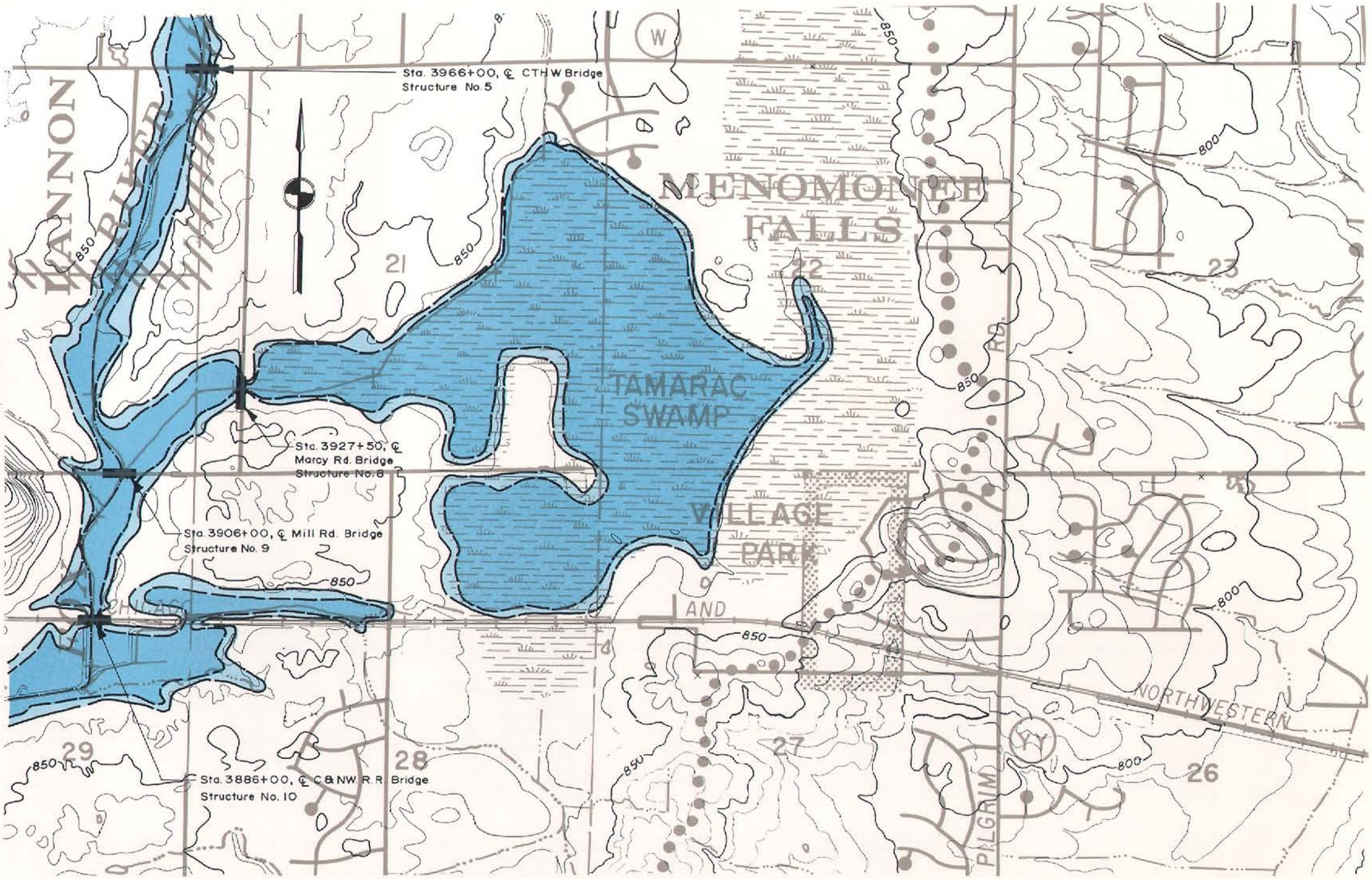
HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

Map D-20
TOPOGRAPHIC MAP
SHOWING
AREAS SUBJECT TO FLOODING
ALONG THE
TAMARAC SWAMP

FROM STA.3905+50 TO STA.3935+00
WAUKESHA COUNTY, WISCONSIN
PREPARED BY
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
DRAWN: RHH DATE: OCTOBER 1969
CHECKED: DRB DATE: OCTOBER 1969
SCALE: 1" = 2000'
GRAPHIC SCALE
0 2000 4000 FEET



LEGEND

DENOTES 10 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES 100 YEAR RECURRENCE INTERVAL FLOOD INUNDATION LINE
DENOTES APPROXIMATE CENTER LINE OF FLOODWAY

Sta. 131+00 DENOTES DISTANCE ALONG THE THREAD OF STREAM FROM WILMOT DAM

ALL ELEVATIONS REFERRED TO MEAN SEA LEVEL; 1929 ADJUSTMENT

DENOTES STATION TICK

Figure D-20

HIGH WATER AND STREAM BED PROFILES

OF THE

TAMARAC SWAMP

FROM STA. 3906+50 TO STA. 3935+00

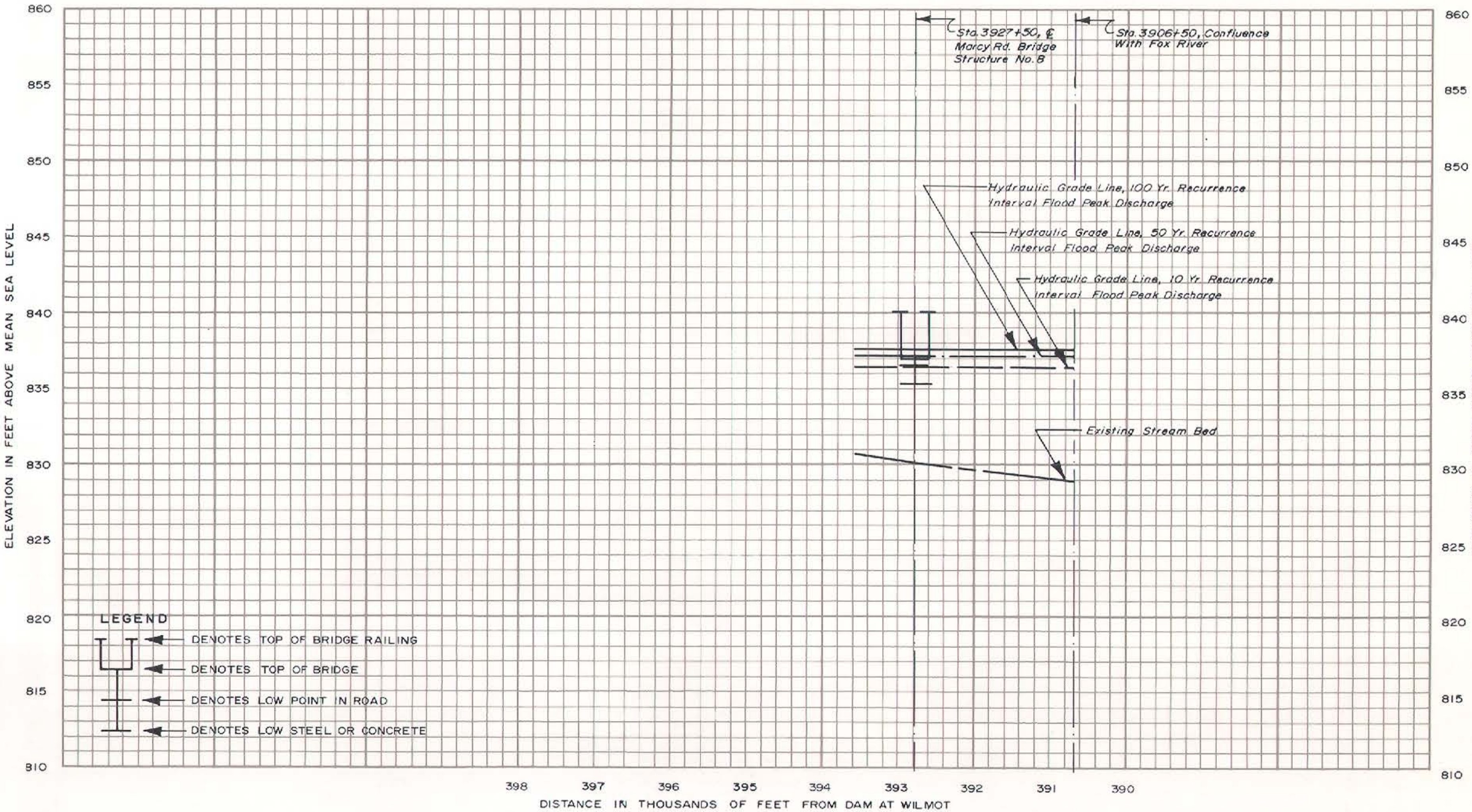
WAUKESHA COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

DRAWN: BLR DATE: DECEMBER 1969

CHECKED: DRB DATE: DECEMBER 1969

HYDRAULIC GRADE LINES REPRESENT PEAK DISCHARGE CONDITIONS OCCURRING UNDER 1990 LAND USE CONDITIONS



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

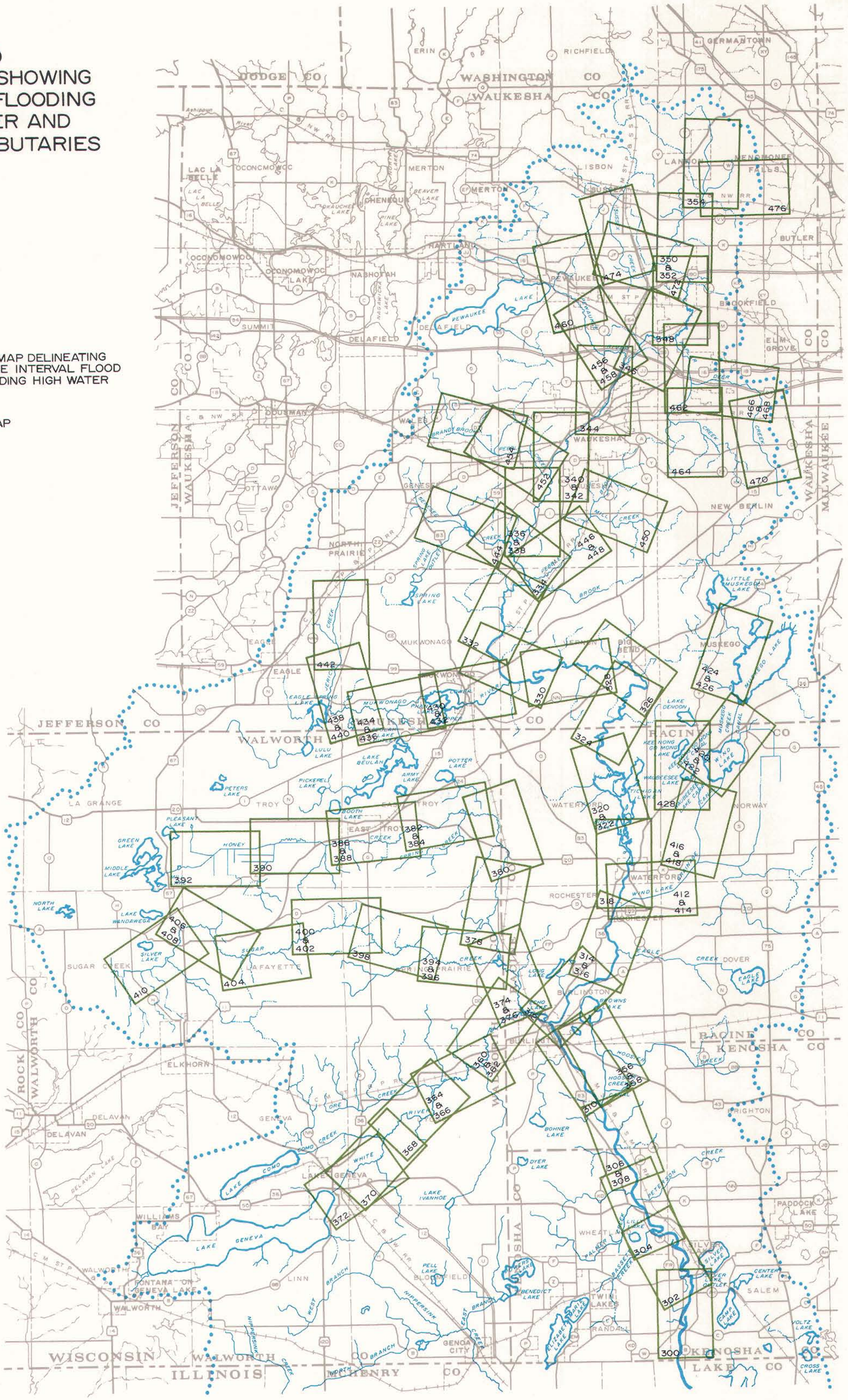
Map D-21

INDEX MAP TO TOPOGRAPHIC MAPS SHOWING AREAS SUBJECT TO FLOODING FOR THE FOX RIVER AND SELECTED MAJOR TRIBUTARIES

LEGEND

AREA COVERED BY TOPOGRAPHIC MAP DELINEATING THE 10 AND 100 YEAR RECURRENCE INTERVAL FLOOD HAZARD LINES WITH CORRESPONDING HIGH WATER AND STREAM BED PROFILE

305 PAGE NUMBER OF TOPOGRAPHIC MAP



Appendix E

HYDRAULIC DATA SUMMARY FOR BRIDGES OVER THE FOX RIVER AND ITS MAJOR TRIBUTARIES

TABLE E-1

HYDRAULIC ANALYSIS SUMMARY LOWER FOX RIVER MAIN STEM

					10-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						50-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						100-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS					
								EXISTING WATERWAY OPENING						EXISTING WATERWAY OPENING						EXISTING WATERWAY OPENING		
STRUCTURE NUMBER	LOCATION	CONSTRUCTION DATE OF EXISTING BRIDGE	RECOMMENDED DESIGN FREQUENCY STANDARD (YEARS)	REPLACEMENT REQUIRED BY APPLICATION OF STANDARD	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)
98	CTH HI	1966	50	YES	2,060	789.1	1.6	0.6	- 0.4	- 5.9	3,060	790.9	4.4	0.7	0.6	- 4.1	3,500	791.1	4.6	0.8	0.8	- 3.9
108	CTH I	1965	50	NO	1,880	786.3	6.3	0.4	- 3.9	- 6.2	2,560	787.6	7.6	0.5	- 2.6	- 4.9	2,850	788.1	8.1	0.5	- 2.1	- 4.4
120	M.ST.P.&S.STE.M.R.R.	UNKNOWN	--	--	1,470	784.0	5.5	0.2	-17.0	-19.0	2,070	785.1	6.6	0.1	-15.9	-17.9	2,360	785.6	6.1	0.1	-15.4	-17.4
121	STH 15	1921	50	NO	1,480	783.7	4.7	0.2	- 5.4	- 5.7	2,080	784.7	5.7	0.2	- 4.4	- 4.7	2,370	785.1	6.1	0.2	- 4.0	- 4.3
--	PROPOSED ROCK FRWY	--	100	--	1,980	--	--	--	--	--	2,860	--	--	--	--	--	3,290	--	--	--	--	--
139	CENTER DRIVE	UNKNOWN	10	YES[a]	2,000	782.3	3.3	0.1	1.3	- 2.2	2,950	783.5	4.5	0.1	2.5	- 1.0	3,300	783.8	4.8	0.1	2.8	- 0.7
140	STH 24	1950	50	YES[b]	2,000	781.5	2.4	0.1	0.8	- 4.4	2,950	782.5	3.4	0.3	0.3	- 3.4	3,300	782.2	3.7	0.2	0.5	- 3.1
141	TICHIGAN DRIVE	1912	10	YES[b]	2,300	775.2	2.2	0.2	0.5	- 5.5	3,200	775.5	2.5	0.3	0.8	- 5.2	3,590	775.6	2.6	0.3	0.9	- 5.1
145	STH 20 & 36	1939	50	NO	2,050	769.4	- 0.6	0.4	- 6.8	- 7.1	2,950	770.5	0.5	0.4	- 5.7	- 6.0	3,330	770.9	0.9	0.4	- 5.3	- 5.6
164	STH 189	1940	50	NO	2,700	766.9	2.9	0.4	- 8.3	- 9.1	3,700	767.5	3.5	0.3	- 7.7	- 8.5	4,130	767.8	3.8	0.4	- 7.4	- 8.2
--	NEW STH 36	1968	50	--	2,700	--	--	--	--	--	3,700	--	--	--	--	--	4,140	--	--	--	--	--
--	PROPOSED STH 83	--	50	--	2,800	--	--	--	--	--	3,880	--	--	--	--	--	4,300	--	--	--	--	--
171	CTH W	1954	50	NO	2,800	759.9	1.4	0.2	- 5.1	- 5.1	3,880	761.2	2.7	0.2	- 3.8	- 3.8	4,300	761.7	3.2	0.3	- 3.3	- 3.3
172	GOLF COURSE ROAD	UNKNOWN	--	--	2,850	758.1	0.3	0.0	3.1	- 3.4	3,900	759.5	1.7	0.1	4.5	- 2.0	4,350	759.9	2.1	0.1	4.9	- 1.6
246	STH 11	1949	50	YES[b]	4,800	756.9	0.4	0.2	0.8	- 5.5	7,300	758.8	2.3	0.3	1.1	- 3.6	8,300	759.5	3.0	0.3	1.8	- 2.9
247	C.M.ST.P.&P.R.R.	1900	--	--	4,800	754.6	4.6	0.3	- 9.4	- 9.4	7,300	756.4	6.4	0.4	- 7.6	- 7.6	8,300	757.1	7.1	0.4	- 6.9	- 6.9
--	PROPOSED STH 11	--	50	--	4,900	--	--	--	--	--	7,400	--	--	--	--	--	8,400	--	--	--	--	--
248	M.ST.P.&S.STE.M.R.R.	UNKNOWN	--	--	5,000	752.4	4.9	0.2	- 9.6	- 9.6	7,600	754.3	6.8	0.3	- 7.7	- 7.7	8,700	755.1	7.6	0.4	- 6.9	- 6.9
259	CTH JB	1969	50	YES	5,100	748.9	5.9	0.4	- 0.6	- 3.9	7,900	750.9	7.9	0.3	1.4	- 1.9	9,100	751.6	8.6	0.3	2.1	- 1.2
265	STH 83 & 50	1932	50	YES	5,300	747.4	3.9	0.5	- 0.2	- 5.6	8,100	749.1	5.6	0.4	1.5	- 3.9	9,300	749.8	6.3	0.4	2.2	- 3.2
269	CTH F	1929	50	YES	5,300	745.5	4.0	0.7	- 1.3	- 6.4	8,100	747.1	5.6	0.8	0.3	- 4.8	9,300	747.7	6.2	0.8	0.9	- 4.2
273	CTH C	(C)1940	50	NO	5,400	744.0	1.0	0.3	- 4.4	- 7.2	8,200	745.2	2.2	0.5	- 3.2	- 6.0	9,400	745.6	2.6	0.5	- 2.8	- 5.6

[a] BOTH STRUCTURE REPLACEMENT AND ELEVATION OF THE APPROACH ROAD WOULD BE REQUIRED TO MEET STANDARD.

[b] STANDARD COULD BE MET BY ELEVATION OF THE APPROACH ROAD.

SOURCE: U.S. SOIL CONSERVATION SERVICE AND SEWRPC.

TABLE E-2

HYDRAULIC ANALYSIS SUMMARY UPPER FOX RIVER MAIN STEM

					10-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						50-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						100-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS					
								EXISTING WATERWAY OPENING						EXISTING WATERWAY OPENING						EXISTING WATERWAY OPENING		
STRUCTURE NUMBER	LOCATION	CONSTRUCTION DATE OF EXISTING BRIDGE	RECOMMENDED DESIGN FREQUENCY STANDARD (YEARS)	REPLACEMENT REQUIRED BY APPLICATION OF STANDARD	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)
4	CUSTER LANE	CULVERT	10	YES[a]	410	857.8	1.8	0.2	0.8	0.4	690	858.3	2.3	0.3	1.3	0.9	840	858.5	2.5	0.3	1.5	1.1
--	PROPOSED BELT FRWY	--	100	--	410	--	--	--	--	--	690	--	--	--	--	--	840	--	--	--	--	--
5	CTH W	CULVERT	50	YES	380	845.5	3.7	1.4	0.3	- 1.9	650	845.9	4.1	1.4	0.7	- 1.5	780	846.1	4.3	1.4	0.9	- 1.3
9	MILL ROAD	1935	10	YES	690	836.4	5.4	0.5	0.4	0.0	1,060	837.1	6.1	0.2	1.1	0.7	1,250	837.5	6.5	0.2	1.5	1.1
10	C.&N.W.R.R.	1910	--	--	920	835.6	6.3	0.7	- 5.2	- 5.8	1,470	836.7	7.4	0.9	- 4.1	- 4.7	1,720	837.4	8.1	1.2	- 3.4	- 4.0
11	CTH Y	1938	50	YES[a]	1,210	834.7	6.7	0.7	1.2	0.7	1,980	835.7	7.7	0.4	2.2	1.7	2,320	836.0	8.0	0.3	2.5	2.0
12	CTH VV	(C)1950	50	YES	1,210	834.0	5.4	0.7	- 0.9	- 1.4	1,980	835.3	6.7	1.0	0.4	- 0.1	2,320	835.7	7.1	1.1	0.8	0.3
13	CTH K	1940	50	NO	1,140	832.5	5.6	0.4	- 2.1	- 2.1	1,890	833.4	6.5	0.8	- 1.2	- 1.2	2,220	833.7	6.8	0.9	- 0.9	- 0.9
14	RIVER ROAD	1935	10	YES[b]	1,140	832.1	4.1	0.8	1.4	- 2.9	1,890	832.6	4.6	0.7	1.9	- 2.4	2,220	832.8	4.8	0.8	2.1	- 2.2
--	PROPOSED BAY FRWY	--	100	--	1,140	--	--	--	--	--	1,890	--	--	--	--	--	2,220	--	--	--	--	--
26&27	CAPITOL DRIVE	1965	100	NO	1,100	825.2	3.7	0.2	- 3.2	- 3.8	1,700	826.0	4.5	0.2	- 2.4	- 3.0	1,950	826.5	5.0	0.4	- 1.9	- 2.5
28	RIVER ROAD	1935	10	YES[a]	1,020	824.6	5.1	0.1	1.8	- 0.8	1,600	825.5	6.0	0.2	2.7	0.1	1,840	825.8	6.3	0.4	3.0	0.4
30	C.M.ST.P.&P.R.R.	1903	--	--	1,020	824.5	5.5	0.3	2.3	- 2.9	1,560	825.3	6.3	0.4	- 1.5	- 2.2	1,780	825.5	6.5	0.3	- 1.3	- 2.0
31	CTH M	1935	50	YES[a]	1,010	824.0	4.5	0.2	1.9	- 0.3	1,500	824.8	5.3	0.1	2.7	0.5	1,720	825.0	5.5	0.0	2.9	0.7
32	BARKER ROAD	1940	50	YES	990	823.6	3.6	0.1	3.1	1.1	1,480	824.6	4.6	0.1	4.1	2.1	1,700	824.9	4.9	0.1	4.4	2.4
58	M.ST.P.&S.STE.M.R.R.	(C)1920	--	--	1,430	823.0	4.5	0.3	- 1.9	- 2.4	2,150	824.1	5.6	0.3	- 0.8	- 1.3	2,490	824.5	6.0	0.3	- 0.4	- 0.9
59	TOWN LINE ROAD	(C)1950	10	YES[a]	1,420	822.4	3.9	0.1	2.4	- 0.1	2,130	823.4	4.9	0.0	3.4	0.9	2,450	823.8	5.3	0.0	3.8	1.3
60	CTH SS	(C)1920	50	YES	1,410	821.7	8.9	0.4	- 1.0	- 1.0	2,110	823.0	9.5	0.3	0.3	0.3	2,410	823.4	9.9	0.2	0.7	0.7
61	C.M.ST.P.&P.R.R.	1905	--	--	1,400	820.7	5.7	0.6	- 2.5	- 3.0	2,110	822.0	7.0	0.6	- 1.2	- 1.7	2,410	822.6	7.6	0.7	- 0.6	- 1.1
63&64	IH 94	1958	100	NO	1,400	819.8	6.8	0.2	-10.8	-12.1	2,110	821.1	8.1	0.3	- 9.5	-10.8	2,410	821.5	8.5	0.3	- 9.1	-10.4
65	M.ST.P.&S.STE.M.R.R.	1919	--	--	1,400	819.4	4.8	0.3	- 5.0	- 5.0	2,110	820.5	5.9	0.2	- 3.9	- 3.9	2,410	821.0	6.4	0.3	- 3.4	- 3.4
80	PRIVATE ROAD	(C)1920	--	--	1,630	817.5	3.9	0.7	0.1	- 1.2	2,650	818.7	5.1	0.4	1.3	0.0	3,110	819.1	5.5	0.3	1.7	0.4
81	PRIVATE ROAD	1968	--	--	1,66C	814.4	1.1	0.6	- 2.8	- 2.9	2,690	816.1	0.8	0.8	- 1.1	- 1.2	3,150	816.6	1.3	0.8	- 0.6	- 0.7
82	MORELAND ROAD	1939	50	NO	1,700	813.0	- 0.5	0.0	- 4.4	- 5.5	2,710	814.3	0.8	0.2	- 3.1	- 4.0	3,190	814.8	1.3	0.3	- 2.6	- 3.5
84	BARSTOW STREET	1957	50	NO	1,690	810.5	- 2.5	0.5	- 3.9	- 4.5	2,690	812.0	- 1.0	0.7	- 2.0	- 3.0	3,180	812.8	- 0.2	0.9	- 1.6	- 2.3
85	FOOT BRIDGE	1957	--	--	1,690	807.5	- 2.7	0.5	- 2.7	- 3.1	2,690	809.2	- 0.2	0.5	0.8	- 1.2	3,180	810.1	0.1	0.4	0.1	- 0.3
86	MADISON STREET	1968	50	NO	1,710	807.0	- 1.7	0.7	- 3.9	- 4.4	2,710	808.9	0.2	0.8	- 2.0	- 2.5	3,200	809.7	1.2	0.8	- 1.2	- 1.7
87	STH 59	1928	50	NO	1,710	802.6	- 0.9	0.2	- 2.9	- 4.3	2,710	804.1	0.6	0.3	- 1.4	- 2.8	3,200	804.8	1.8	0.4	- 0.7	- 2.1
88	C.&N.W.R.R.	1964	--	--	1,720	800.7	0.7	0.3	-10.3	-11.7	2,730	802.4	2.4	0.6	- 8.6	-10.0	3,220	803.0	3.0	0.5	- 8.0	- 9.4
89	PRAIRIE AVENUE	1915	50	NO	1,720	800.4	0.4	0.6	- 2.0	- 5.6	2,730	801.8	1.8	0.6	- 0.6	- 4.2	3,220	802.5	2.5	0.8	0.1	- 3.5
90	C.M.ST.P.&P.R.R.	1964	--	--	1,720	798.3	3.6	0.2	- 6.1	- 6.3	2,790	799.9	5.2	0.3	- 4.5	- 4.7	3,220	800.4	5.7	0.3	- 4.0	- 4.2
91	CTH D & X	(C)1940	50	NO	1,720	791.6	3.1	0.2	- 3.4	- 3.4	2,790	793.2	4.7	0.7	- 1.8	- 1.8	3,220	793.5	5.0	0.7	- 1.5	- 1.5

[a] BOTH STRUCTURE REPLACEMENT AND ELEVATION OF THE APPROACH ROAD WOULD BE REQUIRED TO MEET STANDARD.

[b] STANDARD COULD BE MET BY ELEVATION OF THE APPROACH ROAD.

SOURCE: U.S. SOIL CONSERVATION SERVICE AND SEWRPC.

TABLE E-3

HYDRAULIC ANALYSIS SUMMARY NIPPERSINK CREEK

					10-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						50-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						100-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS					
								EXISTING WATERWAY OPENING						EXISTING WATERWAY OPENING						EXISTING WATERWAY OPENING		
STRUCTURE NUMBER	LOCATION	CONSTRUCTION DATE OF EXISTING BRIDGE	RECOMMENDED DESIGN FREQUENCY STANDARD (YEARS)	REPLACEMENT REQUIRED BY APPLICATION OF STANDARD	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)
275	DARLING ROAD	(C)1930	10	YES	1,670	826.7	4.5	0.3	1.9	- 0.3	2,740	827.6	5.4	0.3	2.8	0.6	3,280	828.0	5.8	0.3	3.2	1.0
276	C.&N.W.R.R.	1911	--	--	1,680	823.2	2.2	0.4	-10.8	-10.9	2,760	824.5	3.5	0.6	- 9.5	- 9.6	3,300	825.1	4.1	0.7	- 8.9	- 9.0
277	STH 12	1965	50	NO	1,680	822.8	1.8	0.3	- 8.0	- 8.5	2,760	823.9	2.9	0.4	- 6.9	- 7.4	3,300	824.4	3.4	0.5	- 6.4	- 6.9
278	MAIN STREET	(C)1930	50	YES[a]	1,690	818.1	3.6	0.6	- 1.3	- 2.4	2,770	819.6	5.1	1.3	0.2	- 0.9	3,310	820.2	5.7	1.6	0.8	- 0.3
279	C.&N.W.R.R.	1912	--	--	1,690	817.5	4.5	0.6	-14.8	-15.0	2,770	818.3	5.3	0.7	-14.0	-14.2	3,310	818.6	5.6	0.8	-13.7	-13.9

[a] STANDARD COULD BE MET BY ELEVATION OF THE APPROACH ROAD.

SOURCE: U.S. SOIL CONSERVATION SERVICE AND SEWRPC.

TABLE E-4

HYDRAULIC ANALYSIS SUMMARY SILVER LAKE OUTLET

					10-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						50-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						100-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS					
STRUCTURE NUMBER	LOCATION	CONSTRUCTION DATE OF EXISTING BRIDGE	RECOMMENDED DESIGN FREQUENCY STANDARD (YEARS)	REPLACEMENT REQUIRED BY APPLICATION OF STANDARD	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)
270	CTH F	CULVERT	50	NO	80	749.2[a]	0.7	--	- 0.1	- 4.1	75	748.7[a]	0.2	--	- 0.6	- 4.6	55	748.2[a]	- 0.3	--	- 1.1	- 5.1
271	M.ST.P.&S.STE.M.R.R.	CULVERT	--	--	80	749.1[a]	0.6	--	- 3.9	- 4.8	75	748.6[a]	0.1	--	- 4.4	- 5.3	55	748.1[a]	- 0.4	--	- 4.9	- 5.8
272	CTH B	CULVERT	50	YES[b]	170	747.9	2.9	0.1	0.7	0.5	150	747.8	2.8	0.1	0.6	0.4	105	747.5	2.5	0.1	0.3	0.1
272A	STP ROAD	CULVERT	--	--	170	747.8[c]	2.8	0.2	2.8	2.1	150	747.7[d]	2.7	0.2	2.7	2.0	105	747.4[e]	2.5	0.1	2.4	1.7

[a]ELEVATION WAS DETERMINED BY ESTIMATES OF STAGE-FREQUENCY RELATIONSHIPS ON SILVER LAKE AND NOT BY STAGE-DISCHARGE RELATIONSHIPS.

[b]BOTH STRUCTURE REPLACEMENT AND ELEVATION OF THE APPROACH ROAD WOULD BE REQUIRED TO MEET STANDARD.

[c]ASSUMES FOX RIVER MAIN STEM IS AT 100-YEAR FLOOD STAGE.

[d]ASSUMES FOX RIVER MAIN STEM IS AT 50-YEAR FLOOD STAGE.

[e]ASSUMES FOX RIVER MAIN STEM IS AT 10-YEAR FLOOD STAGE.

SOURCE: U.S. SOIL CONSERVATION SERVICE AND SEWRPC.

TABLE E-5

HYDRAULIC ANALYSIS SUMMARY BASSETT CREEK

					10-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						50-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						100-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS					
STRUCTURE NUMBER	LOCATION	CONSTRUCTION DATE OF EXISTING BRIDGE	RECOMMENDED DESIGN FREQUENCY STANDARD (YEARS)	REPLACEMENT REQUIRED BY APPLICATION OF STANDARD	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)
266	CTH F	(C)1930	50	YES	360	779.6	1.6	0.7	0.0	- 0.7	610	780.4	2.4	1.1	0.8	0.1	735	780.7	2.7	1.3	1.1	0.4
267	LILLY LAKE ROAD	UNKNOWN	10	YES[a]	360	754.8	2.8	0.6	0.1	- 1.1	625	755.5	3.5	0.7	0.8	- 0.4	750	735.6	3.6	0.6	0.9	- 0.3
268	FOX RIVER ROAD	(C)1930	50	YES[a]	365	746.7	3.2	0.4	- 0.8	- 1.8	640	748.3[b]	4.8	0.0	0.8	- 0.2	765	749.0[c]	5.5	0.0	1.5	0.5

[a]STANDARD COULD BE MET BY ELEVATION OF THE APPROACH ROAD.

[b]MAXIMUM WATER SURFACE ELEVATION PRODUCED BY A 50-YEAR RECURRENCE INTERVAL FLOOD ON THE FOX RIVER MAIN STEM.

[c]MAXIMUM WATER SURFACE ELEVATION PRODUCED BY A 100-YEAR RECURRENCE INTERVAL FLOOD ON THE FOX RIVER MAIN STEM.

SOURCE: U.S. SOIL CONSERVATION SERVICE AND SEWRPC.

TABLE E-6

HYDRAULIC ANALYSIS SUMMARY PETERSON CREEK

					10-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						50-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						100-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS					
STRUCTURE NUMBER	LOCATION	CONSTRUCTION DATE OF EXISTING BRIDGE	RECOMMENDED DESIGN FREQUENCY STANDARD (YEARS)	REPLACEMENT REQUIRED BY APPLICATION OF STANDARD	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)
260	CTH B	(C)1940	50	NO	425	771.7	2.1	0.6	- 1.5	- 1.5	670	772.0	2.4	0.7	1.2	- 1.2	775	772.1	2.5	0.7	- 1.1	- 1.1
261	HAHN ROAD	CULVERT	10	YES	415	758.3	2.3	0.1	0.2	- 0.7	660	758.6	2.6	0.1	0.5	- 0.4	765	758.7	2.7	0.1	0.6	- 0.3
262	RICHTER ROAD	UNKNOWN	10	YES[a]	415	752.6	2.1	0.1	1.8	1.1	650	752.9	2.4	0.1	2.1	1.4	755	753.0	2.5	0.1	2.2	1.5
--	PROPOSED STH 83	--	50	--	410	--	--	--	--	--	630	--	--	--	--	--	730	--	--	--	--	--
263	M.ST.P.&S.STE.M.R.R.	1917	--	--	410	750.5	2.0	0.5	- 7.6	- 7.6	630	751.2	2.7	0.6	- 6.9	- 6.9	730	751.5	3.0	0.8	- 6.6	- 6.6
264	CTH W	1957	50	YES	405	749.1	4.1	1.2	- 0.7	- 1.0	630	750.0	5.0	1.9[b]	0.2	- 0.1	730	750.2[c]	5.2	0.0	0.4	0.1

[a]BOTH STRUCTURE REPLACEMENT AND ELEVATION OF THE APPROACH ROAD WOULD BE REQUIRED TO MEET STANDARD.

[b]MAXIMUM WATER SURFACE ELEVATION ON THE DOWNSTREAM SIDE OF BRIDGE PRODUCED BY 50-YEAR RECURRENCE INTERVAL FLOOD ON THE FOX RIVER MAIN STEM.

[c]MAXIMUM WATER SURFACE ELEVATION PRODUCED BY 100-YEAR RECURRENCE INTERVAL FLOOD ON THE FOX RIVER MAIN STEM.

SOURCE: U.S. SOIL CONSERVATION SERVICE AND SEWRPC.

TABLE E-7

HYDRAULIC ANALYSIS SUMMARY HOOSIER CREEK

					10-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						50-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						100-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS					
STRUCTURE NUMBER	LOCATION	CONSTRUCTION DATE OF EXISTING BRIDGE	RECOMMENDED DESIGN FREQUENCY STANDARD (YEARS)	REPLACEMENT REQUIRED BY APPLICATION OF STANDARD	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)
251	STH 11	1949	50	NO	12	768.6	- 1.1	0.2	- 2.5	- 3.4	17	769.1	- 0.6	0.4	- 2.0	- 2.9	20	769.3	- 0.4	0.5	- 1.8	- 2.7
--	PROPOSED STH 11	--	50	--	135	--	--	--	--	--	220	--	--	--	--	--	260	--	--	--	--	--
252	MT. TOM ROAD	(C)1930	10	NO	135	759.6	0.0	0.1	- 0.4	- 1.7	220	760.4	0.8	0.2	0.4	- 0.9	260	760.5	0.9	0.1	0.5	- 0.8
256	STH 43	1931	50	YES	1,040	757.2	4.7	1.1	0.1	- 0.3	1,530	757.7	5.5	0.8	0.6	0.2	2,090	757.9	5.7	0.3	0.8	0.4
257	BREVER ROAD	(C)1930	10	YES[a]	950	751.4	4.8	0.1	2.6	0.8	1,500	752.6[b]	6.0	0.0	3.8	2.0	1,790	753.2[c]	6.6	0.0	4.4	2.6
258	M.ST.P.&S.STE.M.R.R.	1942	--	--	910	751.2	4.4	0.4	- 3.9	- 4.0	1,420	752.6[b]	5.8	0.0	- 2.5	- 2.6	1,690	753.2[c]	6.4	0.0	- 1.9	- 2.0

[a]BOTH STRUCTURE REPLACEMENT AND ELEVATION OF THE APPROACH ROAD WOULD BE REQUIRED TO MEET STANDARD.

[b]MAXIMUM WATER SURFACE ELEVATION PRODUCED BY 50-YEAR RECURRENCE INTERVAL FLOOD ON FOX RIVER MAIN STEM.

[c]MAXIMUM WATER SURFACE ELEVATION PRODUCED BY 100-YEAR RECURRENCE INTERVAL FLOOD ON FOX RIVER MAIN STEM.

SOURCE: U.S. SOIL CONSERVATION SERVICE AND SEWRPC.

TABLE E-8

HYDRAULIC ANALYSIS SUMMARY HOOSIER CREEK CANAL

					10-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						50-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						100-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS					
STRUCTURE NUMBER	LOCATION	CONSTRUCTION DATE OF EXISTING BRIDGE	RECOMMENDED DESIGN FREQUENCY STANDARD (YEARS)	REPLACEMENT REQUIRED BY APPLICATION OF STANDARD	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)
253	CTH B	CULVERT	50	YES[a]	320	794.5	1.5	0.9	- 1.9	- 1.9	530	796.5	3.5	1.3	0.1	0.1	630	796.9	3.4	1.2	0.5	0.5
254	CTH J	CULVERT	50	YES[b]	830	782.4	3.4	0.1	1.8	1.4	1,300	783.3	4.3	0.0	2.7	2.3	1,510	783.6	4.6	0.0	3.0	2.6
255	MT. TOM ROAD	(C)1930	10	YES	950	772.4	2.9	0.5	1.8	- 0.9	1,480	772.9	3.4	0.6	2.3	- 0.4	1,710	773.1	3.6	0.6	2.5	- 0.2
--	PROPOSED STH 83	--	50	--	950	--	--	--	--	--	1,480	--	--	--	--	--	1,710	--	--	--	--	--

[a]STANDARD COULD BE MET BY ELEVATION OF THE APPROACH ROAD.

[b]BOTH STRUCTURE REPLACEMENT AND ELEVATION OF THE APPROACH ROAD WOULD BE REQUIRED TO MEET STANDARD.

SOURCE: U.S. SOIL CONSERVATION SERVICE AND SEWRPC.

TABLE E-9

HYDRAULIC ANALYSIS SUMMARY WHITE RIVER

STRUCTURE NUMBER	LOCATION	CONSTRUCTION DATE OF EXISTING BRIDGE	RECOMMENDED DESIGN FREQUENCY STANDARD (YEARS)	REPLACEMENT REQUIRED BY APPLICATION OF STANDARD	10-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						50-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						100-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS					
					INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)
217	LAKE ROAD	1929	10	NO	300	864.6	0.0	0.0	- 3.2	- 6.9	420	864.7	0.0	0.0	- 3.1	- 6.8	470	864.7	0.0	0.0	- 3.1	- 6.8
222	WILLOW STREET	1923	10	NO	220[a]	855.9	0.9	3.6	- 4.8	- 4.9	300[c]	856.5	1.5	3.6	- 4.2	- 4.3	340[d]	856.9	1.9	3.8	- 3.8	- 3.9
223	C.&N.W.R.R.	1908	--	--	310	852.3	1.3	0.4	-27.7	-28.7	435	852.9	1.9	0.5	-27.1	-28.1	495	853.1	2.1	0.5	-26.9	-27.9
--	PROPOSED USH 12	--	100	--	320	--	--	--	--	--	450	--	--	--	--	--	520	--	--	--	--	--
224	PRIVATE ROAD	1968	--	--	580	829.5	2.0	0.1	3.2	- 0.9	890	830.0	2.5	0.1	3.7	- 0.4	1,050	830.3	2.8	0.2	4.0	- 0.1
225	SHERIDAN SPRINGS RD	1968	10	NO	580	827.3	2.5	0.1	- 0.7	- 2.1	890	827.8	3.0	0.1	- 0.2	- 1.6	1,050	828.1	3.3	0.2	0.1	- 1.3
226	SHERIDAN SPRINGS RD	1967	10	NO	810	822.3	3.3	0.4	- 2.5	- 3.8	1,320	823.4	4.4	0.3	- 1.4	- 2.7	1,580	823.9	4.9	0.4	- 0.9	- 2.2
236	SOUTH ROAD	1935	10	NO	1,450	787.0	3.0	0.7	- 2.5	- 4.4	2,350	787.9	3.9	0.7	- 1.6	- 3.5	2,800	788.3	4.3	0.8	- 1.2	- 3.1
237	C.M.ST.P.&P.R.R.	(C)1920	--	--	1,530	774.5	5.5	0.7	- 6.2	- 6.3	2,550	776.2	6.7	1.0	- 4.5	- 4.6	3,020	776.9	7.9	1.2	- 3.8	- 3.9
238	YAHNKE ROAD	1900	10	YES[b]	1,530	773.3	3.8	0.0	3.1	- 2.1	2,550	774.8	5.3	0.1	4.6	- 0.6	3,020	775.4	5.9	0.1	5.2	0.0
239	STH 36	1923	50	NO	1,950	772.4	4.4	0.4	- 1.4	- 1.7	3,100	773.8	5.8	0.6	0.0	- 0.3	3,680	774.4	6.4	0.7	0.6	0.3
--	PROPOSED STH 11	--	50	--	1,950	--	--	--	--	--	3,100	--	--	--	--	--	3,680	--	--	--	--	--
240	STH 11	1923	50	YES[b]	2,100	768.9	2.4	0.6	1.1	- 1.3	3,300	769.8	3.3	0.4	2.0	- 0.4	3,970	770.2	3.7	0.3	2.4	0.0
241	BIENEMAN ROAD	1916	10	NO	2,100	764.6	2.1	0.3	- 0.3	- 7.0	3,300	765.2	2.7	0.2	0.3	- 6.4	3,970	765.3	2.8	0.2	0.4	- 6.3
242	M.ST.P.&S.STE.M.R.R.	1930	--	--	4,000	764.3	0.0	0.0	- 5.0	- 5.6	6,350	765.0	0.0	0.0	- 4.3	- 4.9	7,450	765.1	0.0	0.0	- 4.2	- 4.8
244	STH 36&83	1956	50	NO	3,950	758.0	- 1.0	0.4	- 6.0	- 6.7	6,300	760.4	1.4	0.5	- 3.6	- 4.3	7,400	761.4	2.4	0.6	- 2.6	- 3.3
245	BRIDGE STREET	(C)1930	10	NO	3,950	757.6	2.6	0.7	- 1.0	- 3.9	6,300	759.9	4.9	1.2	1.3	- 1.6	7,400	760.8	5.8	1.3	2.2	0.7

[a]ASSUMES 80 CFS DISCHARGED THROUGH WISCONSIN POWER CANAL.

[c]ASSUMES 120 CFS DISCHARGED THROUGH WISCONSIN POWER CANAL.

[d]ASSUMES 130 CFS DISCHARGED THROUGH WISCONSIN POWER CANAL.

[b]BOTH STRUCTURE REPLACEMENT AND ELEVATION OF APPROACH ROAD WOULD BE REQUIRED TO MEET STANDARD.

SOURCE: U.S. SOIL CONSERVATION SERVICE AND SEWRPC.

TABLE E-10

HYDRAULIC ANALYSIS SUMMARY COMO CREEK

STRUCTURE NUMBER	LOCATION	CONSTRUCTION DATE OF EXISTING BRIDGE	RECOMMENDED DESIGN FREQUENCY STANDARD (YEARS)	REPLACEMENT REQUIRED BY APPLICATION OF STANDARD	10-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						50-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						100-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS					
					INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)
211	STH 12	1941	50	NO	50	849.8	2.1	0.3	- 1.6	- 2.2	70	850.6	2.9	0.3	- 0.8	- 1.4	80	850.9	3.2	0.3	- 0.5	- 1.1
--	PROPOSED USH 12	--	100	--	50	--	--	--	--	--	70	--	--	--	--	--	80	--	--	--	--	--
212	PARK DRIVE	(C)1930	10	NO	50	849.5	1.8	0.1	- 0.3	- 0.4	70	850.3	2.5	0.1	- 0.5	0.4	80	850.6	2.9	0.1	0.8	0.7
213	CTH NN	1942	50	NO	320	849.2	2.9	0.1	- 4.5	- 4.5	530	850.1	3.8	0.1	- 3.6	- 3.6	640	850.4	4.1	0.1	- 3.3	- 3.3
215	MT. FUGI ROAD	UNKNOWN	--	--	340	837.6	1.4	0.4	0.3	- 0.1	550	838.3	2.1	0.2	1.0	0.6	660	838.5	2.3	0.1	1.2	0.8
216	STH 36	1954	50	NO	350	831.0	1.4	0.3	- 1.8	- 2.0	570	831.7	2.1	0.8	- 1.1	- 1.3	670	831.9	2.3	0.9	- 0.9	- 1.1

SOURCE: U.S. SOIL CONSERVATION SERVICE AND SEWRPC.

TABLE E-11

HYDRAULIC ANALYSIS SUMMARY ORE CREEK

STRUCTURE NUMBER	LOCATION	CONSTRUCTION DATE OF EXISTING BRIDGE	RECOMMENDED DESIGN FREQUENCY STANDARD (YEARS)	REPLACEMENT REQUIRED BY APPLICATION OF STANDARD	10-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						50-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						100-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS					
					INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)
230	STH 36	1929	50	NO	620	837.8	2.8	0.5	- 7.0	- 8.0	1,030	838.6	3.1	0.7	- 6.2	- 7.2	1,220	838.9	3.4	0.8	- 5.9	- 6.9
231	STH 36	1928	50	NO	620	823.4	3.7	0.6	- 4.0	- 4.1	1,030	824.5	4.8	0.7	- 2.9	- 3.0	1,220	825.0	5.3	0.9	- 2.4	- 2.5
232	PRIVATE ROAD	UNKNOWN	--	--	710	821.2	2.9	0.7	- 1.4	- 2.8	1,160	822.2	3.9	0.9	- 0.4	- 1.8	1,400	822.7	4.4	1.0	0.1	1.3
233	PRIVATE ROAD	UNKNOWN	--	--	790	814.7	2.0	0.3	1.0	- 0.7	1,300	815.2	2.5	0.1	1.5	- 0.2	1,520	815.5	2.8	0.2	1.8	0.1
234	STH 36	1928	50	NO	880	797.7	1.2	0.4	- 1.6	- 4.1	1,410	798.5	2.0	0.4	- 0.8	- 3.3	1,670	798.8	2.3	0.4	- 0.5	- 3.0
235	S. CHURCH STREET	1965	10	YES[a]	880	790.0	3.8	0.5	0.3	- 3.2	1,410	791.1	4.9	0.6	0.4	- 2.1	1,670	791.4	5.2	0.6	1.7	- 1.8

[a]STANDARD COULD BE MET BY ELEVATION OF APPROACH ROAD.

SOURCE: U.S. SOIL CONSERVATION SERVICE AND SEWRPC.

TABLE E-12

HYDRAULIC ANALYSIS SUMMARY HONEY CREEK

STRUCTURE NUMBER	LOCATION	CONSTRUCTION DATE OF EXISTING BRIDGE	RECOMMENDED DESIGN FREQUENCY STANDARD (YEARS)	REPLACEMENT REQUIRED BY APPLICATION OF STANDARD	10-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						50-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						100-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS					
					INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)
173A	STERLINGWORTH DRIVE	CULVERT	--	--	40	885.3	0.0	0.0	- 1.4	- 1.7	60	886.0	0.0	0.0	- 0.7	- 1.0	70	886.4	0.0	0.0	- 0.3	- 0.6
175	STH 67	CULVERT	50	NO	40	877.6	- 1.9	0.1	-10.3	-10.3	60	878.2	- 1.3	0.2	- 9.7	- 9.7	70	878.4	- 1.1	0.2	- 9.5	- 9.5
177	MARSH ROAD	UNKNOWN	10	YES[b]	230	846.0	5.0	0.1	4.2	1.5	375	847.0	6.0	0.2	5.2	2.5	445	847.3	6.3	0.2	5.5	2.8
178	BOWERS ROAD	(C)1930	10	NO	500	845.8	2.8	0.3	- 1.1	- 2.5	810	846.6	3.6	0.3	- 0.3	- 1.7	960	846.9	3.9	0.3	0.0	- 1.4
179	STH 15	1949	50	NO	500	845.0	2.0	0.3	- 2.3	- 2.3	810	845.8	2.8	0.5	- 1.5	- 1.5	960	846.1	3.1	0.6	- 1.2	- 1.2
179A	TOWN LINE ROAD	(C)1950	10	NO	950	836.0	0.2	2.7	- 0.9	- 1.7	1,590	837.4	1.6	3.4	0.5	- 0.3	1,900	837.8	2.0	3.6	0.9	0.1
181	CTH G	1948	50	NO	1,000	826.3	2.3	0.3	- 6.2	- 6.2	1,630	828.2	4.2	0.4	- 4.3	- 4.3	1,945	829.0	5.0	0.5	- 3.5	- 3.5
--	PROPOSED ROCK FRWY	--	100	--	950	--	--	--	--	--	1,570	--	--	--	--	--	1,900	--	--	--	--	--
182	CARVER ROAD	(C)1950	10	YES[b]	875	816.8	2.3	0.1	2.0	- 0.4	1,430	817.8	3.3	0.2	3.0	0.6	1,700	818.4	3.9	0.5	3.6	1.2
183	STH 20	1955	50	NO	875	813.1	- 0.9	0.6	- 7.1	- 7.5	1,430	813.9	- 0.1	0.7	- 6.3	- 6.7	1,700	814.2	0.2	0.7	- 6.0	- 6.4
185	BELL SCHOOL ROAD	(C)1950	10	YES	1,065	802.2	3.7	1.0	0.6	- 0.6	1,740	802.9	4.4	1.0	1.3	0.1	2,080	803.1	4.6	0.9	1.5	0.3
186	HELBACH ROAD	(C)1950	10	YES[b]	1,180	793.8	4.3	0.2	1.1	- 1.9	1,900	794.9	5.4	0.1	2.2	- 0.8	2,240	795.3	5.8	0.1	2.6	- 0.4
187	STH 20	1939	50	YES	910	791.1	1.1	2.0	- 0.7	- 0.7	1,600	792.3	2.3	2.4	0.5	0.5	1,965	792.8	2.8	2.5	1.0	1.0
188	CTH D	(C)1940	50	YES[b]	1,060	782.0	3.0	0.3	0.4	- 0.2	1,770	782.9	3.9	0.4	1.3	0.7	2,110	783.3	4.3	0.5	1.7	1.1
189	PRIVATE ROAD	UNKNOWN	--	--	1,040	778.9	1.9	0.1	2.0	0.0	1,750	779.9	2.9	0.1	3.0	1.0	2,100	780.2	3.2	0.1	3.3	1.3
190	CTH CD	(C)1940	50	NO	1,180	772.0	5.0	0.5	- 1.8	- 1.8	1,985	773.3	6.3	0.8	- 0.5	- 0.5	2,400	773.8	6.8	0.8	0.0	0.0
203	BEACH ROAD	UNKNOWN	10	NO	1,180	771.2	- 0.8	0.1	- 1.3	- 1.4	1,985	772.1	0.1	0.1	- 0.4	- 0.5	2,400	772.6	0.6	0.1	0.1	0.0
204	DAM ROAD	UNKNOWN	10	NO	1,180	770.6	- 1.4	0.3	- 0.8	- 1.7	1,985	771.1	- 0.9	0.5	- 0.3	- 1.2	2,400	771.3	- 0.7	0.4	- 0.1	- 1.0
206	SPRING PRAIRIE ROAD	(C)1920	10	YES[c]	2,130	766.6	1.6	0.6	0.9	- 3.0	3,430	768.0	3.0	0.6	2.3	- 1.6	4,100	768.6	3.6	0.6	2.9	- 1.0
207	TALBOT ROAD	UNKNOWN	10	NO	2,070	765.0	2.0	0.4	- 1.8	- 5.2	3,430	766.3	3.3	0.7	- 0.5	- 3.9	4,100	766.9	3.9	0.9	0.1	- 3.3
208	PRIVATE ROAD	(C)1910	--	--	2,070	764.3[d]	0.9	0.0	- 0.5	- 3.7	3,430	765.0[e]	1.7	0.0	0.3	- 3.0	4,100	765.1[f]	1.7	0.0	0.3	- 2.9

[b]BOTH STRUCTURE REPLACEMENT AND ELEVATION OF APPROACH ROAD WOULD BE REQUIRED TO MEET STANDARD.

[c]STANDARD COULD BE MET BY ELEVATION OF APPROACH ROAD.

[d]MAXIMUM WATER SURFACE ELEVATION PRODUCED BY A 10-YEAR RECURRENCE INTERVAL FLOOD LEVEL ON ECHO LAKE.

[e]MAXIMUM WATER SURFACE ELEVATION PRODUCED BY A 50-YEAR RECURRENCE INTERVAL FLOOD LEVEL ON ECHO LAKE.

[f]MAXIMUM WATER SURFACE ELEVATION PRODUCED BY A 100-YEAR RECURRENCE INTERVAL FLOOD LEVEL ON ECHO LAKE.

SOURCE: U.S. SOIL CONSERVATION SERVICE AND SEWRPC.

TABLE E-13

HYDRAULIC ANALYSIS SUMMARY SUGAR CREEK

					10-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						50-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						100-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS					
								EXISTING WATERWAY OPENING						EXISTING WATERWAY OPENING						EXISTING WATERWAY OPENING		
STRUCTURE NUMBER	LOCATION	CONSTRUCTION DATE OF EXISTING BRIDGE	RECOMMENDED DESIGN FREQUENCY STANDARD (YEARS)	REPLACEMENT REQUIRED BY APPLICATION OF STANDARD	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)
191	CTH H	1953	50	YES[a]	520	894.5	1.5	0.5	- 1.0	- 1.9	830	895.6	2.6	0.9	0.1	- 0.8	980	895.9	2.9	1.0	0.4	- 0.5
--	PROPOSED USH 12 FRWY	--	100	--	650	--	--	--	--	--	1,030	--	--	--	--	--	1,215	--	--	--	--	--
192	FOSTER ROAD	(C)1930	10	NO	778	885.8	2.8	0.3	- 0.7	- 1.4	1,225	886.7	3.7	0.5	0.2	- 0.5	1,450	887.0	4.0	0.5	0.5	- 0.2
193	CTH D	(C)1940	50	YES[a]	1,240	869.2	3.2	0.3	- 1.0	- 2.3	2,000	870.3	4.3	0.4	0.1	- 1.2	2,370	870.7	4.7	0.5	0.5	- 0.8
194	STH 67	1966	50	NO	1,190	859.6	3.6	0.3	- 2.9	- 3.0	1,920	860.4	4.4	0.7	- 2.1	- 2.2	2,290	860.8	4.8	0.8	- 1.7	- 1.8
195	HODGES ROAD	(C)1920	10	YES	1,135	857.6	2.6	0.1	2.3	- 1.6	1,860	858.4	3.4	0.2	3.1	- 0.8	2,210	858.7	3.7	0.3	3.4	- 0.5
196	CTH D	(C)1920	50	YES[a]	1,080	852.8	2.8	0.3	- 0.1	- 2.4	1,790	853.9	3.9	0.3	1.0	- 1.3	2,130	854.3	4.3	0.3	1.4	- 0.9
197	HOOUNK ROAD	(C)1920	10	NO	860	847.7	3.5	0.3	- 0.8	- 1.5	1,500	848.9	4.7	0.5	0.4	- 0.3	1,815	849.3	5.1	0.5	0.8	0.1
--	PROPOSED ROCK FRWY	--	100	--	860	--	--	--	--	--	1,500	--	--	--	--	--	1,815	--	--	--	--	--
198	BOWERS ROAD	(C)1920	10	NO	840	838.5	3.5	0.5	- 1.9	- 3.8	1,460	839.7	4.7	0.5	- 0.7	- 2.6	1,775	840.2	5.2	0.6	- 0.2	- 2.1
199	CTH G	1962	50	NO	850	820.0	1.5	0.4	- 0.6	- 0.7	1,440	820.6	2.1	0.4	0.0	- 0.1	1,720	820.8	2.3	0.4	0.2	0.1
200	HARGRAVES ROAD	(C)1920	10	YES[a]	840	809.4	2.0	0.3	1.3	- 2.8	1,390	810.0	2.6	0.2	1.9	- 1.8	1,655	810.2	2.8	0.2	2.1	- 1.6
201	POTTER ROAD	(C)1940	10	NO	970	788.8	1.3	0.3	- 1.6	- 3.9	1,500	789.8	2.3	0.4	- 0.6	- 2.9	1,750	790.2	2.7	0.6	- 0.2	- 2.5
202	CTH CD	1954	50	NO	1,000	771.8	- 1.7	0.5	- 7.1	- 8.3	1,535	772.4	- 1.1	0.8	- 6.5	- 7.7	1,785	772.7	- 0.8	1.1	- 6.2	- 7.4

[a]STANDARD COULC BE MET BY ELEVATION OF THE APPROACH ROAD.

SOURCE: U.S. SOIL CONSERVATION SERVICE AND SEWRPC.

TABLE E-14

HYDRAULIC ANALYSIS SUMMARY EAGLE CREEK

					10-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						50-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						100-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS					
								EXISTING WATERWAY OPENING						EXISTING WATERWAY OPENING						EXISTING WATERWAY OPENING		
STRUCTURE NUMBER	LOCATION	CONSTRUCTION DATE OF EXISTING BRIDGE	RECOMMENDED DESIGN FREQUENCY STANDARD (YEARS)	REPLACEMENT REQUIRED BY APPLICATION OF STANDARD	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)
166	CTH N	CULVERT	50	NC	210	791.3	1.3	0.4	- 4.9	- 5.2	340	792.3	2.3	0.6	- 3.9	- 4.2	400	792.6	2.6	0.6	- 3.6	- 3.9
167	NOBLE SQUIRE ROAD	CULVERT	10	NO	495	790.0	4.0	1.6	- 0.8	- 0.9	755	791.1	5.1	2.1	0.3	0.2	880	791.2	5.2	2.1	0.4	0.3
168	CTH A	CULVERT	50	YES	630	782.0	4.5	0.9	- 0.9	- 1.0	930	783.0	5.5	1.2	0.1	0.0	1,075	783.3	5.8	1.2	0.4	0.3
169	CTH J	CULVERT	50	YES	690	780.8	2.8	0.8	- 0.4	- 0.9	1,020	781.5	3.5	1.1	0.3	- 0.2	1,170	781.8	3.8	1.3	0.6	0.1
170	EAST RIVER ROAD	CULVERT	10	NO	890	764.1	5.6	2.4[a]	- 0.2	- 0.2	1,270	765.2	6.7	2.3[b]	0.9	0.9	1,465	765.5	7.0	2.2[c]	1.2	1.2

[a]ASSUMES FOX RIVER MAIN STEM IS AT 10-YEAR RECURRENCE INTERVAL FLOOD STAGE.

[b]ASSUMES FOX RIVER MAIN STEM IS AT 50-YEAR RECURRENCE INTERVAL FLOOD STAGE.

[c]ASSUMES FOX RIVER MAIN STEM IS AT 100-YEAR RECURRENCE INTERVAL FLOOD STAGE.

SOURCE: U.S. SOIL CONSERVATION SERVICE AND SEWRPC.

TABLE E-15

HYDRAULIC ANALYSIS SUMMARY WIND LAKE DRAINAGE CANAL

					10-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						50-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						100-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS					
								EXISTING WATERWAY OPENING						EXISTING WATERWAY OPENING						EXISTING WATERWAY OPENING		
STRUCTURE NUMBER	LOCATION	CONSTRUCTION DATE OF EXISTING BRIDGE	RECOMMENDED DESIGN FREQUENCY STANDARD (YEARS)	REPLACEMENT REQUIRED BY APPLICATION OF STANDARD	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)
146&A	STH 24	UNKNOWN	50	NO	205	786.2	- 1.8	0.6	- 2.5	- 4.8	295	786.9	- 1.1	0.8	- 1.8	- 4.1	315	787.4	- 0.6	0.7	- 1.3	- 3.6
147	CTH Y	(C)1930	10	YES[a]	205	785.0	1.5	0.1	0.9	0.8	295	785.4	1.9	0.1	1.3	1.2	340	785.5	2.0	0.1	1.4	1.3
148	WOODS ROAD	(C)1940	10	YES[a]	330	780.7	4.2	0.3	1.3	1.3	525	781.8	5.3	0.3	2.4	2.4	625	782.2	5.7	0.4	2.8	2.8
150	MUSKEGO DAM ROAD	(C)1930	10	YES[b]	85	772.2	0.2	0.1	0.3	- 3.2	115[c]	772.5[d]	0.5	0.0	0.6	- 2.9	135	772.7[d]	0.7	0.0	0.8	- 2.7
--	NEW STH 36	1967	50	--	470	--	--	--	--	--	700	--	--	--	--	--	820	--	--	--	--	--
151	LOOMIS ROAD	(C)1930	50	NO	470	770.2	- 0.3	0.6	- 0.7	- 6.0	700	770.6	0.1	0.6	- 0.3	- 5.6	820	770.8	0.3	0.5	- 0.1	- 5.4
153	WIND LAKE ROAD	(C)1950	10	NO	240[c]	769.6[c]	3.1	0.0	- 0.6	- 1.6	400[c]	770.0[c]	3.5	0.0	- 0.2	- 1.2	490	770.3[c]	3.8	0.0	0.1	- 0.9
159	MALCHINE ROAD	(C)1940	10	NO	430[c]	769.6[c]	2.4	0.0	- 0.7	- 4.2	620[c]	770.0[c]	2.8	0.0	- 0.3	- 3.8	710	770.3[c]	3.1	0.0	0.0	- 3.5
160	CTH K	(C)1940	50	NO	430[c]	769.6[c]	3.1	0.0	- 4.2	- 6.2	620[c]	770.0[c]	3.5	0.0	- 3.8	- 5.8	710	770.3[c]	3.8	0.0	- 3.5	- 5.5
161	GRAYER ROAD	(C)1960	10	NO	730	769.5	- 0.5	0.1	- 7.7	- 8.1	1,200[c]	770.0[c]	0.0	0.0	- 7.2	- 7.6	1,400	770.3[c]	0.3	0.0	- 6.9	- 7.3
162	STH 20	(C)1940	50	NO	730	767.7	- 0.8	0.1	- 4.7	- 6.7	1,200	769.1	0.6	0.2	- 3.3	- 5.3	1,400	769.7	1.2	0.3	- 2.7	- 4.7
--	PROPOSED STH 36	1968	50	--	730	--	--	--	--	--	1,200	--	--	--	--	--	1,400	--	--	--	--	--
163	CTH J	(C)1930	50	NO	730	766.9[e]	1.4	0.0	- 2.2	- 5.3	1,200	767.5[f]	2.0	0.0	- 1.6	- 4.7	1,400	767.9[g]	2.4	0.0	- 1.2	- 4.3

[a]BCTH STRUCTURE REPLACEMENT AND ELEVATION OF APPROACH ROAD WOULD BE REQUIRED TO MEET STANDARD.

[b]STANDARD COULD BE MET BY ELEVATION OF APPROACH ROAD.

[c]ELEVATICNS DETERMINED BY ESTIMATES OF STAGE-FREQUENCY RELATIONSHIPS ON WIND LAKE AND NOT BY STAGE-DISCHARGE RELATIONSHIPS.

[d]ELEVATIONS DETERMINED BY ESTIMATES OF STAGE-FREQUENCY RELATIONSHIPS ON MUSKEGO LAKE AND NOT BY STAGE-DISCHARGE RELATIONSHIPS.

[e]MAXIMUM WATER SURFACE ELEVATION PRODUCED BY 10-YEAR RECURRENCE INTERVAL FLOOD ON FOX RIVER MAIN STEM.

[f]MAXIMUM WATER SURFACE ELEVATION PRODUCED BY 50-YEAR RECURRENCE INTERVAL FLOOD ON FOX RIVER MAIN STEM.

[g]MAXIMUM WATER SURFACE ELEVATION PRODUCED BY 100-YEAR RECURRENCE INTERVAL FLOOD ON FOX RIVER MAIN STEM.

SOURCE: U.S. SOIL CONSERVATION SERVICE AND SEWRPC.

TABLE E-16

HYDRAULIC ANALYSIS SUMMARY WAUBEESEE LAKE CANAL

					10-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						50-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						100-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS					
								EXISTING WATERWAY OPENING						EXISTING WATERWAY OPENING						EXISTING WATERWAY OPENING		
STRUCTURE NUMBER	LOCATION	CONSTRUCTION DATE OF EXISTING BRIDGE	RECOMMENDED DESIGN FREQUENCY STANDARD (YEARS)	REPLACEMENT REQUIRED BY APPLICATION OF STANDARD	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)
155	LONG LAKE ROAD	CULVERT	10	NO	85	778.7	- 0.3	0.0	- 1.7	- 1.7	140	779.2	0.2	0.0	- 1.2	- 1.2	170	779.6	0.6	0.0	- 0.8	- 0.8
156	LOOMIS ROAD	CULVERT	50	NO	75	778.7	--[a]	--[a]	- 0.5	- 1.8	130	779.2	--[a]	--[a]	0.0	- 1.3	160	779.6	--[a]	--[a]	0.4	- 0.9
157	WIND LAKE ROAD	CULVERT	10	NO	75	777.4	0.9	1.4	- 1.8	- 2.8	130	778.9	2.4	0.1	- 0.3	- 1.3	160	779.4	2.9	0.1	0.2	- 1.2
158	POWER LINE ROAD	CULVERT	--	--	75	774.6	2.6	1.4	- 7.2	- 7.2	130	777.7	5.7	3.7	- 4.1	- 4.1	160	779.2	7.2	4.8	- 2.6	- 2.6

[a]NCT APPLICABLE.

SOURCE: U.S. SOIL CONSERVATION SERVICE AND SEWRPC.

TABLE E-17

HYDRAULIC ANALYSIS SUMMARY MUKWONAGO RIVER

STRUCTURE NUMBER	LOCATION	CONSTRUCTION DATE OF EXISTING BRIDGE	RECOMMENDED DESIGN FREQUENCY STANDARD (YEARS)	REPLACEMENT REQUIRED BY APPLICATION OF STANDARD	10-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						50-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						100-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS					
								EXISTING WATERWAY OPENING						EXISTING WATERWAY OPENING						EXISTING WATERWAY OPENING		
					INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)
122	CTH X	CULVERT	50	YES	270	924.1	2.8	1.7	0.2	0.2	495	924.3	3.0	1.5	0.4	0.4	605	924.5	3.2	1.5	0.6	0.7
123	CTH NN	(C)1940	50	NO	670	877.7	1.7	0.7	- 5.2	- 5.5	1,170	878.8	2.8	0.9	- 4.1	- 4.4	1,420	879.3	3.3	1.1	- 3.6	- 4.9
124	STH 99	(C)1930	50	YES[a]	695	823.4	1.9	1.1	0.4	0.4	1,195	824.3	2.8	1.1	1.3	1.3	1,445	824.6	3.1	1.0	1.6	1.6
127	CTH E	UNKNOWN	50	YES[a]	700	813.1	4.1	0.2	1.2	1.2	1,200	814.1	5.1	0.2	2.2	2.2	1,450	814.5	5.5	0.2	2.6	2.6
128	CTH E	CULVERT	50	YES[a]	33	813.2	1.2	0.3	0.0	- 0.2	35	814.2	2.2	0.3	1.0	0.8	37	814.5	2.5	0.3	1.3	1.1
129	PRIVATE ROAD	CULVERT	--	--	700	808.9	1.9	0.2	1.7	1.1	1,200	809.8	2.8	0.2	2.6	1.8	1,450	810.0	3.0	0.1	2.8	2.0
130	BEULAH ROAD	(C)1920	10	YES[a]	745	801.4	3.4	0.5	1.0	1.0	1,245	802.4	4.4	0.4	2.0	2.0	1,505	802.8	4.8	0.4	2.4	2.4
131	CTH I	(C)1930	50	YES	1,000	792.2	1.2	1.0	0.0	- 0.9	1,700	793.1	2.1	1.3	0.9	0.0	2,045	793.4	2.4	1.4	1.2	0.3
132	STH 15	1922	50	NO	640	790.5	--[b]	0.0	- 2.7	- 3.2	920	791.1	--[b]	0.0	- 2.1	- 2.6	1,040	791.3	--[b]	0.0	- 1.9	- 2.4
134	M.ST.P.&S.STE.M.R.R.	1949	--	NO	640	686.8	0.3	0.4	-18.8	-18.8	920	787.6	1.1	0.4	-18.0	-18.0	1,040	787.9	1.4	0.4	-17.7	-17.7
135	STH 83	1920	50	NO	640	786.4	0.2	0.2	- 1.0	- 1.2	920	787.2	1.0	0.2	- 0.2	- 0.4	1,040	787.5	1.3	0.3	0.1	- 0.1
--	PROPOSED STH 83	--	50	--	680	--	--	--	--	--	965	--	--	--	--	--	1,100	--	--	--	--	--

[a]BOTH STRUCTURE REPLACEMENT AND ELEVATION OF APPROACH ROAD WOULD BE NEEDED TO MEET STANDARD.

[b]NOT APPLICABLE.

SOURCE: U.S. SOIL CONSERVATION SERVICE AND SEWRPC.

TABLE E-18

HYDRAULIC ANALYSIS SUMMARY GENESEE CREEK

STRUCTURE NUMBER	LOCATION	CONSTRUCTION DATE OF EXISTING BRIDGE	RECOMMENDED DESIGN FREQUENCY STANDARD (YEARS)	REPLACEMENT REQUIRED BY APPLICATION OF STANDARD	10-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						50-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						100-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS					
								EXISTING WATERWAY OPENING						EXISTING WATERWAY OPENING						EXISTING WATERWAY OPENING		
					INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)
99	STH 59	1960	50	NO	540	848.3	0.3	0.3	- 9.3	-10.7	830	848.7	0.7	0.4	- 8.9	-10.3	970	848.8	0.8	0.4	- 8.8	-10.2
100	GENESEE ROAD	(C)1950	50	NO	540	840.6	0.9	0.4	- 3.5	- 3.7	830	840.8	1.1	0.5	- 3.3	- 3.5	970	840.9	1.2	0.5	- 3.2	- 3.4
--	PROPOSED STH 83	--	50	--	540	--	--	--	--	--	830	--	--	--	--	--	970	--	--	--	--	--
102	CTH X	CULVERT	50	NO	60	886.4	0.4	1.6	- 5.3	- 5.3	67	886.6	0.6	1.7	- 5.1	- 5.1	70	886.7	0.7	1.7	- 5.0	- 5.0
103	STH 83	1955	50	NO	235	854.8	0.8	1.8	- 7.1	- 7.1	370	855.9	1.9	2.1	- 6.0	- 6.0	435	856.4	2.4	2.4	- 5.5	- 5.5
104	HOLIDAY ROAD	UNKNOWN	10	NO	245	834.7	1.7	2.4	- 4.3	- 4.3	390	836.5	3.5	4.0	- 2.5	- 2.5	460	838.2	5.2	5.6	- 0.8	- 0.8
--	PROPOSED STH 83	--	50	--	245	--	--	--	--	--	390	--	--	--	--	--	460	--	--	--	--	--
106	CTH X	(C)1950	50	YES	845	792.1	2.6	0.8	- 0.4	- 1.9	1,400	792.9	3.4	1.2	0.4	- 1.1	1,675	793.1	3.6	1.3	0.6	- 0.9
107	CTH XI	(C)1930	50	YES[a]	845	788.0	2.0	0.3	1.1	- 1.0	1,400	788.3	2.3	0.3	1.4	- 0.7	1,675	788.4[b]	2.4	0.0	1.5	- 0.6

[a]BOTH STRUCTURE REPLACEMENT AND ELEVATION OF APPROACH ROAD WOULD BE REQUIRED TO MEET STANDARD.

[b]MAXIMUM WATER SURFACE ELEVATION PRODUCED BY 100-YEAR RECURRENCE INTERVAL FLOOD ON FOX RIVER MAIN STEM.

SOURCE: U.S. SOIL CONSERVATION SERVICE AND SEWRPC.

TABLE E-19

HYDRAULIC ANALYSIS SUMMARY PEBBLE BROOK

STRUCTURE NUMBER	LOCATION	CONSTRUCTION DATE OF EXISTING BRIDGE	RECOMMENDED DESIGN FREQUENCY STANDARD (YEARS)	REPLACEMENT REQUIRED BY APPLICATION OF STANDARD	10-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						50-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						100-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS					
								EXISTING WATERWAY OPENING						EXISTING WATERWAY OPENING						EXISTING WATERWAY OPENING		
					INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)
109	BIG BEND ROAD	1935	50	NO	255	819.7	1.2	0.6	- 1.7	- 1.9	420	820.1	1.6	0.3	- 1.3	- 1.5	500	820.5	2.0	1.1	- 0.9	- 1.0
--	NEW CTH F	1968	50	--	260	--	--	--	--	--	420	--	--	--	--	--	500	--	--	--	--	--
110	CTH I	(C)1940	50	YES[a]	405	809.1	2.6	0.1	0.6	- 1.0	690	809.6	3.1	0.1	1.1	- 0.5	835	809.8	3.3	0.1	1.3	- 0.3
111	CTH U	CULVERT	50	YES[b]	415	849.9	4.4	2.4	0.0	- 0.7	585	850.2	4.7	2.4	0.3	- 0.4	825	850.4	4.9	2.4	0.5	- 0.2
112	BIG BEND ROAD	1935	50	YES[b]	500	822.7	3.2	1.2	- 0.8	- 3.8	875	823.8	4.3	1.9	0.3	- 2.7	1,065	824.2	4.7	2.1	0.7	- 2.3
--	NEW CTH F	1968	50	--	500	--	--	--	--	--	875	--	--	--	--	--	1,065	--	--	--	--	--
113	M.ST.P.&S.STE.M.R.R.	1957	--	--	760	809.0	2.0	0.3	- 3.4	- 3.4	1,290	809.5	2.5	0.5	- 2.9	- 2.9	1,550	809.7	2.7	0.6	- 2.7	- 2.7
114	GLENDALE ROAD	(C)1930	50	YES[a]	775	805.8	4.3	0.6	1.6	0.7	1,300	806.6	5.1	0.2	- 2.4	1.5	1,580	807.0	5.5	0.3	2.8	1.9
115	M.ST.P.&S.STE.M.R.R.	1959	--	--	775	801.4	2.1	0.6	- 4.1	- 4.4	1,300	801.9	2.6	0.8	- 3.6	- 3.9	1,580	802.1	2.8	0.9	- 3.4	- 3.7
116	M.ST.P.&S.STE.M.R.R.	1960	--	--	790	796.5	5.0	0.4	- 2.2	- 2.7	1,350	797.7	6.2	0.9	- 1.0	- 1.5	1,655	798.4	6.9	1.3	- 0.3	- 0.8
117	CTH XX	(C)1940	50	YES[a]	790	796.1	4.1	1.3	0.7	- 0.6	1,360	796.8	4.8	1.4	1.4	0.1	1,655	797.1	5.1	1.2	1.7	0.4
118	M.ST.P.&S.STE.M.R.R.	1943	--	--	790	794.5	2.0	--[c]	- 3.2	- 3.5	1,350	794.9	2.4	--[c]	- 2.8	- 3.1	1,655	795.4	2.9	--[c]	- 2.3	- 2.6
119	M.ST.P.&S.STE.M.R.R.	1943	--	--	790	792.0	0.7	--[c]	- 5.8	- 5.9	1,385	792.8	2.1	--[c]	- 5.0	- 5.1	1,695	793.0	2.3	--[c]	- 4.8	- 4.9

[a]BOTH STRUCTURE REPLACEMENT AND ELEVATION OF APPROACH ROAD WOULD BE REQUIRED TO MEET STANDARD.

[b]STANDARD COULD BE MET BY ELEVATION OF APPROACH ROAD.

[c]BRIDGE LOSS NOT COMPUTED, FLOW IS NOT CONFINED TO BRIDGE.

SOURCE: U.S. SOIL CONSERVATION SERVICE AND SEWRPC.

TABLE E-20

HYDRAULIC ANALYSIS SUMMARY PEBBLE CREEK

STRUCTURE NUMBER	LOCATION	CONSTRUCTION DATE OF EXISTING BRIDGE	RECOMMENDED DESIGN FREQUENCY STANDARD (YEARS)	REPLACEMENT REQUIRED BY APPLICATION OF STANDARD	10-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						50-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						100-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS					
								EXISTING WATERWAY OPENING						EXISTING WATERWAY OPENING						EXISTING WATERWAY OPENING		
					INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	BRIDGE HEAD LOSS (FEET)	DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	DEPTH ON ROAD AT C/L OF BRIDGE (FEET)
92	CTH DT	(C)1960	50	NO	615	819.5	3.8	0.8	- 1.8	- 1.8	980	820.7	5.0	1.3	- 0.6	- 0.6	1,170	821.1	5.4	1.4	- 0.2	- 0.2
93	CTH TT	(C)1940	50	YES	935	803.9	3.9	1.3	- 0.7	- 1.9	1,480	805.3	5.3	1.8	0.7	- 0.5	1,765	805.8	5.8	1.9	1.2	0.0
94	C.&N.W.R.R.[a]	1907	--	NO	950[a]	800.5[a]	3.0[a]	1.2[a]	- 8.9[a]	- 9.2[a]	1,510[a]	801.7[a]	4.2[a]	1.8[a]	- 7.7[a]	- 8.0[a]	1,800[a]	802.3[a]	4.8[a]	2.1[a]	- 7.1[a]	- 7.4[a]
95	C.M.ST.P.&P.R.R.[a]	1930	--	NO	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]
96	CTH D	(C)1940	50	YES	940	796.2	3.7	0.2	0.4	0.0	1,490	797.0	4.5	0.2	1.2	0.8	1,750	797.3	4.8	0.2	1.5	1.1
--	PROPOSED WAUK BYPASS	--	50	--	940	--	--	--	--	--	1,480	--	--	--	--	--	1,730	--	--	--	--	--
97	STH 59	1960	50	NO	933	793.6	4.1	2.1	- 6.6	- 9.9	1,470	795.1	5.6	2.9	- 5.1	- 8.4	1,710	795.7	6.2	3.3	- 4.3	- 7.8

[a]CONSIDERED AS ONE UNIT FOR ANALYSIS PURPOSES.

SOURCE: U.S. SOIL CONSERVATION SERVICE AND SEWRPC.

TABLE E-21

HYDRAULIC ANALYSIS SUMMARY PEWAUKEE RIVER

STRUCTURE NUMBER	LOCATION	CONSTRUCTION DATE OF EXISTING BRIDGE	RECOMMENDED DESIGN FREQUENCY STANDARD (YEARS)	REPLACEMENT REQUIRED BY APPLICATION OF STANDARD	10-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						50-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						100-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS					
					INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)
67	CTH JJ	1943	50	NO	75	853.0	--	2.4[a]	- 0.7	- 2.8	105	853.3	--	2.2[a]	- 0.4	- 2.5	120	853.5	--	2.2[a]	- 0.2	- 2.3
69	OAKTON AVENUE	UNKNOWN	10	NO	320	848.2	0.5	0.5	- 0.3	- 1.3	520	849.6	2.1	0.5	1.1	0.1	620	849.9	2.4	0.2	1.4	0.4
70	CLARK STREET	UNKNOWN	10	NO	320	847.3	- 4.2	0.5	- 4.2	- 4.2	520	848.3	- 3.2	0.7	- 3.2	- 3.2	620	848.7	- 2.8	0.7	- 2.8	- 2.8
72	CTH SS	(C)1950	50	NO	360	846.4	3.4	0.6	- 1.8	- 1.8	610	877.3	4.3	0.7	- 0.9	- 0.9	720	847.8	4.8	1.0	- 0.4	- 0.4
73	IH 94	1958	100	NO	470	842.0	2.9	0.5	- 6.8	-11.1	760	843.2	4.1	0.8	- 5.6	- 9.9	910	843.8	4.7	1.0	- 5.0	- 9.3
74	CTH F	(C)1940	50	NO	470	841.2	2.5	0.7	- 1.8	- 2.7	760	842.2	3.5	0.8	- 0.8	- 1.7	910	842.8	4.1	1.0	- 0.2	- 1.1
75	BUSSE ROAD	1948	10	NO	460	836.0	2.0	1.3	- 5.0	- 5.0	750	837.4	3.4	1.7	- 3.6	- 3.6	900	837.9	3.9	1.9	- 3.1	- 3.1
76	PRIVATE ROAD	UNKNOWN	--	--	460	825.2	3.2	2.0	- 2.3	- 2.8	750	826.5	4.5	2.7	- 1.0	- 1.0	900	827.1	5.1	3.0	- 0.4	- 0.4
77	STH 164	1966	50	NO	460	819.9	- 0.1	2.1	- 2.9	- 3.2	750	821.5	1.5	2.5	- 1.3	- 1.6	900	822.4	2.4	2.8	- 0.4	- 0.7
78	C.M.ST.P.&P.R.R.	1930	--	--	460	818.1[b]	1.1	0.0	- 2.7	- 3.2	750	819.3[c]	2.3	0.0	- 1.5	- 2.0	900	819.6[d]	2.6	0.0	- 1.2	- 1.7

[a]DIFFERENCE BETWEEN THE POOL ELEVATION UPSTREAM FROM BRIDGE AND DOWNSTREAM WATER LEVELS.

[b]MAXIMUM WATER SURFACE ELEVATION PRODUCED BY 10-YEAR RECURRENCE INTERVAL FLOOD ON FOX RIVER MAIN STEM.

[c]MAXIMUM WATER SURFACE ELEVATION PRODUCED BY 50-YEAR RECURRENCE INTERVAL FLOOD ON FOX RIVER MAIN STEM.

[d]MAXIMUM WATER SURFACE ELEVATION PRODUCED BY 100-YEAR RECURRENCE INTERVAL FLOOD ON FOX RIVER MAIN STEM.

SOURCE: U.S. SOIL CONSERVATION SERVICE AND SEWRPC.

TABLE E-22

HYDRAULIC ANALYSIS SUMMARY POPLAR CREEK

STRUCTURE NUMBER	LOCATION	CONSTRUCTION DATE OF EXISTING BRIDGE	RECOMMENDED DESIGN FREQUENCY STANDARD (YEARS)	REPLACEMENT REQUIRED BY APPLICATION OF STANDARD	10-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						50-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						100-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS					
					INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)
46	LINCOLN ROAD	CULVERT	10	YES	530	832.5	2.9	0.5	0.2	- 0.8	840	833.2	3.6	0.4	0.9	- 0.1	1,000	833.4	3.8	0.2	1.1	0.1
--	PROPOSED BELT FRWY	--	100	--	530	--	--	--	--	--	840	--	--	--	--	--	1,000	--	--	--	--	--
47	PRIVATE ROAD	(C)1960	--	--	540	831.3	4.1	0.0	3.5	3.0	840	832.7	5.5	0.1	4.9	4.4	930	833.2	6.0	0.1	5.4	4.9
48	C.&N.W.R.R.	1929	--	--	540	831.3	4.8	0.3	- 7.1	- 7.2	770	832.6	6.1	0.5	- 5.8	- 5.9	880	833.0	6.5	0.5	5.4	- 5.5
49	POWER LINE ROAD	(C)1910	--	--	540	831.0	4.5	0.4	- 8.7	- 8.7	770	832.1	5.6	0.6	- 7.6	- 7.6	880	832.5	6.0	0.7	7.2	- 7.2
50	STH 59	1920	50	YES[a]	520	830.0	7.8	0.3	- 0.6	- 1.6	750	830.9	8.9	0.2	0.3	- 0.7	860	831.4	9.4	0.3	0.8	- 0.2
51	CTH SS	(C)1930	50	YES[a]	520	829.5	5.0	0.3	0.1	- 0.5	750	830.5	6.0	0.3	1.1	0.5	860	831.3	6.8	0.5	1.9	1.3
52	DAVIDSON ROAD	(C)1950	10	NO	500	828.7	5.2	0.5	- 4.0	- 4.0	740	829.7	6.2	0.5	- 3.0	- 3.0	850	830.4	6.9	0.7	- 2.4	- 2.4
53	IH 94	1963	100	NO	840	826.2	5.7	0.3	-10.5	-11.0	1,810	827.5	7.0	0.3	- 9.2	- 9.7	1,530	828.1	7.6	0.4	- 8.6	- 9.1
54	STH 18	1962	50	NO	840	825.6	5.6	0.4	- 4.9	- 8.1	1,310	826.8	6.8	0.5	- 3.7	- 6.9	1,530	827.3	7.3	0.5	- 3.2	- 6.4
55	STH 18	1962	50	NO	840	825.2	5.6	0.5	- 3.3	- 7.0	1,310	826.3	6.7	0.5	- 2.2	- 5.9	1,530	826.8	7.2	0.6	- 1.7	- 5.4
--	PROPOSED BELT FRWY	--	100	--	840	--	--	--	--	--	1,310	--	--	--	--	--	1,530	--	--	--	--	--
56	CTH Y	(C)1930	50	YES[a]	760	823.6	4.6	0.1	0.0	- 2.0	1,220	824.7	5.7	0.1	1.1	- 0.9	1,420	825.1	6.1	0.1	1.5	- 0.5
57	PRIVATE ROAD	(C)1960	--	--	750	823.2	4.2	0.2	0.7	0.7	1,200	824.2	5.2	0.1	1.7	1.7	1,400	824.6	5.6	0.1	2.1	2.1

[a]BOTH STRUCTURE REPLACEMENT AND ELEVATION OF APPROACH ROAD WOULD BE REQUIRED TO MEET STANDARD.

SOURCE: U.S. SOIL CONSERVATION SERVICE AND SEWRPC.

TABLE E-23

HYDRAULIC ANALYSIS SUMMARY DEER CREEK

STRUCTURE NUMBER	LOCATION	CONSTRUCTION DATE OF EXISTING BRIDGE	RECOMMENDED DESIGN FREQUENCY STANDARD (YEARS)	REPLACEMENT REQUIRED BY APPLICATION OF STANDARD	10-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						50-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						100-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS					
					INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)
33	STH 15	CULVERT	50	NO	175	871.0	3.0	1.1	- 6.1	- 6.8	272	871.5	3.5	1.5	- 5.6	- 6.3	320	871.7	3.7	1.6	- 5.4	- 6.1
34	MOORLAND ROAD	CULVERT	50	NO	220	860.4	3.9	0.6	- 1.8	- 1.9	340	861.3	4.8	1.0	0.9	- 1.0	400	861.7	5.2	1.2	- 0.5	- 0.6
35	CTH D	1960	50	NO	240	858.8	2.7	0.8	-23.3	-23.2	375	859.4	3.3	1.1	-22.7	-22.7	440	859.6	3.5	1.3	-22.5	-22.5
38	STH 59	1920	50	NO	315	838.5	3.1	0.8	- 3.8	- 4.0	500	839.2	3.8	1.2	- 3.1	- 3.3	590	839.5	4.1	1.2	- 2.8	- 3.0
39	PRIVATE ROAD	CULVERT	--	--	323	835.5	3.5	0.1	1.1	0.0	515	836.2	4.2	0.1	1.8	0.7	610	836.5	4.5	0.2	2.1	1.0
40	IH 94	1963	100	NO	330	835.3	3.8	0.3	- 7.7	- 7.7	530	835.9	4.4	0.4	- 7.1	- 7.1	630	836.2	4.7	0.5	- 6.8	- 6.8
41	DECANT STREET	CULVERT	10	NO	330	834.6	4.6	1.1	- 0.1	- 0.3	530	835.1	5.1	1.0	0.4	0.2	630	835.3	5.3	0.9	0.6	0.4
42	JOANNE DRIVE	CULVERT	10	YES[b]	330	833.1	1.9	0.2	1.1	1.1	530	833.7	2.5	0.2	1.7	1.7	630	833.9	2.7	0.2	1.9	1.9
43	CTH KX	1935	50	YES[b]	360	832.7	2.4	0.4	0.2	- 0.8	570	833.3	3.0	0.3	0.8	- 0.2	675	833.5	3.2	0.3	1.0	0.0
--	PROPOSED BELT FRWY	--	100	--	390	--	--	--	--	--	620	--	--	--	--	--	725	--	--	--	--	--
44	BROOKFIELD ROAD	(C)1930	10	YES[b]	390	829.3	1.1	0.1	0.5	0.0	620	829.8	1.6	0.2	1.0	0.5	725	830.0	1.8	0.2	1.2	0.7
45	IH 94	1963	100	NO	450	827.2	1.7	0.1	-10.2	-11.0	700	828.2	2.7	0.1	- 9.2	-10.0	820	828.6	3.1	0.1	- 8.8	- 9.6

[b]BOTH STRUCTURE REPLACEMENT AND ELEVATION OF APPROACH ROAD WOULD BE REQUIRED TO MEET STANDARD.

SOURCE: U.S. SOIL CONSERVATION SERVICE AND SEWRPC.

TABLE E-24

HYDRAULIC ANALYSIS SUMMARY TAMARAC SWAMP

STRUCTURE NUMBER	LOCATION	CONSTRUCTION DATE OF EXISTING BRIDGE	RECOMMENDED DESIGN FREQUENCY STANDARD (YEARS)	REPLACEMENT REQUIRED BY APPLICATION OF STANDARD	10-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						50-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						100-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS					
					INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)
8	MARCY ROAD	UNKNOWN	10	NO	420	836.6	4.2	0.0	- 0.1	- 0.7	630	837.2	4.8	0.0	0.5	- 0.1	725	837.6	5.2	0.0	0.9	0.3
--	PROPOSED BELT FRWY	--	100	--	420	--	--	--	--	--	630	--	--	--	--	--	725	--	--	--	--	--

SOURCE: U.S. SOIL CONSERVATION SERVICE AND SEWRPC.

TABLE E-25

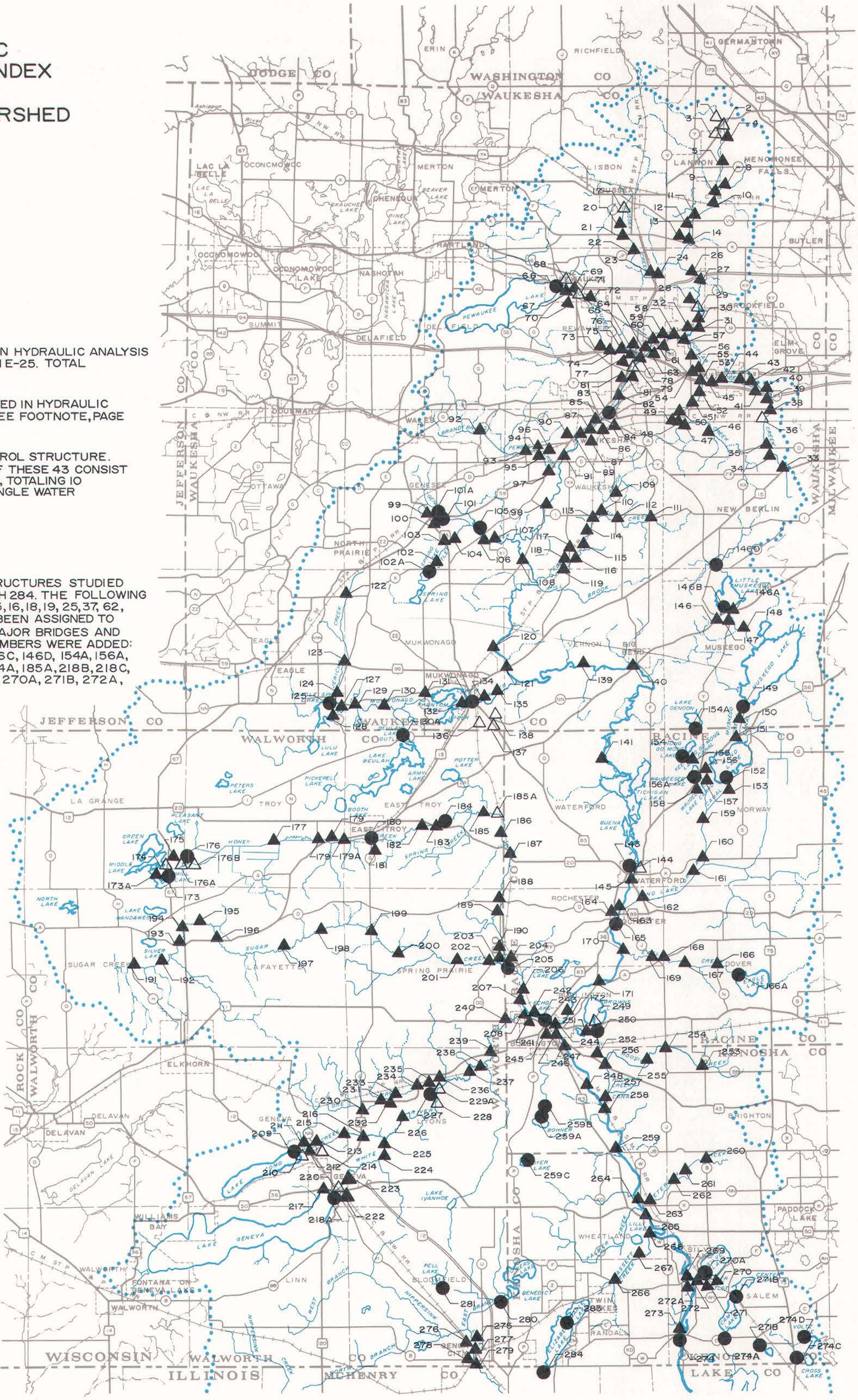
HYDRAULIC ANALYSIS SUMMARY SUSSEX CREEK

STRUCTURE NUMBER	LOCATION	CONSTRUCTION DATE OF EXISTING BRIDGE	RECOMMENDED DESIGN FREQUENCY STANDARD (YEARS)	REPLACEMENT REQUIRED BY APPLICATION OF STANDARD	10-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						50-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS						100-YEAR RECURRENCE INTERVAL FLOOD--1990 LAND USE CONDITIONS					
					INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)	INSTANTANEOUS PEAK DISCHARGE (CFS)	ELEVATION OF UPSTREAM WATER LEVEL (FEET ABOVE MSL)	OVERBANK DEPTH (FEET)	EXISTING WATERWAY OPENING: BRIDGE HEAD LOSS (FEET)	EXISTING WATERWAY OPENING: DEPTH AT LOW POINT IN BRIDGE APPROACH ROAD (FEET)	EXISTING WATERWAY OPENING: DEPTH ON ROAD AT C/L OF BRIDGE (FEET)
20	PRIVATE ROAD	CULVERT	--	--	530	879.5	3.7	0.5	1.0	- 0.3	880	879.8	4.0	0.2	1.3	0.0	1,040	879.9	4.1	0.1	1.4	0.1
21	CTH K	1961	50	YES	540	877.4	3.4	0.4	- 0.4	- 0.8	900	878.1	4.1	0.4	0.3	- 0.1	1,060	878.3	4.3	0.4	0.5	0.1
22	CTH JF	CULVERT	50	YES[a]	570	854.8	3.8	0.7	1.0	- 0.9	940	855.5	4.5	0.7	1.7	- 0.2	1,110	855.7	4.7	0.7	1.9	0.0
--	PROPOSED BAY FRWY	--	100	--	570	--	--	--	--	--	940	--	--	--	--	--	1,110	--	--	--	--	--
--	NEW STH 164	--	50	--	400	--	--	--	--	--	670	--	--	--	--	--	800	--	--	--	--	--
23	DUPLAINVILLE ROAD	(C)1960	10	NO	340	834.7	0.2	0.1	- 2.0	- 2.0	590	836.6	2.1	0.2	- 0.1	- 0.1	700	837.7	3.2	0.4	1.0	1.0
24	M.ST.P.&S.STE.M.R.R.	1933	--	--	340	834.6	0.2	1.3	- 6.3	- 6.4	590	836.4	2.0	2.7	- 4.5	- 6.2	700	837.3	2.9	3.4	- 3.6	- 3.7

[a]BOTH STRUCTURE REPLACEMENT AND ELEVATION OF THE APPROACH ROAD WOULD BE REQUIRED TO MEET STANDARD.

SOURCE: U.S. SOIL CONSERVATION SERVICE AND SEWRPC.

Map E-1
HYDRAULIC STRUCTURE INDEX FOR THE FOX RIVER WATERSHED 1966



LEGEND

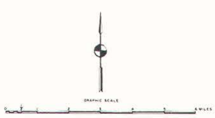
▲ BRIDGE OR CULVERT INCLUDED IN HYDRAULIC ANALYSIS SUMMARY TABLES E-1 THROUGH E-25. TOTAL NUMBER: 228

△ BRIDGE OR CULVERT NOT INCLUDED IN HYDRAULIC ANALYSIS SUMMARY TABLES (SEE FOOTNOTE, PAGE 299). TOTAL NUMBER: 23

● MILL DAM OR LAKE LEVEL CONTROL STRUCTURE. TOTAL IN WATERSHED: 43. SIX OF THESE 43 CONSIST OF TWO OR MORE STRUCTURES, TOTALING 10 ALTOGETHER, WHICH ACT AS SINGLE WATER CONTROL UNITS.

262 STRUCTURE CONTROL NUMBER

NOTE: THE 304 WATER CONTROL STRUCTURES STUDIED ARE NUMBERED FROM 1 THROUGH 284. THE FOLLOWING NUMBERS WERE OMITTED: 6, 7, 15, 16, 18, 19, 25, 37, 62, AND 282, HAVING ORIGINALLY BEEN ASSIGNED TO MINOR FARM OR ABANDONED MAJOR BRIDGES AND CULVERTS. THE FOLLOWING NUMBERS WERE ADDED: 101A, 102A, 130A, 146A, 146B, 146C, 146D, 154A, 156A, 166A, 173A, 176A, 176B, 179A, 184A, 185A, 218B, 218C, 218D, 229A, 259A, 259B, 259C, 270A, 271B, 272A, 274A, 274B, 274C, AND 274D



(This page intentionally left blank)

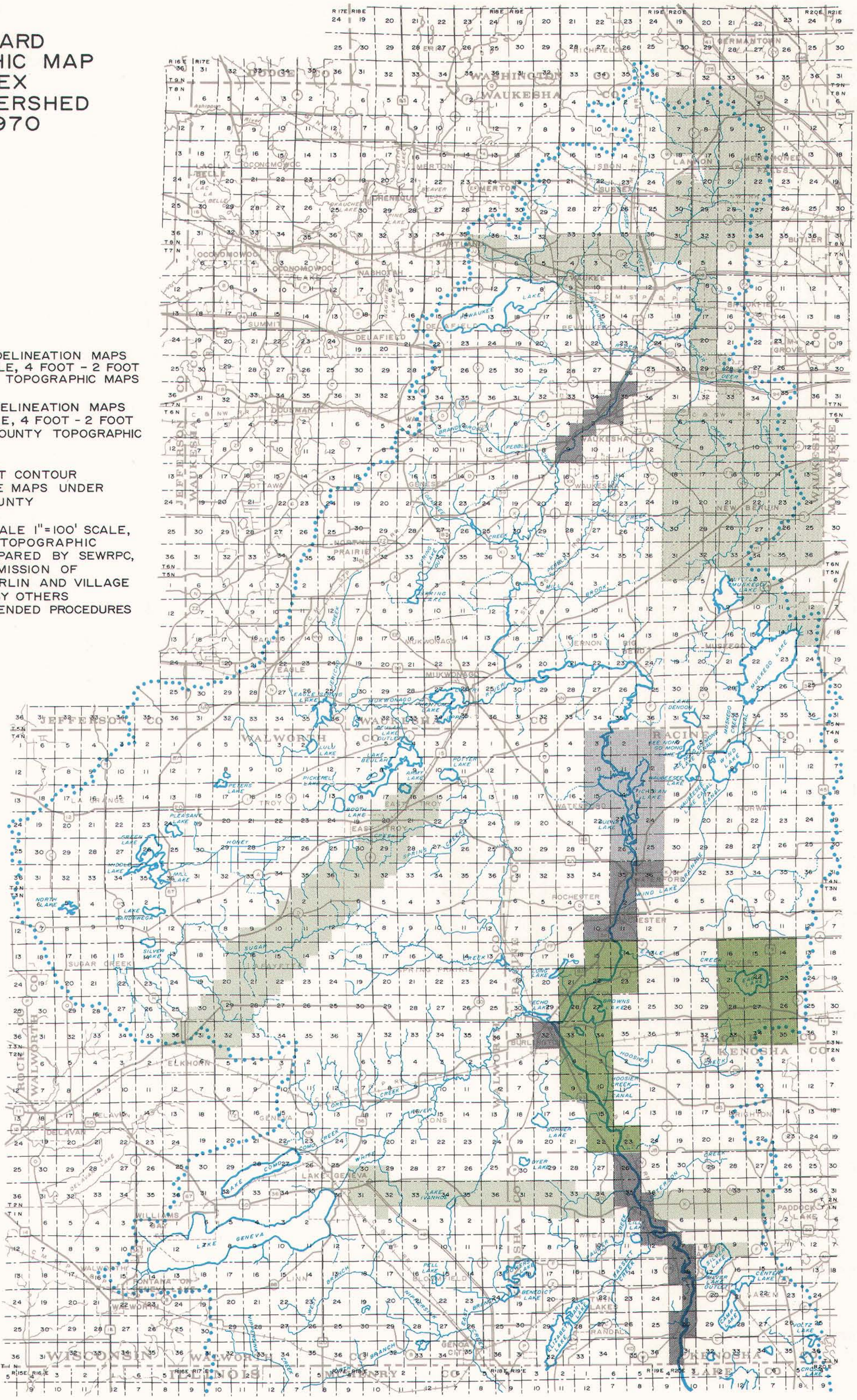
Appendix F

FLOOD HAZARD MAPS

Map F-1
FLOOD HAZARD AND TOPOGRAPHIC MAP SHEET INDEX FOX RIVER WATERSHED FEBRUARY 1970

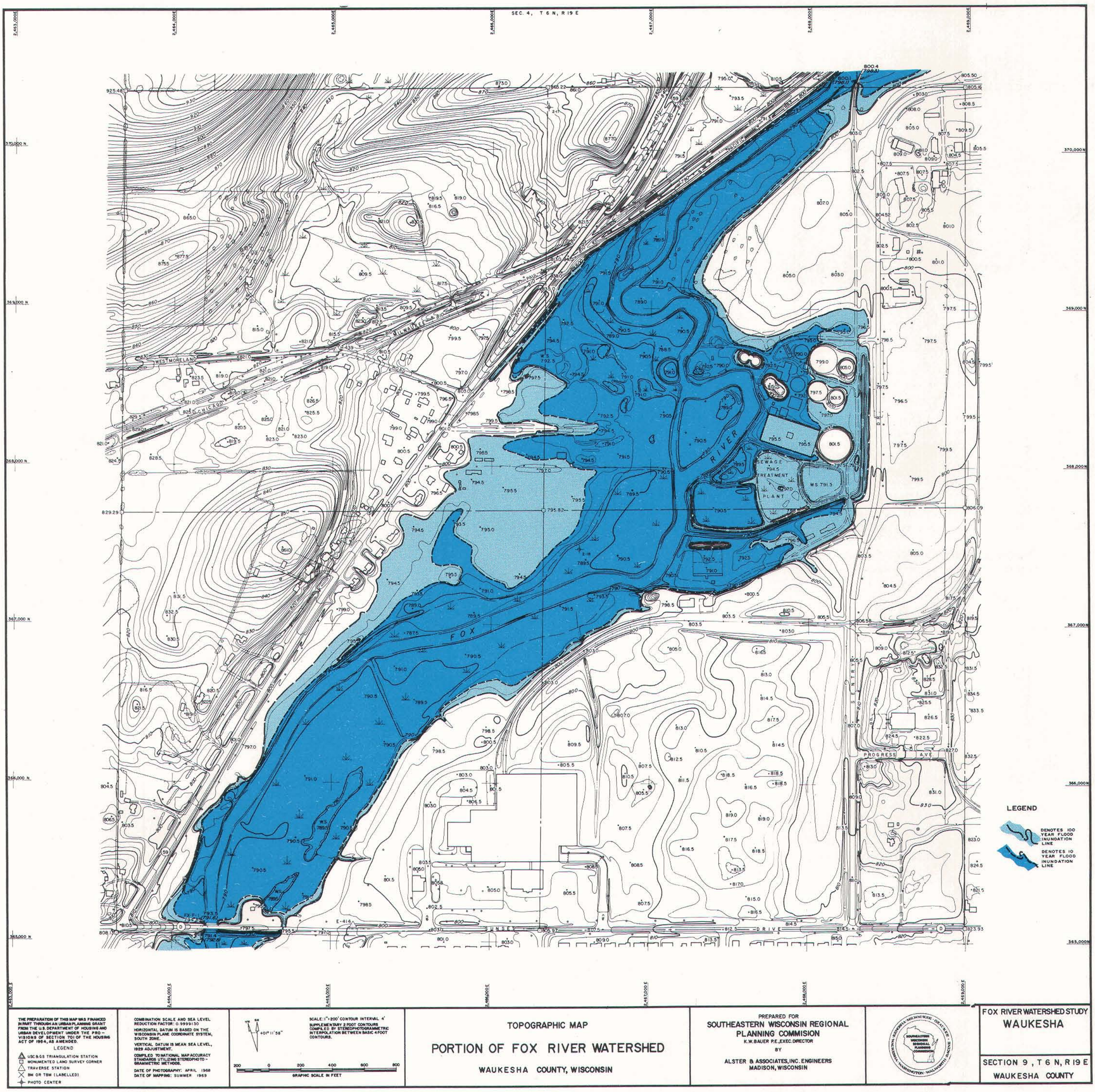
LEGEND

- FLOODWAY AND FLOODPLAIN DELINEATION MAPS PREPARED FROM 1"=200' SCALE, 4 FOOT - 2 FOOT CONTOUR INTERVAL SEWRPC TOPOGRAPHIC MAPS
- FLOODWAY AND FLOODPLAIN DELINEATION MAPS PREPARED FROM 1"=200' SCALE, 4 FOOT - 2 FOOT CONTOUR INTERVAL RACINE COUNTY TOPOGRAPHIC MAPS
- 1"=200' SCALE, 4 FOOT - 2 FOOT CONTOUR INTERVAL TOPOGRAPHIC BASE MAPS UNDER PREPARATION BY RACINE COUNTY
- AREAS FOR WHICH LARGE SCALE 1"=100' SCALE, 2 FOOT CONTOUR INTERVAL TOPOGRAPHIC BASE MAPS HAVE BEEN PREPARED BY SEWRPC, BY THE STATE HIGHWAY COMMISSION OF WISCONSIN, CITY OF NEW BERLIN AND VILLAGE OF MENOMONEE FALLS, OR BY OTHERS UTILIZING SEWRPC RECOMMENDED PROCEDURES



Map F-2

FLOOD HAZARD MAP
PORTION OF FOX RIVER WATERSHED
WAUKESHA COUNTY, WISCONSIN



Appendix G

DETAILED COST ESTIMATES
ALTERNATIVE STREAM WATER QUALITY MANAGEMENT PLAN ELEMENTS

Table G-1
DETAILED COST ESTIMATES
ALTERNATIVE STREAM WATER QUALITY MANAGEMENT PLAN ELEMENT IA[a]

Plan Subelement	Estimated Cost						
		Present Worth (1970-2020)			Equivalent Annual		
	Capital (Construction)	Construction	Operation and Maintenance	Total	Construction	Operation and Maintenance	Total
Upper Fox River Watershed							
Treatment Facilities							
Brookfield (5.0 MGD)	$ 2,560,000	$ 3,184,000	$ 3,169,000	$ 6,353,000	$ 202,000	$ 201,000	$ 403,000
Lannon (3.4 MGD)	2,420,000	2,995,000	2,253,000	5,248,000	190,000	143,000	333,000
Pewaukee (1.2 MGD)	914,000	1,134,000	1,057,000	2,191,000	72,000	67,000	139,000
Poplar Creek (Brookfield) (6.7 MGD)	3,441,000	4,286,000	3,814,000	8,100,000	272,000	242,000	514,000
Sussex (1.6 MGD)	1,218,000	1,529,000	1,230,000	2,759,000	97,000	78,000	175,000
Waukesha (18.5 MGD)	5,030,000	6,431,000	9,914,000	16,345,000	408,000	629,000	1,037,000
Subtotal	*$ 15,583,000*	*$ 19,559,000*	*$ 21,437,000*	*$ 40,996,000*	*$ 1,241,000*	*$ 1,360,000*	*$ 2,601,000*
Trunk Sewers[b]	1,690,000	1,690,000	15,000	1,705,000	107,000	1,000	108,000
Subtotal--Upper Watershed	*$ 17,273,000*	*$ 21,249,000*	*$ 21,452,000*	*$ 42,701,000*	*$ 1,348,000*	*$ 1,361,000*	*$ 2,709,000*
Lower Fox River Watershed							
Treatment Facilities							
Burlington (2.5 MGD)	$ 1,348,000	$ 1,662,100	$ 2,080,100	$ 3,742,200	$ 105,500	$ 132,000	$ 237,500
East Troy (0.7 MGD)	427,000	526,500	843,400	1,369,900	33,400	53,500	86,900
Fontana[c]	--	--	--	--	--	--	--
Genoa City (0.3 MGD)[d]	126,000	155,400	247,000	402,400	9,900	15,700	25,600
Lake Geneva (2.3 MGD)	1,389,000	1,712,600	2,211,100	3,923,700	108,700	140,300	249,000
Mukwonago (1.2 MGD)	663,000	817,500	1,200,900	2,018,400	51,800	76,200	128,000
Silver Lake (0.3 MGD)[d]	--	--	161,000	161,000	--	10,200	10,200
Twin Lakes (0.6 MGD)	360,000	443,800	784,600	1,228,400	28,100	49,800	77,900
Waterford-Rochester (1.0 MGD)	719,000	886,500	1,045,200	1,931,700	56,300	66,300	122,600
Williams Bay[c]	--	--	--	--	--	--	--
Subtotal--Lower Watershed	*$ 5,032,000*	*$ 6,204,400*	*$ 8,573,300*	*$ 14,777,700*	*$ 393,700*	*$ 544,000*	*$ 937,700*
Watershed Total	$ 22,305,000	$ 27,453,400	$ 30,025,300	$ 57,478,700	$ 1,741,700	$ 1,905,000	$ 3,646,700

[a] *This alternative plan element includes the provision of advanced waste treatment facilities for additional removal of oxygen-demanding organic matter and nutrients at nearly all existing and locally proposed municipal sewage treatment plants in the watershed (exceptions noted below).*

[b] *Includes 6,000 feet of 27-inch sewer at an estimated capital cost of $360,000; 5,000 feet of 30-inch sewer at an estimated cost of $320,000; and 8,500 feet of 54-inch sewer at an estimated cost of $1,010,000, all in the Waukesha tributary drainage area below the confluence of Poplar Creek and the Fox River.*

[c] *No costs are assigned to these facilities in this plan element because it is proposed that they continue to be operated as secondary treatment plants discharging treated effluents to seepage ponds.*

[d] *It is proposed that these facilities, because of their small size, continue to be operated as secondary treatment plants with the addition of disinfection.*

Source: Harza Engineering Company and SEWRPC.

Table G-2

DETAILED COST ESTIMATES

ALTERNATIVE STREAM WATER QUALITY MANAGEMENT PLAN ELEMENT IB[a]

Plan Subelement	Estimated Cost						
	Capital (Construction)	Present Worth (1970-2020)			Equivalent Annual		
		Construction	Operation and Maintenance	Total	Construction	Operation and Maintenance	Total
Upper Fox River Watershed							
Treatment Facilities							
Poplar Creek (Brookfield) (17.9 MGD)	$ 8,645,000	$ 8,797,000	$ 8,722,000	$ 17,519,000	$ 558,000	$ 553,000	$ 1,111,000
Waukesha (18.5 MGD)	5,030,000	6,431,000	9,914,000	16,345,000	408,000	629,000	1,037,000
Subtotal	*$ 13,675,000*	*$ 15,228,000*	*$ 18,636,000*	*$ 33,864,000*	*$ 966,000*	*$ 1,182,000*	*$ 2,148,000*
Trunk Sewers							
To Poplar Creek[b]	$ 4,500,000	$ 4,500,000	$ 63,000	$ 4,563,000	$ 285,000	$ 4,000	$ 289,000
To Waukesha[c]	1,690,000	1,690,000	15,000	1,705,000	107,000	1,000	108,000
Subtotal	*$ 6,190,000*	*$ 6,190,000*	*$ 78,000*	*$ 6,268,000*	*$ 392,000*	*$ 5,000*	*$ 397,000*
Subtotal--Upper Watershed	*$ 19,865,000*	*$ 21,418,000*	*$ 18,714,000*	*$ 40,132,000*	*$ 1,358,000*	*$ 1,187,000*	*$ 2,545,000*
Lower Fox River Watershed							
Treatment Facilities							
Burlington (2.5 MGD)	$ 1,348,000	$ 1,662,100	$ 2,080,100	$ 3,742,200	$ 105,500	$ 132,000	$ 237,500
East Troy (0.7 MGD)	427,000	526,500	843,400	1,369,900	33,400	53,500	86,900
Fontana[d]	--	--	--	--	--	--	--
Genoa City (0.3 MGD)[e]	126,000	155,400	247,000	402,400	9,900	15,700	25,600
Lake Geneva (2.3 MGD)	1,389,000	1,712,600	2,211,100	3,923,700	108,700	140,300	249,000
Mukwonago (1.2 MGD)	663,000	817,500	1,200,900	2,018,400	51,800	76,200	128,000
Silver Lake (0.3 MGD)[e]	--	--	161,000	161,000	--	10,200	10,200
Twin Lakes (0.6 MGD)	360,000	443,800	784,600	1,228,400	28,100	49,800	77,900
Waterford-Rochester (1.0 MGD)	719,000	886,500	1,045,200	1,931,700	56,300	66,300	122,600
Williams Bay[d]	--	--	--	--	--	--	--
Subtotal--Lower Watershed	*$ 5,032,000*	*$ 6,204,400*	*$ 8,573,300*	*$ 14,777,700*	*$ 393,700*	*$ 544,000*	*$ 937,700*
Watershed Total	$ 24,897,000	$ 27,622,400	$ 27,287,300	$ 54,909,700	$ 1,751,700	$ 1,731,000	$ 3,482,700

[a] *This alternative plan element includes the provision of advanced waste treatment facilities for additional removal of oxygen-demanding organic matter and nutrients at two large sewage treatment plants in the upper watershed and at six individual plants in the lower watershed.*

[b] *Includes 18,500 feet of 21-inch sewer at an estimated capital cost of $569,000; 25,000 feet of 24-inch sewer at an estimated cost of $936,800; 9,100 feet of 30-inch sewer at an estimated cost of $534,500; 16,000 feet of 36-inch sewer at an estimated cost of $815,200; and 16,750 feet of 48-inch sewer at an estimated cost of $1,644,500.*

[c] *Includes 6,000 feet of 27-inch sewer at an estimated capital cost of $360,000; 5,000 feet of 30-inch sewer at an estimated cost of $320,000; and 8,500 feet of 54-inch sewer at an estimated cost of $1,010,000.*

[d] *No costs are assigned to these facilities in this plan element because it is proposed that they continue to be operated as secondary treatment plants discharging treated effluents to seepage ponds.*

[e] *It is proposed that these facilities, because of their small size, continue to be operated as secondary treatment plants with the addition of disinfection.*

Source: Harza Engineering Company and SEWRPC.

Table G-3

DETAILED COST ESTIMATES

ALTERNATIVE STREAM WATER QUALITY MANAGEMENT PLAN ELEMENT IC[a]

Plan Subelement	Estimated Cost						
	Capital (Construction)	Present Worth (1970-2020)			Equivalent Annual		
		Construction	Operation and Maintenance	Total	Construction	Operation and Maintenance	Total
Upper Fox River Watershed							
Treatment Facilities							
Waukesha (36.4 MGD)[b]	$ 12,878,000	$ 13,614,000	$ 16,789,000	$ 30,403,000	$ 863,000	$ 1,066,000	$ 1,929,000
Trunk Sewers							
To Waukesha[c]	11,690,000	11,690,000	90,000	11,780,000	742,000	6,000	748,000
Subtotal--Upper Watershed	*$ 24,568,000*	*$ 25,304,000*	*$ 16,879,000*	*$ 42,183,000*	*$ 1,605,000*	*$ 1,072,000*	*$ 2,677,000*
Lower Fox River Watershed							
Treatment Facilities							
Burlington (2.5 MGD)	$ 1,348,000	$ 1,662,100	$ 2,080,100	$ 3,742,200	$ 105,500	$ 132,000	$ 237,500
East Troy (0.7 MGD)	427,000	526,500	843,400	1,369,900	33,400	53,500	86,900
Fontana[d]	--	--	--	--	--	--	--
Genoa City (0.3 MGD)[e]	126,000	155,400	247,000	402,400	9,900	15,700	25,600
Lake Geneva (2.3 MGD)	1,389,000	1,712,600	2,211,100	3,923,700	108,700	140,300	249,000
Mukwonago (1.2 MGD)	663,000	817,500	1,200,900	2,018,400	51,800	76,200	128,000
Silver Lake (0.3 MGD)[e]	--	--	161,000	161,000	--	10,200	10,200
Twin Lakes (0.6 MGD)	360,000	443,800	784,600	1,228,400	28,100	49,800	77,900
Waterford-Rochester (1.0 MGD)	719,000	886,500	1,045,200	1,931,700	56,300	66,300	122,600
Williams Bay[d]	--	--	--	--	--	--	--
Subtotal--Lower Watershed	*$ 5,032,000*	*$ 6,204,400*	*$ 8,573,300*	*$ 14,777,700*	*$ 393,700*	*$ 544,000*	*$ 937,700*
Watershed Total	$ 29,600,000	$ 31,508,400	$ 25,452,300	$ 56,960,700	$ 1,998,700	$ 1,616,000	$ 3,614,700

[a] *This alternative plan element includes the provision of advanced waste treatment facilities for additional removal of oxygen-demanding organic matter and nutrients at one large sewage treatment plant in the upper watershed and at six individual plants in the lower watershed.*

[b] *Proposed new facility to be located about 2 miles downstream from the existing Waukesha sewage treatment plant.*

[c] *Includes 18,500 feet of 21-inch sewer at an estimated capital cost of $569,000; 25,000 feet of 24-inch sewer at an estimated cost of $936,800; 4,000 feet of 30-inch sewer at an estimated cost of $177,500; 16,000 feet of 36-inch sewer at an estimated cost of $815,200; 16,750 feet of 48-inch sewer at an estimated cost of $1,644,500; 25,250 feet of 66-inch sewer at an estimated cost of $5,673,000; and 8,500 feet of 84-inch sewer at an estimated cost of $1,874,000.*

[d] *No costs are assigned to these facilities in this plan element because it is proposed that they continue to be operated as secondary treatment plants discharging treated effluents to seepage ponds.*

[e] *It is proposed that these facilities, because of their small size, continue to be operated as secondary treatment plants with the addition of disinfection.*

Source: Harza Engineering Company and SEWRPC.

Table G-4
DETAILED COST ESTIMATES
ALTERNATIVE STREAM WATER QUALITY MANAGEMENT PLAN ELEMENT 2[a]

Plan Subelement	Estimated Cost						
	Capital (Construction)	Present Worth (1970-2020)			Equivalent Annual		
		Construction	Operation and Maintenance	Total	Construction	Operation and Maintenance	Total
Upper Fox River Watershed							
Trunk Sewers[b]	$ 33,072,000	$ 33,533,000	$ 914,000	$ 34,447,000	$ 2,127,000	$ 58,000	$ 2,185,000
Treatment Facilities--Milwaukee-Metropolitan Sewerage System (36.4 MGD)[c]	9,000,000	11,097,000	9,173,000	20,270,000	704,000	582,000	1,286,000
Subtotal--Upper Watershed	*$ 42,072,000*	*$ 44,630,000*	*$ 10,087,000*	*$ 54,717,000*	*$ 2,831,000*	*$ 640,000*	*$ 3,471,000*
Lower Fox River Watershed							
Treatment Facilities							
Burlington (2.5 MGD)	$ 1,348,000	$ 1,662,100	$ 2,080,100	$ 3,742,200	$ 105,500	$ 132,000	$ 237,500
East Troy (0.7 MGD)	427,000	526,500	843,400	1,369,900	33,400	53,500	86,900
Fontana[d]	--	--	--	--	--	--	--
Genoa City (0.3 MGD)[e]	126,000	155,400	247,000	402,400	9,900	15,700	25,600
Lake Geneva (2.3 MGD)	1,389,000	1,712,600	2,211,100	3,923,700	108,700	140,300	249,000
Mukwonago (1.2 MGD)	663,000	817,500	1,200,900	2,018,400	51,800	76,200	128,000
Silver Lake (0.3 MGD)[e]	--	--	161,000	161,000	--	10,200	10,200
Twin Lakes (0.6 MGD)	360,000	443,800	784,600	1,228,400	28,100	49,800	77,900
Waterford-Rochester (1.0 MGD)	719,000	886,500	1,045,200	1,931,700	56,300	66,300	122,600
Williams Bay[d]	--	--	--	--	--	--	--
Subtotal--Lower Watershed	*$ 5,032,000*	*$ 6,204,400*	*$ 8,573,300*	*$ 14,777,700*	*$ 393,700*	*$ 544,000*	*$ 937,700*
Watershed Total	$ 47,104,000	$ 50,834,400	$ 18,660,300	$ 69,494,700	$ 3,224,700	$ 1,184,000	$ 4,408,700

[a] *This alternative plan element includes the diversion of all wastes generated in the upper watershed to the Milwaukee-Metropolitan Sewerage System, where advanced waste treatment facilities for additional removal of oxygen-demanding organic matter and nutrients would be provided. Advanced waste treatment facilities would also be provided at all sewage treatment plants in the lower watershed, with exceptions noted below.*

[b] *Includes 18,500 feet of 21-inch sewer at an estimated capital cost of $569,000; 23,300 feet of 24-inch sewer at an estimated cost of $878,100; 12,600 feet of 27-inch sewer at an estimated cost of $775,700; 10,000 feet of 30-inch sewer at an estimated cost of $497,500; 15,000 feet of 36-inch sewer at an estimated cost of $815,200; 39,400 feet of 48-inch sewer at an estimated cost of $2,960,500; 8,500 feet of 54-inch sewer at an estimated cost of $1,010,000; 11,000 feet of 72-inch sewer at an estimated cost of $1,480,000; 110,720 feet of 84-inch sewer at an estimated cost of $17,757,000; 17,800 feet of 42-inch force main at an estimated cost of $1,025,000; 38,000 feet of 54-inch force main at an estimated cost of $3,324,000; two 37 MGD pumping stations at 50 feet of head at an estimated cost of $1,066,000; and one 72 MGD pumping station at 50 feet of head at an estimated cost of $767,000.*

[c] *It is proposed that these facilities be located at the existing South Shore Waste Water Treatment Plant operated by the Milwaukee-Metropolitan Sewerage Commissions.*

[d] *No costs are assigned to these facilities in this plan element because it is proposed that they continue to be operated as secondary treatment plants discharging treated effluents to seepage ponds.*

[e] *It is proposed that these facilities, because of their small size, continue to be operated as secondary treatment plants with the addition of disinfection.*

Source: Harza Engineering Company and SEWRPC.

Table G-5
DETAILED COST ESTIMATES
ALTERNATIVE STREAM WATER QUALITY MANAGEMENT PLAN ELEMENT 3[a]

Plan Subelement	Estimated Cost						
		Present Worth (1970-2020)			Equivalent Annual		
	Capital (Construction)	Construction	Operation and Maintenance	Total	Construction	Operation and Maintenance	Total
Treatment Facilities and Trunk Sewers							
Upper Fox River Watershed							
Waukesha (36.4 MGD)[b]	$ 9,024,000	$ 9,582,000	$ 9,310,600	$ 18,892,600	$ 608,100	$ 590,700	$ 1,198,800
Trunk Sewers to Waukesha[c]	11,690,000	11,690,000	90,000	11,780,000	742,000	6,000	748,000
Subtotal	*$ 20,714,000*	*$ 21,272,000*	*$ 9,400,600*	*$ 30,672,600*	*$ 1,350,100*	*$ 596,700*	*$ 1,946,800*
Lower Fox River Watershed							
Burlington (2.5 MGD)	$ 818,000	$ 1,008,600	$ 1,021,000	$ 2,029,600	$ 64,000	$ 64,800	$ 128,800
East Troy (0.7 MGD)	257,000	316,900	473,000	789,900	20,100	30,000	50,100
Fontana[d]	--	--	--	--	--	--	--
Genoa City (0.3 MGD)	126,000	155,400	247,000	402,400	9,900	15,700	25,600
Lake Geneva (2.3 MGD)	819,000	1,009,800	1,103,000	2,112,800	64,100	70,000	134,100
Mukwonago (1.2 MGD)	393,000	484,600	624,000	1,108,600	30,700	39,600	70,300
Silver Lake (0.3 MGD)	--	--	161,000	161,000	--	10,200	10,200
Twin Lakes (0.6 MGD)	210,000	258,900	441,000	699,900	16,400	28,000	44,400
Waterford-Rochester (1.0 MGD)	474,000	584,400	596,000	1,180,400	37,100	37,800	74,900
Williams Bay[d]	--	--	--	--	--	--	--
Subtotal	*$ 3,097,000*	*$ 3,818,600*	*$ 4,666,000*	*$ 8,486,600*	*$ 242,300*	*$ 296,100*	*$ 538,400*
Subtotal--Treatment Facilities and Trunk Sewers	*$ 23,811,000*	*$ 25,090,600*	*$ 14,066,600*	*$ 39,157,200*	*$ 1,592,400*	*$ 892,800*	*$ 2,485,200*
Irrigation Facilities							
Field Equipment[e]	$ 5,522,000	$ 6,810,000	$ 4,200,000	$ 11,010,000	$ 432,000	$ 266,540	$ 698,540
Transmission Lines to Fields	3,377,000	4,163,000	105,000	4,268,000	264,000	6,660	270,660
Pumping Stations[f]	2,534,000	3,125,000	10,780,000	13,905,000	198,000	684,000	882,000
Land[g]	9,229,000	11,379,000	--	11,379,000	721,000	--	721,000
Subtotal--Irrigation Facilities	*$ 20,662,000*	*$ 25,477,000*	*$ 15,085,000*	*$ 40,562,000*	*$ 1,615,000*	*$ 957,200*	*$ 2,572,200*
Watershed Total	$ 44,473,000	$ 50,567,600	$ 29,151,600	$ 79,719,200	$ 3,207,400	$ 1,850,000	$ 5,057,400
Less Benefits Incurred From Annual Crop Yields[h]	--	--	-3,910,000	-3,910,000	--	-248,000	-248,000
Net Watershed Total	$ 44,473,000	$ 50,567,600	$ 25,241,600	$ 75,809,200	$ 3,207,400	$ 1,602,000	$ 4,809,400

[a] *This alternative plan element includes the provision of secondary waste treatment facilities at one new large plant in the upper watershed and at existing individual plants in the lower watershed, together with effluent disposal through land irrigation.*

[b] *Proposed new secondary treatment plant to be located about 2 miles downstream from the existing Waukesha sewage treatment plant.*

[c] *For a detailed breakdown of the proposed trunk sewer sizes and costs, see Table G-3, footnote c.*

[d] *No costs are assigned to these facilities in this plan element because it is proposed that they continue to be operated as secondary treatment plants discharging treated effluents to seepage ponds.*

[e] *Includes such elements as spray nozzles, distribution piping, valves, and other appurtenances.*

[f] *It is estimated that nine pumping stations would be required, one at each treatment facility in the watershed.*

[g] *Includes an estimated 12,000 acres in the upper watershed and 3,740 acres in the lower watershed at an estimated acquisition cost of $585 per acre.*

[h] *Assumes a $20 per acre annual benefit on 12,400 acres of irrigated land, with 3,340 acres out of crop production annually.*

Source: Harza Engineering Company and SEWRPC.

Table G-6
DETAILED COST ESTIMATES
ALTERNATIVE STREAM WATER QUALITY MANAGEMENT PLAN ELEMENT 4[a]

Plan Subelement	Capital (Construction)	Estimated Cost: Present Worth (1970-2020): Construction	Present Worth: Operation and Maintenance	Present Worth: Total	Equivalent Annual: Construction	Equivalent Annual: Operation and Maintenance	Equivalent Annual: Total
Treatment Facilities and Trunk Sewers							
Upper Fox River Watershed							
Waukesha (36.4 MGD)[b,d]	$ 10,298,000	$ 10,862,000	$ 12,191,600	$ 23,053,600	$ 689,400	$ 773,500	$ 1,462,900
Trunk Sewers to Waukesha[c]	11,690,000	11,690,000	90,000	11,780,000	742,000	6,000	748,000
Subtotal	*$ 21,988,000*	*$ 22,552,000*	*$ 12,281,600*	*$ 34,833,600*	*$ 1,431,400*	*$ 779,500*	*$ 2,210,900*
Lower Fox River Watershed							
Burlington (2.5 MGD)	$ 818,000	$ 1,008,600	$ 1,021,000	$ 2,029,600	$ 64,000	$ 64,800	$ 128,800
East Troy (0.7 MGD)[d]	387,000	477,700	670,000	1,147,700	30,300	42,500	72,800
Fontana[e]	--	--	--	--	--	--	--
Genoa City (0.3 MGD)	126,000	155,400	247,000	402,400	9,900	15,700	25,600
Lake Geneva (2.3 MGD)[d]	1,259,000	1,552,000	1,670,400	3,222,400	98,500	106,000	204,500
Mukwonago (1.2 MGD)	393,000	484,600	624,000	1,108,600	30,700	39,600	70,300
Silver Lake (0.3 MGD)	--	--	161,000	161,000	--	10,200	10,200
Twin Lakes (0.6 MGD)[d]	330,000	407,100	620,900	1,028,000	25,800	39,400	65,200
Waterford-Rochester (1.0 MGD)	474,000	584,400	596,000	1,180,900	37,100	37,800	74,900
Williams Bay[e]	--	--	--	--	--	--	--
Subtotal	*$ 3,787,000*	*$ 4,669,800*	*$ 5,610,300*	*$ 10,280,600*	*$ 296,300*	*$ 356,000*	*$ 652,300*
Subtotal--Treatment Facilities and Trunk Sewers	*$ 25,775,000*	*$ 27,221,800*	*$ 17,891,900*	*$ 45,114,200*	*$ 1,727,700*	*$ 1,135,500*	*$ 2,863,200*
Chemical Spraying for Algae and Weed Control	$ 1,500	$ 8,800	$ 1,339,800	$ 1,348,600	$ 560	$ 85,000	$ 85,560
Watershed Total	$ 25,776,500	$ 27,230,600	$ 19,231,700	$ 46,462,800	$ 1,728,260	$ 1,220,500	$ 2,948,760

[a] *This alternative plan element includes the provision of secondary treatment facilities and disinfection at one new large sewage treatment plant in the upper watershed and at individual plants in the lower watershed; additional removal of oxygen-demanding organic matter at the new upper watershed plant and at the East Troy, Lake Geneva, and Twin Lakes plants; and algae and weed control through the use of algicides and herbicides in the streams.*

[b] *Proposed new facility to be located about 2 miles downstream from the existing Waukesha sewage treatment plant.*

[c] *For a detailed breakdown of the proposed trunk sewer sizes and costs, see Table G-3, footnote c.*

[d] *Facility to provide tertiary treatment for additional removal of oxygen-demanding organic matter but not for additional nutrient removal.*

[e] *No costs are assigned to these facilities in this plan element because it is proposed that they continue to be operated as secondary treatment plants discharging treated effluents to seepage ponds.*

Source: Harza Engineering Company and SEWRPC.

Table G-7
DETAILED COST ESTIMATES
ALTERNATIVE STREAM WATER QUALITY MANAGEMENT PLAN ELEMENT 5[a]

Plan Subelement	Capital (Construction)	Estimated Cost: Present Worth (1970-2020) Construction	Present Worth (1970-2020) Operation and Maintenance	Present Worth (1970-2020) Total	Equivalent Annual Construction	Equivalent Annual Operation and Maintenance	Equivalent Annual Total
Treatment Facilities and Trunk Sewers							
Upper Fox River Watershed							
Waukesha (36.4 MGD)[b]	$ 9,024,000	$ 9,582,000	$ 9,310,600	$ 18,892,600	$ 608,100	$ 590,700	$ 1,198,800
Trunk Sewers to Waukesha[c]	11,690,000	11,690,000	90,000	11,780,000	742,000	6,000	748,000
Subtotal	*$ 20,714,000*	*$ 21,272,000*	*$ 9,400,600*	*$ 30,672,600*	*$ 1,350,100*	*$ 596,700*	*$ 1,946,800*
Lower Fox River Watershed							
Burlington (2.5 MGD)	$ 818,000	$ 1,008,600	$ 1,021,000	$ 2,029,600	$ 64,000	$ 64,800	$ 128,800
East Troy (0.7 MGD)[d]	387,000	477,700	670,000	1,147,700	30,300	42,500	72,800
Fontana[e]	--	--	--	--	--	--	--
Genoa City (0.3 MGD)	126,000	155,400	247,000	402,400	9,900	15,700	25,600
Lake Geneva (2.3 MGD)[d]	1,259,000	1,552,000	1,670,400	3,222,400	98,500	106,000	204,500
Mukwonago (1.2 MGD)	393,000	484,600	624,000	1,108,600	30,700	39,600	70,300
Silver Lake (0.3 MGD)	--	--	161,000	161,000	--	10,200	10,200
Twin Lakes (0.6 MGD)[d]	330,000	407,100	620,900	1,028,000	25,800	39,400	65,200
Waterford-Rochester (1.0 MGD)	474,000	584,400	596,000	1,180,900	37,100	37,800	74,900
Williams Bay[e]	--	--	--	--	--	--	--
Subtotal	*$ 3,787,000*	*$ 4,669,800*	*$ 5,610,300*	*$ 10,280,600*	*$ 296,300*	*$ 356,000*	*$ 652,300*
Subtotal--Treatment Facilities and Trunk Sewers	*$ 24,501,000*	*$ 25,941,800*	*$ 15,010,900*	*$ 40,953,200*	*$ 1,646,400*	*$ 952,700*	*$ 2,599,100*
Low-Flow Augmentation Facilities							
Water Supply Pipeline[f]	$ 6,320,000	$ 6,320,000	$ 47,700	$ 6,367,700	$ 400,900	$ 3,000	$ 403,900
Pumping Stations[g]	1,980,000	2,441,500	1,765,300	4,206,800	154,900	112,000	266,900
Subtotal--Low-Flow Augmentation Facilities	*$ 8,300,000*	*$ 8,761,500*	*$ 1,813,000*	*$ 10,574,500*	*$ 555,800*	*$ 115,000*	*$ 670,800*
Chemical Spraying For Algae and Weed Control	$ 1,500	$ 8,800	$ 1,339,800	$ 1,348,600	$ 560	$ 85,000	$ 85,560
Watershed Total	$ 32,802,500	$ 34,712,100	$ 18,163,700	$ 52,876,300	$ 2,202,760	$ 1,152,700	$ 3,355,460

[a] *This alternative plan element includes the provision of secondary treatment facilities and disinfection at one new large sewage treatment plant in the upper watershed and at individual plants in the lower watershed; low-flow augmentation utilizing Lake Michigan water pumped to the Fox River watershed and discharged to the Fox River above Waukesha; additional removal of oxygen-demanding organic matter at the East Troy, Lake Geneva, and Twin Lakes plants; and algae and weed control through the use of algicides and herbicides in the streams.*

[b] *Proposed new facility to be located about 2 miles downstream from the existing Waukesha sewage treatment plant.*

[c] *For a detailed breakdown of the proposed trunk sewer sizes and costs, see Table G-3, footnote c.*

[d] *Facility to provide tertiary treatment for additional removal of oxygen-demanding organic matter but not for additional nutrient removal.*

[e] *No costs are assigned to these facilities in this plan element because it is proposed that they continue to be operated as secondary treatment plants discharging treated effluents to seepage ponds.*

[f] *An estimated 12 miles of 42-inch pipeline would be needed for this plan subelement.*

[g] *It is estimated that one intake pumping station with a capacity of 50 cfs and 125 feet of head and three booster pumping stations with capacities of 50 cfs and 125 feet of head would be needed.*

Source: *Harza Engineering Company and SEWRPC.*

Table G-8

DETAILED COST ESTIMATES

ALTERNATIVE STREAM WATER QUALITY MANAGEMENT PLAN ELEMENT 6[a]

Plan Subelement	Estimated Cost						
		Present Worth (1970-2020)			Equivalent Annual		
	Capital (Construction)	Construction	Operation and Maintenance	Total	Construction	Operation and Maintenance	Total
Upper Fox River Watershed							
Treatment Facilities							
Brookfield (5.0 MGD)	$ 1,895,000	$ 2,340,000	$ 1,440,600	$ 3,780,600	$ 148,000	$ 91,400	$ 239,400
Lannon (3.4 MGD)	1,820,000	2,250,000	1,065,500	3,315,500	142,100	67,600	209,700
Pewaukee (1.2 MGD)	649,000	800,000	479,200	1,279,200	50,800	30,400	81,200
Poplar Creek (Brookfield) (6.7 MGD)	2,585,000	3,194,000	1,721,200	4,915,200	202,200	109,200	311,400
Sussex (1.6 MGD)	850,000	1,077,000	625,700	1,702,700	68,300	39,700	108,000
Waukesha (18.5 MGD)	3,441,000	4,432,000	3,634,700	8,066,700	281,200	230,600	511,800
Subtotal	*$ 11,240,000*	*$ 14,093,000*	*$ 8,966,900*	*$ 23,059,900*	*$ 892,600*	*$ 568,900*	*$ 1,461,500*
Trunk Sewers[b]	$ 1,690,000	$ 1,690,000	$ 15,000	$ 1,705,000	$ 107,000	$ 1,000	$ 108,000
Subtotal--Upper Watershed	*$ 12,930,000*	*$ 15,783,000*	*$ 8,981,900*	*$ 24,764,900*	*$ 999,600*	*$ 569,900*	*$ 1,569,500*
Lower Fox River Watershed							
Treatment Facilities							
Burlington (2.5 MGD)	$ 818,000	$ 1,008,600	$ 1,021,000	$ 2,029,600	$ 64,000	$ 64,800	$ 128,800
East Troy (0.7 MGD)	257,000	316,900	473,000	789,900	20,100	30,000	50,100
Fontana[c]	--	--	--	--	--	--	--
Genoa City (0.3 MGD)	126,000	155,400	247,000	402,400	9,900	15,700	25,600
Lake Geneva (2.3 MGD)	819,000	1,009,800	1,103,000	2,112,800	64,100	70,000	134,100
Mukwonago (1.7 MGD)	393,000	484,600	624,000	1,108,600	30,700	39,600	70,300
Silver Lake (0.3 MGD)	--	--	161,000	161,000	--	10,200	10,200
Twin Lakes (0.6 MGD)	210,000	258,900	441,000	699,900	16,400	28,000	44,400
Waterford-Rochester (1.0 MGD)	474,000	584,400	596,000	1,180,900	37,100	37,800	74,900
Williams Bay[c]	--	--	--	--	--	--	--
Subtotal--Lower Watershed	*$ 3,097,000*	*$ 3,818,600*	*$ 4,666,000*	*$ 8,485,100*	*$ 242,300*	*$ 296,100*	*$ 538,400*
Watershed Total	$ 16,027,000	$ 19,601,600	$ 13,647,900	$ 33,250,000	$ 1,241,900	$ 866,000	$ 2,107,900

[a] *This alternative plan element includes the provision of secondary treatment facilities and disinfection at all existing and locally proposed (Lannon and Poplar Creek) sewage treatment plants in the watershed.*

[b] *For a detailed breakdown of the proposed trunk sewer sizes and costs, see Table G-1, footnote b.*

[c] *No costs are assigned to these facilities in this plan element because it is proposed that they continue to be operated as secondary treatment plants discharging treated effluents to seepage ponds.*

Source: Harza Engineering Company and SEWRPC.

Table G-9

DETAILED COST ESTIMATES

ALTERNATIVE STREAM WATER QUALITY MANAGEMENT PLAN ELEMENT 7[a]

Plan Subelement	Estimated Cost						
	Present Worth (1970-2020)				Equivalent Annual		
	Capital (Construction)	Construction	Operation and Maintenance	Total	Construction	Operation and Maintenance	Total
Upper Fox River Watershed							
Treatment Facilities							
Brookfield (5.0 MGD)[b]	$ 2,163,000	$ 2,667,000	$ 2,214,600	$ 4,881,600	$ 169,200	$ 140,500	$ 309,700
Lannon (3.4 MGD)[b]	2,070,000	2,560,000	1,673,900	4,233,900	162,100	106,200	268,300
Pewaukee (1.2 MGD)[b]	754,000	930,000	788,100	1,718,100	59,000	50,000	109,000
Poplar Creek (Brookfield) (6.7 MGD)[b]	2,922,000	3,606,000	2,493,500	6,099,500	228,600	158,200	386,800
Sussex (1.6 MGD)[b]	1,000,000	1,263,000	1,028,700	2,291,700	80,100	65,300	145,400
Waukesha (18.5 MGD)[b]	4,094,000	5,263,000	5,456,800	10,719,800	333,900	346,200	680,100
Subtotal	*$ 13,003,000*	*$ 16,289,000*	*$ 13,655,600*	*$ 29,944,600*	*$ 1,032,900*	*$ 866,400*	*$ 1,899,300*
Trunk Sewers[c]	$ 1,690,000	$ 1,690,000	$ 15,000	$ 1,705,000	$ 107,000	$ 1,000	$ 108,000
Subtotal--Upper Watershed	*$ 14,693,000*	*$ 17,979,000*	*$ 13,670,600*	*$ 31,649,600*	*$ 1,139,900*	*$ 867,400*	*$ 2,007,300*
Lower Fox River Watershed							
Treatment Facilities							
Burlington (2.5 MGD)	$ 818,000	$ 1,008,600	$ 1,021,000	$ 2,029,600	$ 64,000	$ 64,800	$ 128,800
East Troy (0.7 MGD)[b]	387,000	477,700	670,000	1,147,700	30,300	42,500	72,800
Fontana[d]	--	--	--	--	--	--	--
Genoa City (0.3 MGD)	126,000	155,400	247,000	402,400	9,900	15,700	25,600
Lake Geneva (2.3 MGD)[b]	1,259,000	1,552,000	1,670,400	3,222,400	98,500	106,000	204,500
Mukwonago (1.2 MGD)	393,000	484,600	624,000	1,108,600	30,700	39,600	70,300
Silver Lake (0.3 MGD)	--	--	161,000	161,000	--	10,200	10,200
Twin Lakes (0.6 MGD)[b]	330,000	407,100	620,900	1,028,000	25,800	39,400	65,200
Waterford-Rochester (1.0 MGD)	474,000	584,400	596,000	1,180,400	37,100	37,800	74,900
Williams Bay[d]	--	--	--	--	--	--	--
Subtotal--Lower Watershed	*$ 3,787,000*	*$ 4,669,800*	*$ 5,610,300*	*$ 10,280,100*	*$ 296,300*	*$ 356,000*	*$ 652,300*
Watershed Total	$ 18,480,000	$ 22,648,800	$ 19,280,900	$ 41,929,700	$ 1,436,200	$ 1,223,400	$ 2,659,600

[a] *This alternative plan element includes the provision of secondary treatment facilities and disinfection at all existing and locally proposed (Lannon and Poplar Creek) sewage treatment plants in the watershed, plus the addition of tertiary treatment for additional removal of oxygen-demanding organic matter, but not for additional nutrient removal, at all of the upper watershed plants and at the East Troy, Lake Geneva, and Twin Lakes plants in the lower watershed.*

[b] *Facility to provide tertiary treatment for additional removal of oxygen-demanding organic matter but not for additional nutrient removal.*

[c] *For a detailed breakdown of the proposed trunk sewer sizes and costs, see Table G-1, footnote b.*

[d] *No costs are assigned to these facilities in this plan element because it is proposed that they continue to be operated as secondary treatment plants discharging treated effluents to seepage ponds.*

Source: Harza Engineering Company and SEWRPC.

Appendix H

MODEL RESOLUTION FOR ADOPTION OF THE COMPREHENSIVE PLAN FOR THE FOX RIVER WATERSHED

WHEREAS, the Southeastern Wisconsin Regional Planning Commission, which was duly created by the Governor of the State of Wisconsin in accordance with Section 66. 945(2) of the Wisconsin Statutes on the 8th day of August 1960 upon petition of the Counties of Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, and Waukesha, has the function and duty of making and adopting a master plan for the physical development of the Region; and

WHEREAS, the several county units of government in the Fox River watershed, on the 12th day of November 1965, entered into contracts with the Southeastern Wisconsin Regional Planning Commission pursuant to the provisions of Sections 66. 30 and 66. 945(12) of the Wisconsin Statutes for the development of a comprehensive plan for the Fox River watershed leading to recommendations for the development of water-related community facilities in the watershed, including integrated proposals for water pollution abatement, drainage and flood control, land and water use, and park and public open-space reservation, to generally promote the orderly and economical development of the Fox River watershed; and

WHEREAS, such plan has been completed and the Southeastern Wisconsin Regional Planning Commission did on the 4th day of June 1970 approve a resolution adopting the comprehensive plan for the Fox River watershed and has recommended such plan to the local units of government within the watershed; and

WHEREAS, such plan contains recommendations for land use development and regulation, environmental corridor land acquisition and preservation, park and outdoor recreation land acquisition and development, floodway and floodplain regulation, water control facility construction, floodland evacuation, stream flow recordation, pollution abatement facility construction, soil and water conservation practices, stream water quality monitoring, and water supply management and is, therefore, a desirable and workable water control and water-related community facility plan for the Fox River watershed; and

WHEREAS, the aforementioned recommendations, including all studies, data, maps, figures, charts, and tables, are set forth in a published report entitled SEWRPC Planning Report No. 12, A Comprehensive Plan for the Fox River Watershed, comprised of the following volumes:

Volume 1. Inventory Findings and Forecasts, published in April 1969, and

Volume 2. Alternative Plans and Recommended Plan, published in February 1970; and

WHEREAS, the Commission has transmitted certified copies of its resolution adopting such comprehensive plan for the Fox River watershed, together with the aforementioned SEWRPC Planning Report No. 12, to the local units of government; and

WHEREAS, the (Name of Local Governing Body) has supported, participated in the financing of, and generally concurred in the watershed and other regional planning programs undertaken by the Southeastern Wisconsin Regional Planning Commission and believes that the comprehensive plan for the Fox River watershed prepared by the Commission is a valuable guide, not only to the development of the watershed but also of the community, and the adoption of such plan by the (Name of Local Governing Body) will assure a common understanding by the several governmental levels and agencies concerned and enable these levels and agencies of government to program the necessary areawide and local plan implementation work.

NOW, THEREFORE, BE IT HEREBY RESOLVED that, pursuant to Section 66. 945(12) of the Wisconsin Statutes, the (Name of Local Governing Body) on__________of________, 1970, hereby adopts the comprehensive plan for the Fox River watershed previously adopted by the Commission as set forth in SEWRPC Planning Report No. 12 as a guide for watershed and community development.

BE IT FURTHER HEREBY RESOLVED, that the_____________clerk transmit a certified copy of this resolution to the Southeastern Wisconsin Regional Planning Commission.

____
(President, Mayor, or Chairman of the Local Governing Body)

ATTESTATION:

____
(Clerk of Local Governing Body)

INTERAGENCY STAFF
FOX RIVER WATERSHED STUDY

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

William W. Russell
State Conservationist

Curt Lindholm
Assistant State Conservationist

Carl K. Otte
Watershed-River Basin Staff Leader

Dale D. Secher
Civil Engineer

Thomas J. Faliski
Hydraulic Engineer

HARZA ENGINEERING COMPANY

James C. Ringenoldus
Head, Water Resources Division

John S. Crane
Sanitary Engineer

Richard E. Fedler
Water Resources Engineer

ALSTER & ASSOCIATES, INC.

L. R. Evans
Vice-President

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Charles L. R. Holt, Jr.
District Chief
Water Resources Division

Kenneth B. Young
Associate District Chief
Water Resources Division

Jack H. Green
Assistant District Chief
Ground Water Branch

Richard D. Hutchinson
Geologist, Ground Water Branch

Dale Cotter
Hydrologist, Ground Water Branch

WISCONSIN DEPARTMENT OF NATURAL RESOURCES

Cyril Kabat
Assistant Director, Bureau of Research
Division of Services

D. John O'Donnell
Supervisor, Watershed Development Unit

D. R. Thompson
Supervisor, Technical Services Section
Bureau of Research

Ruth L. Hine
Editor

Theodore Kouba
Specialist, Bureau of Research

Ronald Poff
Natural Resource Specialist
Bureau of Fish Management

C. W. Threinen
Natural Resource Specialist
Bureau of Fish Management

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

Kurt W. Bauer, P.E.
Executive Director

Harlan E. Clinkenbeard
Assistant Director

Philip C. Evenson
Assistant to the Director

Dallas R. Behnke
Chief Planning Illustrator

Robert L. Fisher
Chief Land Use Planner

William D. McElwee, P. E.
Chief Natural Resources Planner

Eugene E. Molitor
Chief of Planning Research

Margaret M. Shanley
Executive Secretary-Editor

Jerome S. Chudzik
Senior Planner

Paul E. Milewski
Junior Planner