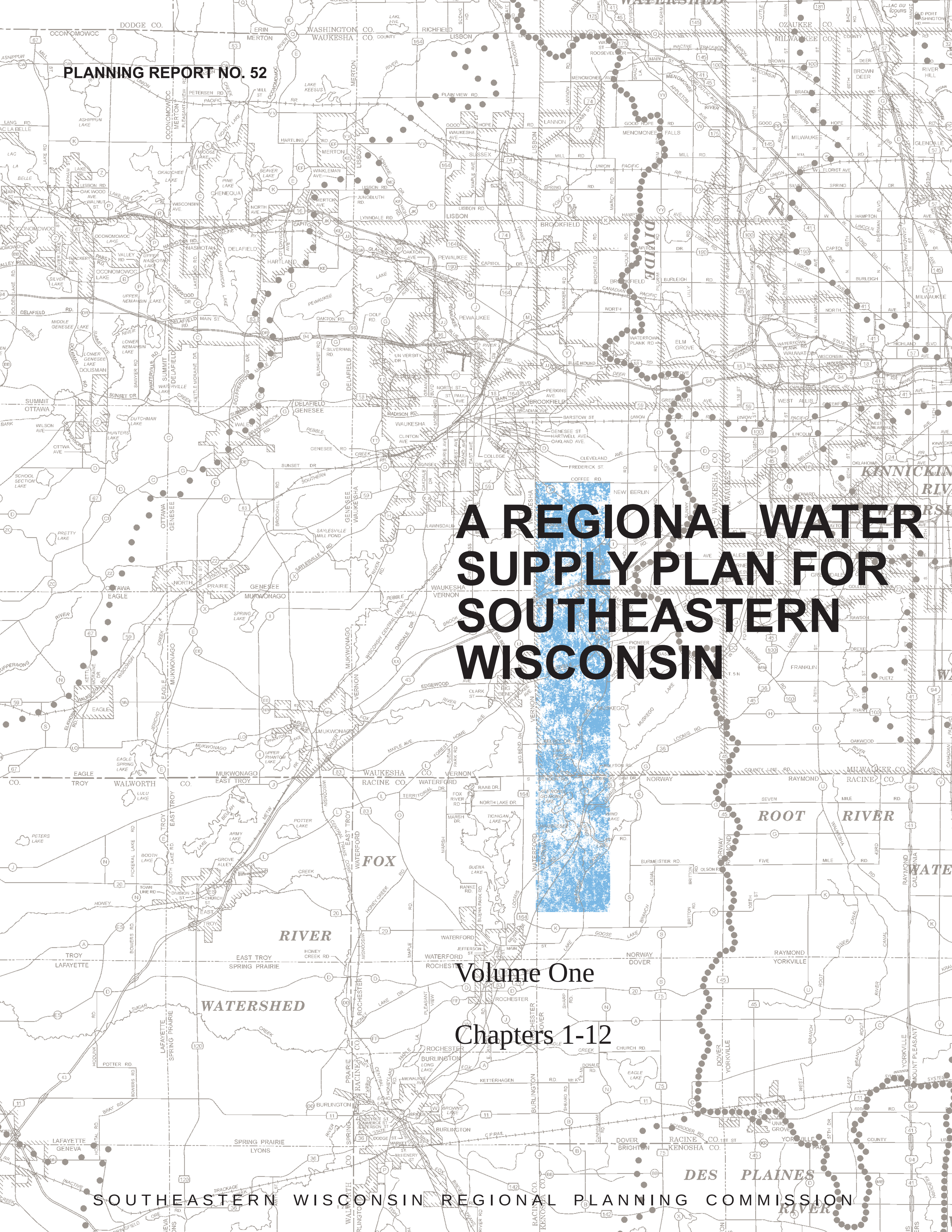
PLANNING REPORT NO. 52



A REGIONAL WATER SUPPLY PLAN FOR SOUTHEASTERN WISCONSIN

Volume One

Chapters 1-12

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SUBJECT: Certification of Adoption of the Year 2035 Regional Water Supply Plan for Southeastern Wisconsin

TO: The Legislative Bodies of All the Local Units of Government within The Southeastern Wisconsin Region, Consisting of the Counties of Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, and Waukesha

This is to certify that at a regular meeting of the Southeastern Wisconsin Regional Planning Commission held at the Milwaukee County War Memorial Center, North Memorial Hall, Milwaukee, Wisconsin, on the 1st day of December 2010, the Commission, by vote of all Commissioners present, being 16 ayes and 2 nays, and by appropriate resolution, a copy of which is made a part hereof and is incorporated by reference to the same force and effect as if it had been specifically set forth herein in detail, did adopt a design year 2035 regional water supply plan for Southeastern Wisconsin as part of the master plan for the physical development of the Southeastern Wisconsin Region. Said plan is documented in SEWRPC Planning Report No. 52, *A Regional Water Supply Plan for Southeastern Wisconsin: 2035*, published in December 2010, which is attached hereto and made a part hereof. Such action taken by the Commission is hereby recorded on and is a part of said plan, which plan is hereby transmitted to all concerned levels and agencies of government in the Southeastern Wisconsin Region for consideration, adoption or endorsement, and implementation.

IN TESTIMONY WHEREOF, I have hereunto set my hand and seal and cause the Seal of the Southeastern Wisconsin Regional Planning Commission to be hereto affixed.

Dated at the City of Pewaukee, Wisconsin, this 7th day of December 2010.

David L. Stroik, Chairman
Southeastern Wisconsin
Regional Planning Commission

ATTEST:

Kenneth R. Yunker, Deputy Secretary

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RESOLUTION NO. 2010-18

RESOLUTION OF THE SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION ADOPTING A DESIGN YEAR 2035 REGIONAL WATER SUPPLY PLAN FOR SOUTHEASTERN WISCONSIN, THE PLAN BEING A PART OF THE MASTER PLAN FOR THE PHYSICAL DEVELOPMENT OF THE REGION CONSISTING OF THE COUNTIES OF KENOSHA, MILWAUKEE, OZAUKEE, RACINE, WALWORTH, WASHINGTON, AND WAUKESHA IN THE STATE OF WISCONSIN

WHEREAS, the Southeastern Wisconsin Regional Planning Commission is charged by Section 66.0309(9) of the *Wisconsin Statutes* with the function and duty of making and adopting a master plan for the physical development of the Region; and

WHEREAS, under the guidance of the Commission Regional Water Supply Planning Advisory Committee, the Commission staff has completed all planning and engineering studies necessary for the preparation of the design year 2035 regional water supply plan, including the preparation of SEWRPC Planning Report No. 52, *A Regional Water Supply Plan for Southeastern Wisconsin*, which report contains maps, charts, tables, programs, and descriptive and explanatory matter intended by the Commission to comprise the year 2035 regional water supply plan and to constitute an integral part of the master plan for the physical development of the Region; and

WHEREAS, the Commission for preparation of the regional water supply plan conducted extensive inventories to provide the necessary climatological; surface water; groundwater and hydrogeologic; water quality; water use; demographic, economic and land use; natural resource base; public utility facility and water law data; developed a regional aquifer performance simulation model; analyzed the state-of-the-art of water supply technology including measures for water conservation; developed a set of water supply management and system development objectives and standards; prepared forecasts of probable future employment, population, and land use development, and of the attendant need for water supply; prepared alternative water supply plans incorporating various combinations of groundwater sources of supply and expanded use of Lake Michigan as a source of supply; evaluated the alternative plans to assess their technological, economic and environmental characteristics, including simulation of the performance of the aquifers underlying the Region under each alternative considered; selected a recommended plan that best meets the objectives and standards; and identified means for plan implementation; and

WHEREAS, the Regional Water Supply Planning Advisory Committee consisting of 32 representatives of the constituent counties and municipalities; water utilities operating within the Region; State and Federal agencies; the academic community; concerned businesses and industries including agriculture; and the environmental protection community all of whom were particularly knowledgeable and experienced in the provision and use of water supply; and

WHEREAS, the Regional Water Supply Planning Advisory Committee at its meeting held on August 24, 2010, acted to approve the regional water supply plan as that plan is described in the aforereferenced SEWRPC Planning Report No. 52, and recommended the adoption of the plan to the Commission; and

WHEREAS, the proposed design year 2035 regional water supply plan was subject to a series of public informational meetings and hearings held in each County in the Region; and

WHEREAS, Section 66.0309(9) of the *Wisconsin Statutes*, authorizes and empowers the Regional Planning Commission to prepare and adopt elements of the master plan as the work of making the whole plan progresses; and the Commission intends the regional water supply plan to constitute an integral part of the master plan for the physical development of the Southeastern Wisconsin Region;

RESOLUTION NO. 2010-18

NOW THEREFORE, BE IT HEREBY RESOLVED:

FIRST: That the design year 2035 regional water supply plan, as set forth in SEWRPC Planning Report No. 52, *A Regional Water Supply Plan for Southeastern Wisconsin,* dated December 2010, shall be and the same hereby is in all respects ratified, approved, and officially adopted.

SECOND: That the said SEWRPC Planning Report No. 52, together with the maps, charts, plats, programs, and descriptive and explanatory matter contained therein, are hereby made a matter of public record, and the originals and true copies thereof shall be kept at all times at the offices of the Southeastern Wisconsin Regional Planning Commission, presently located in the City of Pewaukee, Waukesha County, and State of Wisconsin, or at any subsequent office that the Commission may occupy, for examination and study by whomsoever may desire to examine the same.

THIRD: That a true, correct, and exact copy of this resolution and the aforereferenced SEWRPC Planning Report No. 52 shall be forthwith distributed to each of the local legislative bodies of the government units within the Region entitled thereto and to such other bodies, agencies, or individuals as the law may require or as the Commission or its Executive Committee or its Executive Director in their discretion shall determine and direct.

FOURTH: That the design year 2035 regional water supply plan for Southeastern Wisconsin, following the adoption of this resolution, shall become an element of the master plan for the entire Region, which master plan shall be made for the general purpose of guiding and accomplishing a coordinated, adjusted, and harmonious development of the entire Region and which will, in accordance with existing and future needs, best promote public health, safety, morals, order, convenience, prosperity, or the general welfare, as well as efficiency and economy in the process of development; and that the purpose and effect of the adoption of the master plan shall be solely to aid the Regional Planning Commission, the local governments and local government officials in the Region, the State government and State government officials, and the Federal government and Federal government officials in the performance of their functions and duties.

The foregoing resolution, upon motion duly made and seconded, was regularly adopted at the meeting of the Southeastern Wisconsin Regional Planning Commission held on the 1st day of December 2010, the vote being: Ayes 16; Nays 2.

David L. Stroik, Chairman

ATTEST:

Kenneth R. Yunker, Deputy Secretary

PLANNING REPORT NUMBER 52

A REGIONAL WATER SUPPLY PLAN FOR SOUTHEASTERN WISCONSIN

Volume One of Two Volumes
Chapters 1-12

Prepared by the

Southeastern Wisconsin Regional Planning Commission
In Cooperation with the
Wisconsin Geological and Natural History Survey,
University of Wisconsin-Milwaukee,
U.S. Geological Survey,
Ruekert & Mielke, Inc.,
and
Boardman, Suhr, Curry & Field, LLP

December 2010

Two Volume Set – $30.00

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SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

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December 1, 2010

STATEMENT OF THE CHAIRMAN

We are pleased to present this regional water supply plan as a culmination of five years of study by the staff, Commission, the technical advisory committee, special consultants and countless cooperative agencies in Southeastern Wisconsin. I want to thank all of those involved for their dedicated effort in producing this well-reasoned document.

This report presents the findings and recommendations of the regional water supply planning program conducted by this Commission in response to requests from its constituent counties and municipalities. It presents a sound and viable plan for the provision of an adequate supply of water to existing, and to planned future, development within the seven county Southeastern Wisconsin Region. The plan recommends the provision of this water supply in a manner consistent with the conservation and wise use of the ground and surface water resources of the Region.

The planning program involved the extensive inventories to determine the existing and proposed service areas and capacities of the existing water supply facilities within the Region; of the related surface and groundwater resources; and of the demographic, economic, land and water use, and related natural resources of the Region. The program included the development and application of a mathematical model for the simulation of the performance of the aquifers underlying the Region and the relationship of the aquifers to surface waters under alternative patterns of future use and development; an inventory of the state-of-the-art of water supply technology; and an analysis of governing water law. The planning program included the preparation of forecasts of probable future water supply needs; the identification of existing and probable future water supply problems; and the development of a set of regional water supply system management and development objectives and supporting standards. Importantly, the program involved the preparation, test, and evaluation of alternative water supply plans, and the selection of a recommended plan.

The plan presented in this report identifies recommended sources of supply, and the infrastructure needed to deliver that supply. Water conservation measures, and the protection of groundwater recharge areas are specified. Recommended system development and operation costs are presented together with needed plan implementation measures. The plan includes specific recommendations with respect to the source of supply for each public water utility operating, or proposed to be operating, within the Region to service existing and proposed urban development. The needs of agriculture are considered, and the effects of the proposed water supply facilities on the streams, inland lakes and wetlands of the Region carefully evaluated. The constraints placed upon water supply development within the Region by the subcontinental divide that transverses the Region which separates the Great Lakes drainage basin from the Mississippi River basin was a particularly important consideration in the planning program.

The planning program involved an extensive public information and hearing process in which the findings and recommendations of the work were subject to evaluation by elected and appointed public officials and concerned citizens. The planning work was guided by a technical advisory committee, the membership of which included representatives of the constituent counties and municipalities; of concerned State and Federal agencies; and of the academic, agricultural, business and industrial; and environmental communities. The technical staff work was carried out by the Commission planning and engineering staff, a consulting engineering firm, a consulting law firm, and by the hydrogeology staffs of the Wisconsin Geologic and Natural History Survey, the U.S. Geological Survey, and the University of Wisconsin-Milwaukee. (See inside front cover for complete listing.)

The regional water supply plan, as presented in this report and as adopted by this Commission, constitutes another important element of the evolving comprehensive plan for the rational planned development of our Region. The Commission, whose statutory role is entirely advisory, recommends the plan to all of the implementing Federal, State, county, and municipal agencies concerned for adoption, and for use as a sound point of departure in the making of water supply and related land use development decisions. In its continuing role as a coordinator of planning and plan implementation activities within the Region, the Commission stands ready to assist the units and agencies of government concerned with the implementation of the plan, and through such implementation in attaining a more healthful and attractive environment for life within the Region.

Respectfully submitted,

David L. Stroik,
Chairman

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Chapter I

INTRODUCTION AND BACKGROUND

INTRODUCTION

The Southeastern Wisconsin Regional Planning Commission (Commission) is the official areawide planning agency for the seven-county Southeastern Wisconsin Region. The Commission is charged by law with making and adopting a comprehensive plan for the physical development of the Region. The permissible scope and content of that plan, as outlined in the enabling legislation, extends to all phases of regional development, implicitly emphasizing, however, the preparation of plans for the use of land and for the supporting transportation, utility, and other public infrastructure facilities. The work of the Commission is intended to assist the responsible Federal, State, county, and local units of government in the making of decisions concerning the development of the planning Region. Accordingly, the work of the Commission emphasizes close cooperation between the various levels, units, and agencies of government with oversight for land use development and with the responsibility for the design, construction, operation, and maintenance of the supporting infrastructure facilities.

Pursuant to requests received from several constituent counties and municipalities, the Commission, following its long-established practices, with the assistance of an advisory committee on water supply planning created for this purpose, published a prospectus for the preparation of a regional water supply system plan.[1] The prospectus sets forth the need for and scope and content of a regional water supply plan, an estimated cost of the needed plan, and recommended means for funding the planning effort. The membership of the advisory committee that guided the preparation of the prospectus included knowledgeable and concerned representatives of the constituent counties and municipalities; of concerned State and Federal agencies; of the academic community; and of concerned businesses and industries.

The preparation of the regional water supply plan, as outlined in the prospectus, would represent the third, and final, element of a Commission water supply planning program. The first element consisted of basic groundwater resource inventories; the second consisted of the development of a groundwater simulation model for the Region. These elements involved interagency partnership programs with the U.S. Geological Survey (USGS), the Wisconsin Geological and Natural History Survey (WGNHS), the University of Wisconsin-Milwaukee (UWM), the Wisconsin Department of Natural Resources (WDNR), and a number of the water supply utilities serving the Region.

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[1]*See* Regional Water Supply Planning Program Prospectus, *Southeastern Wisconsin Regional Planning Commission, September 2002.*

The regional water supply planning program, as outlined in the prospectus, was to include the following major components:

- Formulation of a set of regional water supply management and system development objectives and supporting standards;
- Conduct of the inventories required to determine the service areas and capacities of the existing water supply facilities within the planning area; of the related surface water and groundwater systems and aquifer performance; and of the demographic and economic, land and water use, natural resource base, and water law data for the planning area;
- Determination of the state-of-the-art of water supply;
- Technical analyses of the inventory data, preparation of forecasts of probable future water supply needs, and identification of existing and probable future water supply problems;
- Preparation, test, and evaluation of alternative water supply plans;
- Selection of a recommended plan, including identification of recommended sources of supply, development of the infrastructure needed to deliver the supply, and of conservation measures needed to reduce water demand; and
- Identification of needed plan implementation measures, including implementation of any new required intuitional structures.

This report documents the regional water supply plan for southeastern Wisconsin, as well as the process used to arrive at that plan. The plan is based upon the design year 2035 and represents a major element of the comprehensive plan for the seven-county Southeastern Wisconsin Region.

STUDY AREA

The study area considered in the water supply planning effort is the Southeastern Wisconsin Region, hereinafter called the Region, consisting of Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, and Waukesha Counties (see Map 1). Exclusive of Lake Michigan, these seven counties have a total area of about 2,689 square miles, or about 5 percent of the total area of Wisconsin. These counties, however, account for about 35 percent of the total population of the State, about 36 percent of all jobs in the State, and about 38 percent of the total tangible wealth of the State as measured by equalized real property value. Exclusive of school and other special-purpose districts, the study area contains 154 county and local units of government.[2]

The study area is bounded on the east by Lake Michigan, which is an important source of water supply. It is bounded on the south by the rapidly expanding metropolitan region of northeastern Illinois, and on the west and north by the fertile agricultural lands and desirable recreation areas of the rest of the State of Wisconsin. Map 1 also shows the boundaries of the urbanized areas within the Region as defined in 2000 by the U.S. Bureau of the Census. These areas may be thought of as those portions of the developing Region actually devoted to relatively dense urban development radiating outward from the core cities in a contiguous fashion.

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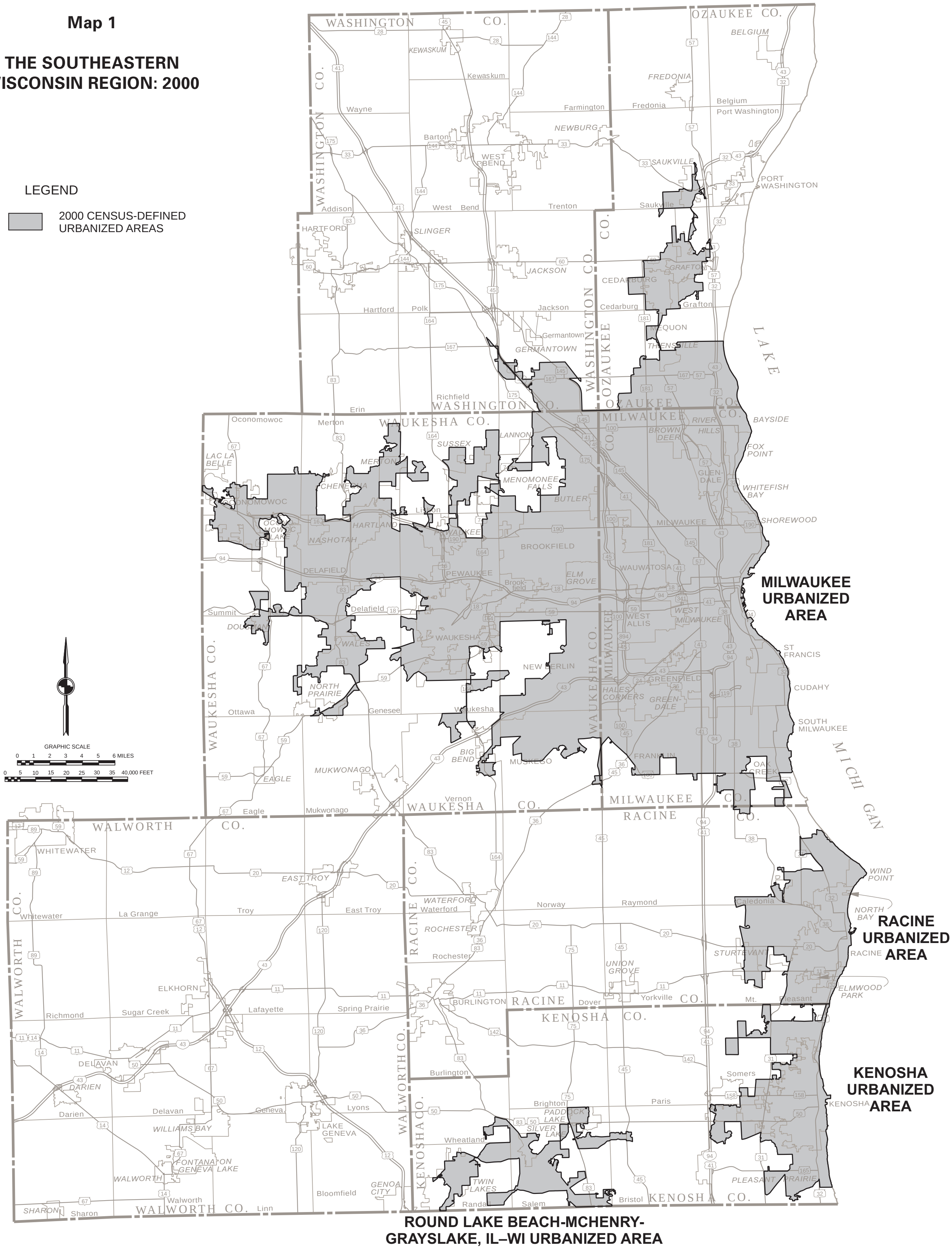
[2]*In December 2008, the Village and Town of Rochester in Racine County were consolidated, reducing the number of county and local units of government within the Region to 153. In November 2009, the residents of a portion of the Town of Bristol voted to incorporate the central core of the Town, which would create a nine-square-mile village inside the boundaries of the Town. Upon certification of the vote, there will be an increase of one local unit of government, resulting in 154 county and local units of government.*

Map 1

THE SOUTHEASTERN WISCONSIN REGION: 2000



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

While the focus of the water supply planning is on the Southeastern Wisconsin Region, it is recognized that the importance of some sources of water supply concerned extend beyond the boundaries of that study area. Most importantly, the largest current source of supply used in the study area, Lake Michigan, is of interstate and international importance. In addition, the deep sandstone aquifer, and its important recharge areas—an important source of supply in the Region—extends well beyond the Region. Thus, in some cases, there is a need to consider the water supply sources of the study area within the context of larger, related areas. For example, the regional groundwater model developed as part of the regional water supply planning program was constructed to represent the aquifer system primarily in southeastern Wisconsin—the so-called model nearfield area—as shown in Figure 1. However, because the deep aquifer underlying the seven-county southeastern Wisconsin planning region extends well beyond that area, the analyses also considered a somewhat larger model nearfield area, and a much larger farfield area in order to properly establish aquifer boundary conditions for the planning region. Finally, the water supply planning specifically considered areas outside of the Region that are part of general-purpose units of government lying partially within the Region. These areas, in 2000, included portions of the Cities of Hartford and Whitewater.

PLAN PURPOSE

The primary purpose of the regional water supply system planning program was to develop a sound and workable plan to guide the provision of adequate water supply service to existing and planned future development within the Region, and to do so in a manner consistent with the protection and wise use of the natural resource base, particularly, of the ground and surface water resources of the Region. The plan is intended to incorporate measures to resolve existing water supply quality and quantity problems and to avoid the future creation of such problems. The plan is intended to be in sufficient depth and detail to provide a sound framework for local water supply planning and engineering, including recommendations concerning the location and extent of areas to be served by public water supply, together with identification of the sources of supply to be used to serve the delineated service areas. The plan is intended to address associated legal and environmental issues, including the transfer of water across the subcontinental divide traversing the Region. It should be recognized that plan implementation will be dependent upon local actions, including, but not limited to: refinement and detailing of water supply service areas; the development of detailed local water supply facilities plans consistent with the regional system plan and consistent with appropriate regulations regarding sources of water supply, including the diversion of water; and the integration of the plan recommendations into comprehensive county and local planning programs.

NEED FOR REGIONAL PLANNING

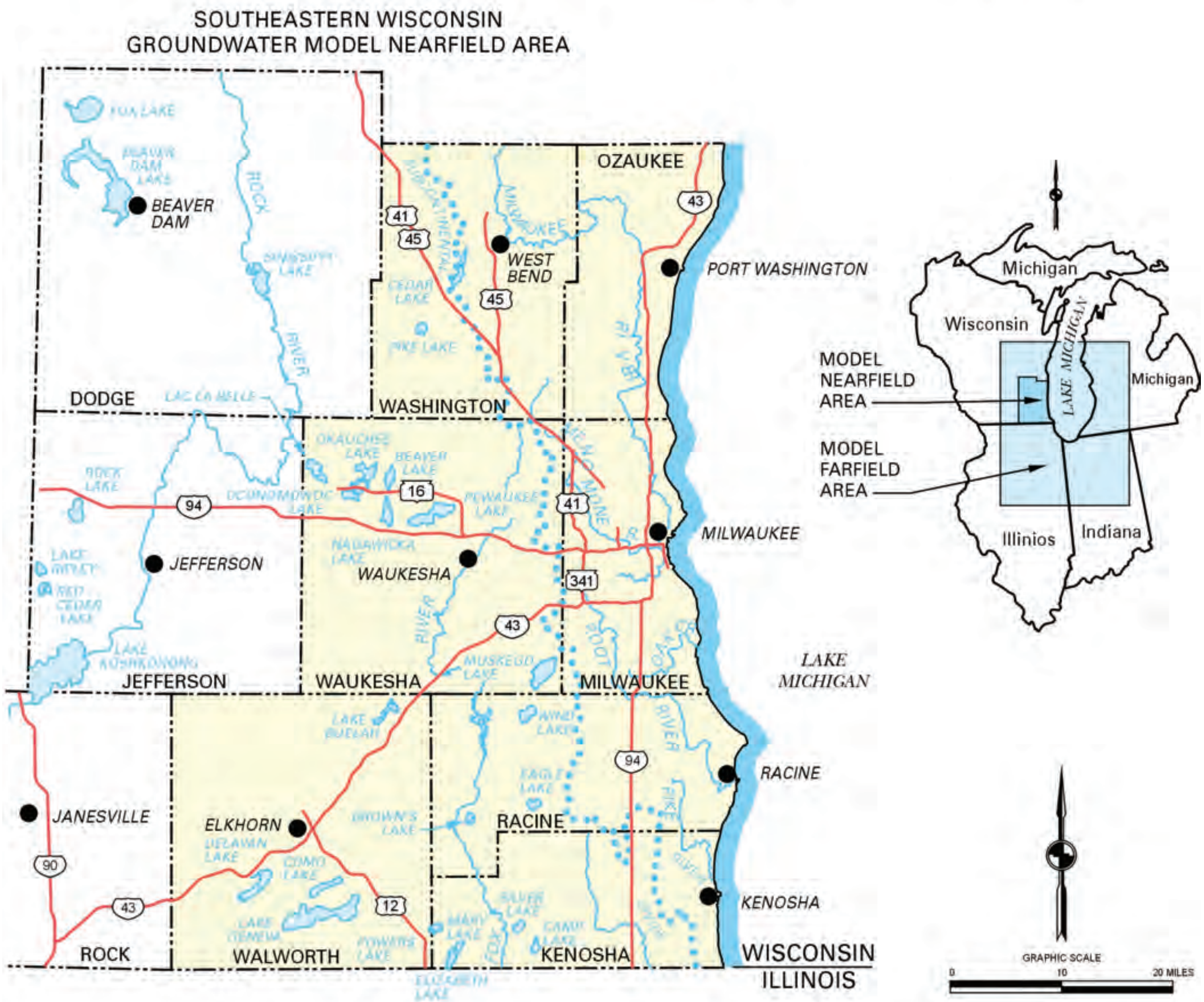
Regional, or areawide, planning has become increasingly accepted as a necessary governmental function in the large metropolitan areas of the United States. This acceptance is based, in part, on an awareness that problems of physical and economic development and of environmental deterioration transcend the geographic limits of local units of government. It has also been recognized that sound resolution of areawide problems requires the cooperation of all units and agencies of government concerned and of private interests, as well.

Public, as well as private, interests are vitally affected by areawide developmental and environmental problems and by proposed solutions to these problems. Regional planning is necessary to promote a consensus on proposed solutions and the necessary cooperation among urban and rural; local, State, and Federal; and public and private interests. In this light, regional planning is not a substitute for Federal, State, or local public planning or for private planning. Rather, regional planning is an important supplement to such planning.

As already noted, the Southeastern Wisconsin Regional Planning Commission is the official areawide planning agency for the seven-county Southeastern Wisconsin Region. The Commission is charged with the responsibility for the collection, analysis, and dissemination of basic planning and engineering data on a uniform, areawide basis; for the preparation of a framework of long range plans for the physical development of the Region; and for the promotion of intergovernmental cooperation and coordination in the adoption and implementation of such long range plans.

Figure 1

AREA OF SOUTHEASTERN WISCONSIN SIMULATED IN GROUNDWATER MODEL



Source: U.S. Geological Survey, University of Wisconsin-Extension, Wisconsin Geological and Natural History Survey, and SEWRPC.

Section 66.0309 of the *Wisconsin Statutes* specifically charges the Commission with the function and duty of "making and adopting a master plan for the physical development of the region." The permissible scope and content of this plan, as outlined in the enabling legislation, extends to all phases of regional development, implicitly emphasizing, however, the preparation of plans for the use of land and for the supporting transportation, utility, and other public infrastructure facilities. In the pursuit of its statutory responsibilities, the Commission has, to date, prepared and adopted a number of elements of a comprehensive plan for the development of the seven-county Region, including a land use plan, a park and open space plan, a natural areas management plan, a transportation system plan, a series of eight watershed plans for the major natural watersheds lying within the Region, a water quality management plan, and a sanitary sewerage system plan. The watershed plans specifically address drainage and flood control and related problems.

The Commission has long-recognized that the comprehensive plan for the development of the Region lacked a water supply element. The regional water supply plan documented in this report is intended to provide that element by addressing water supply problems and issues which have developed, or are developing, within the Region that are regional and subregional in nature, as documented in the aforenoted prospectus. The urbanizing Southeastern Wisconsin Region is richly endowed with water resources. The historic growth and development of the Region may be attributed, in part, to the abundant water supply available within the Region for domestic, commercial, and industrial uses. Properly husbanded, these water resources can serve the Region for all time to come. Misused and mismanaged, however, these resources can become a severe constraint on the sound social, economic, and physical development of the Region.

BASIC PRINCIPLES

The regional water supply planning program is based on four basic principles:

1. Water Supply System Planning Must Be Conducted Concurrently with, and Cannot Be Separated from, Land Use Planning. The land use pattern determines the amount and spatial distribution of water supply demand to be accommodated by the water supply system. In turn, the water supply systems may have some impact on shaping the future land use pattern. Although detailed land use patterns are primarily of local concern and properly subject to local planning and control, the aggregate effects of the spatial distribution of land use activities are regional in scope and interact with the need for and capacity of water supply systems.

2. Land Use and Water Supply System Planning Must Recognize the Existence of a Limited Natural Resource Base to Which Urban and Rural Development Must Be Properly Coordinated to Ensure the Overall Environmental Quality of the Region. Land and water resources are limited and subject to potential misuse through improper land use and water supply system development.

3. The Regional Water Supply System Plan is Intended to Provide a Framework Plan within Which Local Water Supply Facilities Planning Can Be Soundly Conducted. Under this concept, water supply system planning recommendations are initially advanced at the regional systems level of planning and are followed by implementation actions in the form of local project planning and preliminary engineering. If, for whatever reasons, a particular water supply facility, or management proposal, advanced at the regional systems planning level cannot be implemented at the project level, that determination is taken into account through consideration of amendment to the regional water supply plan.

4. Water Supply System Planning in Southeastern Wisconsin Must Recognize the Constraints of Regulations and Policies Relating to the Ability to Obtain Water from the Great Lakes Basin and Groundwater Aquifers. The current and potential future regulatory framework, including the Great Lakes-St. Lawrence River Basin Water Resources Compact put forth by the Council of Great Lakes Governors and the recent State of Wisconsin groundwater legislation and the related activities of the Groundwater Advisory Council, are important factors which will impact the framework of the regional water supply plan.

RELATIONSHIP TO OTHER PLANNING PROGRAMS

The regional land use plan for 2035, which was completed in 2005,[3] serves as a basis for the land use development envisioned in the regional water supply plan. In addition to the regional land use plan, the regional water supply plan is directly, or indirectly, related to a number of completed plans and ongoing planning

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[3]*The findings and recommendations of this planning effort are documented in SEWRPC Planning Report No. 48,* A Regional Land Use Plan for Southeastern Wisconsin: 2035, *June 2006.*

programs. These include, among others, the regional water quality management plan and its current update; county land and water resource management plans; the ongoing and anticipated future comprehensive or "smart growth" plans being prepared at the county and local levels of government within the Region; and the basin planning being carried out by the Wisconsin Department of Natural Resources. The regional water supply plan is also related to the ongoing activities of the State Groundwater Advisory Committee created to make recommendations to the State Legislature regarding future groundwater management needs. In addition to these plans and programs, there are other local planning programs which are relevant to the regional water supply planning effort and which were considered, as appropriate, in the regional planning process. These include local water supply system facility plans, local stormwater management plans, and local land use plans.

Regional 2035 Land Use Plan

The future land use pattern used in the development of the regional water supply plan is based upon the 2035 regional land use plan. That plan seeks, to the extent practicable, to recentralize development in the Region, encouraging redevelopment and new development to occur at higher densities in defined neighborhood units located in areas that are either served by, or can readily be served by, public water supply, other utility systems, and mass transit. It is recognized that the regional water supply planning program may identify a need to refine or revise the 2035 land use pattern owing to water supply considerations which were not known during development of the regional land use plan. In that event, the regional water supply plan was intended to include recommendations for appropriate amendments to the regional land use plan.

Regional Water Quality Management Plan

The Commission is the State-designated and Federally recognized areawide water quality management planning agency for southeastern Wisconsin. Pursuant to the provisions of Section 208 of the Federal Clean Water Act, the Commission prepared and adopted in 1979 an areawide water quality management plan for the Southeastern Wisconsin Region. That plan was subsequently adopted by the Wisconsin Natural Resources Board and approved by the U.S. Environmental Protection Agency (USEPA).[4]

The regional water quality management plan was designed, in part, to meet the Congressional mandate that the waters of the United States be made to the extent practicable "fishable and swimmable." In accordance with the requirements of Section 208 of the Federal Clean Water Act, the plan provides recommendations for the control of water pollution from such point sources as sewage treatment plants; points of separate and combined sewer overflow; industrial waste outfalls; and from such nonpoint sources as urban and rural stormwater runoff.

Since completion of the initial regional water quality management plan, the Commission and the Wisconsin Department of Natural Resources have cooperatively conducted a continuing water quality management planning effort. That effort, however, has been limited by fiscal constraints, with work confined largely to sanitary sewer service area planning, groundwater inventories and analyses, and selected plan implementation activities. A major update of the plan was completed in 2007 for the Kinnickinnic River, Milwaukee River, Menomonee River, Oak Creek, and Root River watersheds, as well as the Milwaukee Harbor estuary and a portion of the nearshore Lake Michigan and its direct tributary drainage area.[5] The plan includes a groundwater management component. The planning effort was coordinated with the preparation of a new facilities plan by the Milwaukee Metropolitan Sewerage District (MMSD), also completed in 2007.

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[4] *The findings and recommendations of this planning effort are documented in SEWRPC Planning Report No. 30,* A Regional Water Quality Management Plan for Southeastern Wisconsin—2000, *Volume One,* Inventory Findings, *September 1978; Volume Two,* Alternative Plans, *February 1979; and Volume Three,* Recommended Plan, *June 1979.*

[5] *The findings and recommendations of this planning effort are documented in SEWRPC Planning Report No. 50,* A Regional Water Quality Management Plan Update for the Greater Milwaukee Watersheds, *December 2007.*

Components of the regional water quality management plan are directly related to the water supply plan, including the sewer service area component of the point source pollution abatement element, and the groundwater management and related stormwater management components of the nonpoint source pollution control element. With regard to the sewer service area plan component, a need exists to correlate the recommended sewer service areas with the water service areas. Particular attention was given in the planning effort to the coordination of drainage basin water withdrawals with sewerage system discharge requirements. With regard to groundwater management, components of both the regional water supply plan and the regional water quality management plan provide recommendations for the protection and management of groundwater recharge areas and for the development of stormwater management practices which are designed to maintain the natural hydrology of the planning effort.

County Land and Water Resource Management Plans

Each of the counties within the study area has prepared a land and water resource management plan pursuant to Chapter 92 of the *Wisconsin Statutes*. Those plans are typically updated every five to seven years. These plans provide information on the natural resources, including groundwater, of each county; on the limitations, issues, and problems relating to those resources; and set forth a strategy to address those limitations, issues, and problems. The plans also provide a means to inform the public about these limitations, issues, and problems and to include the public in developing the steps necessary to protect the natural resource base. These plans were carefully reviewed during development of the water supply system plan, and the recommended regional water supply plan contains recommendations which require integration into the county land and water resource management plans as those plans undergo local refinement and implementation.

County and Local Comprehensive Planning

Pursuant to Section 66.1001 of the *Wisconsin Statutes*, counties, cities, villages, and towns need to adopt so-called “smart growth” plans if the counties and municipalities are to continue to exercise certain land use regulations, including zoning, land subdivision control, and official mapping. These plans are to consist of nine specific elements, four of which are directly related to the regional water supply plan. These elements include:

- <u>Land Use Element</u>: The land use element is to consist of a compilation of objectives, policies, goals, maps and programs to guide the future development and redevelopment of public and private property. The element is to include a series of maps that show current land uses and proposed future land uses; that identify productive agricultural soils, areas with natural limitations for building site development, floodplains, wetlands and other environmentally sensitive lands; and that set forth the boundaries of areas to which public utility and community facility services are proposed to be provided in the future.

- <u>Utilities and Community Facilities Element</u>: The utilities and community facilities plan element is to consist of a compilation of objectives, policies, goals, maps and programs to guide the future development of utilities and community facilities by the local governmental unit concerned, including sanitary sewerage, stormwater management, and water supply facilities. This element is to describe the location, use, and capacity of existing public utilities and community facilities that serve the local governmental unit concerned; is to include an approximate schedule for needed expansion and rehabilitation of existing facilities, for the development of new facilities; and is to assess future needs for public services within the local governmental unit that are related to such utilities and facilities.

- <u>Agricultural, Natural and Cultural Resources Element</u>: The agricultural, natural and cultural resources element is to consist of a compilation of objectives, policies, goals, maps and programs for the conservation and effective management of natural resources, such as groundwater and surface water, woodlands, productive agricultural areas, environmentally sensitive areas, floodplains, and wetlands.

- <u>Intergovernmental Cooperation</u>: The intergovernmental cooperation element is intended, as the name implies, to promote cooperation between the various levels and units of government operating within an area, including the general purpose units of government and such special-purpose units of government as school and sewerage districts; with particular emphasis upon coordination in the siting and construction of public facilities and sharing of public services.

The development of the regional water supply plan was coordinated with the ongoing county and municipal smart growth planning efforts within the Region. The plan implementation strategies include specific recommendations for the integration of applicable water supply plan recommendations into, and the local refinement of selected elements of the recommended regional water supply plan.

Wisconsin Department of Natural Resources Basin Planning

The Wisconsin Department of Natural Resources conducts planning and program management activities for the Milwaukee River basin, comprised of the Kinnickinnic, Menomonee, and Milwaukee River watersheds; the Root-Pike River basin, which includes the Root River, Pike River, and Oak Creek watersheds; the Fox River basin, which includes the Fox River and Des Plaines River watersheds; and the Rock River basin, which includes the Rock River watershed. The Department has prepared "state-of-the-basin" plans for each of these basins.[6] These plans include resource management recommendations related to Department programmatic activities, including surface and groundwater management, sewerage system management, and related water resources management programs. The regional water supply planning effort included coordination with the basin planning.

State Groundwater Advisory Committee Activities

A State Groundwater Advisory Committee was created by *2003 Wisconsin Act 310*, and charged with making recommendations to the State Legislature regarding meeting future groundwater management needs in Wisconsin. In this regard, two reports were prepared by the Committee and submitted to the environmental and natural resources standing committees of the Legislature, one in December 2006, and the other in December 2007. These reports: 1) provide recommendations on how to address existing groundwater problems in those subareas of the State with identified problems; and 2) make findings on how the current groundwater law is working to protect the groundwater resources. The first report specifically relates to the regional water supply planning efforts in that it includes recommended strategies for addressing groundwater management in areas designated as "groundwater management areas," one of which includes all, or portions, of each of the counties in the Southeastern Wisconsin Region. Ideally, the regional water supply plan for southeastern Wisconsin would serve as the model for developing management recommendations in the groundwater management areas.

ORGANIZATIONAL STRUCTURE AND PUBLIC INVOLVEMENT FOR THE WATER SUPPLY PLANNING PROGRAM

Technical staffing for the regional water supply plan preparation was carried out under a cooperative staff arrangement involving the Commission staff; a consulting engineering firm; a consulting law firm; and the hydrogeology staffs of the Wisconsin Geological and Natural History Survey, the U.S. Geological Survey, and the University of Wisconsin-Milwaukee. The Commission served as the lead agency in the planning effort.

The work leading to the preparation of the regional water supply plan was carried out under the guidance of the Commission Advisory Committee on Regional Water Supply Planning. This Committee is a successor committee to that created to assist the Commission in the preparation of the prospectus for the program. Membership on the Advisory Committee included, like that of the predecessor committee, knowledgeable and concerned representatives of the constituent counties and municipalities; of State and Federal agencies; of the academic community; and of concerned businesses and industries. A list of the membership of the Advisory Committee is provided on

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[6]*Wisconsin Department of Natural Resources,* The State of the Milwaukee River Basin*, August 2001; Wisconsin Department of Natural Resources,* The State of the Root-Pike River Basin*, May 2002; Wisconsin Department of Natural Resources,* The State of the Southeast Fox River Basin*, February 2002; and Wisconsin Department of Natural Resources,* The State of the Rock River Basin*, April 2002.*

the inside front cover of this report. The Advisory Committee guided the planning process, and carefully reviewed and approved this report.

During the course of the study, the Commission staff worked with a number of interests through individual and group meetings, providing information about, and obtaining input on, the plan and the planning process. Also during the course of the study, newsletters were issued from time-to-time to a wide audience including elected officials, technical and appointed planning and engineering officials, interested citizen groups, business and industry groups, print and broadcast media, and citizens who have indicated in the past, or during the study, an interest in the planning issues concerned. A series of nine public informational meetings were held to present the preliminary recommended water supply plan for public review and comment.

The Commission also maintained a website—*www.sewrpc.org/2035 regional plans*—which included materials prepared under the water supply planning effort, including summary and background information, drafts of the planning documents, newsletters, and provided opportunity to offer comments on the planning effort.

SCHEME OF PRESENTATION

The findings and recommendations of the regional water supply planning effort and the recommended regional water supply plan are documented in this report. Following this introductory chapter, Chapter II presents base year 2000 information regarding the demographic and economic base, the land use pattern, the natural resource base, and other pertinent aspects of the Southeastern Wisconsin Region, presenting information that is essential to the water supply planning process. Chapter III presents an inventory of the existing water supply sources and systems in the Region. Chapter IV sets forth forecasts of anticipated change in population, households, and employment within the Region through the plan design year of 2035, and forecast water supply demands under planned land use conditions. Chapter V presents the objectives and supporting standards adopted for use in the water supply planning program. Chapter VI summarizes the legal structures affecting water supply planning. Chapter VII identifies the water supply problems and issues which need to be addressed in the planning program as revealed by the forecasts and analyses of the existing water supply systems. Chapter VIII presents a description and evaluation of alternative regional water supply plans designed to address the identified existing and probable future water supply problems and issues. Chapter IX presents a comparative evaluation of the alternative plans considered and sets forth a preliminary recommended regional water supply plan to be presented for public review. Chapter X presents a recommended water supply system plan designed to serve anticipated design year 2035 conditions within the Region. Chapter XI describes the actions which should be taken by the units and agencies of government concerned and others to implement the recommended plan. Chapter XII provides a summary of the report. This planning report is supplemented by five technical reports. These reports document findings of an inventory of the state-of-the-art of water supply practices,[7] an inventory of water supply law;[8] the development and application of groundwater impact indices to be used in alternative plan evaluation;[9] an inventory and analysis of aquifer recharge in the Region;[10] and an analysis of the impacts of varying densities of residential development on groundwater sustainability.[11]

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[7]*SEWRPC Technical Report No. 43,* State-of-the-Art of Water Supply Practices*, July 2007.*

[8]*SEWRPC Technical Report No. 44,* Water Supply Law*, April 2007.*

[9]*SEWRPC Technical Report No. 46,* Groundwater Budget Indices and Their Use in Assessing Water Supply Plans for Southeastern Wisconsin*, in preparation.*

[10]*SEWRPC Technical Report No. 47,* Groundwater Recharge in Southeastern Wisconsin Estimated by a GIS-Based Water-Balance Model*, July 2008.*

[11]*SEWRPC Technical Report No. 48,* Shallow Groundwater Quantity Sustainability Analysis Demonstration for the Southeastern Wisconsin Region*, in preparation.*

Chapter II

DESCRIPTION OF THE STUDY AREA

INTRODUCTION

The water supply problems of a region, as well as the ultimate solutions to those problems, are a function of the human activities within the region and of the ability of the underlying sources of supply to sustain those activities. Regional water supply planning seeks to rationally guide human actions so as to promote the conservation and wise use of the sustaining water supply resources. Accordingly, the purpose of this chapter is to describe the findings of the inventories of those features of the Southeastern Wisconsin Region most directly related to water demand and supply systems, thereby establishing a factual base upon which regional water supply planning may proceed on a technically sound basis. The Southeastern Wisconsin Regional Planning Commission has developed an extensive database pertaining to the seven-county planning region, updating that database periodically. A major inventory update effort was carried out by the Commission in the early 2000s in support of the preparation of new regional land use and transportation system plans and other elements of the comprehensive plan for the development of the Region. This chapter presents a summary of the inventory data pertaining most directly to water supply planning, including data on civil divisions and special-purpose units of government with water supply management responsibilities, population and household levels, economic activity levels, land use, utility systems and service areas, the natural resource base, the agricultural resource base, and community plans and zoning. The inventory information is based upon year 2000 conditions, the base year for the planning program, except in some instances where the presentation of historic or more recent inventory data was deemed important.

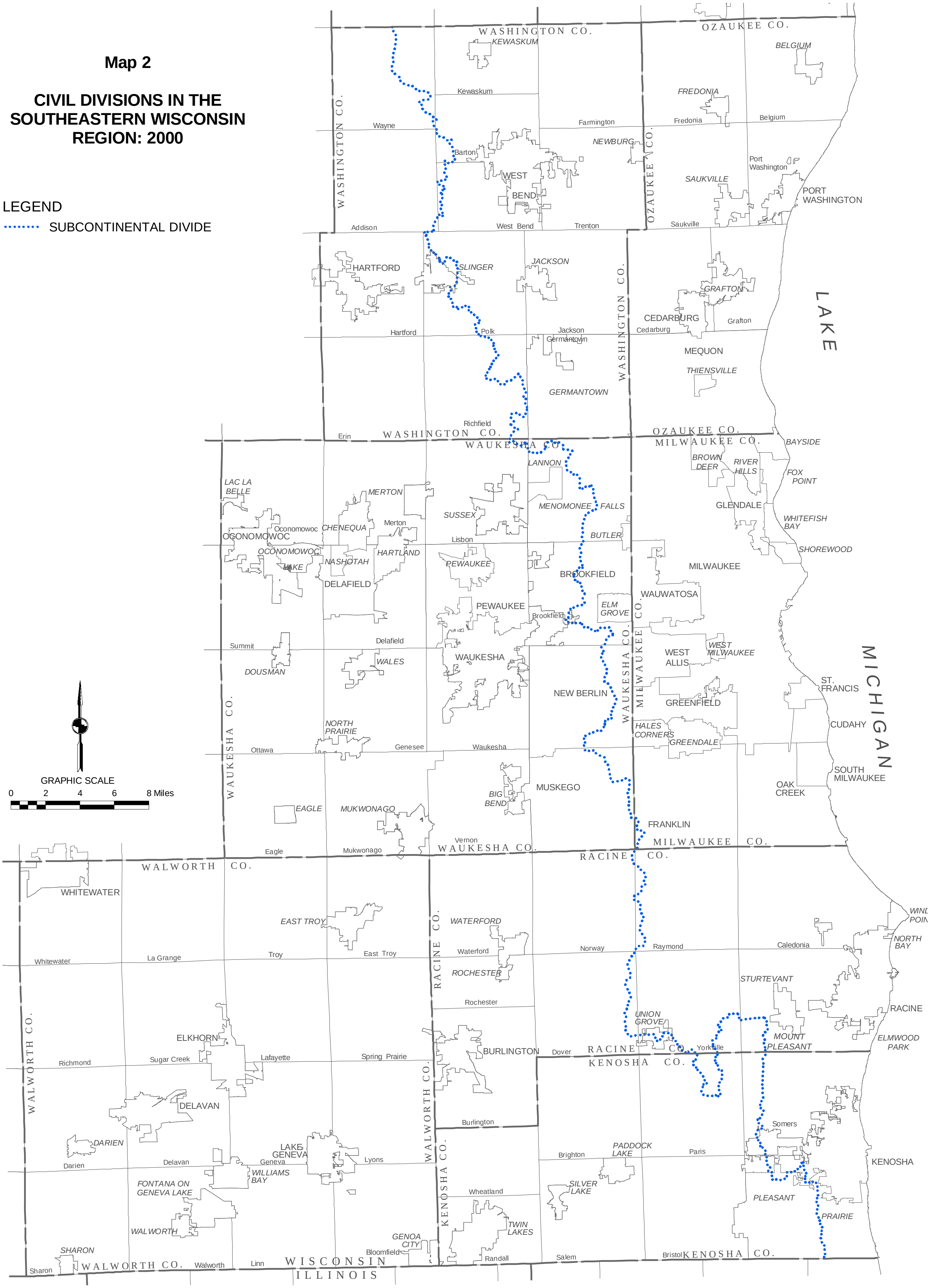
CIVIL DIVISIONS AND SPECIAL-PURPOSE UNITS OF GOVERNMENT WITH WATER SUPPLY MANAGEMENT RESPONSIBILITIES

Superimposed on the planning region is a pattern of local political boundaries, as shown on Map 2. In 2000, there were 147 municipal governmental units within the seven-county Region—29 cities, 55 villages, and 63 towns. The areal extents of the civil divisions concerned are listed in Table 1. The geographic boundaries of the civil divisions are an important factor to be considered in the regional water supply program, since the civil divisions form a basic part of the public decision-making framework within which intergovernmental, environmental, and utility problems must be addressed.

In addition to the civil divisions within the Region, there are 18 special-purpose units of government which provide water supply services. These units of government include town utility or sanitary districts created under Sections 66.0827, 60.71, and 60.72 of the *Wisconsin Statutes*. These districts are shown on Map 3. In addition to the special-purpose units of government with water supply responsibilities, there are a number of other special-purpose units of government which are indirectly related to water supply planning. These special-purpose units of

Map 2

CIVIL DIVISIONS IN THE SOUTHEASTERN WISCONSIN REGION: 2000



Source: SEWRPC.

Table 1

AREAL EXTENT OF COUNTIES, CITIES, VILLAGES AND TOWNS IN THE SOUTHEASTERN WISCONSIN REGION: 2000

Civil Division	Area (square miles)
Kenosha County	
City of Kenosha	23.7
Village of Genoa City[a]	- -
Village of Paddock Lake	2.1
Village of Pleasant Prairie	33.5
Village of Silver Lake	1.4
Village of Twin Lakes	7.1
Town of Brighton	35.9
Town of Bristol	34.7
Town of Paris	36.0
Town of Randall	16.9
Town of Salem	32.7
Town of Somers	30.2
Town of Wheatland	24.1
Subtotal	278.3
Milwaukee County	
City of Cudahy	4.8
City of Franklin	34.7
City of Glendale	6.0
City of Greenfield	11.5
City of Milwaukee[b]	96.7
City of Oak Creek	28.5
City of South Milwaukee	4.9
City of St. Francis	2.6
City of Wauwatosa	13.2
City of West Allis	11.4
Village of Bayside[c]	2.3
Village of Brown Deer	4.4
Village of Fox Point	2.9
Village of Greendale	5.6
Village of Hales Corners	3.2
Village of River Hills	5.3
Village of Shorewood	1.6
Village of West Milwaukee	1.1
Village of Whitefish Bay	2.1
Subtotal	242.8
Ozaukee County	
City of Cedarburg	3.7
City of Mequon	47.0
City of Port Washington	3.9
Village of Bayside[d]	0.1
Village of Belgium	1.6
Village of Fredonia	1.4
Village of Grafton	4.1
Village of Newburg[e]	0.1
Village of Saukville	2.9
Village of Thiensville	1.1
Town of Belgium	36.2
Town of Cedarburg	26.0
Town of Fredonia	35.1
Town of Grafton	20.3
Town of Port Washington	18.7
Town of Saukville	33.4
Subtotal	235.6

Table 1 (continued)

Civil Division	Area (square miles)
Racine County	
City of Burlington[f]	6.1
City of Racine	15.7
Village of Elmwood Park	0.2
Village of North Bay	0.1
Village of Rochester	0.5
Village of Sturtevant	3.0
Village of Union Grove	1.7
Village of Waterford	2.4
Village of Wind Point	1.3
Town of Burlington	35.9
Town of Caledonia	45.6
Town of Dover	36.2
Town of Mt. Pleasant	35.1
Town of Norway	35.7
Town of Raymond	35.7
Town of Rochester	17.2
Town of Waterford	33.8
Town of Yorkville	34.6
Subtotal	340.8
Walworth County	
City of Burlington[g]	0.1
City of Delavan	6.7
City of Elkhorn	7.3
City of Lake Geneva	5.8
City of Whitewater[h]	5.4
Village of Darien	1.2
Village of East Troy	3.6
Village of Fontana-on-Geneva Lake	4.0
Village of Genoa City[i]	2.2
Village of Mukwonago[j]	0.1
Village of Sharon	1.0
Village of Walworth	1.4
Village of Williams Bay	3.5
Town of Bloomfield	33.2
Town of Darien	34.1
Town of Delavan	28.3
Town of East Troy	32.2
Town of Geneva	30.8
Town of LaFayette	34.5
Town of LaGrange	35.7
Town of Linn	33.8
Town of Lyons	34.8
Town of Richmond	36.0
Town of Sharon	35.5
Town of Spring Prairie	35.8
Town of Sugar Creek	33.8
Town of Troy	35.5
Town of Walworth	29.7
Town of Whitewater	30.6
Subtotal	576.6
Washington County	
City of Hartford[k]	5.5
City of Milwaukee[l]	- -
City of West Bend	12.6

Table 1 (continued)

Civil Division	Area (square miles)
Washington County (continued)	
Village of Germantown	34.4
Village of Jackson	2.5
Village of Kewaskum	1.4
Village of Newburg[m]	0.8
Village of Slinger	3.5
Town of Addison	36.0
Town of Barton	19.4
Town of Erin	36.1
Town of Farmington	36.8
Town of Germantown	1.8
Town of Hartford	31.0
Town of Jackson	34.2
Town of Kewaskum	22.9
Town of Polk	32.5
Town of Richfield	36.4
Town of Trenton	33.5
Town of Wayne	35.8
Town of West Bend	18.2
Subtotal	435.3
Waukesha County	
City of Brookfield	27.3
City of Delafield	11.0
City of Milwaukee[n]	0.1
City of Muskego	36.0
City of New Berlin	36.9
City of Oconomowoc	8.9
City of Pewaukee	23.3
City of Waukesha	21.8
Village of Big Bend	2.1
Village of Butler	0.8
Village of Chenequa	4.6
Village of Dousman	1.5
Village of Eagle	1.2
Village of Elm Grove	3.3
Village of Hartland	4.5
Village of Lac La Belle	0.7
Village of Lannon	2.5
Village of Menomonee Falls	33.3
Village of Merton	2.5
Village of Mukwonago[g]	5.0
Village of Nashotah	1.7
Village of North Prairie	2.4
Village of Oconomowoc Lake	3.2
Village of Pewaukee	4.5
Village of Sussex	5.9
Village of Wales	2.4
Town of Brookfield	5.5
Town of Delafield	20.7
Town of Eagle	35.0
Town of Genesee	31.9
Town of Lisbon	30.2
Town of Merton	28.1
Town of Mukwonago	31.8
Town of Oconomowoc	32.7
Town of Ottawa	35.1

Table 1 (continued)

Civil Division	Area (square miles)
Waukesha County (continued)	
Town of Summit	26.6
Town of Vernon	32.8
Town of Waukesha	22.8
Subtotal	580.6
Total[o]	2,690.0

[a]Less than 0.05 square mile. Does not include 2.2 square miles in Walworth County.

[b]Does not include the less than 0.05 square mile in Washington County or 0.1 square mile in Waukesha County.

[c]Does not include 0.1 square mile in Ozaukee County.

[d]Does not include 2.3 square miles in Milwaukee County.

[e]Does not include 0.8 square mile in Washington County.

[f]Does not include 0.1 square mile in Walworth County.

[g]Does not include 6.1 square miles in Racine County.

[h]Does not include 2.0 square miles in Jefferson County.

[i]Does not include the less than 0.05 square mile in Kenosha County.

[j]Does not include 5.0 square miles in Waukesha County.

[k]Does not include 0.5 square mile in Dodge County.

[l]Less than 0.05 square mile. Does not include 96.7 square miles in Milwaukee County or 0.1 square mile in Waukesha County.

[m]Does not include 0.1 square mile in Ozaukee County.

[n]Does not include 96.7 square miles in Milwaukee County or the less than 0.05 square mile in Washington County.

[o]Regional total of 2,690.0 does not match published figure of 2,689.9 due to rounding.

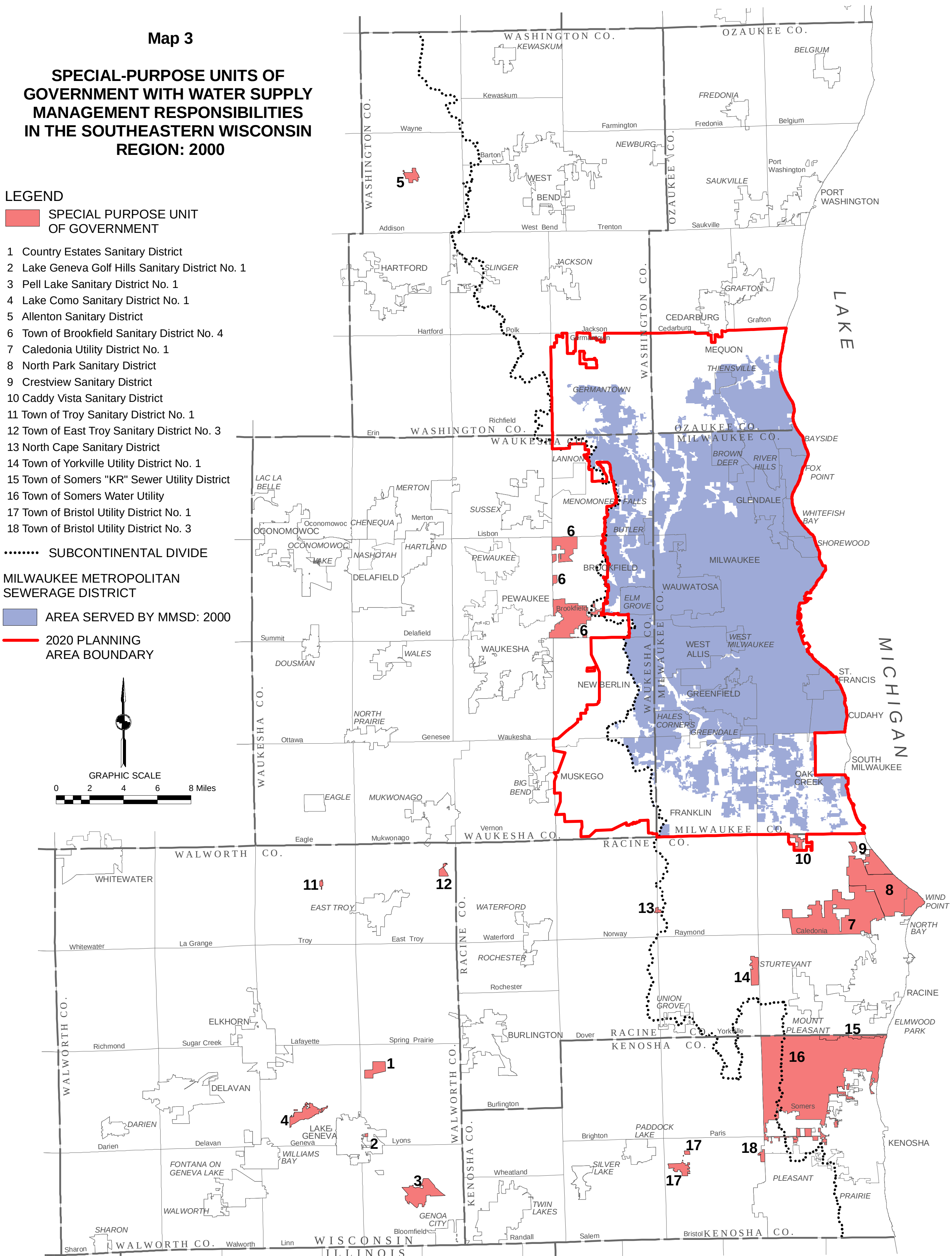
Source: SEWRPC.

government include the legally established town sanitary and utility districts created to provide various urban development-related services, such as sanitary sewerage, water supply, and solid waste collection and disposal, to designated portions of rural towns with urban service needs. A number of these districts exist within the planning area, but do not currently provide water supply management services.

In addition to the special-purpose units of government noted above, there are a number of inland lake protection and rehabilitation districts within the study area. These districts are special-purpose units of government created pursuant to Chapter 33 of the *Wisconsin Statutes*. Lake protection and rehabilitation district powers include 1) study of existing water-quality conditions to determine the causes of existing or expected future water-quality problems, 2) control of aquatic macrophytes and algae, 3) implementation of lake rehabilitation techniques, including aeration, diversion, nutrient removal or inactivation, dredging, sediment covering, and drawdown, 4) construction and operation of water-level-control structures, 5) control of nonpoint source pollution, and 6) creation, operation, and maintenance of a water safety patrol unit.

Map 3

SPECIAL-PURPOSE UNITS OF GOVERNMENT WITH WATER SUPPLY MANAGEMENT RESPONSIBILITIES IN THE SOUTHEASTERN WISCONSIN REGION: 2000



Source: SEWRPC.

A special-purpose unit of government that does not have water supply service responsibilities, but which has a particularly important indirect relationship to water supply planning, is the Milwaukee Metropolitan Sewerage District (MMSD). The MMSD provides sanitary sewage conveyance and treatment services to the greater Milwaukee area. The boundaries of the District, its existing sanitary sewer service area and its long-range planning area—which together total approximately 411 square miles in area—are shown on Map 3, together with the location of the subcontinental divide that traverses the Region. It is important to note that the District existing sanitary sewer service area in eastern Waukesha County ant its planning area extend beyond the subcontinental divide, and—in effect—provide existing and potential return flow for any Lake Michigan water supply currently provided, or proposed to be provided, within that portion of the District service area. There are three other special-purpose units of government that provide areawide sanitary sewer service: the Western Racine County Sewerage District, the Walworth County Metropolitan Sewerage District, and the Delafield-Hartland Water Pollution Control Commission. These do not, however, have the same importance for regional water supply planning as does the MMSD.

DEMOGRAPHIC AND ECONOMIC BASE

An understanding of the size, characteristics, and spatial distribution of the resident population is basic to any water supply planning effort because of the direct relationships which exist between population and household levels and the demand for water, land, and other elements of the natural resource base, as well as the demand for utility facilities and services. The size and other characteristics of the population of an area are greatly influenced by growth and other changes in economic activity. Population characteristics and economic activity must, therefore, be considered together.

Population[1]—Historic Trends and Distribution Among Counties

The resident population of the Region totaled about 1,931,200 persons in 2000, compared to about 1,810,400 in 1990. The increase of about 120,800 persons, or 7 percent, in the regional population over the decade was substantially greater than the increase experienced during the 1970s (about 8,700 persons) and 1980s (about 45,600 persons), but less than the increases of about 333,000 persons and about 182,500 persons experienced during the 1950s and 1960s, respectively (see Table 2).

During the 1990s, six of the counties in the Region experienced significant population growth, while Milwaukee County lost population. Waukesha County gained the most population during the 1990s, increasing by about 56,000 persons, or about 18 percent. Kenosha, Ozaukee, Racine, Walworth, and Washington Counties gained between 9,500 and 22,200 persons each. Milwaukee County lost about 19,000 persons, or about 2 percent. The past decade saw further change in the relative distribution of the population among the counties within the Region, continuing long-term trends in this respect (see Table 2 and Figure 2).

It should be noted that there has been a rapid increase in the population of counties located immediately south of the Region in Illinois. The population of Lake and McHenry Counties, combined, increased by about 204,800 persons, during the 1990s, well above the increase of about 120,800 persons for the entire Southeastern Wisconsin Region. By 2000, the combined population of Lake and McHenry Counties stood at about 904,400 persons.

Households—Historic Trends and Distribution Among Counties

In addition to population size, the number of households, or occupied housing units, is of importance in land use and public facility planning. Households directly influence the demand for urban land, as well as the demand for transportation and other public facilities and services, including water supply. By definition, a household consists

[1]*The Regional Planning Commission conducted an inventory and analysis of the regional population in 2004 following the release of the 2000 Federal census. The findings are presented in detail in SEWRPC Technical Report No. 11 (4th edition),* The Population of Southeastern Wisconsin, *July 2004.*

Table 2

POPULATION IN THE SOUTHEASTERN WISCONSIN REGION BY COUNTY: 1950-2000

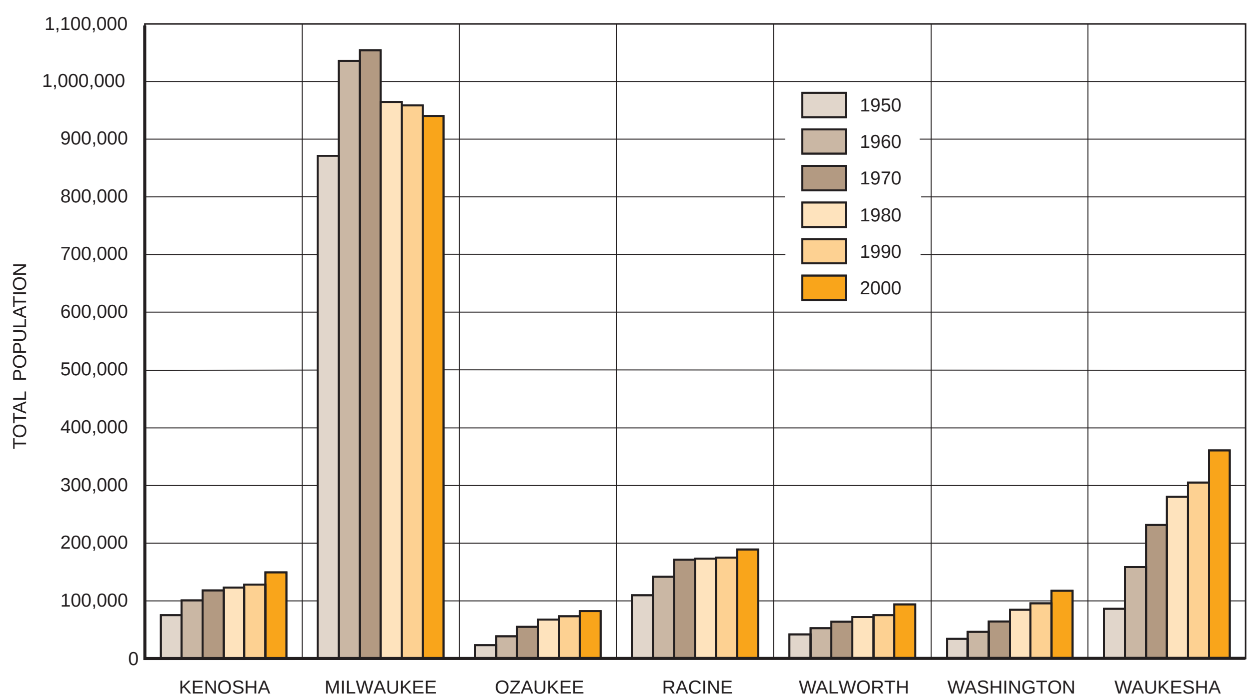
County	Total Population											
	1950		1960		1970		1980		1990		2000	
	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Kenosha	75,238	6.1	100,615	6.4	117,917	6.7	123,137	7.0	128,181	7.1	149,577	7.7
Milwaukee	871,047	70.2	1,036,041	65.8	1,054,249	60.0	964,988	54.7	959,275	53.0	940,164	48.7
Ozaukee	23,361	1.9	38,441	2.5	54,461	3.1	66,981	3.8	72,831	4.0	82,317	4.2
Racine	109,585	8.8	141,781	9.0	170,838	9.7	173,132	9.8	175,034	9.7	188,831	9.8
Walworth	41,584	3.4	52,368	3.3	63,444	3.6	71,507	4.0	75,000	4.1	92,013	4.8
Washington	33,902	2.7	46,119	2.9	63,839	3.7	84,848	4.8	95,328	5.3	117,496	6.1
Waukesha	85,901	6.9	158,249	10.1	231,335	13.2	280,203	15.9	304,715	16.8	360,767	18.7
Region	1,240,618	100.0	1,573,614	100.0	1,756,083	100.0	1,764,796	100.0	1,810,364	100.0	1,931,165	100.0

County	Population Change									
	1950-1960		1960-1970		1970-1980		1980-1990		1990-2000	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Kenosha	25,377	33.7	17,302	17.2	5,220	4.4	5,044	4.1	21,396	16.7
Milwaukee	164,994	18.9	18,208	1.8	-89,261	-8.5	-5,713	-0.6	-19,111	-2.0
Ozaukee	15,080	64.6	16,020	41.7	12,520	23.0	5,850	8.7	9,486	13.0
Racine	32,196	29.4	29,057	20.5	2,294	1.3	1,902	1.1	13,797	7.9
Walworth	10,784	25.9	11,076	21.2	8,063	12.7	3,493	4.9	17,013	22.7
Washington	12,217	36.0	17,720	38.4	21,009	32.9	10,480	12.4	22,168	23.3
Waukesha	72,348	84.2	73,086	46.2	48,868	21.1	24,512	8.7	56,052	18.4
Region	332,996	26.8	182,469	11.6	8,713	0.5	45,568	2.6	120,801	6.7

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

Figure 2

POPULATION IN THE REGION BY COUNTY: 1950-2000



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

of all persons who occupy a housing unit, defined by the Census Bureau as a house, an apartment, a mobile home, a group of rooms, or a single-room that is occupied, or intended for occupancy, as separate living quarters. Persons not living in households are classified as living in group quarters, such as correctional facilities, college dormitories, and military quarters. In 2000, the household population accounted for about 98 percent of the total population of the Region, the remaining 2 percent being comprised of occupants of group quarters. This proportional relationship has been relatively stable over the past several decades.

The number of households in the Region increased by about 72,900 households, or about 11 percent, from about 676,100 households in 1990 to about 749,000 households in 2000. This followed increases of about 48,200 households during the 1980s, 91,500 households during the 1970s, 70,600 households during the 1960s, and 111,400 households during the 1950s.

During the 1990s, all counties in the Region experienced increases in the number of households, led by Waukesha County, which gained about 29,200 households, an increase of about 28 percent. Milwaukee County gained about 4,700 households, about a 1 percent increase, during the 1990s, despite having a decrease in total population. Changes in the distribution of households within the Region over the last 50 years are indicated in Table 3 and Figure 3. These changes are similar to the distributional changes in the total population.

In relative terms, the growth rate of households in the Region during the 1990s, about 11 percent, exceeded the rate of growth in the total population, about 7 percent, as well as the rate of growth in the household population, also of about 7 percent. Similar patterns were observed over each of the four previous decades. The number of households within the Region increased by about 111 percent over the last 50 years; while the total population increased by about 56 percent and the household population increased by about 58 percent. These differential growth rates between households and population are reflected in a declining average household size in the Region.

Within the Region as a whole, the average household size—calculated as the household population divided by the number of households—was 2.52 persons in 2000 (see Table 4). During the 1990s, the average household size in the Region decreased by 0.10 person per household, or by about 4 percent, from the 1990 figure of 2.62 persons. The decrease in household size during the 1990s represents a continuation of a long-term trend in declining average household size for the Region over the past 50 years. A particularly large decrease in the average household size for the Region occurred between 1970 and 1980. Each of the seven counties in the Region has experienced a similar long-term trend of declining household size. The decline in household size is related in part to changing household types in the Region. Single-person households and other nonfamily households have increased at a much faster rate than family households in the Region over the past three decades.

Table 5 shows the household population, the number of households, and the average household size within the Region in the year 2000 broken down by civil division. As previously noted, mean household size within the Region was 2.52 persons per household. This number varied among the civil divisions, ranging from a low of 2.03 persons per household in the Village of West Milwaukee, Milwaukee County, to a high of 3.26 persons per household in the Village of Merton, Waukesha County.

Employment[2]—Historic Trends and Distribution Among Counties

Information regarding the number and type of employment opportunities, or jobs, in an area is an important measure of the size and structure of the economy of the area and has direct and indirect relationships to population levels, water supply demand, and utility system needs. Economic data presented in this section pertain to both wage and salary employment and to the self-employment, and consider both full-time and part-time employment.

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[2]*The Regional Planning Commission conducted an inventory and analysis of the regional economy in 2004. The findings are presented in detail in SEWRPC Technical Report No. 10 (4th edition),* The Economy of Southeastern Wisconsin, *July 2004.*

Table 3

HOUSEHOLDS IN THE SOUTHEASTERN WISCONSIN REGION BY COUNTY: 1950-2000

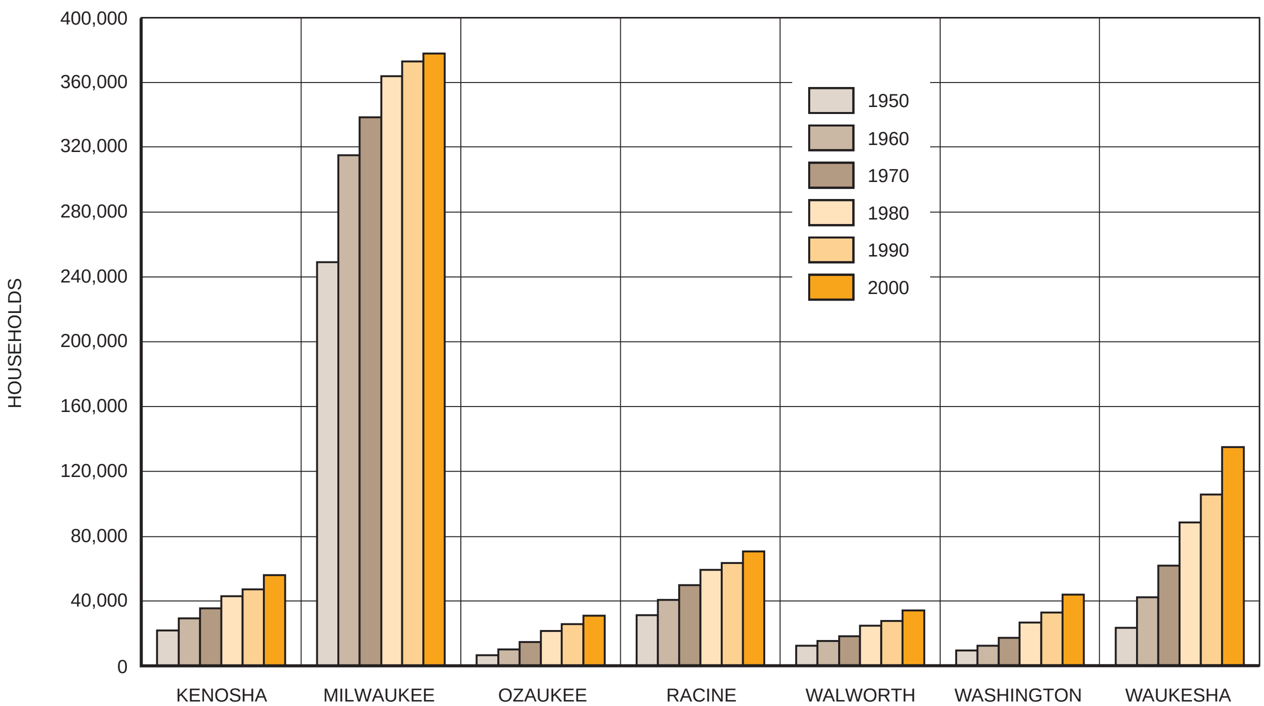
County	Total Households											
	1950		1960		1970		1980		1990		2000	
	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Kenosha	21,958	6.2	29,545	6.4	35,468	6.6	43,064	6.9	47,029	6.9	56,057	7.5
Milwaukee	249,232	70.3	314,875	67.6	338,605	63.1	363,653	57.9	373,048	55.2	377,729	50.4
Ozaukee	6,591	1.9	10,417	2.2	14,753	2.8	21,763	3.5	25,707	3.8	30,857	4.1
Racine	31,399	8.8	40,736	8.7	49,796	9.3	59,418	9.5	63,736	9.4	70,819	9.5
Walworth	12,369	3.5	15,414	3.3	18,544	3.5	24,789	3.9	27,620	4.1	34,505	4.6
Washington	9,396	2.7	12,532	2.7	17,385	3.2	26,716	4.2	32,977	4.9	43,843	5.8
Waukesha	23,599	6.6	42,394	9.1	61,935	11.5	88,552	14.1	105,990	15.7	135,229	18.1
Region	354,544	100.0	465,913	100.0	536,486	100.0	627,955	100.0	676,107	100.0	749,039	100.0

County	Household Change									
	1950-1960		1960-1970		1970-1980		1980-1990		1990-2000	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Kenosha	7,587	34.6	5,923	20.0	7,596	21.4	3,965	9.2	9,028	19.2
Milwaukee	65,643	26.3	23,730	7.5	25,048	7.4	9,395	2.6	4,681	1.3
Ozaukee	3,826	58.0	4,336	41.6	7,010	47.5	3,944	18.1	5,150	20.0
Racine	9,337	29.7	9,060	22.2	9,622	19.3	4,318	7.3	7,083	11.1
Walworth	3,045	24.6	3,130	20.3	6,245	33.7	2,831	11.4	6,885	24.9
Washington	3,136	33.4	4,853	38.7	9,331	53.7	6,261	23.4	10,866	32.9
Waukesha	18,795	79.6	19,541	46.1	26,617	43.0	17,438	19.7	29,239	27.6
Region	111,369	31.4	70,573	15.1	91,469	17.0	48,152	7.7	72,932	10.8

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

Figure 3

HOUSEHOLDS IN THE REGION BY COUNTY: 1950-2000



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

Table 4

HOUSEHOLDS, HOUSEHOLD POPULATION, AND AVERAGE HOUSEHOLD SIZE IN THE REGION BY COUNTY AND WISCONSIN: 1950-2000

County	Data Item	Year					
		1950	1960	1970	1980	1990	2000
Kenosha	Households	21,958	29,545	35,468	43,064	47,029	56,057
	Household Population	73,707	99,381	115,710	120,460	125,577	145,553
	Average Household Size	*3.36*	*3.36*	*3.26*	*2.80*	*2.67*	*2.60*
Milwaukee	Households	249,232	314,875	338,605	363,653	373,048	377,729
	Household Population	831,324	1,010,342	1,029,104	940,172	933,426	916,054
	Average Household Size	*3.34*	*3.21*	*3.04*	*2.59*	*2.50*	*2.43*
Ozaukee	Households	6,591	10,417	14,753	21,763	25,707	30,857
	Household Population	23,122	38,012	53,951	66,211	71,732	80,558
	Average Household Size	*3.51*	*3.65*	*3.66*	*3.04*	*2.79*	*2.61*
Racine	Households	31,399	40,736	49,796	59,418	63,736	70,819
	Household Population	105,761	138,238	166,977	170,189	172,209	183,360
	Average Household Size	*3.37*	*3.39*	*3.35*	*2.86*	*2.70*	*2.59*
Walworth	Households	12,369	15,414	18,544	24,789	27,620	34,505
	Household Population	40,183	50,532	58,534	67,973	71,761	88,563
	Average Household Size	*3.25*	*3.28*	*3.16*	*2.74*	*2.60*	*2.57*
Washington	Households	9,396	12,532	17,385	26,716	32,977	43,843
	Household Population	33,378	45,585	63,135	83,946	94,271	116,198
	Average Household Size	*3.55*	*3.64*	*3.63*	*3.14*	*2.86*	*2.65*
Waukesha	Households	23,599	42,394	61,935	88,552	105,990	135,229
	Household Population	82,718	155,145	226,789	275,616	300,144	355,014
	Average Household Size	*3.51*	*3.66*	*3.66*	*3.11*	*2.83*	*2.63*
Region	Households	354,544	465,913	536,486	627,955	676,107	749,039
	Household Population	1,190,193	1,537,235	1,714,200	1,724,567	1,769,120	1,885,300
	Average Household Size	*3.36*	*3.30*	*3.20*	*2.75*	*2.62*	*2.52*

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

Total employment in the Region stood at 1,222,800 jobs in 2000, compared to 1,062,600 jobs in 1990. The increase of 160,200 jobs during the 1990s compares to 114,400 during the 1980s, 163,300 during the 1970s, 111,900 during the 1960s, and 99,500 during the 1950s (see Table 6). Historically, employment levels, both nationally and within the Region, tend to fluctuate in the short-term, rising and falling in accordance with business cycles. Estimated total employment in the Region stood at 1,179,000 jobs in 2003, about 4 percent below the 2000 level.

Data on current and historic employment levels within the Region are presented by county in the Region in Table 6 and Figure 4. Each county in the Region experienced an increase in employment between 1990 and 2000. With an increase of 81,100 jobs, Waukesha County accounted for just over half of the total increase in the regional employment during the 1990s. Among the other six counties, growth in employment during the 1990s ranged from a low 4,800 jobs in Racine County to a high of 16,500 jobs in Kenosha County.

Over the past five decades, Milwaukee County has experienced a substantial decrease in its share of regional employment; Waukesha County has experienced a substantial increase; and Ozaukee, Walworth, and Washington Counties have experienced modest increases. In Kenosha and Racine Counties, the share of total regional employment in 2000 was about the same as in 1950, with some fluctuations occurring over the intervening decades.

Substantial job growth has also occurred in the counties located in Illinois immediately to the south of the Region. Employment in Lake and McHenry Counties, Illinois, combined, increased by about 146,800 jobs during the 1990s. By 2000, total employment in Lake and McHenry Counties combined stood at 505,200 jobs. A significant number of Kenosha and Walworth County residents find employment in northeastern Illinois.

Table 5

POPULATION AND HOUSEHOLDS BY CIVIL DIVISION IN THE SOUTHEASTERN WISCONSIN REGION: 2000

Civil Division	Household Population	Total Households	Average Household Size
Kenosha County			
City of Kenosha	87,372	34,411	2.54
Village of Paddock Lake	3,003	1,056	2.84
Village of Pleasant Prairie	15,904	5,819	2.73
Village of Silver Lake	2,335	876	2.67
Village of Twin Lakes	5,099	1,973	2.58
Town of Brighton	1,450	504	2.88
Town of Bristol	4,537	1,715	2.65
Town of Paris	1,473	535	2.75
Town of Randall	2,923	1,031	2.84
Town of Salem	9,845	3,529	2.79
Town of Somers	8,320	3,399	2.45
Town of Wheatland	3,292	1,209	2.72
Subtotal	145,553	56,057	2.60
Milwaukee County			
City of Cudahy	18,314	7,888	2.32
City of Franklin	27,391	10,602	2.58
City of Glendale	12,711	5,772	2.20
City of Greenfield	34,554	15,697	2.20
City of Milwaukee	580,571	232,188	2.50
City of Oak Creek	28,357	11,239	2.52
City of South Milwaukee	20,852	8,694	2.40
City of St. Francis	8,530	4,050	2.11
City of Wauwatosa	46,288	20,388	2.27
City of West Allis	60,332	27,604	2.19
Village of Bayside	4,244	1,732	2.45
Village of Brown Deer	11,669	5,134	2.27
Village of Fox Point	6,749	2,825	2.39
Village of Greendale	14,283	6,011	2.38
Village of Hales Corners	7,657	3,260	2.35
Village of River Hills	1,631	590	2.76
Village of Shorewood	13,593	6,539	2.08
Village of West Milwaukee	4,184	2,059	2.03
Village of Whitefish Bay	14,144	5,457	2.59
Subtotal	916,054	377,729	2.43
Ozaukee County			
City of Cedarburg	10,854	4,432	2.45
City of Mequon	21,588	7,861	2.75
City of Port Washington	10,095	4,071	2.48
Village of Bayside	103	37	2.78
Village of Belgium	1,657	582	2.85
Village of Fredonia	1,934	701	2.76
Village of Grafton	10,436	4,125	2.53
Village of Newburg	92	42	2.19
Village of Saukville	4,060	1,583	2.56
Village of Thiensville	3,254	1,503	2.17
Town of Belgium	1,513	547	2.77
Town of Cedarburg	5,550	1,896	2.93
Town of Fredonia	2,060	727	2.83
Town of Grafton	3,980	1,492	2.67
Town of Port Washington	1,627	636	2.56
Town of Saukville	1,755	622	2.82
Subtotal	80,558	30,857	2.61

Table 5 (continued)

Civil Division	Household Population	Total Households	Average Household Size
Racine County			
City of Burlington	9,687	3,838	2.52
City of Racine	79,983	31,449	2.54
Village of Elmwood Park	474	200	2.37
Village of North Bay	260	91	2.86
Village of Rochester	1,149	410	2.80
Village of Sturtevant	3,874	1,477	2.62
Village of Union Grove	4,235	1,631	2.60
Village of Waterford	4,039	1,561	2.59
Village of Wind Point	1,853	736	2.52
Town of Burlington	6,313	2,354	2.68
Town of Caledonia	23,158	8,549	2.71
Town of Dover	3,244	1,193	2.72
Town of Mount Pleasant	22,714	9,453	2.40
Town of Norway	7,590	2,641	2.87
Town of Raymond	3,505	1,245	2.82
Town of Rochester	2,254	782	2.88
Town of Waterford	5,938	2,086	2.85
Town of Yorkville	3,090	1,123	2.75
Subtotal	183,360	70,819	2.59
Walworth County			
City of Delavan	7,853	2,931	2.68
City of Elkhorn	7,227	2,919	2.48
City of Lake Geneva	7,119	3,053	2.33
City of Whitewater	8,930	3,765	2.37
Village of Darien	1,566	537	2.92
Village of East Troy	3,507	1,350	2.60
Village of Fontana-on-Geneva Lake	1,754	764	2.30
Village of Genoa	1,933	674	2.87
Village of Sharon	1,549	565	2.74
Village of Walworth	2,186	850	2.57
Village of Williams Bay	2,335	993	2.35
Town of Bloomfield	5,481	2,067	2.65
Town of Darien	1,689	615	2.75
Town of Delavan	4,553	1,798	2.53
Town of East Troy	3,804	1,427	2.67
Town of Geneva	4,069	1,660	2.45
Town of La Grange	2,405	923	2.61
Town of Lafayette	1,708	595	2.87
Town of Linn	2,194	910	2.41
Town of Lyons	3,350	1,231	2.72
Town of Richmond	1,831	704	2.60
Town of Sharon	912	333	2.74
Town of Spring Prairie	2,089	726	2.88
Town of Sugar Creek	3,310	1,197	2.77
Town of Troy	2,302	837	2.75
Town of Walworth	1,512	529	2.86
Town of Whitewater	1,395	552	2.53
Subtotal	88,563	34,505	2.57
Washington County			
City of Hartford	10,745	4,276	2.51
City of West Bend	27,747	11,375	2.44
Village of Germantown	18,157	6,904	2.63
Village of Jackson	4,922	1,949	2.53
Village of Kewaskum	3,205	1,213	2.64
Village of Newburg	1,023	356	2.87
Village of Slinger	3,849	1,562	2.46

Table 5 (continued)

Civil Division	Household Population	Total Households	Average Household Size
Washington County (continued)			
Town of Addison	3,332	1,149	2.90
Town of Barton	2,542	896	2.84
Town of Erin	3,645	1,287	2.83
Town of Farmington	3,239	1,116	2.90
Town of Germantown	278	89	3.12
Town of Hartford	4,027	1,397	2.88
Town of Jackson	3,516	1,201	2.93
Town of Kewaskum	1,119	394	2.84
Town of Polk	3,912	1,352	2.89
Town of Richfield	10,373	3,614	2.87
Town of Trenton	4,426	1,520	2.91
Town of Wayne	1,727	582	2.97
Town of West Bend	4,414	1,611	2.74
Subtotal	116,198	43,843	2.65
Waukesha County			
City of Brookfield	37,997	13,891	2.74
City of Delafield	6,446	2,553	2.52
City of Muskego	21,098	7,533	2.80
City of New Berlin	38,001	14,495	2.62
City of Oconomowoc	11,945	4,968	2.40
City of Pewaukee	11,697	4,553	2.57
City of Waukesha	62,380	25,663	2.43
Village of Big Bend	1,278	448	2.85
Village of Butler	1,876	916	2.05
Village of Chenequa	583	223	2.61
Village of Dousman	1,482	575	2.58
Village of Eagle	1,707	592	2.88
Village of Elm Grove	6,092	2,444	2.49
Village of Hartland	7,902	3,002	2.63
Village of Lac La Belle	329	117	2.81
Village of Lannon	1,009	425	2.37
Village of Menomonee Falls	32,404	12,844	2.52
Village of Merton	1,926	591	3.26
Village of Mukwonago	6,068	2,392	2.54
Village of Nashotah	1,266	445	2.84
Village of North Prairie	1,571	531	2.96
Village of Oconomowoc Lake	564	208	2.71
Village of Pewaukee	7,975	3,635	2.19
Village of Sussex	8,828	3,310	2.67
Village of Wales	2,523	846	2.98
Town of Brookfield	6,317	2,762	2.29
Town of Delafield	7,381	2,521	2.93
Town of Eagle	3,117	1,049	2.97
Town of Genesee	7,283	2,431	3.00
Town of Lisbon	9,335	3,218	2.90
Town of Merton	7,988	2,706	2.95
Town of Mukwonago	6,868	2,184	3.14
Town of Oconomowoc	7,450	2,765	2.69
Town of Ottawa	3,758	1,375	2.73
Town of Summit	4,823	1,747	2.76
Town of Vernon	7,151	2,380	3.00
Town of Waukesha	8,596	2,891	2.97
Subtotal	355,014	135,229	2.63
Total	1,885,300	749,039	2.52

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

Table 6

EMPLOYMENT IN THE SOUTHEASTERN WISCONSIN REGION BY COUNTY: 1950-2000

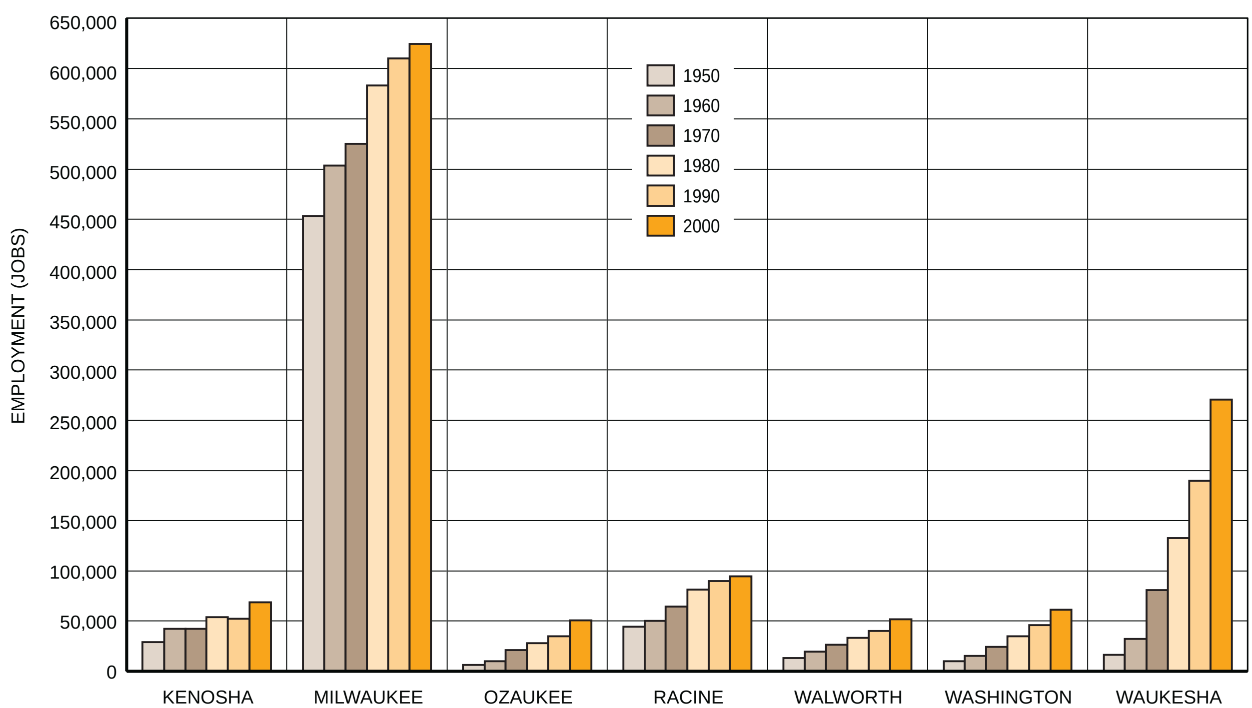
County	Total Employment (Jobs)											
	1950		1960		1970		1980		1990		2000	
	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Kenosha	29,100	5.1	42,200	6.3	42,100	5.4	54,100	5.7	52,200	4.9	68,700	5.6
Milwaukee	453,500	79.1	503,300	74.8	525,200	66.9	583,200	61.5	609,800	57.4	624,600	51.1
Ozaukee	6,600	1.1	10,200	1.5	21,300	2.7	28,200	3.0	35,300	3.3	50,800	4.2
Racine	44,500	7.7	49,900	7.4	64,600	8.2	81,200	8.6	89,600	8.4	94,400	7.7
Walworth	13,200	2.3	19,600	2.9	26,400	3.4	33,500	3.5	39,900	3.8	51,800	4.2
Washington	10,200	1.8	15,200	2.3	24,300	3.1	35,200	3.7	46,100	4.3	61,700	5.0
Waukesha	16,400	2.9	32,600	4.8	81,000	10.3	132,800	14.0	189,700	17.9	270,800	22.2
Region	573,500	100.0	673,000	100.0	784,900	100.0	948,200	100.0	1,062,600	100.0	1,222,800	100.0

County	Employment Change									
	1950-1960		1960-1970		1970-1980		1980-1990		1990-2000	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Kenosha	13,100	45.0	-100	-0.2	12,000	28.5	-1,900	-3.5	16,500	31.6
Milwaukee	49,800	11.0	21,900	4.4	58,000	11.0	26,600	4.6	14,800	2.4
Ozaukee	3,600	54.5	11,100	108.8	6,900	32.4	7,100	25.2	15,500	43.9
Racine	5,400	12.1	14,700	29.5	16,600	25.7	8,400	10.3	4,800	5.4
Walworth	6,400	48.5	6,800	34.7	7,100	26.9	6,400	19.1	11,900	29.8
Washington	5,000	49.0	9,100	59.9	10,900	44.9	10,900	31.0	15,600	33.8
Waukesha	16,200	98.8	48,400	148.5	51,800	64.0	56,900	42.8	81,100	42.8
Region	99,500	17.3	111,900	16.6	163,300	20.8	114,400	12.1	160,200	15.1

Source: U.S. Bureau of Economic Analysis and SEWRPC.

Figure 4

EMPLOYMENT IN THE REGION BY COUNTY: 1950-2000



Source: U.S. Bureau of Economic Analysis and SEWRPC.

Information regarding employment by industry group provides insight into the structure of the regional economy and on changes in that structure over time. These changes in the regional economy can directly impact demand for water and water supply facilities. As indicated in Table 7 and Figure 5, the services sector made up the largest proportion of regional employment in 2000, accounting for over 33 percent of total employment. This was followed by manufacturing and retail trade, with about 18 percent and 16 percent of total regional employment, respectively. Together, these three sectors accounted for roughly two-thirds of regional employment in 2000.

The 1990s saw a continuation of a shift in the regional economy from a manufacturing to a service orientation. Manufacturing employment in the Region was virtually unchanged during the 1990s, following about a 15 percent decrease during the 1980s, and a modest about 4 percent increase during the 1970s. Conversely, service-related employment increased substantially during each of the past three decades: by about 33 percent during the 1990s, by about 41 percent during the 1980s, and by about 53 percent during the 1970s. Due to these differential growth rates, the proportion of manufacturing jobs relative to total jobs in the Region decreased from about 32 percent in 1970 to about 18 percent in 2000, while service-related employment increased from about 18 percent in 1970 to about 33 percent in 2000. In comparison to the manufacturing and services industry groups, employment in other major industry groups, such as wholesale trade, retail trade, government, and finance, insurance and real estate, has been relatively stable in terms of their share of total employment in the Region over the last three decades.

LAND USE

Land use is an important consideration in water supply system planning. The land use pattern determines the quantity and spatial distribution of the demand for water supply, while the availability of water supply facilities and services is an important determination of the land use pattern. The Commission relies on two types of inventories and analyses in order to monitor urban growth and development in the Region—an urban growth ring analysis and a land use inventory. The urban growth ring analysis delineates the outer limits of concentrations of urban development and is intended to depict the urbanization of the Region over the past 150 years. When related to urban population levels, the urban growth ring analysis provides a good basis for calculating urban population and household densities. In contrast, the Commission land use inventory is a detailed inventory that places all land and water areas of the Region into one of 66 discrete land use categories, providing a basis for analyzing the characteristics of specific urban and nonurban land uses, and for determining relationships between land use and the demands for transportation and utility facilities and services. Both the urban growth ring analysis and the land use inventory for the Region have been updated to the year 2000 under the continuing regional planning program.

Urban Growth Ring Analysis

The urban growth ring analysis shows the historical pattern of urban settlement, growth, and development of the Southeastern Wisconsin Region since 1850. Areas identified as urban under this time series analysis include areas of the Region where residential structures or other buildings have been constructed in relatively compact groups, thereby indicating a concentration of residential, commercial, industrial, governmental, institutional, or other urban land uses. In addition, the identified urban areas encompass certain open space lands such as urban parks and small areas being preserved for recreational and resource conservation purposes within the urban areas.[3]

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[3]*As part of the urban growth ring analysis, urban areas are defined as concentrations of residential, commercial, industrial, governmental, or institutional buildings or structures, along with their associated yards, parking, and service areas, having a combined area of five acres or more. In the case of residential uses, such areas must include at least 10 structures—over a maximum distance of one-half mile—located along a linear feature, such as a roadway or lakeshore, or at least 10 structures located in a relatively compact group within a residential development. Urban land uses which do not meet these criteria because they lack the concentration of buildings or structures—such as cemeteries, airports, public parks, golf courses—are identified as urban where such uses are surrounded on at least three sides by urban land uses that do meet the aforereferenced criteria.*

Table 7

EMPLOYMENT BY GENERAL INDUSTRY GROUP IN THE SOUTHEASTERN WISCONSIN REGION: 1970-2000

General Industry Group	Employment								Percent Change in Employment			
	1970		1980		1990		2000					
	Jobs	Percent of Total	Jobs	Percent of Total	Jobs	Percent of Total	Jobs	Percent of Total	1970-1980	1980-1990	1990-2000	1970-2000
Agriculture	12,000	1.5	10,000	1.0	7,200	0.7	6,000	0.5	-16.7	-28.0	-16.7	-50.0
Construction	32,400	4.1	33,900	3.6	45,100	4.2	53,800	4.4	4.6	33.0	19.3	66.0
Manufacturing	254,400	32.4	264,200	27.9	223,500	21.0	224,300	18.3	3.9	-15.4	0.4	-11.8
Transportation, Communication, and Utilities	38,500	4.9	42,200	4.4	46,300	4.4	54,800	4.5	9.6	9.7	18.4	42.3
Wholesale Trade	37,200	4.7	46,200	4.9	55,300	5.2	64,400	5.3	24.2	19.7	16.5	73.1
Retail Trade	133,900	17.1	153,900	16.2	185,400	17.4	193,700	15.8	14.9	20.5	4.5	44.7
Finance, Insurance, and Real Estate	47,600	6.1	75,600	8.0	81,800	7.7	93,700	7.7	58.8	8.2	14.5	96.8
Services	141,800	18.1	216,700	22.8	304,700	28.7	406,000	33.2	52.8	40.6	33.2	186.3
Government and Government Enterprises[a]	84,400	10.8	101,100	10.7	106,200	10.0	114,400	9.3	19.8	5.0	7.7	35.5
Other[b]	2,700	0.3	4,400	0.5	7,100	0.7	11,700	1.0	63.0	61.4	64.8	333.3
Total	784,900	100.0	948,200	100.0	1,062,600	100.0	1,222,800	100.0	20.8	12.1	15.1	55.8

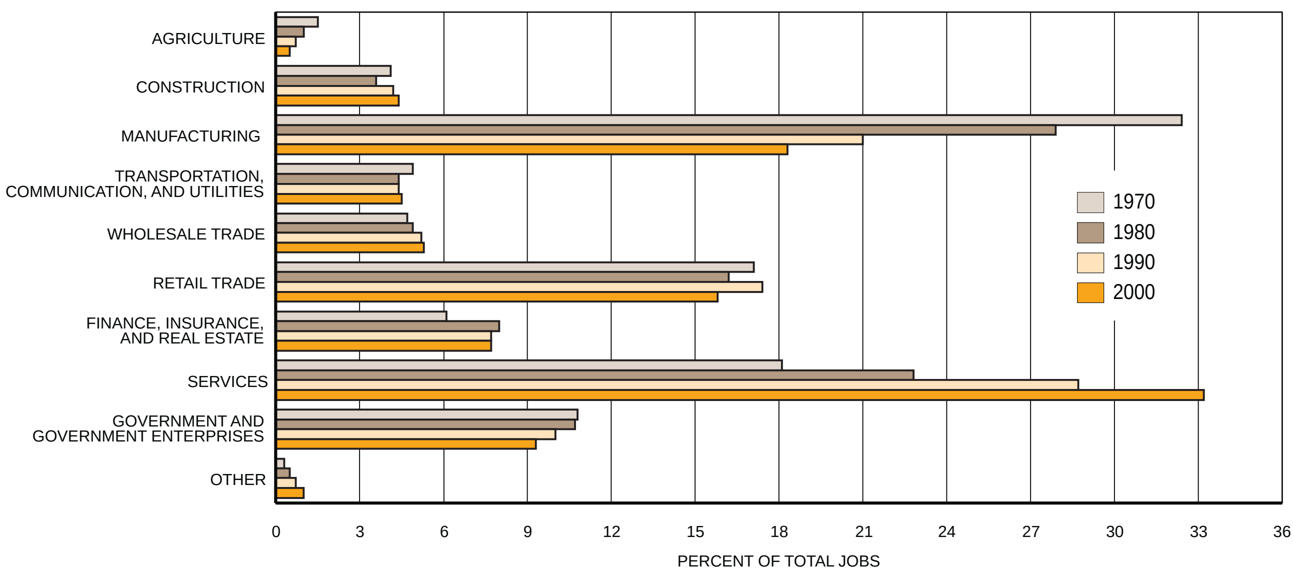
[a] *Includes all nonmilitary government agencies and enterprises.*

[b] *Includes agricultural services, forestry, commercial fishing, mining, and unclassified jobs.*

Source: US. Bureau of Economic Analysis and SEWRPC.

Figure 5

PERCENT DISTRIBUTION OF EMPLOYMENT BY GENERAL INDUSTRY GROUP IN THE REGION: 1970, 1980, 1990, AND 2000



Source: U.S. Bureau of Economic Analysis and SEWRPC.

As part of the urban growth ring analysis, urban growth for the years prior to 1940 was identified using a variety of sources, including the records of local historical societies, land subdivision plat records, farm plat maps, U. S. Geological Survey topographic maps, and Wisconsin Geological and Natural History Survey records. Urban growth rings for the years 1940, 1950, 1963, 1970, 1980, 1990, and 2000 were identified using Commission aerial photographs.

The urban growth ring analysis, updated through 2000, is presented graphically on Map 4. In 1850, the urban portion of the Region was concentrated primarily in the larger urban centers located at Burlington, Kenosha, Milwaukee, Racine, Waukesha, and West Bend, along within many smaller settlements throughout the Region. Over the 100-year period from 1850 to 1950, urban development in the Region occurred in a pattern resembling concentric rings around existing urban centers, resulting in a relatively compact regional settlement pattern. After 1950, there was a significant change in the pattern and rate of urban development in the Region. While substantial amounts of development continued to occur adjacent to established urban centers, considerable development also occurred in isolated enclaves in outlying areas of the Region. Map 4 indicates a continuation of this trend during the 1990s, with significant amounts of development occurring adjacent to existing urban centers, and with considerable development continuing to occur in scattered fashion in outlying areas.

The urban growth ring analysis, in conjunction with the Federal censuses, provides a basis for calculating urban population and household densities in the Region and changes in density over time. Table 8 provides information on urban population and household densities related to the areas identified in the urban growth ring analysis, going back to 1940.[4] The "urban population" is defined as the total population of the Region excluding the rural farm population, as reported by the U.S. Bureau of the Census; similarly, "urban households" as reported in that table consist of all households other than rural farm households.[5]

As indicated in Table 8 and Figure 6, the population density of the urban portion of the Region—as identified by the urban growth ring analysis—decreased significantly, from about 10,700 persons per square mile in 1940 to about 5,100 persons per square mile in 1970, 3,900 persons per square mile in 1980, and 3,500 persons per square mile in 1990. During the 1990s, the urban population density decreased further—to about 3,300 persons per square mile in 2000. This long-term decrease in urban population density within the Region may be attributed to a number of factors including: a decline in household size; a long-term trend toward the use of lower densities in new residential, commercial and industrial development; and to the spatial decentralization of urban development as shown on Map 4.

The decline in household size has been a particularly important contributing factor to the decrease in urban population densities within the Region. From 1963 to 2000, the urban population density within the Region decreased by 43 percent, while the urban household density decreased by only 23 percent.

The trend toward lower development densities has been supported by the long standing, preference by many consumers within the Region for freestanding, single-family homes on large lots. The historic increases in the affluence of, and the leisure time available to, working people has facilitated the pursuit and satisfaction of this consumer preference.

The spatial decentralization of urban development has contributed to the decline in population and household densities within the Region in a number of ways. Residential development in outlying areas beyond the limits of the established urban service areas within the Region is dependent upon the use of onsite sewage treatment and

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[4]*The urban growth ring analysis areas presented in Table 9 were developed using computerized map area measuring software. The area measurements presented in Table 9 differ slightly from the corresponding area measurement reported in the 2020 regional land use plan report, SEWRPC Planning Report No. 45, those measurements having been based on a combination of manual and computer measurement techniques.*

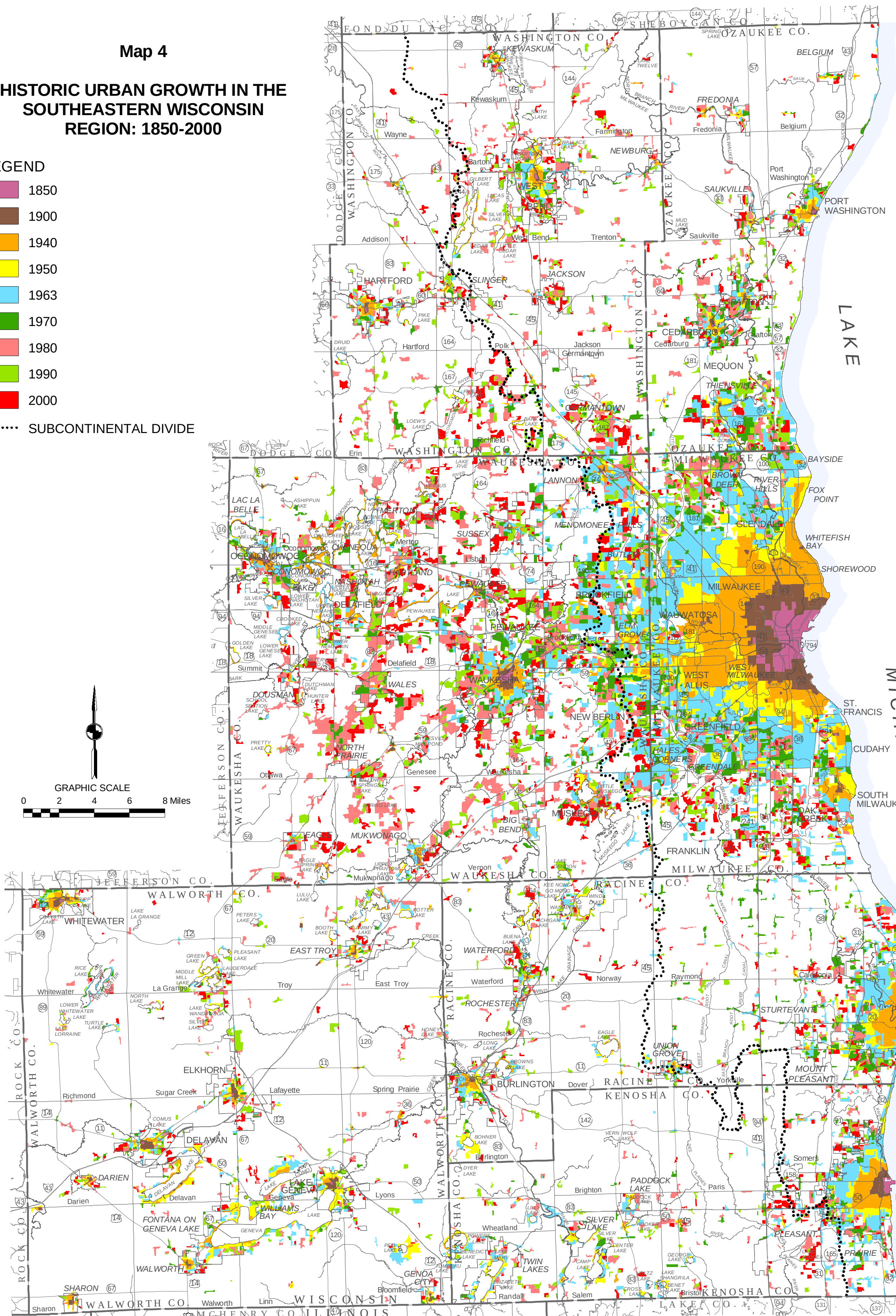
[5]*The Commission uses this method of approximating the population and households within the urban areas identified in the urban growth ring analysis in the absence of actual population and household counts for these areas. This method may include certain nonfarm residents living outside the identified urban areas in the estimate of the urban population and households for the Region, and, as a result, may overstate somewhat the actual urban population and household densities.*

Map 4

HISTORIC URBAN GROWTH IN THE SOUTHEASTERN WISCONSIN REGION: 1850-2000

LEGEND

- 1850
- 1900
- 1940
- 1950
- 1963
- 1970
- 1980
- 1990
- 2000
- SUBCONTINENTAL DIVIDE



 Source: SEWRPC.

Table 8

URBAN POPULATION DENSITY AND URBAN HOUSEHOLD DENSITY IN THE SOUTHEASTERN WISCONSIN REGION: 1940-2000

Year	Urban Area[a] (square miles)	Urban Population		Urban Households	
		Persons[b]	Density (persons per urban square mile)	Households[c]	Density (households per urban square mile)
1940	93	991,535	10,662	272,077	2,926
1950	146	1,179,084	8,076	338,572	2,319
1963	282	1,634,200	5,795	470,856	1,670
1970	338	1,728,666	5,114	529,404	1,566
1980	444	1,749,238	3,940	623,441	1,404
1990	509	1,800,751	3,538	672,896	1,322
2000	579	1,923,674	3,322	746,500	1,289

[a] *Based upon the Regional Planning Commission urban growth ring analysis.*

[b] *Total population, excluding rural farm population, as reported in the Federal Census; 1963 is Commission estimate.*

[c] *Total households, excluding rural farm households, as reported in the Federal Census; 1963 is Commission estimate.*

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

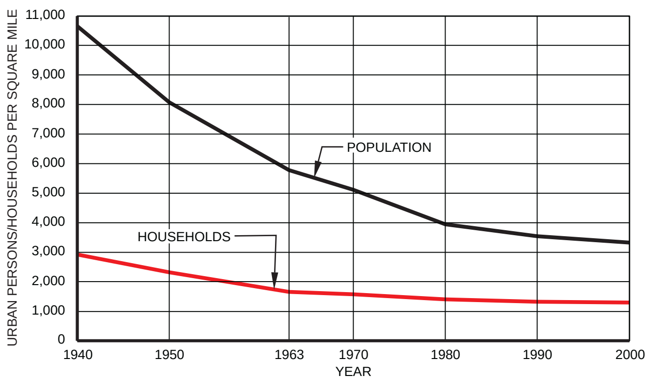
disposal systems and on individual onsite wells for water supply. This dependence requires large lots and fosters attendant use of single-family housing types. The decentralization of residential development has been accompanied by the decentralization of commercial and industrial development, also at lower development densities. Such lower densities are needed in order accommodate the new commercial and industrial uses in large, single-story buildings and to provide desired attendant onsite automobile parking and truck loading and unloading facilities. The historic trend to urban decentralization within the Region has been supported—although not necessarily caused by—by the widespread ownership and use of the automobile for commuting and other personal use; the widespread use of the motor truck for the transportation of goods and services; the widespread availability of electric power; and the introduction of electronic communication, including the telephone, radio, television, personal computer, and the Internet. There is some uncertainty as to whether or not the historic consumer preferences and affluence concerned may be expected to continue to drive trends in the density and spatial location of new urban development within the Region. In this respect, a return to older forms of higher density and centralized urban development long proposed by the Commission and more recently by others will require the support of urban services extended into areas located contiguous to and outward from the existing urban centers within the Region. Such services include, among others, sanitary sewerage, water supply, and mass transit.

Land Use Inventory

The Commission land use inventory is intended to serve as a relatively precise record of the existing land use pattern within the Region at selected points in time. The land use classification system used in the inventory consists of nine major categories which are divided into 66 subcategories, making the inventory suitable for both land use and transportation planning, adaptable to stormwater drainage, public utility, and community facility planning, and compatible with other land use classification systems. Commission aerial photographs serve as the primary basis for identifying existing land use, augmented by field surveys as appropriate. The most recent regional land use inventory was carried out based upon Commission aerial photography taken in spring of 2000. The results of that inventory are summarized on Map 5 and in Table 9.

Figure 6

URBAN POPULATION AND HOUSEHOLD DENSITY IN THE REGION: 1940-2000



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

Areas considered "urban" under the land use inventory include areas identified as being in residential, commercial, industrial, transportation-communication-utility, governmental-institutional, or intensive recreational uses, along with "unused" urban lands.[6] In 2000, urban land uses as identified in the regional land use inventory encompassed about 761 square miles, or about 28 percent of the total area of the Region. Residential land comprised the largest urban land use category, encompassing about 362 square miles, or about 48 percent of all urban land, and about 14 percent of the total area of the Region.[7] In combination, commercial and industrial lands encompassed about 63 square miles, or about 8 percent of all urban land, and about 2 percent of the total area of the Region. Land used for governmental and institutional purposes encompassed 34 square miles, or about 4 percent of all urban land and about 1 percent of the total area of the Region. Land devoted to intensive recreational uses encompassed about 50 square miles, or about 7 percent of all urban land, and about 2 percent of the total area of the Region. Land devoted to transportation, communication, and utility uses—including areas used for streets and highways, railways, airports, and utility and communication facilities—totaled about 201 square miles, or about 26 percent of all urban land and about 8 percent of the total area of the Region. Unused urban lands encompassed about 51 square miles, or about 7 percent of all urban land and about 2 percent of the total area of the Region (see Table 9).

Areas considered "nonurban" under the land use inventory include agricultural lands, wetlands, woodlands, surface water, extractive and landfill sites, and "unused" rural lands.[8] In 2000, nonurban lands as identified in the regional land use inventory encompassed about 1,929 square miles, or about 72 percent of the total area of the Region. Agricultural land constituted the largest nonurban land use category, encompassing about 1,259 square miles, and representing about 65 percent of all nonurban land and about 47 percent of the total area of the Region. Wetlands, woodlands, and surface water together encompassed 536 square miles, representing about 28 percent of all nonurban land, and about 20 percent of the total area of the Region. All other nonurban lands, including extractive, landfill, and unused rural lands, encompassed about 134 square miles, or about 7 percent of all nonurban land, and about 5 percent of the total area of the Region.

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[6]*Unused urban lands consist of open lands, other than wetlands and woodlands, which are located within urban areas but which were not developed for a particular use at the time of the land use inventory. Among the lands included in this category are lands where development was underway but not completed at the time of the inventory, and once-developed lands which have been cleared of development.*

[7]*As identified in the regional land use inventory, the residential land use category encompasses all residential land, including rural residential development, defined as residential development at a density of no more than one dwelling unit per five acres.*

[8]*Unused rural lands consist of open lands, other than wetlands and woodlands, which are located within rural areas but which were not in agricultural, pasture, or related use at the time of the land use inventory.*

Map 5

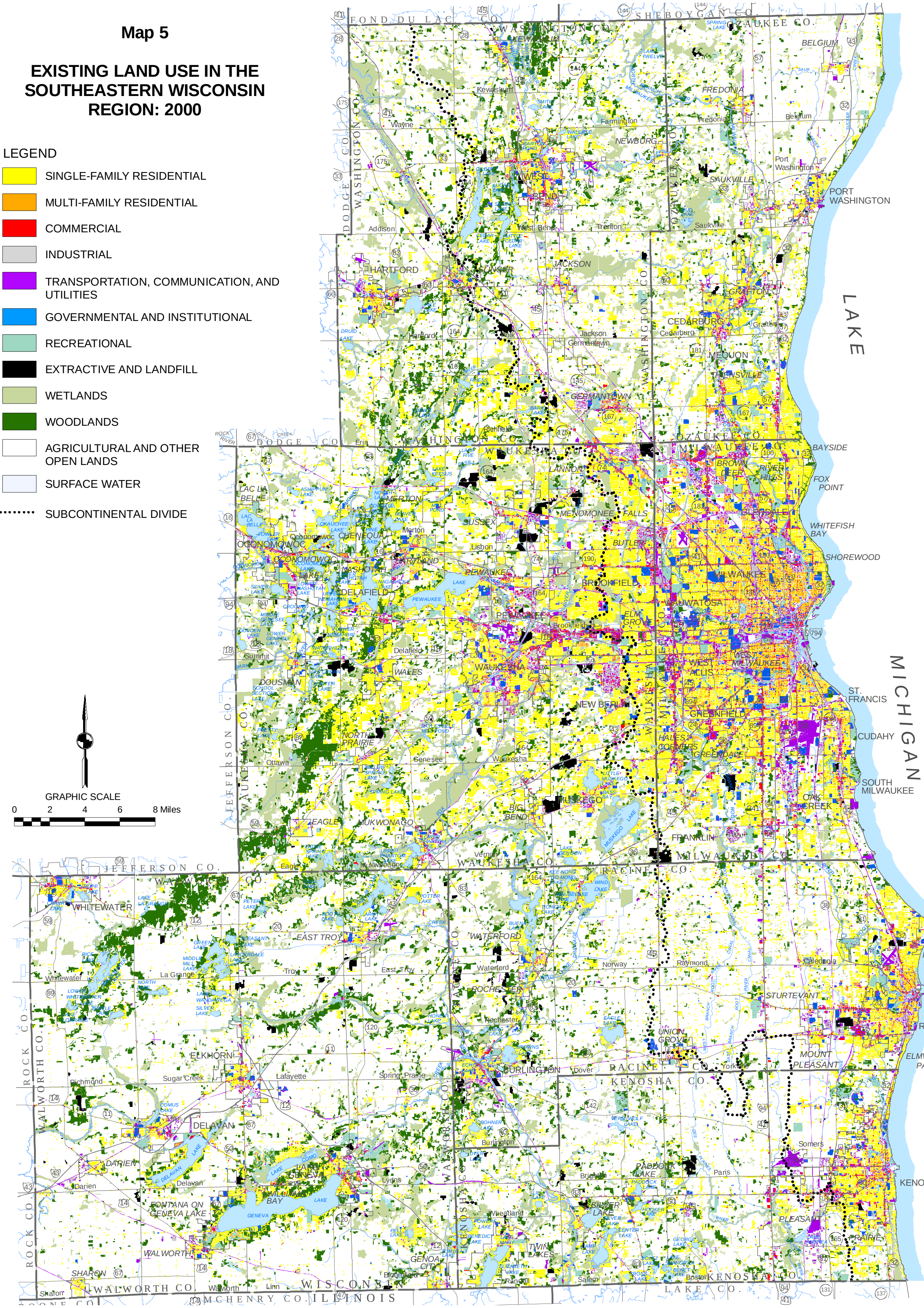
EXISTING LAND USE IN THE SOUTHEASTERN WISCONSIN REGION: 2000

LEGEND

- SINGLE-FAMILY RESIDENTIAL
- MULTI-FAMILY RESIDENTIAL
- COMMERCIAL
- INDUSTRIAL
- TRANSPORTATION, COMMUNICATION, AND UTILITIES
- GOVERNMENTAL AND INSTITUTIONAL
- RECREATIONAL
- EXTRACTIVE AND LANDFILL
- WETLANDS
- WOODLANDS
- AGRICULTURAL AND OTHER OPEN LANDS
- SURFACE WATER
- SUBCONTINENTAL DIVIDE

GRAPHIC SCALE

0 2 4 6 8 Miles



Source: SEWRPC.

Table 9

EXISTING LAND USE IN THE SOUTHEASTERN WISCONSIN REGION: 2000

Land Use Category[a]	Square Miles	Percent of Urban/Nonurban	Percent of Total
Urban			
Residential	362.1	47.6	13.5
Commercial	30.3	4.0	1.1
Industrial	32.9	4.3	1.2
Transportation, Communication, and Utilities	200.9	26.4	7.5
Governmental and Institutional	33.7	4.4	1.2
Recreational	50.4	6.6	1.9
Unused Urban Land	50.9	6.7	1.9
Subtotal Urban	761.2	100.0	28.3
Nonurban			
Natural Areas			
Surface Water	77.4	4.0	2.9
Wetlands	275.7	14.3	10.2
Woodlands	182.7	9.5	6.8
Subtotal	535.8	27.8	19.9
Agricultural	1,259.4	65.3	46.8
Unused Rural and Other Open Land	133.5	6.9	5.0
Subtotal Nonurban	1,928.7	100.0	71.7
Total	2,689.9	- -	100.0

[a]*Off-street parking is included with the associated land use.*

Source: SEWRPC.

PUBLIC UTILITIES

Definitive knowledge about the existing water supply facilities and services is essential to any technically sound water supply system planning effort. Such knowledge about the existing sanitary sewerage facilities and services is also essential to water supply system planning. The alternatives to be considered in water supply system planning are, in some cases, directly related to the existing sanitary sewerage and stormwater management facilities, as well as to the existing water supply facilities serving the areas concerned.

The majority of sewerage and water supply utilities within the Region are organized as sewer and water departments or utility enterprise funds of incorporated municipalities, and largely serve those areas within the respective political boundaries of the municipalities concerned. Stormwater management is typically a responsibility of municipal public works departments. Several communities have established stormwater utilities in order to provide a source of funds to meet stormwater management needs. In addition, there are a number of special-purpose units of government within the Region which have sanitary sewerage and, or, water supply management responsibilities. These units of government include town utility or sanitary districts and, importantly, metropolitan sewerage districts. A general pattern of sewer and water service areas following political boundaries rather than natural topographic boundaries, such as watershed boundaries, exists within the Region.

A subcontinental divide forms the boundary separating the Mississippi River and the Great Lakes-St. Lawrence River surface water drainage systems. This boundary is an important consideration in water supply and related sanitary sewerage and stormwater management systems planning due to regulations and policies governing the use of surface water and groundwater from the Great Lakes-St. Lawrence River basin.

Sanitary Sewer Service
Areas served by public sanitary sewers within the Region in 2000 encompassed a total of about 477 square miles, or about 18 percent of the total area of the Region, compared to about 394 square miles, or about 15 percent of the total area of the Region in 1990 (see Map 6 and Table 10). An estimated 1.71 million persons, or about 89 percent of the resident population of the Region, were served by public sanitary sewers in 2000, compared to 1.59 million persons, representing about 88 percent of the regional population, in 1990.[9]

As already noted, the location of the subcontinental divide which traverses the Region is an important consideration in utility planning. Of the area served by public sanitary sewers, about 342 square miles, or about 72 percent, lies east of the subcontinental divide with the remaining 135 square miles, or about 28 percent, lying west of that divide. Of the 1.71 million persons served by public sanitary sewers, about 1.38 million persons, or 81 percent, reside east of the subcontinental divide, with the remaining about 330,000 persons, or about 19 percent, residing west of that divide. Table 11 lists the population served by public sanitary sewer service as of the year 2000 by county, broken down by location east and west of the subcontinental divide. Table 12 lists the sanitary sewerage facilities in the Region.

The increase in the land area and population served by public sanitary sewerage facilities during the 1990s reflects both new development designed to be served by sanitary sewerage facilities and the retrofitting of existing urban areas; that is, the extension of sanitary sewer service to urban development which was initially developed with onsite sewage disposal systems. Some of the more notable recent retrofitting efforts include the extension of sanitary sewer service to the Lake Como and Pell Lake areas in Walworth County, the Bohner Lake area in Racine County, and the Okauchee Lake area in Waukesha County.

Under State administrative rules, sanitary sewers may be extended only to areas located within planned sanitary sewer service areas as identified in sanitary sewer service area plans adopted as part of the regional water quality management plan, which is in turn based upon the regional land use plan. Sewer service area plans are long-range plans intended to guide the provision of sanitary sewer service over a 20-year period. Sewer service area plans are prepared through a cooperative planning process involving the Commission, the local unit of government responsible for operation of sewerage and sewage treatment facilities, and the Wisconsin Department of Natural Resources. Such plans may be amended in response to changing local conditions and needs as well as in response to new population forecasts, subject to the provisions of *Wisconsin Administrative Code* Chapter NR 121. Currently adopted sanitary sewer service areas in the Region are shown on Map 7.

As of the year 2000, about 218,500 persons, or about 11 percent of the regional population, were served by private onsite sewage disposal systems. In addition, there were numerous such systems serving nonresidential uses located outside the current public sanitary sewer service areas. Most such systems return most of the water used in the households or other establishments concerned to the groundwater system through onsite treatment and disposal. An exception to such return occurs in areas served by holding tanks which do not contribute spent wastewater to the local groundwater system, the stored wastes typically being transported to public sewage

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[9]*A complete reinventory of areas served by public sanitary sewers in the Region was conducted by the Commission in 2000. That inventory made use of digital map files of local sewerage systems not available for prior inventories, allowing for a more precise delineation of areas served by sanitary sewers. As part of the reinventory effort, the more generalized delineation of sewered areas made as part of the previous inventory for the year 1990 was adjusted to ensure consistency with the 2000 inventory and the area served retabulated. As a result, the data regarding the area served by public sanitary sewers in 1990 indicated in Table 10 differ somewhat from the corresponding data for 1990 reported in the previous regional land use plan report, SEWRPC Planning Report No. 45. For similar reasons, the data regarding the area served by public water supply systems in 1990 indicated in Table 13 differ somewhat from the water supply service area data for 1990 presented in SEWRPC Planning Report No. 45.*

Map 6

AREAS SERVED BY CENTRALIZED SANITARY SEWERAGE SYSTEMS IN THE SOUTHEASTERN WISCONSIN REGION: 2000

LEGEND

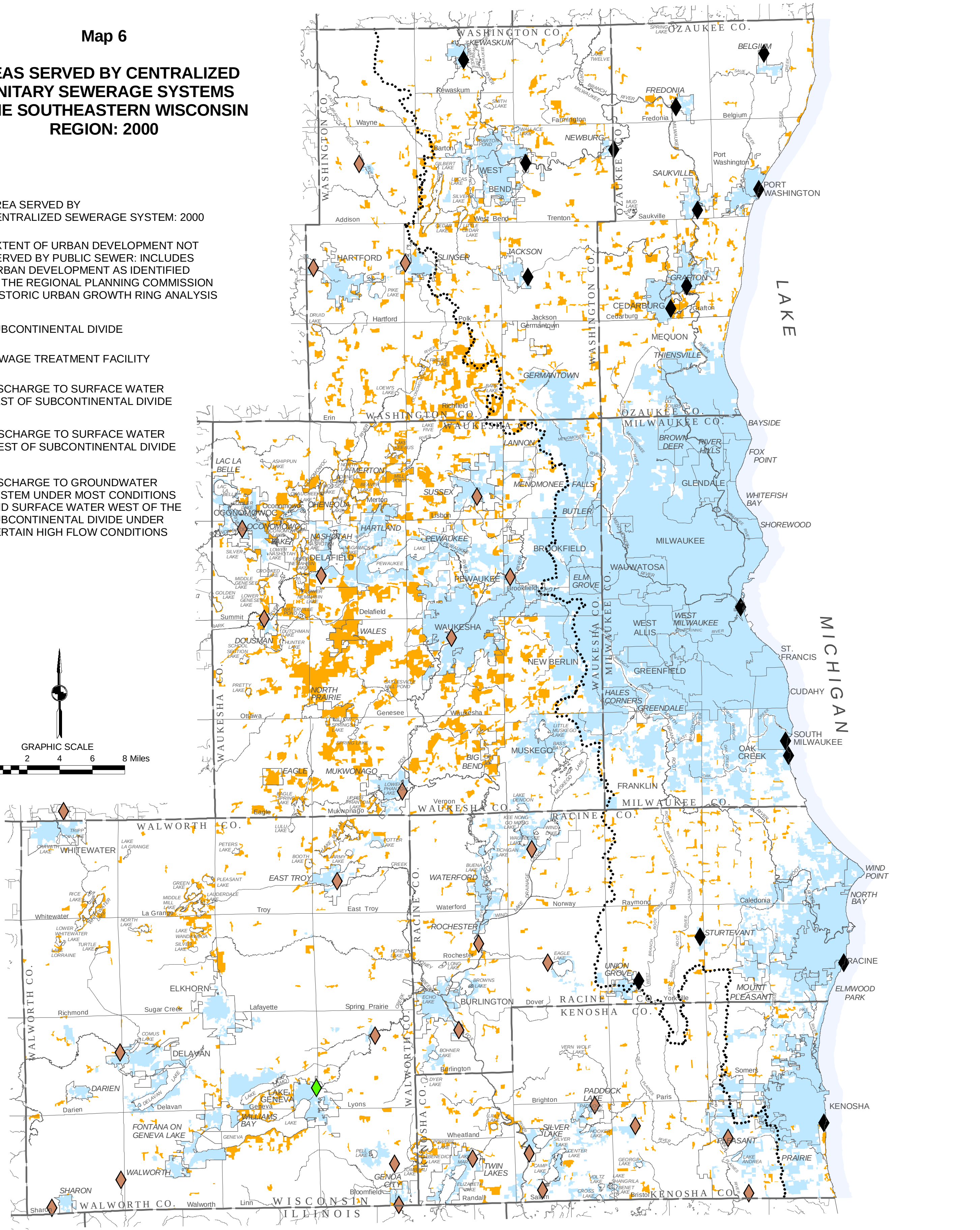
- AREA SERVED BY CENTRALIZED SEWERAGE SYSTEM: 2000
- EXTENT OF URBAN DEVELOPMENT NOT SERVED BY PUBLIC SEWER: INCLUDES URBAN DEVELOPMENT AS IDENTIFIED IN THE REGIONAL PLANNING COMMISSION HISTORIC URBAN GROWTH RING ANALYSIS
- SUBCONTINENTAL DIVIDE

PUBLIC SEWAGE TREATMENT FACILITY

- DISCHARGE TO SURFACE WATER EAST OF SUBCONTINENTAL DIVIDE
- DISCHARGE TO SURFACE WATER WEST OF SUBCONTINENTAL DIVIDE
- DISCHARGE TO GROUNDWATER SYSTEM UNDER MOST CONDITIONS AND SURFACE WATER WEST OF THE SUBCONTINENTAL DIVIDE UNDER CERTAIN HIGH FLOW CONDITIONS

GRAPHIC SCALE

0 2 4 6 8 Miles



Source: SEWRPC.

Table 10

EXISTING AREA AND POPULATION SERVED BY PUBLIC SANITARY SEWERS IN THE SOUTHEASTERN WISCONSIN REGION BY COUNTY: 1990 AND 2000

County	Area Served by Public Sanitary Sewers				Population Served by Public Sanitary Sewers			
	1990		2000		1990		2000	
	Square Miles	Percent of County/ Region Area	Square Miles	Percent of County/ Region Area	Persons	Percent of County/ Region Population	Persons	Percent of County/ Region Population
Kenosha	32.1	11.5	41.2	14.8	111,900	87.3	133,800	89.5
Milwaukee	180.5	74.3	193.2	79.6	954,600	99.5	938,800	99.9
Ozaukee	20.7	8.8	29.3	12.4	54,900	75.4	64,400	78.2
Racine	43.0	12.6	51.6	15.1	154,900	88.5	169,900	90.0
Walworth	17.0	2.9	27.6	4.8	45,200	60.3	62,100	67.5
Washington	15.6	3.6	23.2	5.3	53,300	55.9	71,500	60.9
Waukesha	84.9	14.6	110.7	19.1	219,500	72.0	272,200	75.5
Region	393.8	14.6	476.8	17.7	1,594,300	88.1	1,712,700	88.7

Source: SEWRPC.

Table 11

EXISTING POPULATION SERVED BY PUBLIC SANITARY SEWERS IN THE REGION EAST AND WEST OF THE SUBCONTINENTAL DIVIDE BY COUNTY: 2000

County	Population Served by Public Sanitary Sewers				
	East of the Subcontinental Divide		West of the Subcontinental Divide		
	Persons	Percent of County/ Region Population	Persons	Percent of County/ Region Population	Total
Kenosha	104,600	69.9	29,200	19.5	133,800
Milwaukee	938,800	99.9	0	0.0	938,800
Ozaukee	64,400	78.2	0	0.0	64,400
Racine	136,000	72.0	33,900	18.0	169,900
Walworth	0	0.0	62,100	67.5	62,100
Washington	54,600	46.5	16,900	14.4	71,500
Waukesha	81,200	22.5	191,000	53.0	272,200
Region	1,379,600	71.4	333,100	17.2	1,712,700

Source: SEWRPC.

treatment plants for treatment and disposal. The impact of private onsite sewage disposal systems on groundwater recharge and on groundwater quality is an important factor in water supply planning.

Water Supply Service

Areas served by public water utilities in 2000 encompassed about 390 square miles, or about 14 percent of the total area of the Region, compared to about 316 square miles, or about 12 percent of the Region in 1990 (see Map 8 and Table 13). The water systems serving the eastern portion of the Village of Menomonee Falls, the Village of Butler, and portions of the City of Mequon converted from utilization of a groundwater supply to a Lake Michigan supply over the period from 1998 through 2002. Accordingly, the water supply service area mapping is based upon a 2005 inventory, rather than the year 2000 base year. An estimated 1.56 million persons, or about 81 percent of the regional population, were served by public water utilities in 2000, compared to 1.47 million persons, or also about 81 percent of the regional population, in 1990.

Table 12

PUBLIC SEWERAGE FACILITIES WITHIN THE SOUTHEASTERN WISCONSIN REGION: 2000

Sewerage System	Civil Division Location	Watershed													Sewerage Facility Types	
		Des Plaines	Fox	Lake Michigan Drainage Area	Kinnickinnic River	Menomonee River	Milwaukee River	Oak Creek	Pike River	Rock River	Root River	Sauk Creek	Sheboygan River	Sucker Creek	Public Sewage Treatment Plant	Public Collection/ Conveyance System
Kenosha County																
City of Kenosha	City of Kenosha	X	- -	X	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X	X
Village of Paddock Lake	Village of Paddock Lake	X	- -	- -	- -	- -	- -	- -		- -	- -	- -	- -	- -	X	X
Village of Pleasant Prairie	Village of Pleasant Prairie	X	- -	X	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X	X
Village of Silver Lake	Village of Silver Lake	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	X
Village of Twin Lakes	Village of Twin Lakes	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	X
Town of Bristol Utility District No. 1	Town of Bristol	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	X
Town of Bristol Utility District Nos. 3 & 4	Town of Bristol	X	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X
Town of Salem Utility District No. 2	Town of Salem	X	X	- -	- -	- -	- -	- -		- -	- -	- -	- -	- -	X	X
Town of Somers (KR Sewer Utility District and Utility District No. 1)	Town of Somers	- -	- -	X	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	X
Milwaukee County																
City of Cudahy	City of Cudahy	- -	- -	X	X	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	X
City of Franklin	City of Franklin	- -	- -	- -	- -	- -	- -	X	- -	- -	X	- -	- -	- -	- -	X
City of Glendale	City of Glendale	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	X
City of Greenfield	City of Greenfield	- -	- -	- -- -	X	X	- -	X	- -	- -	X	- -	- -	- -	- -	X
City of Milwaukee	City of Milwaukee	- -	- -	X	X	X	X	X		- -	X	- -	- -	- -	- -	X
City of Oak Creek	City of Oak Creek	- -	- -	X	- -	- -	- -	X	- -	- -	X	- -	- -	- -	- -	X
City of St. Francis	City of St. Francis	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X
City of South Milwaukee	City of South Milwaukee	- -	- -	X	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	X	X
City of Wauwatosa	City of Wauwatosa	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	X
City of West Allis	City of West Allis	- -	- -	- -	X	X	- -	- -	- -	- -	X	- -	- -	- -	- -	X
Village of Bayside	Village of Bayside	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X
Village of Brown Deer	Village of Brown Deer	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	X
Village of Fox Point	Village of Fox Point	- -	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	X
Village of Greendale	Village of Greendale	- -	- -	- -	- -	X	- -	- -	- -	- -	X	- -	- -	- -	- -	X
Village of Hales Corners	Village of Hales Corners	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	X
Village of River Hills	Village of River Hills	- -	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	X
Village of Shorewood	Village of Shorewood	- -	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	X
Village of West Milwaukee	Village of West Milwaukee	- -	- -	- -	X	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	X
Village of Whitefish Bay	Village of Whitefish Bay	- -	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	X
Milwaukee Metropolitan Sewerage District[a]	Milwaukee County	- -	- -	X	X	X	X	X	- -	X	X	- -	- -	- -	X	X
Ozaukee County																
City of Cedarburg	City of Cedarburg	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	X	X
City of Mequon	City of Mequon	- -	- -	X	- -	X	X	- -	- -	- -	- -	- -	- -	- -	- -	X
City of Port Washington	City of Port Washington	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	X	X
Village of Belgium	Village of Belgium	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	X	X	X	X
Village of Fredonia	Village of Fredonia	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	X	- -	- -	X	X
Village of Grafton	Village of Grafton	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	X	X
Village of Newburg	Village of Newburg	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	X	X
Village of Saukville	Village of Saukville	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	X	X
Village of Thiensville	Village of Thiensville	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	X
Racine County																
City of Burlington	City of Burlington	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	X
City of Racine[b]	City of Racine	- -		X	- -	- -	- -	- -	X	- -	X	- -	- -	- -	X	X
Village of Elmwood Park	Village of Elmwood Park	- -	--	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X
Village of North Bay	Village of North Bay	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X
Village of Rochester	Village of Rochester		X	- -	- -	- -	- -	- -	- -	- -		- -	- -	- -	- -	X
Village of Sturtevant	Village of Sturtevant	- -	- -	- -	- -	- -	- -	- -	X	- -	X	- -	- -	- -	- -	X
Village of Union Grove	Village of Union Grove	X		- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	X	X
Village of Waterford	Village of Waterford	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X
Village of Wind Point	Village of Wind Point	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X

Table 12 (continued)

Sewerage System	Civil Division Location	Watershed													Sewerage Facility Types	
		Des Plaines	Fox	Lake Michigan Drainage Area	Kinnickinnic River	Menomonee River	Milwaukee River	Oak Creek	Pike River	Rock River	Root River	Sauk Creek	Sheboygan River	Sucker Creek	Public Sewage Treatment Plant	Public Collection/ Conveyance System
Racine County (continued)																
Bohner's Lake Sanitary District	Town of Burlington	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X
Brown's Lake Sanitary District	Town of Burlington	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X
Caddy Vista Sanitary District	Town of Caledonia	- -		- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	X
Crestview Sanitary District	Town of Caledonia	- -	- -	X	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	X
Eagle Lake Sewer Utility District	Town of Dover	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	X
Mt. Pleasant Sewer Utility District No. 1	Village of Mt. Pleasant	- -	- -	- -	- -	- -	- -	- -	X	- -	X	- -	- -	- -	- -	X
North Park Sanitary District	Town of Caledonia	- -	- -	X	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	X
Town of Caledonia Sewer Utility District No. 1	Town of Caledonia	- -	- -	X	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	X
Town of Norway Sanitary District No. 1	Town of Norway	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	X
Town of Rochester Utility District No. 1	Town of Rochester	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X
Town of Waterford Sanitary District No. 1	Town of Waterford	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X
Town of Yorkville Utility District No. 1	Town of Yorkville	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	X	X
Western Racine County Sewerage District[c]	Villages of Rochester and Waterford and Towns of Rochester and Waterford	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	X
Walworth County																
City of Delavan	City of Delavan	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X
City of Elkhorn	City of Elkhorn	- -	X	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X
City of Lake Geneva	City of Lake Geneva	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	X
City of Whitewater	City of Whitewater	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	X	X
Village of Darien	Village of Darien	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X
Village of East Troy	Village of East Troy	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	X
Village of Fontana	Village of Fontana	- -	X	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X
Village of Genoa City	Village of Genoa City	- -	X	- -	- -	- -	- -	- -	- -		- -	- -	- -	- -	X	X
Village of Sharon	Village of Sharon	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	X	X
Village of Walworth	Village of Walworth	- -	X	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X
Village of Williams Bay	Village of Williams Bay	- -	X	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X
Country Estates Sanitary District	Town of Lyons	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X
Delavan Lake Sanitary District	Town of Delavan	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X
Geneva National Sanitary District	Town of Geneva	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X
Lake Como Sanitary District No. 1	Town of Geneva	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	X
Lake Geneva Golf Hills Sanitary District No. 1	Town of Lyons	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X
Pell Lake Sanitary District No. 1	Town of Bloomfield	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	X
Town of East Troy Sanitary District No. 3	Town of East Troy	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X
Town of Lyons Sanitary District No. 2	Town of Lyons	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	X
Walworth County Metropolitan Sewerage District[d]	Cities of Delavan and Elkhorn; Villages of Darien and Williams Bay; and Towns of Darien, Delavan, and Geneva	- -	X	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	X	X
Fontana-Walworth Water Pollution Control Commission[e]	Villages of Fontana and Walworth and Town of Walworth	- -	X	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	X	X
Washington County																
City of Hartford	City of Hartford	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	X	X
City of West Bend	City of West Bend	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	X	X
Village of Germantown	Village of Germantown	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	X
Village of Jackson	Village of Jackson	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	X	X
Village of Kewaskum	Village of Kewaskum	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	X	X
Village of Newburg	Village of Newburg	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	X	X
Village of Slinger	Village of Slinger	- -	- -	- -	- -	- -	X	- -	- -	X	- -	- -	- -	- -	X	X
Allenton Sanitary District	Town of Addison	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	X	X

Table 12 (continued)

Sewerage System	Civil Division Location	Watershed: Des Plaines	Fox	Lake Michigan Drainage Area	Kinnickinnic River	Menomonee River	Milwaukee River	Oak Creek	Pike River	Rock River	Root River	Sauk Creek	Sheboygan River	Sucker Creek	Sewerage Facility Types: Public Sewage Treatment Plant	Public Collection/ Conveyance System
Washington County (continued)																
Hilldale Sanitary District	Town of Hartford	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X
Pike Lake Utility District	Town of Hartford	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X
Silver Lake Sanitary District	Town of West Bend	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	X
Wallace Lake Sanitary District	Towns of Barton and Trenton	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	X
Waukesha County																
City of Brookfield[f]	City of Brookfield	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	X	X
City of Delafield	City of Delafield	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X
City of Muskego	City of Muskego	- -	X	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	X
City of New Berlin	City of New Berlin	- -	X	- -	- -	X	- -	- -	- -	- -	X	- -	- -	- -	- -	X
City of Oconomowoc	City of Oconomowoc	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	X	X
City of Pewaukee	City of Pewaukee	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X
City of Waukesha	City of Waukesha	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	X
Village of Butler	Village of Butler	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	X
Village of Dousman	Village of Dousman	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	X	X
Village of Elm Grove	Village of Elm Grove	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	X
Village of Hartland	Village of Hartland	- -	X	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X
Village of Lac La Belle	Village of Lac La Belle	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X
Village of Lannon	Village of Lannon	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X
Village of Menomonee Falls	Village of Menomonee Falls	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	X
Village of Mukwonago	Village of Mukwonago	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	X
Village of Nashotah	Village of Nashotah	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X
Village of Pewaukee	Village of Pewaukee	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X
Town of Lisbon Sanitary District No. 1	Town of Lisbon	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X
Town of Summit Sanitary District No. 1	Town of Summit	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X
Town of Summit Silver Lake Sanitary District No. 1	Town of Summit	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X
Delafield-Hartland Water Pollution Control Commission[g]	City of Delafield and Village of Hartland	- -	X	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	X	X
Town of Oconomowoc Mary Lane Sanitary District	Town of Oconomowoc	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X
Town of Oconomowoc Blackhawk Drive Sanitary District	Town of Oconomowoc	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X
Town of Oconomowoc Utility District No. 1	Town of Oconomowoc	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X

[a]*Operates two sewage treatment plants discharging to Lake Michigan and trunk/interceptor sewer system.*

[b]*City of Racine operates a sewage treatment plant discharging directly to Lake Michigan.*

[c]*The Western Racine County Sewerage District operates one sewage treatment plant and a trunk sewer system.*

[d]*The Walworth County Metropolitan Sewerage District operates one sewage treatment plant and a trunk sewer system.*

[e]*The Walworth-Fontana Water Pollution Control Commission operates one sewage treatment plant and a trunk sewer system.*

[f]*City of Brookfield operates a sewage treatment plant tributary to the Fox River and a sewage collection system serving portions of the Fox River and Menomonee River watershed, with the Menomonee River watershed being tributary to the Milwaukee Metropolitan Sewerage District sewerage system.*

[g]*The Delafield-Hartland Water Pollution Control Commission operates one sewage treatment plant and a trunk sewer system.*

Source: SEWRPC.

Map 7

PLANNED SANITARY SEWER SERVICE AREAS IN THE SOUTHEASTERN WISCONSIN REGION: 2000

LEGEND

PLANNED SANITARY SEWER SERVICE AREA

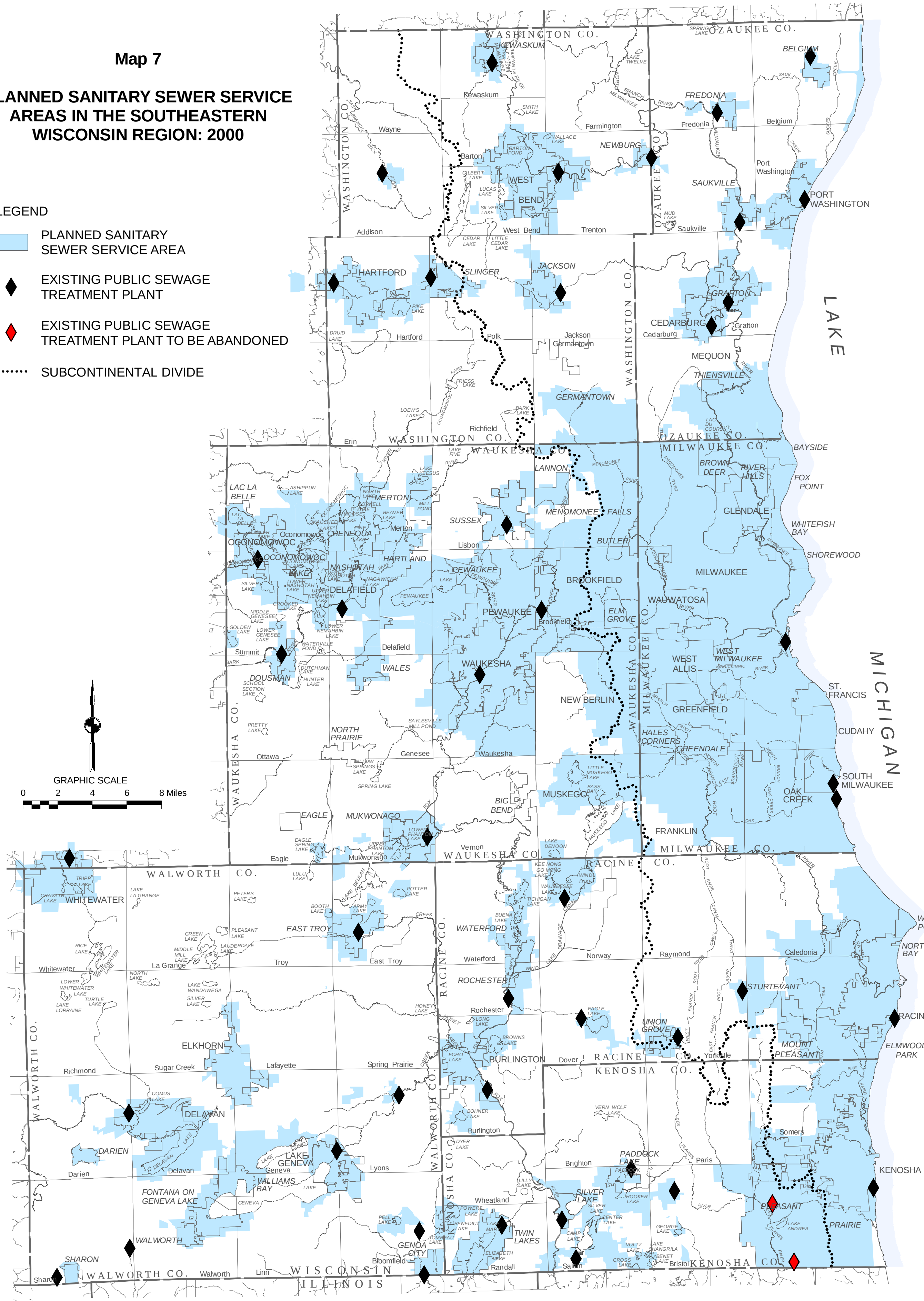
EXISTING PUBLIC SEWAGE TREATMENT PLANT

EXISTING PUBLIC SEWAGE TREATMENT PLANT TO BE ABANDONED

SUBCONTINENTAL DIVIDE

GRAPHIC SCALE

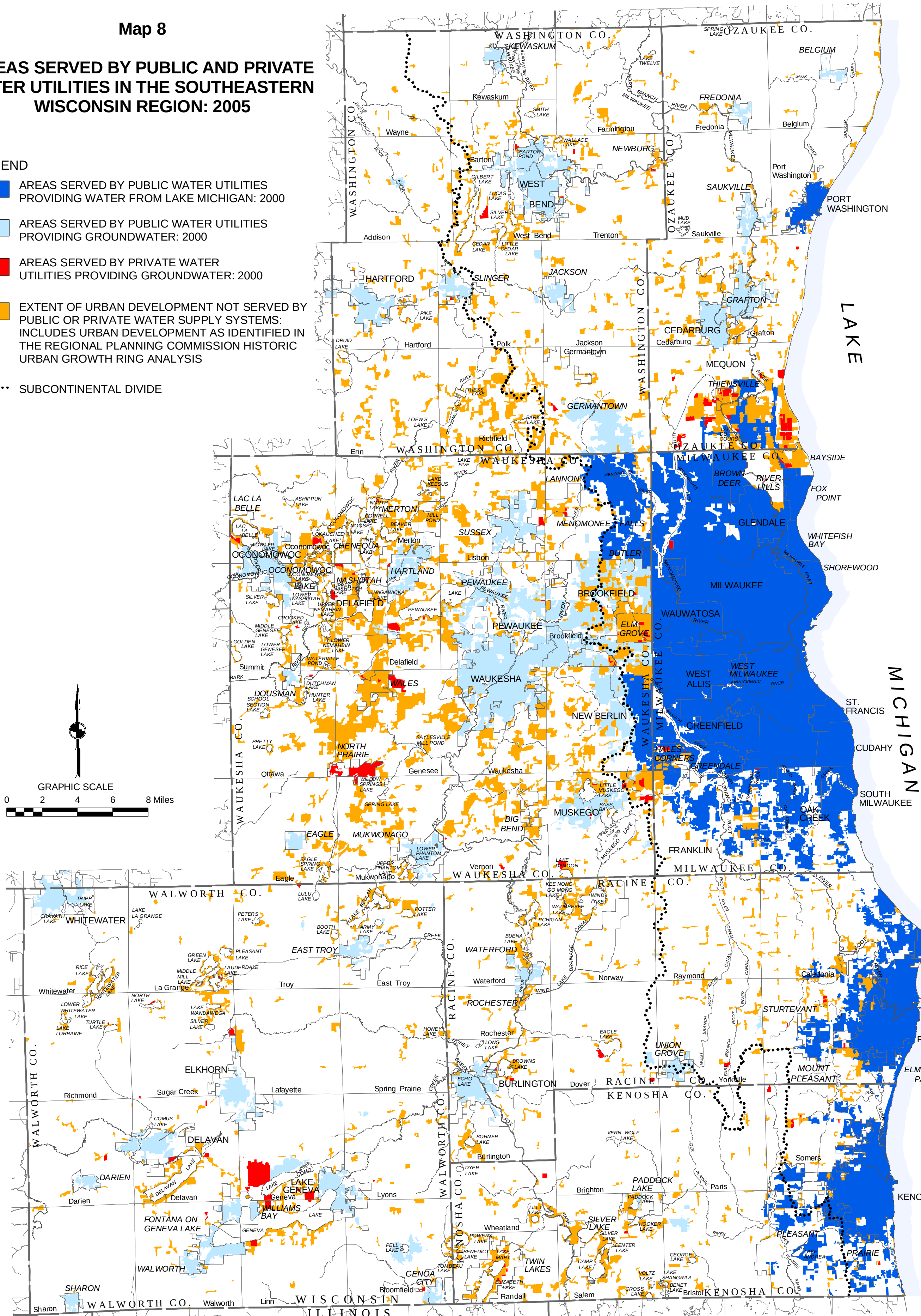
0 2 4 6 8 Miles



Source: SEWRPC.

Map 8

AREAS SERVED BY PUBLIC AND PRIVATE WATER UTILITIES IN THE SOUTHEASTERN WISCONSIN REGION: 2005



Source: SEWRPC.

Table 13

EXISTING AREA AND POPULATION SERVED BY PUBLIC WATER UTILITIES IN THE SOUTHEASTERN WISCONSIN REGION BY COUNTY: 1990 AND 2000

County	Area Served by Public Water Utilities				Population Served by Public Water Utilities			
	1990		2000		1990		2000	
	Square Miles	Percent of County/ Region Area	Square Miles	Percent of County/ Region Area	Persons	Percent of County/ Region Population	Persons	Percent of County/ Region Population
Kenosha	22.2	8.0	29.8	10.7	95,100	74.2	111,000	74.1
Milwaukee	167.2	68.9	179.1	73.8	937,000	97.7	917,300	97.6
Ozaukee	9.3	3.9	17.5	7.4	35,800	49.2	45,400	55.2
Racine	32.0	9.4	37.6	11.0	136,200	77.8	146,400	77.5
Walworth	13.5	2.3	22.2	3.9	40,200	53.6	56,200	61.1
Washington	14.2	3.3	21.4	4.9	50,300	52.8	66,800	56.8
Waukesha	57.1	9.8	82.1	14.1	173,000	56.8	218,400	60.5
Region	315.5	11.7	389.7	14.5	1,467,600	81.1	1,561,500	80.9

NOTE: In addition to publicly owned water utilities, there were numerous private or cooperatively owned water utilities in the Region in 2000 serving residential subdivisions, apartment buildings, mobile home parks, and institutions. These privately owned other than municipal water supply systems served areas encompassing 11.3 square miles, with a population of about 37,000 persons, in 2000.

Source: SEWRPC.

As previously noted, the location of the subcontinental divide is an important consideration in water supply and related utility planning. Of the area served by public water utilities in 2000, about 294 square miles, or about 75 percent, lay east of the subcontinental divide, while the remaining about 96 square miles, or about 25 percent of the area served, are located west of that divide. As may be computed from the figures given in Table 14, about 1,308,500 persons, or about 84 percent of the population served by public water supply in 2000, reside east of the subcontinental divide, with the remaining about 253,000 persons, or about 16 percent, residing west of the divide. It is also important to note that of the 1.56 million persons within the Region served by public water supply in 2000, about 1,197,400 persons, or about 77 percent, including about 7,500 persons residing west of the subcontinental divide, were served by utilities using Lake Michigan surface water as a source of supply, and about 364,100 persons, or about 23 percent, including about 118,600 persons residing east of the subcontinental divide, were served by utilities using groundwater as a source of supply. Table 15 lists all public municipal water facilities operated within the Region in 2000 and the water supply source.

In addition to publicly owned water utilities as of 2000, there were 221 privately or cooperatively owned water systems operating in the Region. These systems are categorized by the Wisconsin Department of Natural Resources as "other than municipal community systems." Such systems serve at least 15 regularly used service connections, or at least 25 year-round residents, and typically serve residential subdivisions, apartment or condominium developments, mobile home parks, and institutions. The areas served by such systems are shown on Map 8 and a listing of these systems is included in Table 16. It is estimated that these systems served a total of about 37,000 persons in the Region in 2000.[10] Additionally, there were, as of 2005, 311 systems categorized by

[10]*The number of private community systems shown on Map 8 is 221, the number in operation in the plan base year 2000. As of 2005, there were 169 such systems. The reduction in the number of such systems is due primarily to the absorption of systems into adjacent public water utilities. In addition, some of the systems have constructed additional private wells, thereby, reducing the number of people served by the private community system to below the 25 year-round person threshold which classifies the system as an "other than municipal community system." Also, as of 2005, there were 1,445 systems categorized as "transient non-community systems." Such systems serve at least 25 people at least 60 days of the year and typically serve motels, restaurants, churches, campgrounds, and parks. Additional information on such systems is included in Chapter III.*

Table 14

POPULATION SERVED BY PUBLIC WATER UTILITIES USING SURFACE AND GROUNDWATER SUPPLIES: 2000

County	Population Served by Surface Water Supply			Population Served by Groundwater Supply			Total Population Served by Public Water Supply
	Population West of the Subcontinental Divide	Population East of the Subcontinental Divide	Total Population Served	Population West of the Subcontinental Divide	Population East of the Subcontinental Divide	Total Population Served	
Kenosha	7,500	101,500	109,000	2,000	0	2,000	111,000
Milwaukee	0	917,300	917,300	0	0	0	917,300
Ozaukee..........	0	15,000	15,000	0	30,400	30,400	45,400
Racine	0	126,500	126,500	16,800	3,100	19,900	146,400
Walworth	0	0	0	56,200	0	56,200	56,200
Washington	0	0	0	15,400	51,400	66,800	66,800
Waukesha	0	29,600	29,600	155,100	33,700	188,800	218,400
Total	7,500	1,189,900	1,197,400	245,500	118,600	364,100	1,561,500

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

the WDNR as “non-transient non-community systems.” Such systems serve at least 25 of the same persons over six months of the year and typically serve schools; daycare centers; and industrial, commercial, or institutional facilities. The number of these facilities in each county is listed in Table 17.

As of the year 2000, there were about 333,000 persons, or about 17 percent of the total resident population of the Region, served by private domestic wells. In addition, there were numerous private wells serving nonresidential uses located outside the current public sanitary sewer service areas.

Additional information on the existing water supply systems in the Region is provided in Chapter III.

Municipal Stormwater Management Systems

Municipal stormwater management systems are comprised of facilities that function to provide stormwater drainage and control of nonpoint source pollution. The facilities that perform those two functions generally work as part of an integrated system which incorporates the streams, lakes, ponds, wetlands, and the groundwater system of the study area. Components of a stormwater management system may include subsurface pipes and appurtenant inlets and outlets, streams and engineered open channels, detention basins, retention basins, pumping facilities, infiltration facilities, constructed wetlands for treatment of runoff, and proprietary treatment devices based on settling processes and control of oil and grease. Within the Region, the urban portions of the communities indicated on Map 9 are served by engineered stormwater management systems. The scope and content of stormwater management plans and ordinances has changed significantly since the adoption of stormwater management rules in Chapters NR 216 and NR 151 of the *Wisconsin Administrative Code* which became effective in 1994 and 2002, respectively. The available inventory of stormwater management plans and ordinances is as of 2005.

In Wisconsin, the U.S. Environmental Protection Agency has designated the Wisconsin Department of Natural Resources as the administering authority for the regulation of stormwater discharges as required under the Federal Clean Water Act. In that respect, the Department administers the Wisconsin Pollutant Discharge Elimination System (WPDES) for permitting of stormwater discharges. Under that program discharge permits have been issued to the units of government listed in Table 18.

In order to establish a reliable funding source to meet the requirements of their stormwater discharge permits, several communities in the study area have established stormwater utilities. Those communities are indentified on Map 9. Seventy-nine communities have a stormwater management ordinance and/or plan and 84 communities have a construction erosion control ordinance. Those communities are indentified on Map 9.

Table 15

SELECTED INFORMATION ON THE PUBLIC WATER UTILITIES WITHIN THE SOUTHEASTERN WISCONSIN REGION: 2005

Water Utility Facility		Watershed													Municipal Water Supply Source		
Name	Class[a]	Des Plaines	Fox	Kinnickinnic River	Menomonee River	Milwaukee River	Oak Creek	Pike River	Rock River	Root River	Sauk Creek	Sheboygan River	Sucker Creek	Lake Michigan Drainage Area	Groundwater	Lake Michigan	Other
Kenosha County																	
City of Kenosha Water Utility	AB	X	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X	- -	X	
Village of Paddock Lake Municipal Water Utility	D	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	
Village of Pleasant Prairie Water Utility	AB	X	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X	- -	- -	X[b]
Town of Bristol Utility District No. 1	D	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	
Town of Bristol Utility District No. 3	D	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	
Town of Somers Water Utility	C	X	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X	- -	- -	X[b]
Milwaukee County																	
City of Cudahy Water Utility	AB	- -	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -	X	- -	X	- -
City of Franklin Water Utility	C	- -	- -	- -	- -	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -	X[f]
City of Glendale Water Utility	AB	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X[d]
City of Milwaukee Water Works[g]	AB	- -	- -	X	X	X	X	- -	- -	X	- -	- -	- -	X	- -	X	- -
City of Oak Creek Water and Sewer Utility	AB	- -	- -	- -	- -	- -	X	- -	- -	X	- -	- -	- -	X	- -	X	- -
City of South Milwaukee Water Utility	AB	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	X	- -	X	- -
City of Wauwatosa Water Utility	AB	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X[e]
City of West Allis Water Utility	AB	- -	- -	X	X	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	X[e]
Village of Bayside We Energies Water Services)[c]	C	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	X[d]
Village of Brown Deer Public Water Utility	AB	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X[e]
Village of Fox Point Water Utility	C	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	X[d]
Village of Greendale Water Utility	AB	- -	- -	- -	X	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	X[e]
Village of Shorewood Municipal Water Utility	C	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	X[e]
Village of West Milwaukee	N/A	- -	- -	X	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X[e]
Village of Whitefish Bay Water Utility	AB	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	X[d]
Ozaukee County																	
City of Cedarburg Light & Water Commission	AB	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -
City of Mequon Water Utility (We Energies Water Services)[c]	AB	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	X[e]
City of Port Washington Water Utility	AB	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	X	- -	X	- -
Village of Belgium Water Utility (waterworks)	C	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	X	X	- -	X	- -	- -
Village of Fredonia Municipal Water Utility	D	- -	- -	- -	- -	X	- -	- -	- -	- -	X	- -	- -	- -	X	- -	- -
Village of Grafton Water and Wastewater Commission	C	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -
Village of Saukville Municipal Water Utility	C	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -
Racine County																	
City of Burlington Water Utility	AB	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -
City of Racine Water and Wastewater Utility	AB	- -	- -	- -	- -	- -	- -	X	- -	X	- -	- -	- -	X	- -	X	- -
Village of Sturtevant Water and Sewer Utility	AB	- -	- -	- -	- -	- -	- -	X	- -	X	- -	- -	- -	- -	- -	- -	X[i]
Village of Union Grove Municipal Water Utility	C	X	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	X	- -	- -
Village of Waterford Water Utility	AB	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -
Village of Wind Point Municipal Water Utility	D	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	X[i]

Table 15 (continued)

Water Utility Facility		Watershed													Municipal Water Supply Source		
Name	Class[a]	Des Plaines	Fox	Kinnickinnic River	Menomonee River	Milwaukee River	Oak Creek	Pike River	Rock River	Root River	Sauk Creek	Sheboygan River	Sucker Creek	Lake Michigan Drainage Area	Groundwater	Lake Michigan	Other
Racine County (continued)																	
Town of Yorkville Water Utility District No. 1	D	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	X	- -	- -
Town of Caledonia Water Utility District No. 1	C	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	X	- -	- -	X[i]
Caddy Vista Sanitary District	D	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	X[h]
Crestview Sanitary District	D	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	X	- -	- -	X[h]
North Cape Sanitary District	D	- -	X	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	X	- -	- -
North Park Sanitary District No. 1	C	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	X	- -	- -	X[h,i]
Walworth County																	
City of Delavan Water and Sewerage Commission	AB	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X	- -	- -
City of Elkhorn Light and Water	AB	- -	X	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X	- -	- -
City of Lake Geneva Municipal Water Utility	AB	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -
City of Whitewater Municipal Water Utility	AB	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X	- -	- -
Village of Darien Water Works and Sewer System	C	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X	- -	- -
Village of East Troy Municipal Water Utility	C	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -
Village of Fontana Municipal Water Utility	C	- -	X	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X	- -	- -
Village of Genoa City Municipal Water Utility	C	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -
Village of Sharon Waterworks and Sewer System	C	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X	- -	- -
Village of Walworth Municipal Water and Sewer Utility	C	- -	X	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X	- -	- -
Village of Williams Bay Municipal Water Utility	C	- -	X	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X	- -	- -
Town of East Troy Sanitary District No. 3	D	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -
Town of Troy Sanitary District No. 1	D	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -
Country Estates Sanitary District	D	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -
Lake Como Sanitary District No. 1	D	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -
Lake Geneva Golf Hills Sanitary District No. 1	D	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -
Pell Lake Sanitary District No. 1	AB	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -
Washington County																	
City of Hartford Water Utilities	AB	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X	- -	- -
City of West Bend Water Utility	AB	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -
Village of Germantown Water Utility	AB	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -
Village of Jackson Water Utility	C	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -
Village of Kewaskum Municipal Water Utility	C	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -
Village of Slinger Utilities	C	- -	- -	- -	- -	X	- -	- -	X	- -	- -	- -	- -	- -	X	- -	- -
Allenton Sanitary District	D	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X	- -	- -
Waukesha County																	
City of Brookfield Municipal Water Utility	AB	- -	X	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -
City of Delafield Municipal Water Utility	D	- -	X	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X	- -	- -
City of Muskego Public Water Utility	C	- -	X	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	X	- -	- -
City of New Berlin Water Utility	AB	- -	X	- -	X	- -	- -	- -	- -	X	- -	- -	- -	- -	X	- -	- -
City of Oconomowoc Utilities	AB	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	X	- -	- -
City of Pewaukee Water and Sewer Utility	AB	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -
City of Waukesha Water Utility	AB	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -

Table 15 (continued)

Water Utility Facility		Watershed													Municipal Water Supply Source		
Name	Class[a]	Des Plaines	Fox	Kinnickinnic River	Menomonee River	Milwaukee River	Oak Creek	Pike River	Rock River	Root River	Sauk Creek	Sheboygan River	Sucker Creek	Lake Michigan Drainage Area	Groundwater	Lake Michigan	Other
Waukesha County (continued)																	
Village of Butler Public Water Utility	C	- -	- -	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X[e]
Village of Dousman Water Utility	C	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X	- -	- -
Village of Eagle Municipal Water Utility	C	- -	X	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X	- -	- -
Village of Hartland Municipal Water Utility	AB	- -	X	- -	- -	- -	- -	- -	X	- -	- -	- -	- -	- -	X	- -	- -
Village of Menomonee Falls Water Utility	AB	- -	X	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	X[e]
Village of Mukwonago Municipal Water Utility	AB	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -
Village of Pewaukee Water Utility	AB	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -
Village of Sussex Water Utility	AB	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -
Town of Brookfield Sanitary District No. 4	C	- -	X	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -
Prairie Village Water Trust (Village of North Prairie)	C	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -

[a]*The municipal water and combined water and sewer utilities are based upon the number of customers as follows: Class AB 4,000 or more customers; Class C from 1,000 to less than 4,000 customers; and Class D less than 1,000 customers.*

[b]*City of Kenosha Water Utility.*

[c]*The We Energies Water Services, a private utility, provides water supply service to portions of the Village of Bayside, the City of Mequon, and the Village of Thiensville.*

[d]*North Shore Water Utility.*

[e]*City of Milwaukee Water Works.*

[f]*City of Milwaukee Water Works and City of Oak Creek Water and Sewer Utility.*

[g]*Provides retail water supply services to the Cities of Greenfield and Saint Francis, a portion of the City of Franklin and Village of Hales Corners.*

[h]*City of Oak Creek Water and Sewer Utility.*

[i]*City of Racine Water and Wastewater Utility.*

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

Table 16

PRIVATE COMMUNITY WATER SYSTEMS WITHIN THE SOUTHEASTERN WISCONSIN REGION: 2000[a]

County	Site/Name	Municipality	Area Served (in acres)
Kenosha	52nd Avenue Water Group	Town of Somers	9.7
	Bell Air Subdivision	Town of Randall	8.2
	Bella Villa Apartments	Town of Salem	0.9
	Bristol Heights Mobile Home Park	Town of Bristol	5.6
	Carefree Estates Mobile Home Park	Town of Salem	39.9
	Castle Apartments	Village of Twin Lakes	1.0
	Colonial View Apartments	Village of Twin Lakes	1.0
	Country Charm Estates	Town of Somers	44.3
	Country Club Trails Subdivision	Village of Twin Lakes	73.1
	Eagle Chateau Apartments	Town of Somers	7.7
	Elizabeth Manor Apartments	Town of Somers	1.6
	Hillcrest Water Service 1	Town of Somers	1.5
	Holy Hill Apartments	Village of Twin Lakes	3.8
	Knolls Water Cooperative	Town of Randall	115.5
	Kriwell Drive Community	Village of Twin Lakes	2.4
	Lake View Apartments	Village of Silver Lake	1.0
	Lakecrest Mobile Home Park	Town of Salem	6.9
	Lakeside Apartments	Town of Salem	2.2
	Lakewood Estates Mobile Home Park	Town of Salem	10.9
	Lakewood Village Apartments	Village of Twin Lakes	4.4
	Lincoln Crest Apartments	Village of Twin Lakes	3.7
	Marino Acres	Town of Randall	2.0
	Meadow Acres Community	Town of Randall	13.3
	Meadow Creek Subdivision	Town of Wheatland	12.4
	Meadow Dale Subdivision	Town of Somers	7.4
	Meadowview Village Apartments	Village of Twin Lakes	3.0
	Newport Bay Condos	Town of Salem	1.8
	Oakdale Estates Mobile Home Park	Town of Somers	44.5
	Pleasant Prairie Mobile Home Park	Town of Somers	5.2
	Prairie Apartments 1 & 2	Town of Salem	4.9
	Prairie Apartments 3 & 4	Town of Salem	3.3
	Rainbow Lake Manor Mobile Home Park	Town of Bristol	65.5
	Schoolview Apartments	Town of Salem	0.9
	Shady Nook Mobile Home Park	Town of Brighton	9.5
	Silvercrest Apartments	Village of Silver Lake	1.2
	St. Benedicts Abbey	Town of Salem	26.7
	Sunset Ridge	Town of Somers	3.1
	Tan Oak Apartments	Village of Twin Lakes	14.7
	Timber Ridge Apartments	Village of Twin Lakes	1.0
	Timber Ridge Manufactured Homes	Village of Pleasant Prairie	16.4
	Twin Lakes Complex	Village of Twin Lakes	3.2
	Twin Lakes Park Water Cooperative	Village of Twin Lakes	12.0
	Van Woods Estates	Village of Twin Lakes	23.9
	Village Plaza Apartments	Village of Paddock Lake	2.0
	Westgate Manor	Village of Silver Lake	3.5
	Wheatland Estates	Town of Wheatland	40.0
	Whispering Pines Apartments	Town of Salem	1.0
	Whittier Heights Subdivision	Village of Pleasant Prairie	10.0
Milwaukee	42nd Street Well Owners	City of Franklin	6.3
	Acre Avenue Water Trust	City of Franklin	6.3
	Blossom Heath 1 and 2	Village of Hales Corners	7.3
	Dreamland Village Apartments	City of Franklin	1.7

Table 16 (continued)

County	Site/Name	Municipality	Area Served (in acres)
Milwaukee (continued)	Fifth Avenue Mobile Home Park	City of Oak Creek	5.3
	Franklin Mobile, LLC, Numbers 1 and 2	City of Franklin	7.1
	Grange Meadows	Village of Hales Corners	5.4
	Hales Happiness Subdivision	Village of Hales Corners	60.1
	Mary Ann Drive Homeowners Association	City of Franklin	6.3
	North Shore East Water Trust[b]	Village of Bayside	101.3
	Northway Water Coop 2	Village of Bayside	43.1
	Robert William Park Water Association	City of Milwaukee	76.6
	Santa Monica Subdivision	Village of Bayside	5.0
	Vista Del Mar	Village of Bayside	13.6
	Whitnall Garden Apartments	Village of Hales Corners	5.9
Ozaukee	Alberta Subdivision	Village of Thiensville	15.2
	Beechwood Farms Estates	City of Mequon	115.9
	Brighton Ridge Subdivision	City of Mequon	76.5
	Century Estates[b]	Village of Thiensville	90.9
	Cherry Wood Apartments	Town of Grafton	1.2
	Columbia Creek Condos[b]	City of Mequon	17.7
	Concordia University	City of Mequon	116.1
	Country Squire Estates	City of Mequon	36.6
	Country Terrace Condo Homes	City of Mequon	16.0
	Eastbrook Estates[b]	City of Mequon	10.4
	Grand Avenue Apartments	Village of Thiensville	3.0
	Greenbrier Homeowners Association[b]	City of Mequon	29.2
	Haddonstone Subdivision	City of Mequon	60.4
	Heidel Road Apartments	Village of Thiensville	1.1
	Highland Colony Estates	City of Mequon	9.8
	Huntington Park	City of Mequon	124.3
	Kenilworth Subdivision	City of Mequon	27.5
	Knightsbridge Subdivision[b]	City of Mequon	34.4
	Laurel Acres	Village of Thiensville	84.4
	Laurel Lakes 508	Village of Thiensville	2.6
	Laurel Lakes 608	Village of Thiensville	2.8
	Linden Lane Apartments	Village of Thiensville	11.9
	Mequon Colony Estates Condominiums	City of Mequon	12.3
	Mequon on the Square Condominiums	City of Mequon	17.2
	Mequon Parc Apartments	City of Mequon	4.2
	Mequon Trail Townhomes	City of Mequon	46.3
	North Shore Heights[b]	City of Mequon	22.7
	Oakwood Apartments	City of Mequon	5.2
	Park Place Apartments	City of Mequon	89.5
	Pine Ridge Estates[b]	Village of Thiensville	11.9
	Pines Subdivision	City of Mequon	79.0
	Pioneer Grafton Mobile Home Park	Town of Grafton	8.5
	Ravine Farms Homeowners Association	City of Mequon	31.1
	River Garden Apartments	Village of Thiensville	1.7
	River Glen[b]	City of Mequon	43.3
	River Lake Subdivision	City of Mequon	19.8
	River Ridge Subdivision[b]	City of Mequon	36.8
	River Trails Estates Water Users	City of Mequon	35.1
	Stonecroft Condominium Association	Town of Grafton	7.1
	Stonefields Subdivision[b]	City of Mequon	81.4
	Trailer Park II LLC	Town of Port Washington	5.6
	Village Glen Apartments	Village of Thiensville	2.0
	Village Heights Apartments	Village of Thiensville	6.4
	Vintage Estates	City of Mequon	47.6

Table 16 (continued)

County	Site/Name	Municipality	Area Served (in acres)
Ozaukee (continued)	Westchester Lakes Subdivision	City of Mequon	109.6
	Williamsburg Apartments	Village of Thiensville	17.0
	Wisconsin Lutheran Seminary	City of Mequon	28.8
	Woodridge Estates	City of Mequon	32.3
	Wyngate Subdivision	City of Mequon	39.8
Racine	Browns Lake Mobile Home Court	Town of Burlington	22.3
	Colonial Court Apartments	Town of Mt. Pleasant	4.6
	Cozy Acres Subdivision	Town of Mt. Pleasant	25.5
	Eagle Lake Manor	Town of Dover	76.4
	Francis Meadows Apartments	Town of Burlington	33.3
	Globe Heights Ranchwood North	Town of Mt. Pleasant	38.8
	Harvest View Estates	Town of Yorkville	46.3
	Hickory Haven	Town of Dover	30.9
	Jensens Mobile Home Village	Town of Mt. Pleasant	11.2
	Pederson/Nason Wells	Town of Mt. Pleasant	1.0
	Riverside Apartments	Village of Rochester	2.1
	Spring Green	Town of Dover	4.2
	Stuart Road Duplexes	Town of Dover	4.2
Walworth	Beach Road Lodge	Town of Geneva	1.3
	Burr Oak Apartments	Town of Delavan	4.5
	Cedar Point Drive Association	Town of Delavan	1.3
	Coachmans Terrace	Town of Geneva	16.9
	Como Cabins	Town of Geneva	1.2
	Delavan Chicago Club	Town of Delavan	1.5
	Delavan Club Condos	Town of Delavan	27.1
	Geneva Landings	Town of Delavan	33.5
	Geneva National Golf Club	Town of Geneva	1,077.2
	Harbor House	Town of Lyons	7.3
	Inspiration Ministries/Meadows	Town of Walworth	26.6
	Interlaken Resort Village	Town of Geneva	82.8
	Ludwell Estates Mobile Home Park 1 and 2	Town of Delavan	17.5
	Moters Mobile Home Park	Town of Lyons	7.2
	Pioneer Estates of Delavan	Town of Darien	34.7
	Sarinas Home for the Elderly	Town of Sugar Creek	1.5
	Skyview Terrace Mobile Home Park	Town of Geneva	7.0
	Snug Harbor Inn	Town of Richmond	6.1
	Town Hall Apartments	Town of Delavan	3.4
	Troy Terrace Mobile Home Park	Town of Troy	22.8
	Vintage on the Ponds	Town of Sugar Creek and Town of Delavan	9.7
	Walworth County Industrial Park	Town of Geneva	33.6
	Westshire Farms at the Lake	Town of Delavan	37.6
	Willow Run RV Condo Association	Town of Sugar Creek	76.6
	Workmens Benefits Recreation Society, Inc.	Town of Bloomfield	31.9
Washington	Carriage Hills Apartments	Village of Germantown	1.1
	Cedar Lake Home 5 & 9	Town of West Bend	139.3
	Eastwood Trail Water Trust	Town of Trenton	1.3
	Highway 33 Apartments North & South	Town of Barton	2.2
	Hilltop Highlands 1,2, 3, 5	Village of Germantown	38.9
	Maple Dale 1932 & North #4	Town of Trenton	5.7
	Maple Terrace Mobile Home Park	Village of Germantown	10.9
	Mt. Moraine Subdivision	Town of Richfield	4.4

Table 16 (continued)

County	Site/Name	Municipality	Area Served (in acres)
Washington (continued)	Tompkins Mobile Home Park	Town of Kewaskum	1.0
	Voigts Lakeside Estates	Town of Hartford	3.9
	Walsh Subdivision 1 & 2	Town of Trenton	8.8
	Wheel Estates Mobile Home Park	Village of Slinger	14.5
Waukesha	Allemande Meadows	City of Brookfield	9.8
	Apartments of Stoneridge	Town of Genesee	16.1
	Brookfield Hills Apartments	City of Brookfield	34.8
	Carriage Hills Condominiums	Village of Elm Grove	5.5
	Champions Village Subdivision	City of Muskego	48.9
	Congregational Home	City of Brookfield	13.6
	Country Aire Apartments 2	Town of Merton	15.1
	Country Court Subdivision	City of Pewaukee	12.2
	Douglas Plaza Condominium	Village of Elm Grove	2.4
	Durham Meadows Water Trust	City of Muskego	42.6
	Elm Grove Terrace Condominiums	Village of Elm Grove	9.0
	Elms Condominium Association	Village of Elm Grove	3.5
	Emerald Woods Condominiums	Village of Elm Grove	7.1
	Freedom Square	City of Muskego	7.4
	Hale Park Meadows Subdivision	City of Muskego	76.9
	Heaven City Apartment Complex	Town of Vernon	8.1
	Hidden Pond Court Homeowners Association	City of Brookfield	9.2
	Hills of Wales Apartments	Village of Wales	15.3
	JRs Resort	Town of Mukwonago	4.3
	Knollcrest	City of Delafield	3.0
	Lad Lake Inc.	Town of Ottawa	14.8
	Lake Country Apartments	City of Delafield	3.0
	Lake Lore Water Trust	City of Muskego	145.1
	Lake Meadows Water Trust	City of Muskego	106.1
	Lakewood Meadows Subdivision Water	City of Muskego	18.1
	Lannon Mobile Home Park	Village of Lannon	39.9
	Marian Heights Subdivision	Village of Elm Grove	35.0
	Marlan Meadows Homeowners	City of Muskego	15.8
	Meadows of the Grove	Village of Elm Grove	16.2
	Midland Place Water Trust	City of Brookfield	3.0
	Nashotah Adolescent Center	Town of Summit	88.2
	Neufeld Apartments	City of New Berlin	0.4
	Norhardt Apartments	City of Brookfield	5.6
	Norris Adolescent Center	Town of Vernon	33.2
	Norwauk Water Trust	Town of Lisbon	28.6
	Notre Dame of Elm Grove	Village of Elm Grove	30.4
	Oakton Beach Condominiums	Town of Delafield	12.8
	Oconomowoc Development Training Center	Town of Summit	17.5
	Park at Elm Grove	Village of Elm Grove	11.1
	Parquelynn Village	City of Delafield	49.6
	Pheasant Meadows Apartments	City of New Berlin	1.6
	Pilgrim Meadows	City of Brookfield	24.8
	Pioneer Centre Homeowners	City of Muskego	7.0
	Prairie Village Water Trust[c]	Village of North Prairie	899.9
	Riverview Condominiums	Town of Summit	6.6
	Squires Grove	Village of Elm Grove	8.9
	St. Elizabeth Nursing Home	Town of Brookfield	4.8
	Stonebank Mobile Home Park	Town of Merton	5.7
	Stoney Creek Apartments	City of Muskego	6.8
	Sunnyfield Acres Subdivision	Town of Oconomowoc	50.5
	Teal Ridge Condominiums	City of Brookfield	5.0

Table 16 (continued)

County	Site/Name	Municipality	Area Served (in acres)
Waukesha (continued)	The Arbors	Town of Delafield	157.7
	The Evergreens	Town of Merton	12.1
	Thornapple Hill Water Trust	City of New Berlin	4.7
	Wilderness Court Condominiums	City of Brookfield	4.3
	Willow Glen Apartments	City of Muskego	4.5
	Willow Springs Mobile Home Park 2 & 3	Town of Lisbon	87.9
	Wimmer Brothers Apartments	City of New Berlin	2.7
	Windsong Apartments	City of Muskego	2.0

[a]*The number of private community systems shown on Map 8 and listed in this table is 221 for the plan base year 2000. As of 2005, there were 169 such systems. The reduction in the number of such systems is due primarily to the absorption of systems into adjacent public water utilities. In addition, some of the systems have constructed additional private wells, thereby, reducing the number of people served by the private community system to below the 25 year-round person threshold which classifies the system as a "other than municipal community system."*

[b]*Subdivision provided with service by We Energies Water Services between 1999 and 2006.*

[c]*This utility is currently classified as a private community system by the Wisconsin Department of Natural Resources. However, the utility has the characteristics of, and functions similar to, a public water utility.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

HYDROLOGIC MONITORING STATIONS

A technically sound comprehensive water supply system planning program requires, among other things, definitive knowledge about the condition of the water resources of the planning area and of the existing degree of utilization of those resources.

Southeastern Wisconsin has a good network of hydrologic data acquisition stations, which monitor all phases of the hydrologic cycle: atmospheric, surface, and subsurface. Map 10 shows the location of climatological data stations, which monitor precipitation; stream-gaging and lake-gaging stations, which monitor stream flows, lake levels, and to a limited degree, stream and lake water quality; and observation wells, which monitor groundwater levels. Data from all of these monitoring stations were utilized to develop the groundwater resources inventories documented in SEWRPC Technical Report No. 37, *Groundwater Resources of Southeastern Wisconsin*, June 2002.

Precipitation data are collected through a cooperative network of observers, maintained by the National Climatic Data Center. The data are available from the Center located in Asheville, North Carolina, or the State Climatologist Office in Madison. The comprehensive stream-gaging network within the Region is a result of a cooperative, intergovernmental program established by the Commission. The U.S. Geological Survey maintains and operates the network. Two-thirds of the gaging stations are financially supported by five local agencies under the cooperative Commission program. The remaining stations are supported through the cooperation of the U.S. Geological Survey with another six local and State agencies. Records on stream discharges, lake levels, and, to a limited extent, the water quality of streams and lakes are available from the U.S. Geological Survey District Office in Madison. Water level measurements on observation wells are available from the U.S. Geological Survey or the Wisconsin Geological and Natural History Survey which jointly operate the groundwater observation well network.

Table 17

NONTRANSIENT, NONCOMMUNITY AND TRANSIENT, NONCOMMUNITY WATER SUPPLY SYSTEMS IN THE SOUTHEASTERN WISCONSIN REGION: 2005

County	Number of Transient, Noncommunity Water Supply Systems	Number of Nontransient, Noncommunity Water Supply Systems
Kenosha	203	35
Milwaukee	72	16
Ozaukee	164	65
Racine	160	39
Walworth	191	18
Washington	197	32
Waukesha	458	106
Total	1,445	311

NOTE: Transient, non-Community water supply systems are defined by the WDNR water supply systems which serve at least 25 people at least 60 days of the year. Examples include taverns, motels, restaurants, churches, campgrounds, and parks. Non-transient, non-Community water supply systems are defined by the WDNR as water supply systems which serve at least 25 of the same persons over six months of the year. Examples include schools; daycare centers; and commercial, industrial, and institutional facilities.

Source: Wisconsin Department of Natural Resources.

NATURAL RESOURCE BASE

The natural resource base is an important determinant of the supply development potential of the water resources of the planning study area and of its ability to provide a pleasant and habitable environment for all forms of life. The principal elements of the natural resource base considered in the regional water supply system planning effort were: climate, soils, glacial geology, vegetation, water resources, and environmentally sensitive areas. Given the urbanization taking place within the Region, it was important that the natural resource base be carefully considered in the water supply planning effort. The areawide diffusion of urban land uses places the underlying and sustaining resource base at risk for over use, deterioration, and destruction. In addition to the natural resources inventory information presented herein, additional data on the surface water and groundwater sources of supply are presented in Chapter III of this report.

Climate

General Climatic Conditions

The mid-continental location of the Southeastern Wisconsin Region, far removed from the moderating effect of the oceans, gives the study area a typical continental climate, characterized primarily by a continuous progression of markedly different seasons and a large range in annual temperature. Low temperatures during winter are intensified by prevailing frigid northwesterly winds, while summer high temperatures are reinforced by the warm southwesterly winds common during that season. Warm weather, seasonal dry periods which occur in the Region have historically been important considerations in water supply planning by placing stress on both public and private water supply systems due to associated high water usage and limitations on supplies.

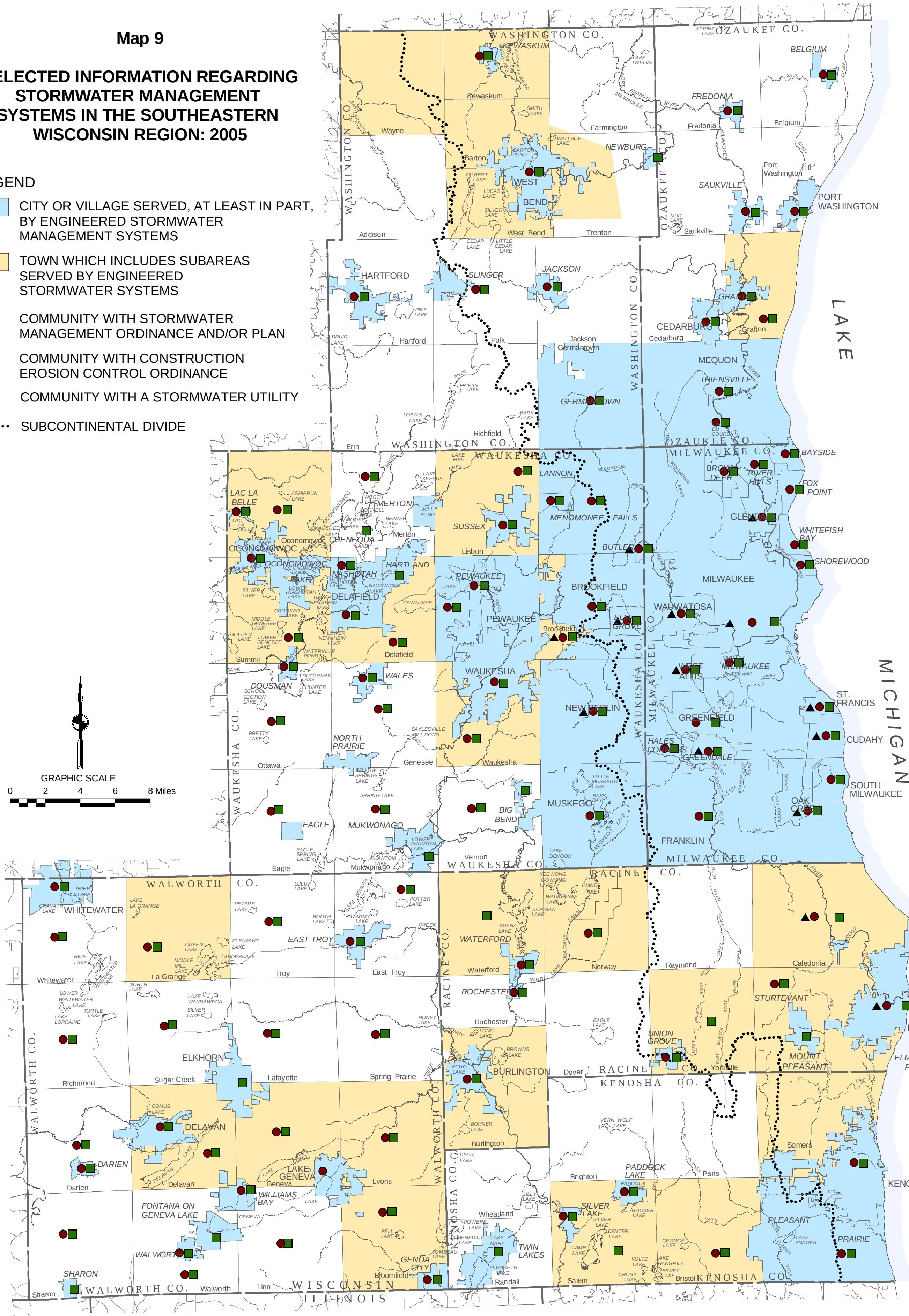
The Region is positioned astride cyclonic storm tracks along which low-pressure centers move from the west and southwest and also lies in the path of high-pressure centers moving in a generally southeasterly direction. This location at the confluence of major migratory air masses results in watersheds being generally influenced by a continuously changing pattern of different air masses. This results in frequent weather changes being superimposed on the large annual range in weather characteristics, particularly in winter and spring, when distinct weather changes normally occur every three to five days. These temporal weather changes consist of marked variations in temperature, type and amount of precipitation, relative humidity, wind speed and direction, and cloud cover.

In addition to these distinct temporal variations in weather, the Region exhibits spatial variations in weather due primarily to its proximity to Lake Michigan, particularly during the spring, summer, and autumn seasons, when the temperature differential between the lake water and the land air masses tends to be the greatest. During these periods, the presence of the Lake tends to moderate the climate of the eastern portion of the study area.

Map 11 shows the location of six meteorological stations located in the Southeastern Wisconsin Region. The meteorological data from these six stations were used to characterize the climatological and meteorological conditions in the Region as presented in the following paragraphs.

Map 9

SELECTED INFORMATION REGARDING STORMWATER MANAGEMENT SYSTEMS IN THE SOUTHEASTERN WISCONSIN REGION: 2005



Source: SEWRPC.

Table 18

COMMUNITIES IN THE SOUTHEASTERN WISCONSIN REGION THAT HAVE STATE OF WISCONSIN WPDES STORMWATER DISCHARGE PERMITS: 2005

Grafton Group
Village of Grafton
Town of Grafton
Menomonee River Watershed Group
City of Brookfield
City of Greenfield
City of Wauwatosa
Village of Butler
Village of Elm Grove
Village of Germantown
Village of Menomonee Falls
Village of West Milwaukee
Mequon/Thiensville Group
City of Mequon
Village of Thiensville
North Shore Group
City of Glendale
Village of Bayside
Village of Brown Deer
Village of Fox Point
Village of River Hills
Village of Shorewood
Village of Whitefish Bay
Root River Watershed Group
City of Franklin
City of New Berlin
City of Racine
Village of Caledonia
Village of Greendale
Village of Hales Corners
Village of Mt. Pleasant
Upper Fox River Watershed Group
City of Pewaukee
City of Waukesha
Village of Pewaukee
Village of Sussex
Town of Brookfield
Town of Delafield
Town of Lisbon
Town of Waukesha
Communities and Districts that Have Made Individual Applications
City of Cedarburg
City of Cudahy
City of Milwaukee
City of Oak Creek
City of St. Francis
City of South Milwaukee
City of West Allis
Southeast Wisconsin Professional Baseball District

Source: Wisconsin Department of Natural Resources and SEWRPC.

Climate Change

Changes in climate over the last century, attributed to both natural and anthropogenic influences, have been extensively studied in recent years. The most significant indicator of climate change presented in the scientific literature is an increase in mean annual air temperature over the last century.[11] That change has influenced other climatological characteristics, hydrology, water quality, and natural ecosystems. Considerable effort has also been directed toward applying mathematical models to project future climate change based on different assumptions regarding natural and anthropogenic influences on climate. Such climate change modeling is generally accomplished at a global scale, and is not directly applicable to more-localized areas, such as the regional water supply planning area. Accordingly, the effects of climate change over the planning period, which extends to the year 2035, cannot be explicitly evaluated within the context of the groundwater-surface water quality model used in the regional water supply planning effort. Model input parameters approximate the current state of the climate, and are considered to adequately represent the anticipated climate regime over the planning period. Additional information on climate change is included in Chapter VII.

Temperature

Temperatures, which exhibit a large annual range within the Region, are relevant to water supply planning. Seasonal temperatures have a direct impact upon the kinds and intensities of water uses. The summer period is often critical and limiting in both water usage and, in some cases, groundwater aquifer supply recharge.

Data for six selected temperature observation stations in southeastern Wisconsin, three of which, Port Washington, Milwaukee, and Kenosha, are located near the Lake Michigan shoreline, and three of which, West Bend, Waukesha, and Lake Geneva, are located at least 15 miles inland, are presented in Table 19 and Figure 7. These data, which encompass periods of record ranging from 46 to 65 years for the various observations, indicate the temporal and spatial variations in temperature and the temperature ranges that

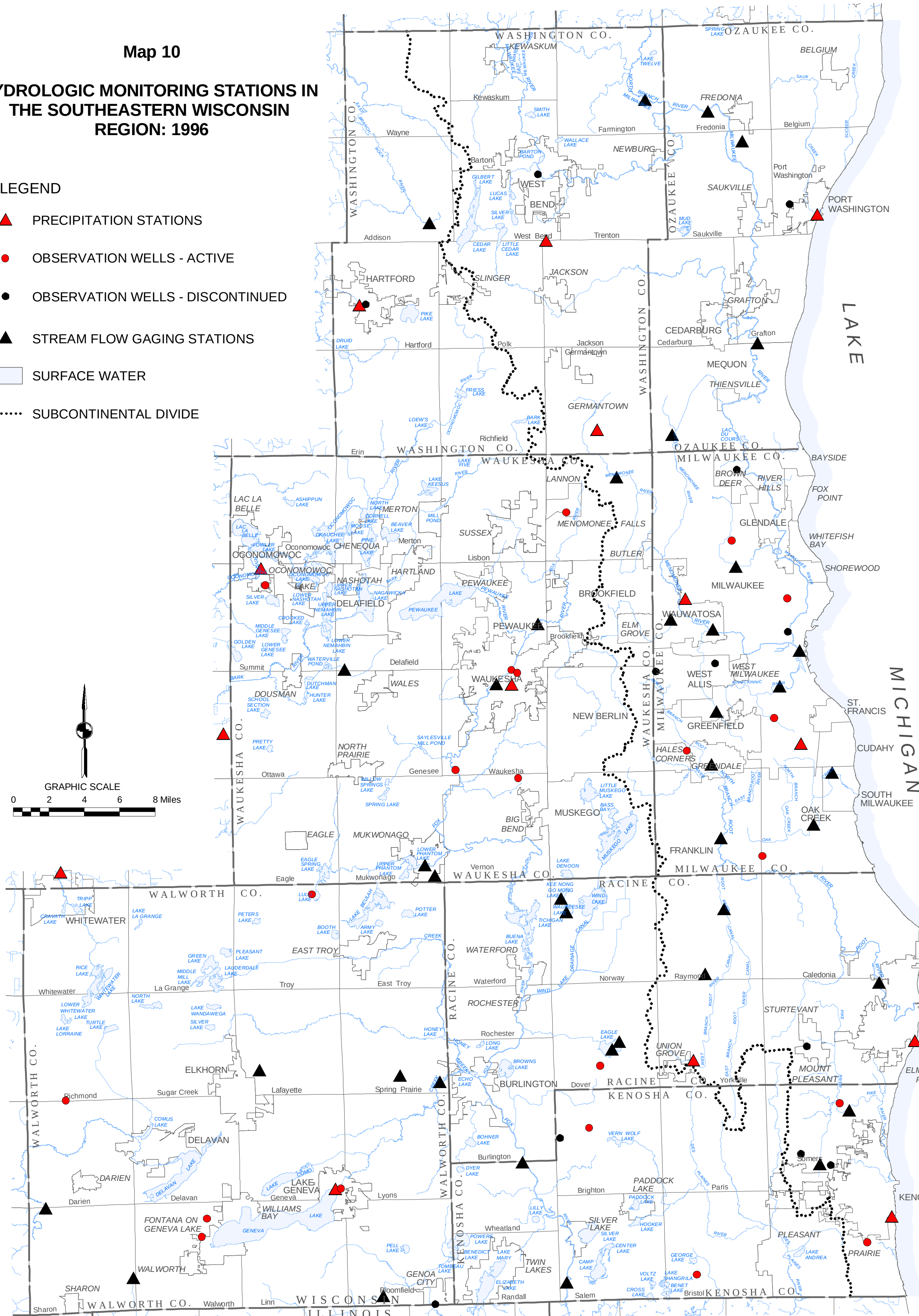
[11]*Great Lakes Water Quality Board of the International Joint Commission,* Climate Change and Water Quality in the Great Lakes Basin," *August 200.*

Map 10

HYDROLOGIC MONITORING STATIONS IN THE SOUTHEASTERN WISCONSIN REGION: 1996

LEGEND

- PRECIPITATION STATIONS
- OBSERVATION WELLS - ACTIVE
- OBSERVATION WELLS - DISCONTINUED
- STREAM FLOW GAGING STATIONS
- SURFACE WATER
- SUBCONTINENTAL DIVIDE



Source: University of Wisconsin-Extension, Wisconsin Geological and Natural History Survey, and SEWRPC.

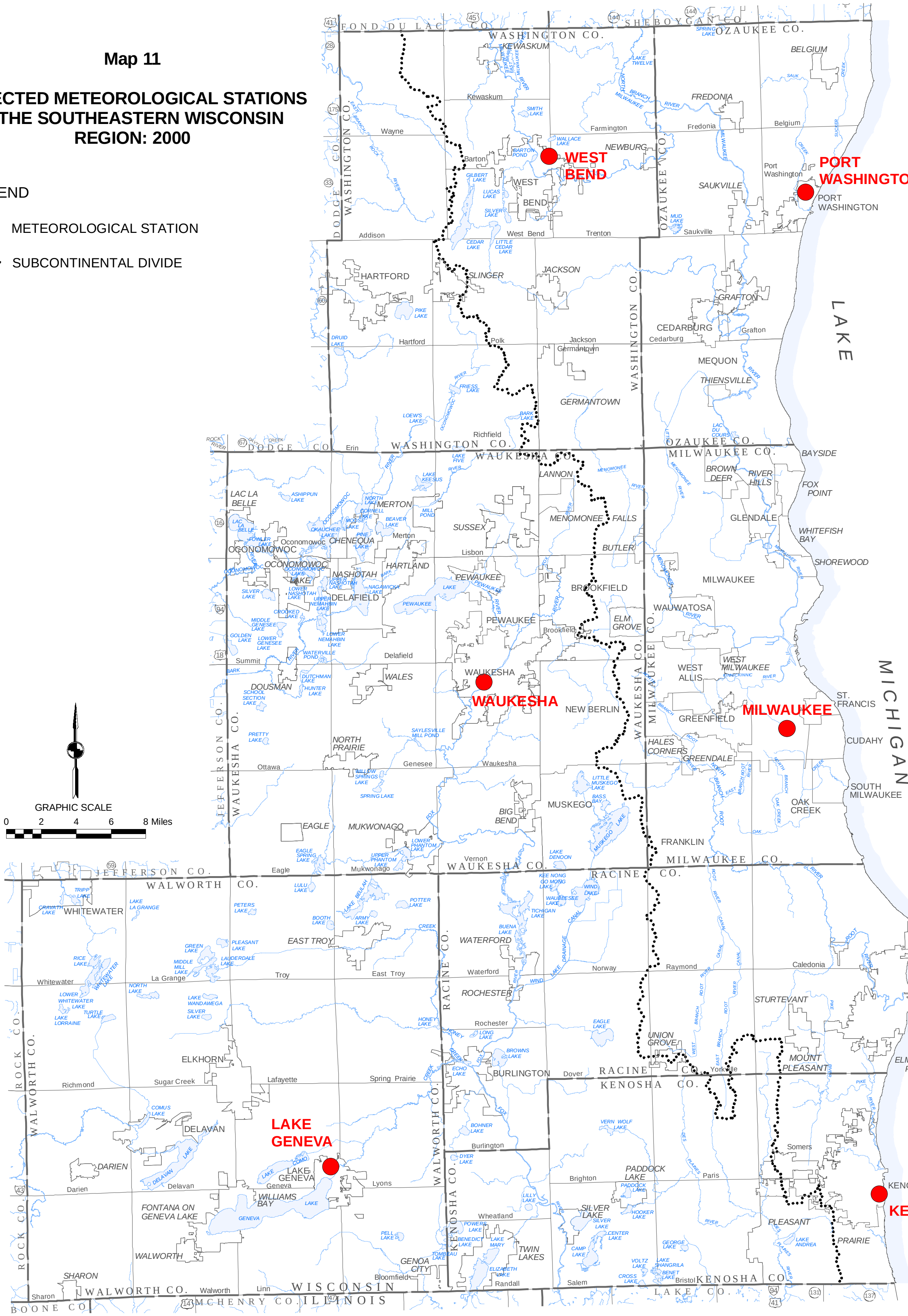
Map 11

SELECTED METEOROLOGICAL STATIONS IN THE SOUTHEASTERN WISCONSIN REGION: 2000

LEGEND

METEOROLOGICAL STATION

SUBCONTINENTAL DIVIDE



Source: SEWRPC.

Table 19

TEMPERATURE CHARACTERISTICS AT SELECTED LOCATIONS IN THE REGION

Month	Observation Station:[a] Lakeshore Locations								
	Port Washington 1959-2004			Milwaukee 1940-2004			Kenosha 1948-2004		
	Average Daily Maximum[b]	Average Daily Minimum[b]	Mean[c]	Average Daily Maximum[b]	Average Daily Minimum[b]	Mean[c]	Average Daily Maximum[b]	Average Daily Minimum[b]	Mean[c]
January	27.7	11.6	19.7	28.1	13.4	20.7	29.2	13.6	21.4
February	31.8	16.0	23.9	31.6	16.9	24.3	33.1	18.2	25.6
March	40.2	24.8	32.5	41.0	26.0	33.5	41.5	26.4	34.0
April	50.7	34.6	42.6	53.4	36.4	44.9	52.6	36.2	44.4
May	60.8	43.8	52.3	64.6	45.1	54.8	63.2	44.7	54.0
June	71.4	53.4	62.4	75.2	55.5	65.4	74.0	54.6	64.3
July	77.5	60.4	68.9	80.2	62.0	71.1	79.5	61.6	70.6
August	77.0	60.0	68.5	78.7	61.7	70.2	78.5	61.4	70.0
September	70.0	52.7	61.4	71.2	53.6	62.4	71.5	53.4	62.5
October	58.8	41.6	50.2	60.2	42.7	51.5	60.7	42.7	50.8
November	45.1	30.2	37.6	45.3	30.6	38.0	46.9	31.3	39.1
December	34.0	18.5	26.3	32.5	18.8	25.7	34.8	19.4	27.1
Yearly Average	53.7	37.3	45.5	55.2	38.6	46.9	55.5	38.6	47.0

Month	Observation Station:[a] Inland Locations									Regional Summary		
	West Bend 1940-2004			Waukesha 1940-2004			Lake Geneva 1945-2003					
	Average Daily Maximum[b]	Average Daily Minimum[b]	Mean[c]	Average Daily Maximum[b]	Average Daily Minimum[b]	Mean[c]	Average Daily Maximum[b]	Average Daily Minimum[b]	Mean[c]	Average Daily Maximum[d]	Average Daily Minimum[d]	Mean[e]
January	27.0	10.2	18.6	27.0	11.2	19.1	28.9	12.5	20.7	28.0	12.1	20.0
February	30.6	13.6	22.1	31.7	15.8	23.8	33.4	15.9	24.6	32.0	16.1	24.1
March	40.1	23.1	31.6	41.2	24.1	32.7	43.2	24.9	34.1	41.2	24.9	33.1
April	54.9	34.1	44.5	56.0	35.6	45.8	57.7	36.0	46.9	54.2	35.5	44.9
May	66.6	43.9	55.3	67.6	45.8	56.8	70.1	46.2	58.2	65.5	44.9	55.2
June	77.1	54.2	65.6	78.1	55.6	66.9	80.5	56.6	68.6	76.1	55.0	65.5
July	81.7	59.4	70.6	83.0	60.9	71.9	84.6	61.8	73.2	81.1	61.0	71.0
August	79.6	58.5	69.1	80.8	59.7	70.3	83.0	60.5	71.7	79.6	60.3	70.0
September	71.8	50.3	61.1	73.1	51.5	62.4	75.1	52.5	63.8	72.1	52.3	62.3
October	60.7	40.4	50.6	61.9	40.9	51.4	63.0	42.3	52.7	60.9	41.8	51.2
November	44.7	28.4	36.6	45.0	29.2	37.1	46.2	30.2	38.2	45.5	30.0	37.8
December	32.0	16.2	24.1	32.5	17.8	25.2	33.1	18.3	25.8	33.2	18.2	25.7
Yearly Average	55.6	36.0	45.8	56.5	37.3	46.9	58.2	38.1	48.2	55.8	37.7	46.7

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

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

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

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

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

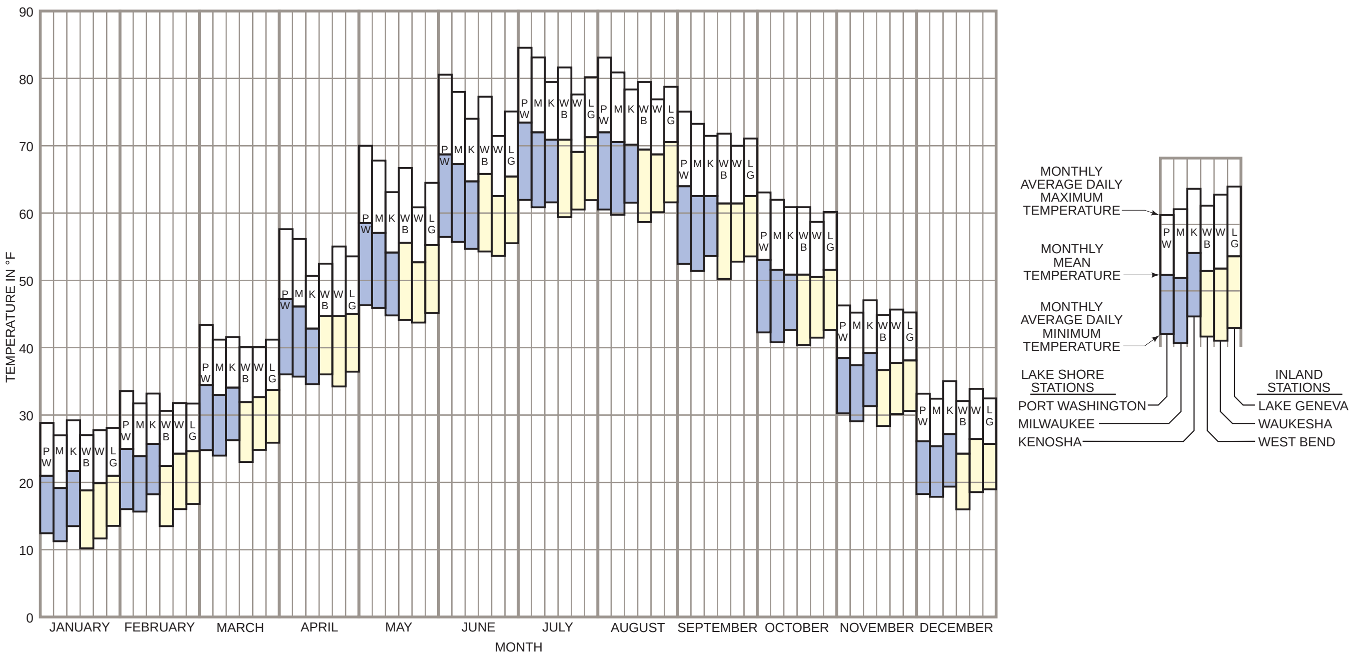
Source: National Climatic Data Center and SEWRPC.

may be expected to occur in the Region. The temperature data also illustrate how regional air temperatures lag approximately one month behind summer and winter solstices during the annual cycle, with the result that July is the warmest month in southeastern Wisconsin and January the coldest. The effects of Lake Michigan are seen when comparisons are made between inland and lakeshore observation stations that have the same latitude.

The growing season, which is defined as the number of days between the last freeze in the spring and the first freeze in the fall, averages about 165 days for the Region, extending approximately from April 15 to October 15.

Figure 7

TEMPERATURE CHARACTERISTICS AT SELECTED LOCATIONS IN THE SOUTHEASTERN WISCONSIN REGION



Source: National Climatic Data Center and SEWRPC.

The lakeshore area has a growing season of about 175 days, while inland locations have a shorter growing season of about 155 days. The last frost in the spring normally occurs during the last week of April for areas near Lake Michigan, and during the first half of May for inland locations. The first frost in the fall normally occurs around the middle of October. The average frost depth reaches a maximum in mid-February, as reported by the Wisconsin Agricultural Statistics Service. During the period in which frost depth observations have been made in southeastern Wisconsin, one of the deepest regionwide frost penetrations occurred in early March 1963, when 25 to 30 inches of frost depth occurred throughout the Region. Even deeper frost depths, over 36 inches, were observed throughout the Region in January and February 1977. The Milwaukee and West Allis City Engineers reported over five feet of frost beneath some city streets in January and February 1977. Frost depth is important in the determination of the vertical location of water supply facilities.

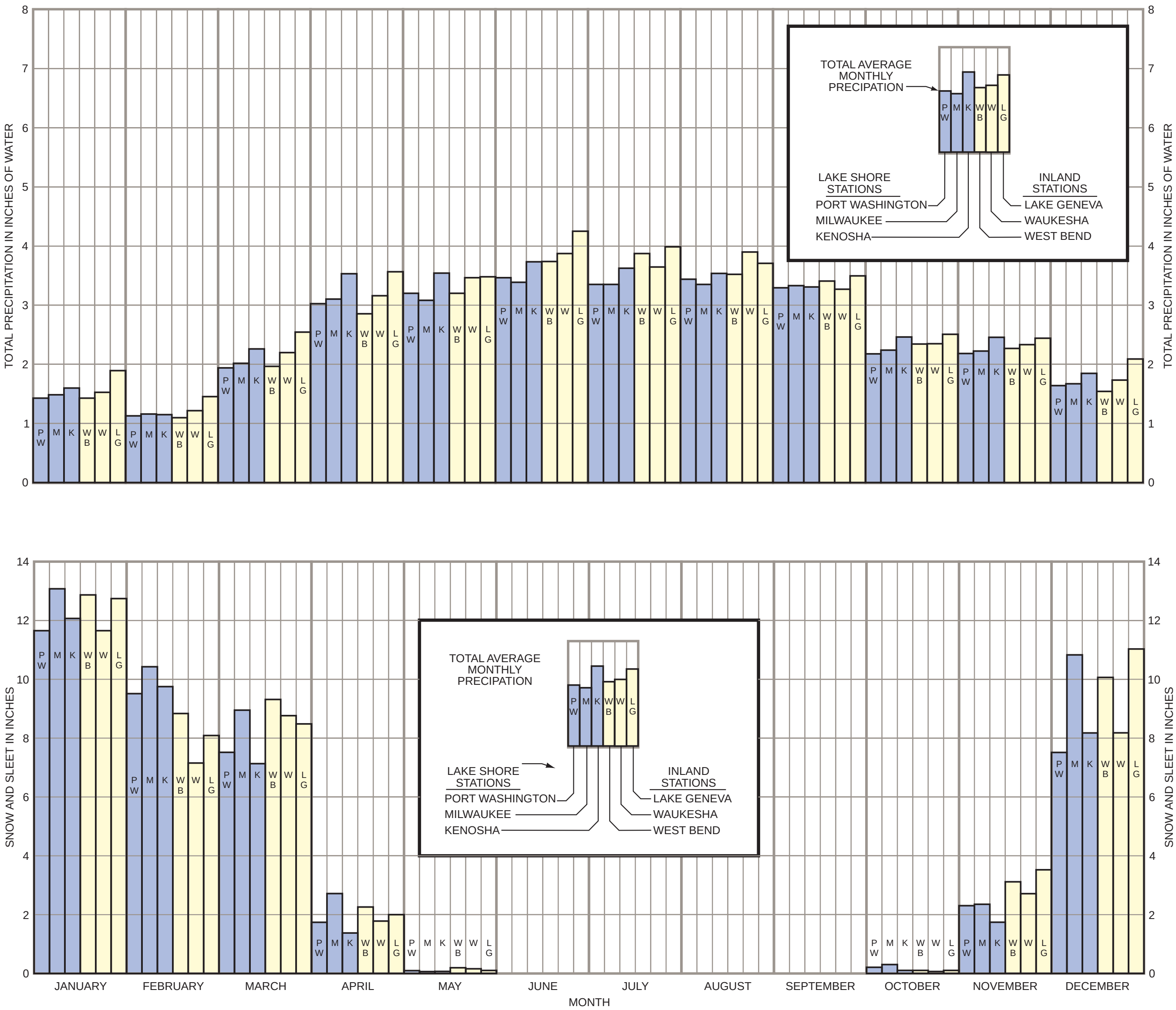
Precipitation

Precipitation within the Southeastern Wisconsin Region takes the form of rain, sleet, hail, and snow. It ranges from gentle showers of trace quantities to destructive thunderstorms. Major rainfall and snowmelt events can cause property and crop damage, inundation of poorly drained areas, and stream flooding. Annual precipitation in the Region averages about 32 inches, with the greatest amount concentrated in the six months of the growing season. The wettest months are June and July with about three to four inches, and the driest month is February with amounts of about one inch (Figure 8).

Of the average of 32 inches of precipitation, it is estimated that 70 to 80 percent is lost to evapotranspiration. Of the remaining precipitation water, part runs off and part becomes groundwater. Recharge of the shallow aquifer in most of the areas of the counties in which groundwater is used as the primary source of supply—Ozaukee, Walworth, Washington, and Waukesha Counties—is estimated to range from about three to six inches per year. Assuming an average of four inches per year of precipitation recharged to the groundwater system in the areas of the four counties concerned, that would equate to about 350 million gallons per day (mgd). The estimated daily

Figure 8

PRECIPITATION CHARACTERISTICS AT SELECTED LOCATIONS IN THE SOUTHEASTERN WISCONSIN REGION



Source: Wisconsin Statistical Reporting Service, National Climatic Data Center, and SEWRPC.

use of groundwater during 2005 in the areas of the four counties concerned was about 71 mgd. This indicates that on an average annual areawide basis, there is adequate recharge to satisfy the water supply demands on the shallow aquifer system of the areas concerned for years to come. However, the availability on a localized basis will vary depending upon usage, pumping system configuration, and groundwater flow patterns. The situation is different for the deep aquifers where withdrawals of groundwater cause supply-demand imbalance in areas of concentrated use of groundwater, resulting in a declining potentiometric surface and mining of groundwater. Further analyses of the availability and sustainability of the aquifers is provided in Chapter VIII.

Precipitation and snowfall data for six representative precipitation observation stations in southeastern Wisconsin located on the Lake Michigan shoreline at Port Washington, Milwaukee, and Kenosha and inland at West Bend, Waukesha, and Lake Geneva are presented in Table 20 and Figure 8. The long-term annual

Table 20

PRECIPITATION CHARACTERISTICS AT SELECTED LOCATIONS IN THE REGION

Month	Observation Station[a]												Regional Summary	
	Lakeshore Locations						Inland Locations							
	Port Washington		Milwaukee		Kenosha		West Bend		Waukesha[b]		Lake Geneva[c]			
	1940-2004	1894-2004[d]	1940-2004	1940-2004	1945-2004	1945-2004	1940-2004	1930-2004	1940-2004	1930-2004	1945-2003	1945-2003		
Month	Average Total Precipitation	Average Snow and Sleet	Average Total Precipitation	Average Snow and Sleet	Average Total Precipitation	Average Snow and Sleet	Average Total Precipitation	Average Snow and Sleet	Average Total Precipitation	Average Snow and Sleet	Average Total Precipitation	Average Snow and Sleet	Average Total Precipitation	Average Snow and Sleet
January	1.43	11.7	1.48	13.1	1.60	12.1	1.43	12.9	1.52	11.7	1.91	12.7	1.56	12.3
February	1.13	9.5	1.17	10.4	1.15	9.8	1.08	8.9	1.23	7.1	1.45	8.1	1.20	9.0
March	1.92	7.5	2.02	9.0	2.26	7.1	1.95	9.3	2.20	8.7	2.53	8.5	2.15	8.3
April	3.03	1.7	3.10	2.7	3.54	1.4	2.86	2.3	3.16	1.8	3.57	2.0	3.21	2.0
May	3.20	0.1	3.08	0.1	3.53	0.1	3.20	0.2	3.45	0.2	3.49	0.1	3.32	0.1
June	3.46	0.0	3.39	0.0	3.73	0.0	3.75	0.0	3.87	0.0	4.24	0.0	3.74	0.0
July	3.35	0.0	3.35	0.0	3.61	0.0	3.87	0.0	3.64	0.0	3.98	0.0	3.63	0.0
August	3.44	0.0	3.35	0.0	3.53	0.0	3.51	0.0	3.88	0.0	3.70	0.0	3.57	0.0
September	3.28	0.0	3.33	0.0	3.30	0.0	3.40	0.0	3.27	0.0	3.50	0.0	3.35	0.0
October	2.17	0.2	2.23	0.3	2.46	0.1	2.35	0.1	2.34	0.0	2.52	0.1	2.34	0.1
November	2.18	2.3	2.21	2.4	2.46	1.7	2.27	3.1	2.32	2.7	2.44	3.5	2.31	2.6
December	1.64	7.5	1.67	10.8	1.84	8.2	1.54	10.1	1.73	8.2	2.08	11.0	1.75	9.3
Yearly Average	30.24	40.2	31.83	48.6	33.01	39.6	31.21	46.7	33.08	40.4	34.63	45.9	32.21	43.6

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

[b] *Precipitation and snow and sleet data for Waukesha are not available for the period between 1988 and 1991.*

[c] *Data collection at the Lake Geneva observation station ended June, 2003.*

[d] *Snow and sleet data for Port Washington are based upon the periods 1894 to 1950 and 1960 to 1988; data are not available for the period 1951 to 1959.*

Source: National Climatic Data Center and SEWRPC.

precipitation and its departure from the long-term average for the stations located at Milwaukee and Waukesha are shown in Figure 9. One of the stations with the longest period of precipitation record is at Waukesha, which was initiated in 1897. These data, for the various observation stations, illustrate the temporal and spatial variations in the type and amount of precipitation that normally occur within the Region.

The precipitation data indicate that Lake Michigan does not have as pronounced an effect on precipitation within the Region as it does on temperature. A minor Lake Michigan effect is evident in a rainfall reduction of up to about 0.5 inch per month in late spring and summer in the eastern areas of the Region relative to the western areas. This may be attributable to cool lake waters maintaining a cooler lower atmosphere, which inhibits convective precipitation.

The influence of Lake Michigan as a source of moisture is reflected by slightly higher seasonal snowfalls for the entire Region relative to inland areas lying west of the Region. Minor intraregional spatial snowfall differences occur in that seasonal snowfall tends to be greatest in the topographically higher northwest portion of the Region because moisture masses moving through that area are forced up onto the higher terrain, where low temperatures normally associated with increased height induce more snowfall than that which would occur in the absence of topographic barrier.

Extreme precipitation data for southeastern Wisconsin, based on observations for stations located throughout the Region for the 135-year period from 1870 through 2004, are presented in Table 21. The minimum annual precipitation within southeastern Wisconsin, as determined from the tabulated data for the indicated observation period, occurred at Waukesha in 1901, when only 17.30 inches of precipitation occurred, or 54 percent of the average annual precipitation of 32.21 inches for southeastern Wisconsin (Table 22). The maximum annual precipitation within southeastern Wisconsin occurred at Milwaukee in 1876, when 50.36 inches of precipitation was recorded, equivalent to 156 percent of the average annual precipitation.

Even though southeastern Wisconsin is located in a humid climatic zone with plentiful precipitation, drought periods—defined as prolonged and abnormal moisture deficiencies—are quite common and may cause problems for agriculture and for water supplies within the Region by depleting soil moisture, lowering groundwater and lake levels, and reducing streamflow. If drought conditions are defined as 85 percent or less of normal annual precipitation, there were at least 10 drought years at all stations in the Region during the last 60 years (Table 22). The most serious droughts occurred in 1958, 1962, and 1963—below 75 percent of normal at most stations. The wettest year on record occurred in 2000, when rainfall exceeded 135 percent of normal precipitation at several stations (Table 22).

Snow Cover

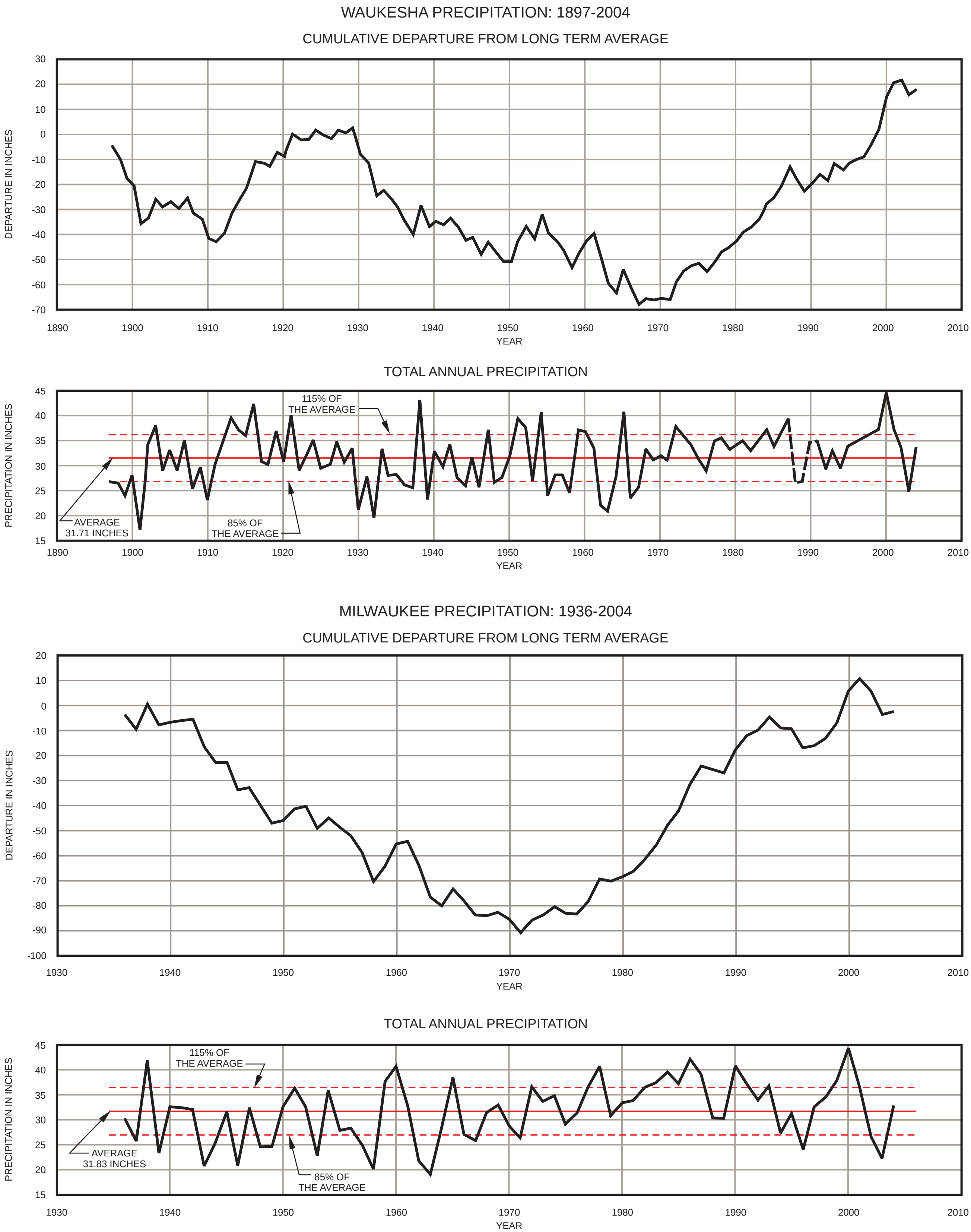
Snow depth as measured at Milwaukee for the 94-year period of 1900 through 1993 is summarized and presented in Table 23. It should be emphasized that the tabulated data pertain to snow depth on the ground as measured at the place and time of observation, and are not a direct measure of average snowfall. Recognizing that snowfall and temperatures, and therefore snow accumulation on the ground, vary spatially within the Region, the Milwaukee area data presented in Table 23 should be considered as an approximation of conditions that may be encountered in other parts of the Region. As indicated by the data, snow cover is most likely during months of December, January, and February, during which at least a 0.40 probability exists of having one inch or more of snow cover at Milwaukee.

Topographic and Physiographic Features

Glaciation has largely determined the physiography and topography of the Southeastern Wisconsin Region. Physiographic features or surficial landforms within the planning area have resulted from the underlying bedrock and the overlying glacial deposits of the watershed.

Figure 9

MILWAUKEE AND WAUKESHA ANNUAL PRECIPITATION DATA



Source: National Climatic Data Center, University of Wisconsin-Extension, Wisconsin Geological and Natural History Survey, and SEWRPC.

Table 21

EXTREME PRECIPITATION PERIODS IN SOUTHEASTERN WISCONSIN: SELECTED YEARS, 1870 THROUGH 2004

Observation Station		Period of Precipitation Records, Except Where Indicated Otherwise	Total Precipitation						
			Maximum Annual		Minimum Annual		Maximum Monthly		
Name	County		Amount	Year	Amount	Year	Amount	Month	Year
Mitchell Field	Milwaukee	1870-2004	50.36	1876	18.69	1901	10.03	June	1917
Racine	Racine	1895-2004	48.33	1954	17.75	1910	10.98	May	1933
Waukesha	Waukesha	1892-2004	44.73	2000	17.30	1901	11.41	July	1952
West Bend	Washington	1922-2004	41.43	1984	19.72	1901	13.14[a]	August	1924
West Allis[b]	Milwaukee	1954-2004	42.85	1960	17.49	1963	9.63	June	1954
Mt. Mary College	Milwaukee	1954-2004	42.26	2004	18.50	1963	10.17	June	1968

[a]*Based on the period 1895 through 1959 in* A Survey Report for Flood Control on the Milwaukee River and Tributaries*, U.S. Army corps of Engineers, Chicago District, November 1964.*

[b]*Based on the periods 1954 to 1987 and 1998 to 2004.*

Source: U.S. Army Corps of Engineers, National Weather Service, National Climatic Data Center, and SEWRPC.

The variation in elevation within the study area is shown on Map 12. Land slopes in the study area may be classified into three major groups: slight, 0 to 6 percent; moderate, 7 to 12 percent; and steep, greater than 12 percent. As shown on Map 13, approximately 81 percent of the Region is characterized as having slight slopes, 11 percent as having moderate slopes, and 8 percent as having steep slopes.

One of the dominant physiographic and topographic features within the study area is the Kettle Moraine, an interlobate glacial deposit or moraine, formed between the Green Bay and Lake Michigan lobes of the continental glacier that moved in a generally southerly direction from its origin in what is now Canada. The Kettle Moraine, which is oriented in a general northeast-southwest direction across the northwestern portion of the study area, is a complex system of hummocky sand and gravel. Some of its features include kames—crudely stratified conical hills; kettles—depressions that mark the site of buried glacial ice blocks that became separated from the ice mass and melted to form depressions; eskers—long, narrow ridges of drift deposited in tunnels of ice; and abandoned drainageways. The Kettle Moraine forms some of the most attractive and interesting landscapes within the Region. It is the location of the highest elevation in the Region, and the location of the greatest local elevation differences, or relief.

The remainder of the study area is covered by a variety of glacial landforms and features, including rolling landscapes of heterogeneous material deposited beneath the glacial ice; terminal moraines—consisting of material deposited at the forward margins of the ice sheet; lacustrine basins—former glacial lake sites; outwash plains formed by the action of flowing glacial meltwater; and drumlins—elongated teardrop shaped mounds of glacial deposits streamlined parallel to the flow of the glacier; and eskers.

Currently, natural surface drainage is poorly developed and very complex within the Region due to the effects of the relatively recent glaciation. The land surface is complex as a result of being covered by glacial deposits, containing thousands of closed—internally drained—depressions that range in size from potholes to large areas. Significant portions of the study area are covered by wetlands, and many streams are mere threads of water through these wetlands.

The drainage and groundwater recharge pattern of an area is a particularly important consideration in water supply planning. As already noted, the planning area is traversed by a subcontinental divide that separates the Great Lakes-St. Lawrence River drainage basin from the Mississippi River drainage basin. This divide has important

Table 22

COMPARISON OF THE TOP 10 DRIEST AND WETTEST YEARS RECORDED AT SELECTED NATIONAL WEATHER SERVICE LOCATIONS IN SOUTHEASTERN WISCONSIN: 1945 THROUGH 2004

	Driest Years								
	Kenosha (LTA = 33.17)			Lake Geneva (LTA = 35.50)			Milwaukee (LTA = 32.01)		
Year	Total Precipitation in Inches	Percent of Long-Term Average	Rank	Total Precipitation in Inches	Percent of Long-Term Average	Rank	Total Precipitation in Inches	Percent of Long-Term Average	Rank
1946	21.35	64.4	2	- -	- -	- -	20.89	65.3	3
1948	- -	- -	- -	27.82	78.4	10	24.62	76.9	8
1949	- -	- -	- -	- -	- -	- -	24.72	77.2	9
1950	- -	- -	- -	- -	- -	- -	- -	- -	- -
1953	25.76	77.7	10	24.76	69.8	3	22.87	71.4	6
1955	- -	- -	- -	25.89	72.9	6	- -	- -	- -
1956	23.25	70.1	5	21.17	59.6	1	- -	- -	- -
1957	- -	- -	- -	- -	- -	- -	24.95	77.9	10
1958	18.68	56.3	1	25.79	72.6	4	20.17	63.0	2
1962	23.11	69.7	4	23.91	67.4	2	21.91	68.4	4
1963	24.57	74.1	7	27.08	76.3	7	19.10	59.7	1
1966	- -	- -	- -	- -	- -	- -	- -	- -	- -
1967	- -	- -	- -	- -	- -	- -	- -	- -	- -
1969	- -	- -	- -	- -	- -	- -	- -	- -	- -
1975	25.07	75.6	8	- -	- -	- -	- -	- -	- -
1976	25.62	77.2	9	- -	- -	- -	- -	- -	- -
1988	- -	- -	- -	25.87	72.9	5	- -	- -	- -
1989	24.46	73.7	6	27.35	77.0	8	- -	- -	- -
1991	- -	- -	- -	- -	- -	- -	- -	- -	- -
1992	23.00	69.3	3		- -	- -	- -	- -	- -
1994	- -	- -	- -	27.52	77.5	9	- -	- -	- -
1996	- -	- -	- -	- -	- -	- -	24.12	75.4	7
2003	- -	- -	- -	- -	- -	- -	22.30	69.7	5

	Port Washington (LTA = 30.37)			Waukesha (LTA=32.55)			West Bend (LTA = 31.54)		
Year	Total Precipitation in Inches	Percent of Long-Term Average	Rank	Total Precipitation in Inches	Percent of Long-Term Average	Rank	Total Precipitation in Inches	Percent of Long-Term Average	Rank
1946	21.89	72.1	4	25.87	79.5	8	24.36	77.2	4
1948	- -	- -	- -	26.85	82.5	10	- -	- -	- -
1949	- -	- -	- -	- -	- -	- -	25.63	81.3	8
1950	24.21	79.7	8	- -	- -	- -	- -	- -	- -
1953	23.59	77.7	7	- -	- -	- -	24.44	77.5	5
1955	- -	- -	- -	24.58	75.5	5	25.25	80.1	7
1956	- -	- -	- -	- -	- -	- -	- -	- -	- -
1957	23.52	77.4	6	- -	- -	- -	- -	- -	- -
1958	22.85	75.2	5	24.77	76.1	6	21.22	67.3	1
1962	21.75	71.6	3	22.29	68.5	3	22.72	72.0	3
1963	19.70	64.9	1	21.36	65.6	1	22.62	71.7	2
1966	- -	- -	- -	23.88	73.4	4	- -	- -	- -
1967	24.99	82.3	10	26.10	80.2	9	- -	- -	- -
1969	24.40	80.3	9	- -	- -	- -	25.67	81.4	9
1975	- -	- -	- -	- -	- -	- -	- -	- -	- -
1976	21.51	70.8	2	- -	- -	- -	24.63	78.1	6
1988	- -	- -	- -	- -	- -	- -	- -	- -	- -
1989	- -	- -	- -	- -	- -	- -	- -	- -	- -
1991	- -	- -	- -	22.08	67.8	2	- -	- -	- -
1992	- -	- -	- -	- -	- -	- -	26.15	82.9	10
1994	- -	- -	- -	- -	- -	- -	- -	- -	- -
1996	- -	- -	- -	- -	- -	- -	- -	- -	- -
2003	- -	- -	- -	24.91	76.5	7	- -	- -	- -

NOTE: LTA indicates long-term average over period of analysis.

Table 22 (continued)

Year	Wettest Years								
	Kenosha (LTA = 33.17)			Lake Geneva (LTA = 35.50)			Milwaukee (LTA = 32.01)		
	Total Precipitation in Inches	Percent of Long-Term Average	Rank	Total Precipitation in Inches	Percent of Long-Term Average	Rank	Total Precipitation in Inches	Percent of Long-Term Average	Rank
1951	- -	- -	- -	42.89	120.8	8	- -	- -	- -
1952	- -	- -	- -	- -	- -	- -	- -	- -	- -
1954	41.84	126.1	5	43.20	121.7	7	41.84	103.7	3
1959	41.75	125.9	6	45.17	127.2	4	37.68	117.7	10
1960	- -	- -	- -	- -	- -	- -	40.71	127.2	5
1965	43.76	131.9	4	47.00	132.4	2	38.49	120.2	8
1972	46.12	139.0	2	49.97	140.8	1	- -	- -	- -
1973	- -	- -	- -	42.54	119.8	9	- -	- -	- -
1977	- -	- -	- -	- -	- -	- -	- -	- -	- -
1978	- -	- -	- -	43.57	122.7	6	40.74	127.3	4
1979	- -	- -	- -	41.42	116.7	10	- -	- -	- -
1982	- -	- -	- -	46.42	130.8	3	- -	- -	- -
1984	- -	- -	- -	- -	- -	- -	39.87	124.6	7
1985	41.06	123.8	7	- -	- -	- -	- -	- -	- -
1986	- -	- -	- -	- -	- -	- -	42.17	131.7	2
1987	45.34	136.7	3	- -	- -	- -	39.14	122.3	9
1990	40.81	123.0	8	- -	- -	- -	40.86	127.6	4
1993	40.70	122.7	9	- -	- -	- -	- -	- -	- -
1996	- -	- -	- -	- -	- -	- -	- -	- -	- -
1998	- -	- -	- -	- -	- -	- -	- -	- -	- -
1999	40.45	121.9	10	- -	- -	- -	40.45	126.4	6
2000	46.99	141.7	1	44.52	125.4	5	44.37	138.6	1
2001	- -	- -	- -	- -	- -	- -	- -	- -	- -
2004	- -	- -	- -	- -	- -	- -	- -	- -	- -

Year	Port Washington (LTA = 30.37)			Waukesha (LTA=32.55)			West Bend (LTA = 31.54)		
	Total Precipitation in Inches	Percent of Long-Term Average	Rank	Total Precipitation in Inches	Percent of Long-Term Average	Rank	Total Precipitation in Inches	Percent of Long-Term Average	Rank
1951	37.60	123.8	5	39.69	121.9	4	- -	- -	- -
1952	- -	- -	- -	38.00	116.7	7	- -	- -	- -
1954	- -	- -	- -	40.73	125.1	3	37.04	117.4	8
1959	- -	- -	- -	37.47	115.1	9	- -	- -	- -
1960	37.50	123.5	6	- -	- -	- -	- -	- -	- -
1965	39.27	129.3	3	40.96	125.8	2	37.64	119.3	5
1972	- -	- -	- -	38.41	118.0	5	37.74	119.7	4
1973	- -	- -	- -	- -	- -	- -	37.22	118.0	6
1977	- -	- -	- -	- -	- -	- -	36.90	117.0	9
1978	37.34	123.0	8	- -	- -	- -	- -	- -	- -
1979	- -	- -	- -	- -	- -	- -	- -	- -	- -
1982	- -	- -	- -	- -	- -	- -	- -	- -	- -
1984	- -	- -	- -	37.50	115.2	8	41.43	131.4	1
1985	45.24	149.0	1	- -	- -	- -	38.59	122.4	2
1986	- -	- -	- -	- -	- -	- -	- -	- -	- -
1987	37.38	123.1	7	- -	- -	- -	- -	- -	- -
1990	- -	- -	- -	- -	- -	- -	- -	- -	- -
1993	- -	- -	- -	38.02	116.8	6	- -	- -	- -
1996	37.81	124.5	4	- -	- -	- -	- -	- -	- -
1998	- -	- -	- -	- -	- -	- -	- -	- -	- -
1999	35.82	117.9	10	- -	- -	- -	38.00	120.5	3
2000	41.93	138.1	2	44.73	137.4	1	36.65	116.2	10
2001	- -	- -	- -	37.32	114.7	10	- -	- -	- -
2004	36.82	121.2	9	- -	- -	- -	37.18	117.9	7

NOTE: LTA indicates long-term average over period of analysis.

Source: National Climatic Data Center and SEWRPC.

Table 23

SNOW COVER PROBABILITIES AT MILWAUKEE BASED ON DATA FOR 1900 THROUGH 1993

	Snow Cover[a]									
	1.0 inch or more		5.0 inches or more		10.0 inches or more		15.0 inches or more		Average (inches)	
Month and Day	Number of Occurrences[b]	Probability of Occurrences[c]	Number of Occurrences[b]	Probability of Occurrences[c]	Number of Occurrences[b]	Probability of Occurrences[c]	Number of Occurrences[b]	Probability of Occurrences[c]	Per Occurrence[d]	Overall[e]
November 15	5	0.05	0	0.00	0	0.00	0	0.00	1.3	0.1
November 30	16	0.17	2	0.02	1	0.01	0	0.00	2.9	0.5
December 15	41	0.44	14	0.15	0	0.00	0	0.00	3.5	1.5
December 31	48	0.51	14	0.15	2	0.02	0	0.00	3.6	1.9
January 15	59	0.63	30	0.32	6	0.06	4	0.04	5.6	3.3
January 31	64	0.68	30	0.32	13	0.14	5	0.05	6.3	4.3
February 15	63	0.67	33	0.35	12	0.13	5	0.05	6.2	4.1
February 28	37	0.39	12	0.13	4	0.04	1	0.01	4.4	1.2
March 15	29	0.31	9	0.10	4	0.04	0	0.00	3.8	1.2
March 31	8	0.09	1	0.01	1	0.01	0	0.00	2.7	0.2

[a]*Data pertain to snow depth on the ground as it was measured at the time and place of observation and are not direct measures of average snowfall.*

[b]*Number of occurrences is the number of times during the period of record when measurements revealed that the indicated snow depth was reached or exceeded on the indicated date.*

[c]*Probability of occurrence for a given snow depth and date is computed by dividing the number of occurrences by 94, the number or years recorded, and is defined as the probability that the indicated snow cover will be reached or exceeded on the indicated date.*

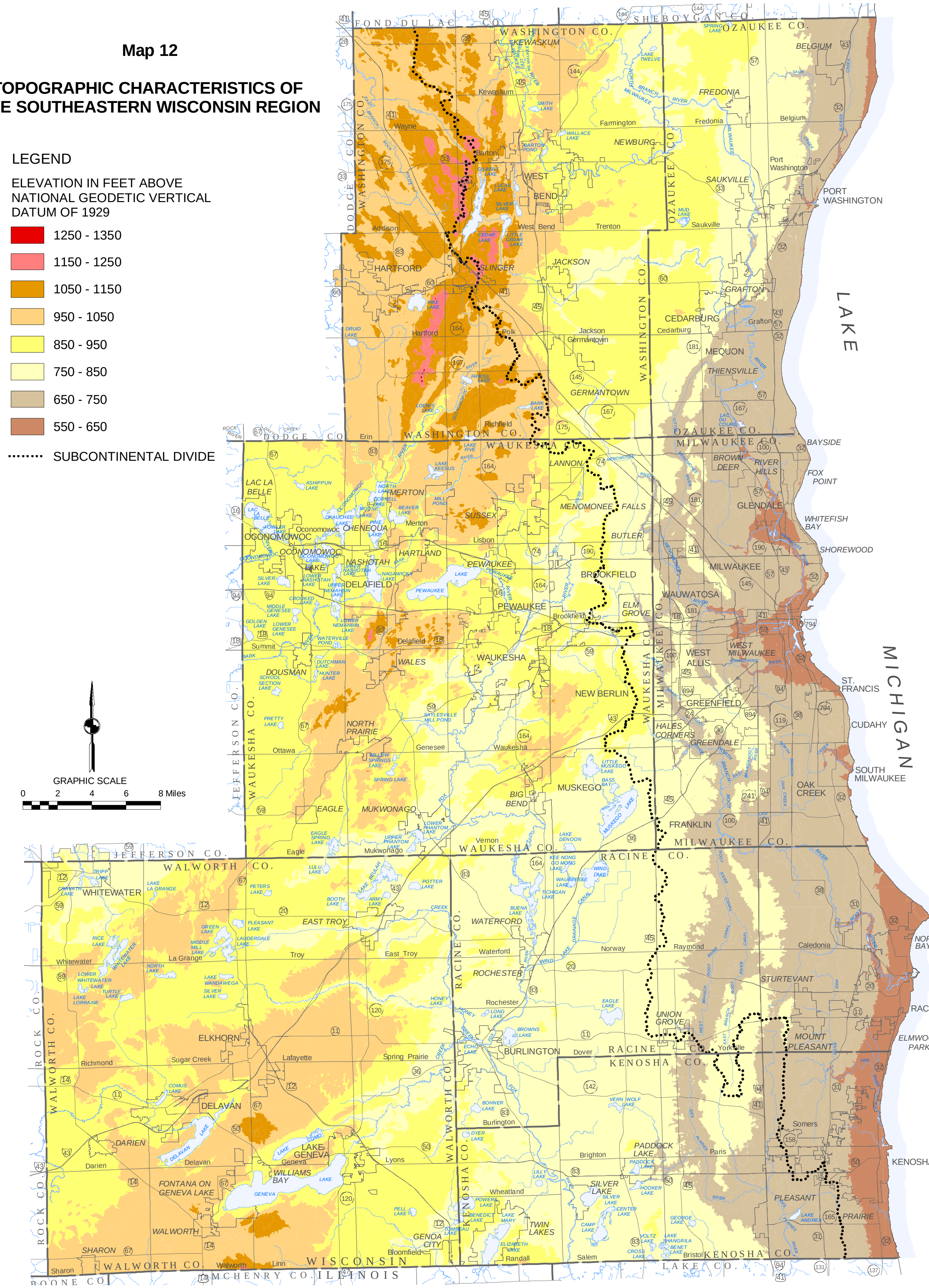
[d]*Average snow cover per occurrence is defined as the sum of all snow cover measurements in inches for the indicated date divided by the number of occurrences for that date, that is, the number of occurrences in which 1.0 inch or more of snow cover was recorded.*

[e]*Overall average snow cover is defined as the sum of all snow cover measurements in inches for the indicated date divided by 94, that is, the number of observation times.*

Source: U.S. Department of Commerce, National Climatic Data Center, and SEWRPC.

Map 12

TOPOGRAPHIC CHARACTERISTICS OF THE SOUTHEASTERN WISCONSIN REGION



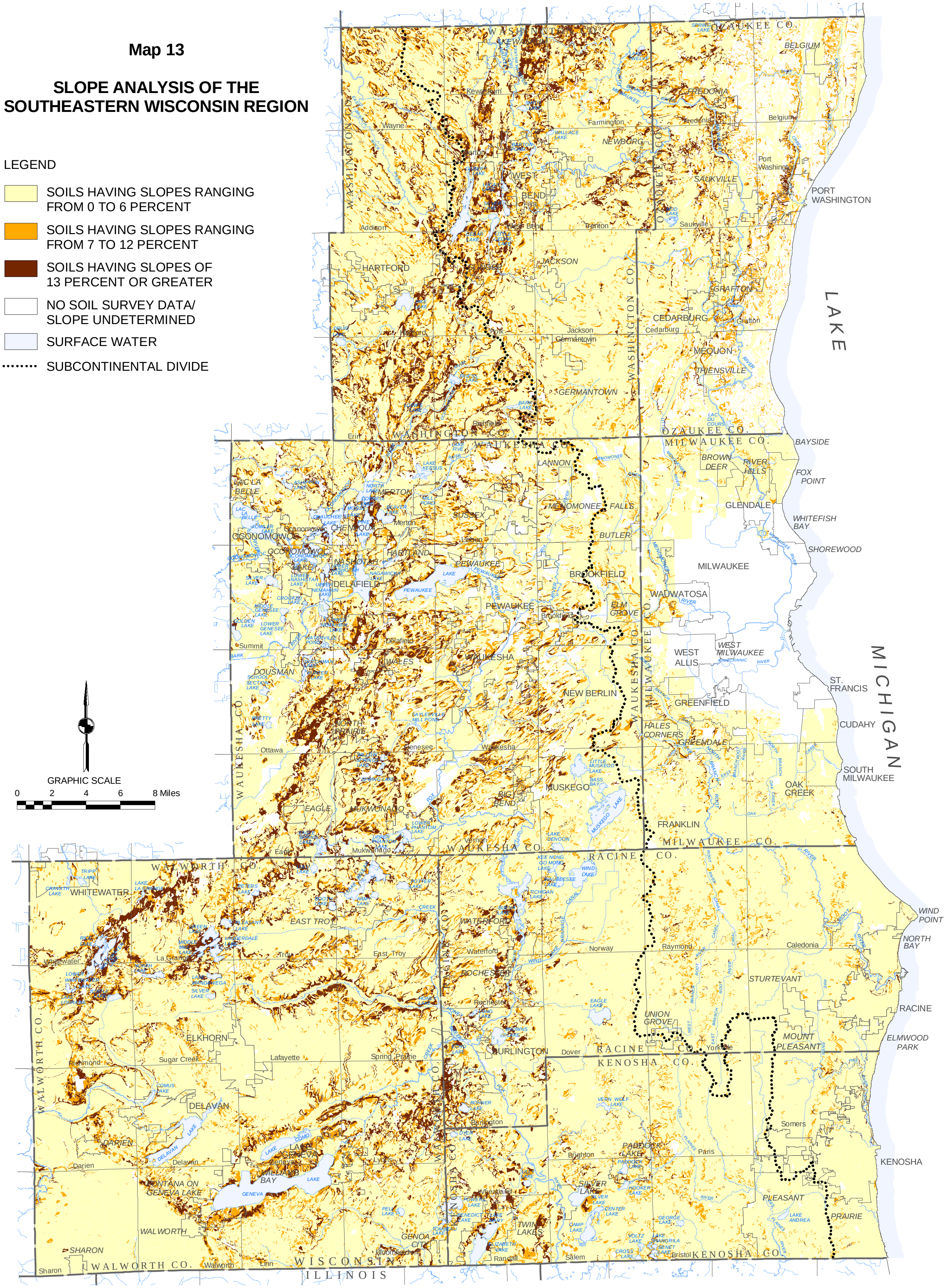
Source: SEWRPC.

Map 13

SLOPE ANALYSIS OF THE SOUTHEASTERN WISCONSIN REGION

LEGEND

- SOILS HAVING SLOPES RANGING FROM 0 TO 6 PERCENT
- SOILS HAVING SLOPES RANGING FROM 7 TO 12 PERCENT
- SOILS HAVING SLOPES OF 13 PERCENT OR GREATER
- NO SOIL SURVEY DATA/ SLOPE UNDETERMINED
- SURFACE WATER
- SUBCONTINENTAL DIVIDE



Source: SEWRPC.

implications for water supply, sanitary sewerage, and stormwater management system planning in that any diversion of Lake water across this divide is legally constrained. The divide is, thus, a major determinant of the configuration of the water supply, sanitary sewerage, and stormwater management systems serving the study area.

Drainage basins and recharge area determination can best be made based upon analyses of large-scale topographic maps, existing stormwater infrastructure configurations, and of public street locations, configurations, and grades. As of the end of 2004, large-scale topographic maps had been or were being prepared to Commission-recommended standards for about 2,181 square miles, or about 81 percent of the total area of the study area. These maps were prepared under cooperative programs involving the Commission, its constituent counties and a number of constituent municipalities, administered by the Commission, and sometimes partially funded by Federal and State agencies. In some cases, the large-scale topographic mapping program include acquisition of digital terrain model files.

Soils

The nature of the soils within the Southeastern Wisconsin Region has been determined primarily by the interaction between the parent glacial deposits covering southeastern Wisconsin and the topography, climate, plants, animals, and time. The soils of southeastern Wisconsin have developed over the past approximately 10,000 years, which in a geologic sense, is a relatively short period of time. Soils usually comprise only the upper two to four feet of unconsolidated materials at the earth's surface. Soils are the basis of agricultural production, provide the foundation for buildings and roads, and if properly used, aid in the treatment and recycling of wastewater from land uses served by onsite sewage treatment and disposal facilities. Soil characteristics, particularly depth, texture, and permeability, are significant factors in determining the rate and extent of groundwater recharge and the degree of natural protection against groundwater contamination. Land characteristics, such as slope, vegetation type, and type of rock or unconsolidated material will, in conjunction with the soil, determine the overall potential of the environment to protect and sustain the groundwater resources of the area.

In order to assess the significance of these soil types to sound regional development, the Commission in 1963 undertook, in cooperation with the then U.S. Soil Conservation Service (now the U.S. Natural Resources Conservation Service), the completion of a detailed soil survey of the entire Region. The survey was completed in 1965 and results were published in SEWRPC Planning Report No. 8, *Soils of Southeastern Wisconsin*, June 1966. The regional soil survey not only has resulted in the mapping of soils within the Region in great detail and provided data on the physical, chemical, and biological properties of the soils, but also has provided interpretations of the soil properties for planning, engineering, agricultural, and resource conservation purposes.

Map 14 shows the hydrologic soil groups within the Region. Soils within the Region have been categorized into four main hydrologic groups. Soils that could not be so categorized were included in an "other" group. About 9 percent of the Region is covered by well-drained soils, about 54 percent by moderately drained soils, about 29 percent by poorly drained soils, and about 2 percent by very poorly drained soils. About 6 percent of the Region is covered by disturbed soils that could not be classified.

The soil is an integral part of the natural protection of groundwater from surface-applied contaminants. Attenuation of pollutants is a complex process. During attenuation, the soil holds essential plant nutrients for uptake by agronomic crops; immobilizes metals that might be contained in municipal sewage sludge; and removes parasites, bacteria, and viruses contained in animal or human wastes. However, the natural pollutant attenuation capacity of the soil is limited. Sometimes soils that retain pollutants become contaminated. Cleaning contaminated soil can be as difficult and costly as cleaning contaminated groundwater.

In the conduct of the Commission regional groundwater resources inventory,[12] for southeastern Wisconsin, a unique classification system was used by the Wisconsin Geological and Natural History Survey to categorize

[12]*SEWRPC Technical Report No. 37*, Groundwater Resources of Southeastern Wisconsin, *June 2002.*

Map 14

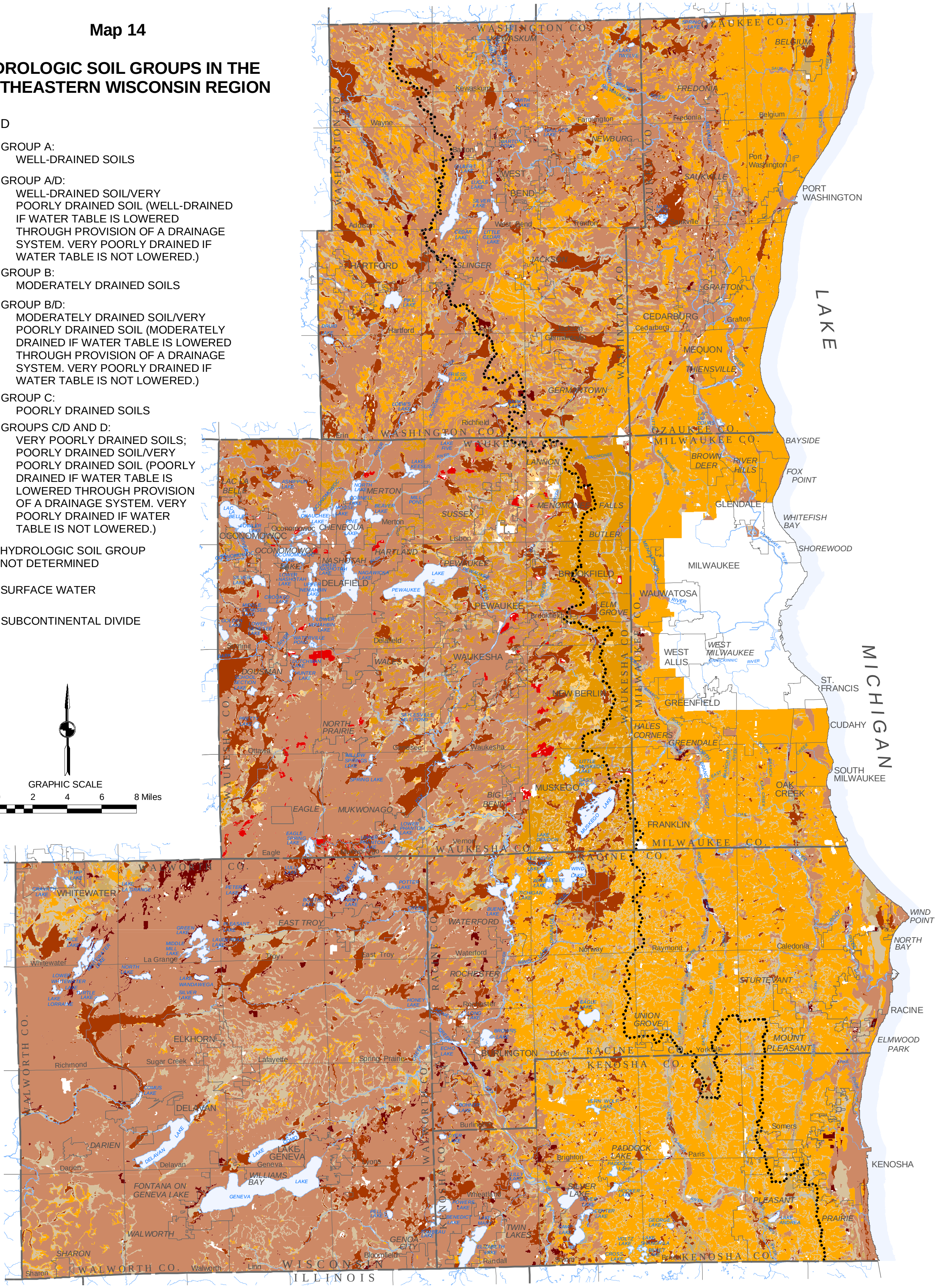
HYDROLOGIC SOIL GROUPS IN THE SOUTHEASTERN WISCONSIN REGION

LEGEND

- GROUP A: WELL-DRAINED SOILS
- GROUP A/D: WELL-DRAINED SOIL/VERY POORLY DRAINED SOIL (WELL-DRAINED IF WATER TABLE IS LOWERED THROUGH PROVISION OF A DRAINAGE SYSTEM. VERY POORLY DRAINED IF WATER TABLE IS NOT LOWERED.)
- GROUP B: MODERATELY DRAINED SOILS
- GROUP B/D: MODERATELY DRAINED SOIL/VERY POORLY DRAINED SOIL (MODERATELY DRAINED IF WATER TABLE IS LOWERED THROUGH PROVISION OF A DRAINAGE SYSTEM. VERY POORLY DRAINED IF WATER TABLE IS NOT LOWERED.)
- GROUP C: POORLY DRAINED SOILS
- GROUPS C/D AND D: VERY POORLY DRAINED SOILS; POORLY DRAINED SOIL/VERY POORLY DRAINED SOIL (POORLY DRAINED IF WATER TABLE IS LOWERED THROUGH PROVISION OF A DRAINAGE SYSTEM. VERY POORLY DRAINED IF WATER TABLE IS NOT LOWERED.)
- HYDROLOGIC SOIL GROUP NOT DETERMINED
- SURFACE WATER
- SUBCONTINENTAL DIVIDE

GRAPHIC SCALE

0 2 4 6 8 Miles



Source: SEWRPC.

areas of the Region with regard to the potential vulnerability to groundwater contamination. That system was based upon consideration of a number of factors, including: the characteristics of the sod layer (see Map 15); of the unsaturated zone materials below the soil layer; and of the aquifer, including the depth below the land surface. The regional inventory includes mapping illustrating the shallow aquifer groundwater contamination potential in the Region based upon these factors.

Glacial Deposits and Bedrock Geology

The surficial geology of southeastern Wisconsin was greatly influenced by the Wisconsin age continental glaciation, especially the last advances of ice about 10,000 years ago. Advances of ice sheets out of the Great Lakes basins during the Pleistocene glaciations, of which the Wisconsin age glaciation was the latest, have sculpted the bedrock and the land surface, leaving characteristic landforms and depositing unlithified sediments. These sediments—till, outwash, and glaciolacustrine deposits—blanket the bedrock surface underlying the Region to depths of as much as several hundred feet and are important in understanding regional hydrogeology. Groundwater in the shallow, water table aquifer and in the deep, confined aquifer originally infiltrated from the surface through these unlithified sediments.

The characteristic glacial landforms in southeastern Wisconsin and their associated deposits were created by two lobes of the Wisconsin ice sheet: the Green Bay Lobe, which advanced from the northwest, and the Lake Michigan Lobe, which advanced from the east in this region. Until about 10,000 years ago, ice in these lobes advanced and melted back repeatedly, in response to climate fluctuations. At the location of farthest advance of the ice sheets, and other locations where the ice margin was stationary for some time, deposits accumulated in ridges called moraines. These moraines are the major topographic features in southeastern Wisconsin. A region of hummocky topography, the Kettle Moraine area of the Region, was formed where ice of the Green Bay and Lake Michigan Lobes met.

The advances of the ice lobes over uneven bedrock topography, and the landforms they created, resulted in a wide range in the thickness of glacial deposits covering the bedrock. This thickness, represented as depth to bedrock on Map 16, ranges from zero to more than 500 feet and is commonly between 50 and 150 feet. Areas where outcrops occur and where bedrock is less than 25 feet deep are often found along an irregular buried bedrock ridge, a continuation of a prominent geologic feature of eastern Wisconsin called the Silurian escarpment. This ridge passes through southeastern Wisconsin from eastern Washington County southwest through the middle of Waukesha County. It is deeply dissected by buried preglacial bedrock valleys.

The inventory data herein presented is based upon the Commission inventories presented in SEWRPC Technical Report No. 37, *Groundwater Resources of Southeastern Wisconsin*, June 2002. More detail and referenced sources for the inventory information can be found in that report.

Glacial Deposits

Three major types of sediment were deposited during the Wisconsin Glaciation: till, outwash, and glaciolacustrine deposits. Till, which constitutes much of the surface material in glaciated areas and is thickest in moraines, generally consists of very poorly sorted sandy or clay and silt containing cobbles and boulders. Till units were deposited directly from the ice sheet as it advanced or retreated, and their exact composition is characteristic of the particular ice lobe or advance. They typically exhibit moderate to low permeability, and surface water infiltrates slowly through them to the water table.

Another type of deposit, called outwash, consists mainly of sand and gravel with varying amounts of silt and clay. This deposit originated from the ice but was transported away from the ice margin by meltwater and is therefore well sorted and stratified. In addition to filling deep bedrock valleys as the ice retreated, outwash often constitutes the core of drumlins and separates layers of till deposited by different ice advances. Outwash is typically highly permeable, and surface water infiltrates rapidly through it to the water table.

Map 15

CONTAMINATION ATTENUATION POTENTIAL OF THE SOILS IN THE SOUTHEASTERN WISCONSIN REGION

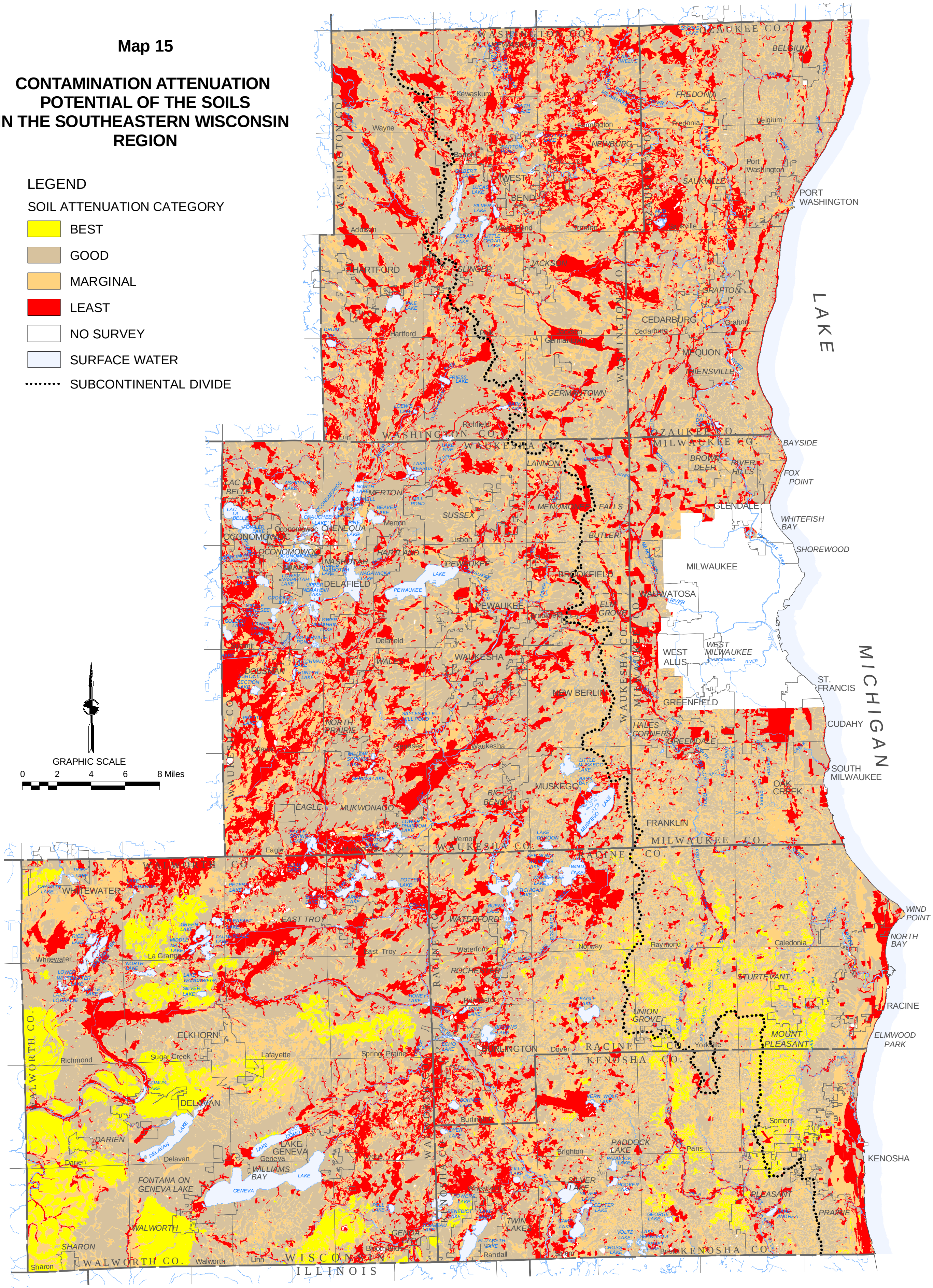
LEGEND

SOIL ATTENUATION CATEGORY

- BEST
- GOOD
- MARGINAL
- LEAST
- NO SURVEY
- SURFACE WATER
- SUBCONTINENTAL DIVIDE

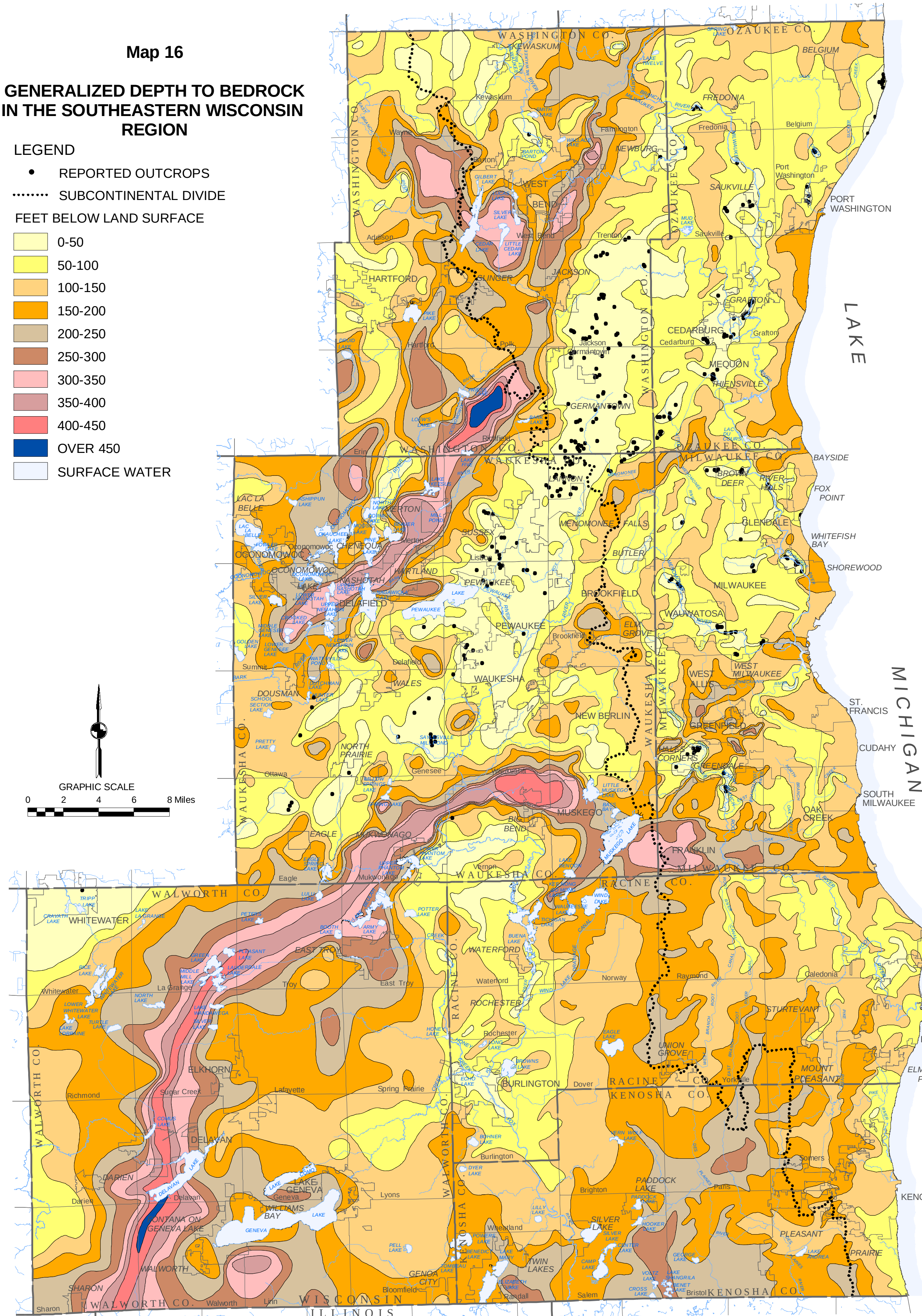
GRAPHIC SCALE

0 2 4 6 8 Miles



Map 16

GENERALIZED DEPTH TO BEDROCK IN THE SOUTHEASTERN WISCONSIN REGION



Source: University of Wisconsin-Extension, Wisconsin Geological and Natural History Survey, and SEWRPC.

The third major type of glacial sediment, glaciolacustrine deposits, were deposited in meltwater lakes formed in front of the retreating ice sheet. Some of these lakes remained to form the large inland lakes of southeastern Wisconsin. In addition to the inland glacial lakes, very large lakes filled the present basin of Lake Michigan at different times, and left deposits at different levels, up to 60 feet above the modern lake level. The glaciolacustrine units have a wide range of sediment characteristics, from laminated clays to stratified silty sands, and tend to have values of permeability ranging between those of till and outwash. They are often found at the land surface, associated with peat deposits, or between till sheets deposited by different ice advances, and commonly interfinger with the other types of sediment.

The Pleistocene deposits in the Region consist of a complex sequence of deposits differing in origin, age, lithology, thickness, and areal extent. The hydrogeologic properties of the Pleistocene materials are critical to the study of groundwater resources on a regional basis. Recharge to the water table, and eventually, the deep confined aquifer percolates through the unsaturated zone at various rates depending on the vertical permeability of the Pleistocene materials. Any contaminants spilled on the ground surface that move through the soil zone will percolate down to the water table at roughly the same rates as water. Mapped Pleistocene units can therefore be regrouped according to their lithology and estimated permeability for the purposes of assessing the vulnerability to groundwater to contamination.

The hydrogeologic properties of the Pleistocene materials, as well as the methods used to determine those properties, are described in the aforecited SEWRPC Technical Report No. 37. Coarse-grained deposits like sand and gravel are the most permeable units found within the Region, so all outwash deposits are considered high permeability units. Sandy till units and lacustrine sediments are generally fine-grained and less permeable, so they are considered moderate permeability units. Very silty and clayey till deposits are the least permeable units found within the Region, and they are considered low permeability units. In addition to Pleistocene units mapped at the land surface, subsurface information such as cross-sections and boring logs were used to estimate the vertical permeability of the unsaturated zone.

Bedrock Geology

Knowledge of bedrock geology is important to land use, transportation, and other public facility and utility, as well as water supply system planning. Bedrock geology is an important factor in the assessment of groundwater availability, of the quality of groundwater, and of the potential for groundwater contamination. The bedrock of southeastern Wisconsin may be separated into two major divisions: younger, relatively flat-lying sedimentary rocks of Paleozoic age; and older, predominantly crystalline rocks of Precambrian age (Table 24).

The Paleozoic rocks are of primary importance to understanding the water resources of southeastern Wisconsin because they form major aquifers that comprise the municipal and industrial groundwater supplies within the Region. They consist of a sequence of sedimentary rocks—dolomite, shale, and sandstone—that range from Cambrian to Devonian in age (Table 24). The Paleozoic rocks are nearly flat-lying, but dip gently to the east from the Wisconsin Arch into the Michigan Basin, and thicken significantly from west to east. An older basement of Precambrian crystalline rock, primarily granite and quartzite, underlies the Paleozoic sedimentary sequence. The distribution of the major stratigraphic units is shown on Map 17.

Devonian strata, the youngest Paleozoic rock in Wisconsin, are present only along a narrow band parallel to the Lake Michigan shoreline from Milwaukee to the north. They constitute the westernmost occurrence of Devonian strata in the Michigan Basin. The Silurian dolomites are at the bedrock surface throughout most of the Region. The Ordovician age Maquoketa shale formation and Sinnipee age dolomite formation underlie the western edge of the Region (Map 17). The remaining Ordovician rock units, the St. Peter formation, the Prairie du Chien group, and the Cambrian sandstone sequence are not exposed at the bedrock surface, but are encountered in deep wells throughout the Region.

Table 24

GEOLOGIC COLUMN FOR BEDROCK AND GLACIAL DEPOSITS IN SOUTHEASTERN WISCONSIN

Geologic Time	Rock Unit		Lithologic Description
QUATERNARY			
Recent	Undifferentiated		Soil, muck, peat, alluvium, colluvium, beach sediment
Pleistocene (all units include lake and stream sediment in addition to till)	Kewaunee Formation		Brown to reddish-brown, silty and clayey till
	Horicon Formation		Coarser, brown, sandy till with associated sand and gravel
	Oak Creek Formation		Fine-textured, gray clayey till; lacustrine clay, silt, and sand
	New Berlin Formation		Upper: medium-textured. gravelly sandy till; Lower: outwash sand and gravel
	Zenda Formation		Medium-textured, pink, sandy till; limited distribution
PALEOZOIC			
Devonian	Antrim Formation		Gray, silty shale; thin; limited distribution
	Milwaukee Formation		Shaly dolomite and dolomitic siltstone
	Thiensville Formation		Dolomite and shaly dolomite
Upper Silurian	Waubakee Formation		Dense, thin-bedded, gray, slightly shaly dolomite
	Racine Formation		Finely crystalline dolomite; locally shaly beds and dolomite reefs
	Waukesha Formation		Cherty, white to buff, medium bedded, shaly dolomite
	Brandon Bridge beds		Pink to green shaly dolomite with shaly beds
	Lower Silurian beds (undifferentiated)		Dolomite and shaly dolomite
Ordovician	Neda Formation		Brown hematitic shale and oolite; occurs sporadically
	Maquoketa Formation		Green to gray dolomitic shale; locally layers of dolomite, fossiliferous
	Sinnipee Group	Galena Formation	Cherty dolomite with shaly dolomite at the base
		Decorah Formation	Shaly dolomite with fossils; thin or absent
		Platteville Formation	Dolomite and shaly dolomite
	Ancell Group	Glenwood Formation	Blue to green shale or sandy dolomite; thin or absent
		St. Peter Formation	Predominantly medium-grained quartz sandstone
	Prairie du Chien Group	Shakopee Formation	Light gray to tan dolomite or dolomitic sandstone; locally absent
		Oneota Formation	Massive, light gray to tan, cherty, sandy dolomite; locally absent
Cambrian	Trempealeau Group	Jordan Formation	Fine- to medium-grained quartz sandstone; locally absent
		St. Lawrence Formation	Tan to pink silty dolomite; locally absent
	Tunnel City Group		Fine- to medium-grained sandstone and dolomitic sandstone; locally absent
	Elk Mound Group	Wonewoc Formation	Medium- to coarse-grained, tan to white, quartz sandstone
		Eau Claire Formation	Fine- to medium-grained sandstone; local beds of green shale
		Mt. Simon Formation	Coarse- to medium-grained sandstone; lower beds very coarse and pebbly
PRECAMBRIAN	Undifferentiated		Granite or quartzite

Source: University of Wisconsin-Extension and Wisconsin Geological Natural History Survey.

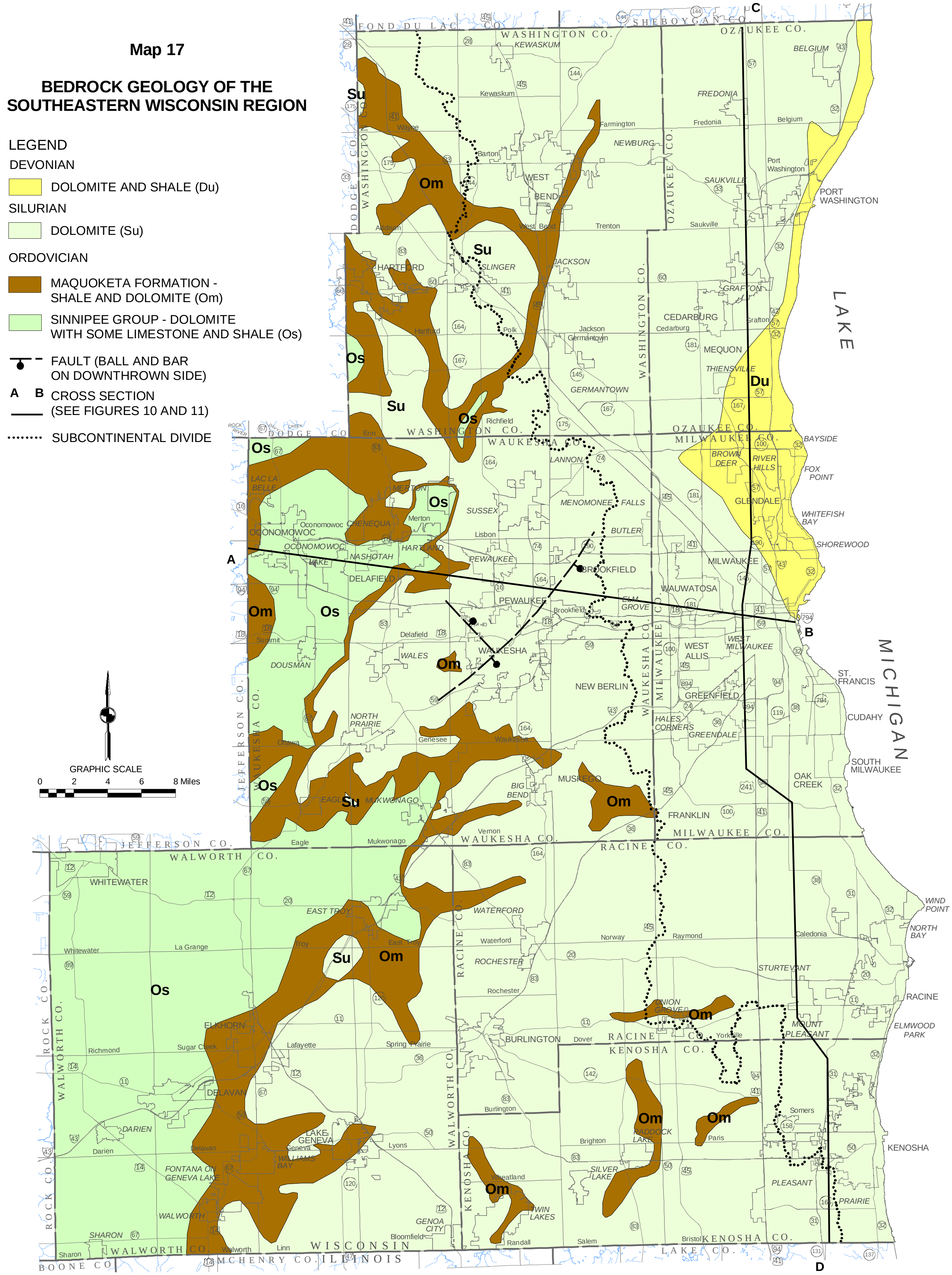
Structural Geology

The area of southeastern Wisconsin has remained largely tectonically inactive for geological ages and structural deformations are, therefore, minimal. The cross-sections provided in Figures 10 and 11 show diagrammatically the stratigraphic formations and their regional dip, and the regional dip of the Precambrian surface. The cross-section lines are shown on Map 17.

Faults shown on the cross-sections are inferred from the differences in elevation of formation boundaries, both in wells shown on the sections presented in Figures 10 and 11 and by comparison with wells located within the several miles of the sections. There are no known wells that actually cross a fault trace. Because most large faults

Map 17

BEDROCK GEOLOGY OF THE SOUTHEASTERN WISCONSIN REGION

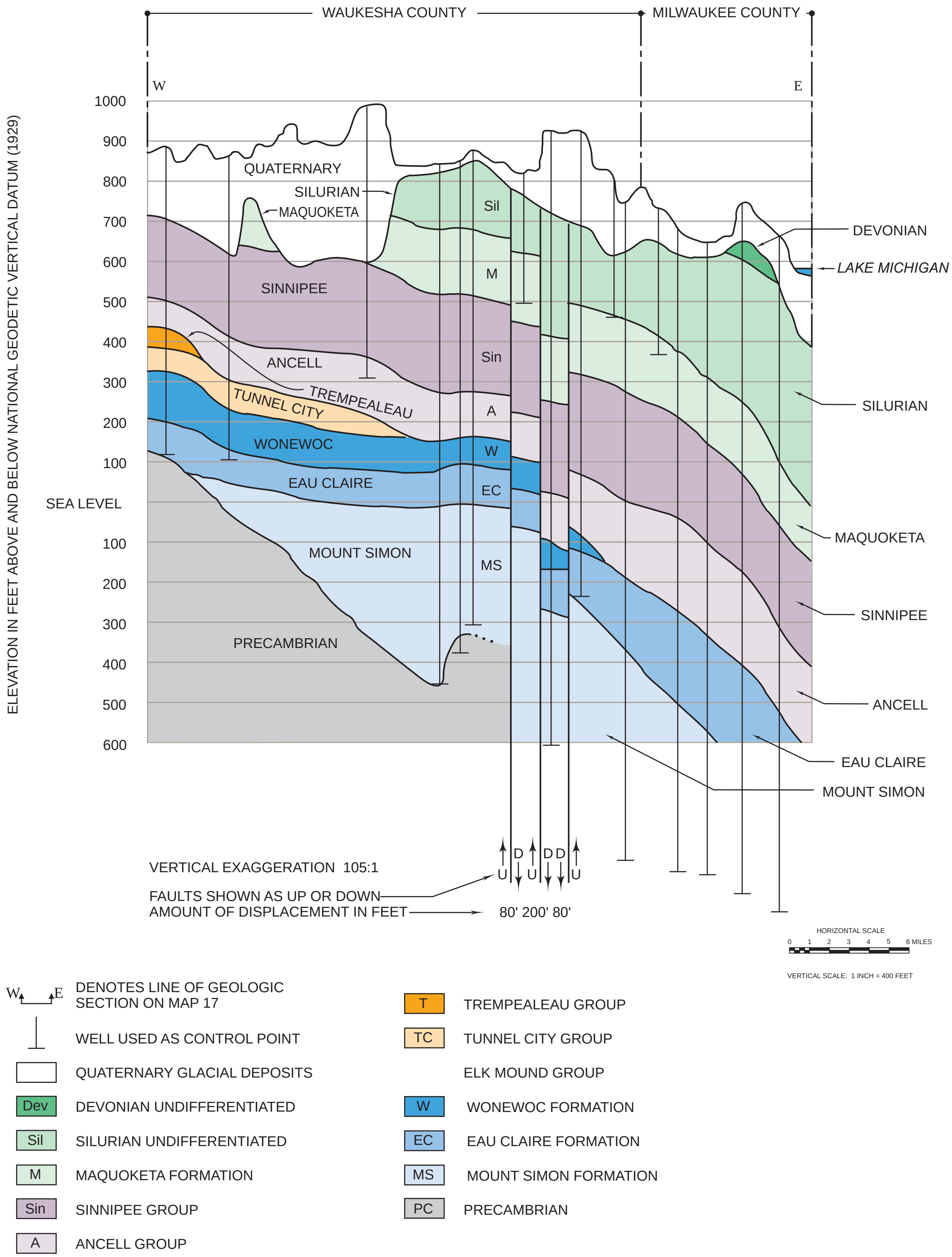


Source: Mudrey, Brown, and Greenberg, 1982, and Wisconsin Geological and Natural History Survey.

Figure 10

GEOLOGIC CROSS-SECTION OF THE SOUTHEASTERN WISCONSIN REGION, WEST TO EAST

CROSS SECTION AB ON MAP 17

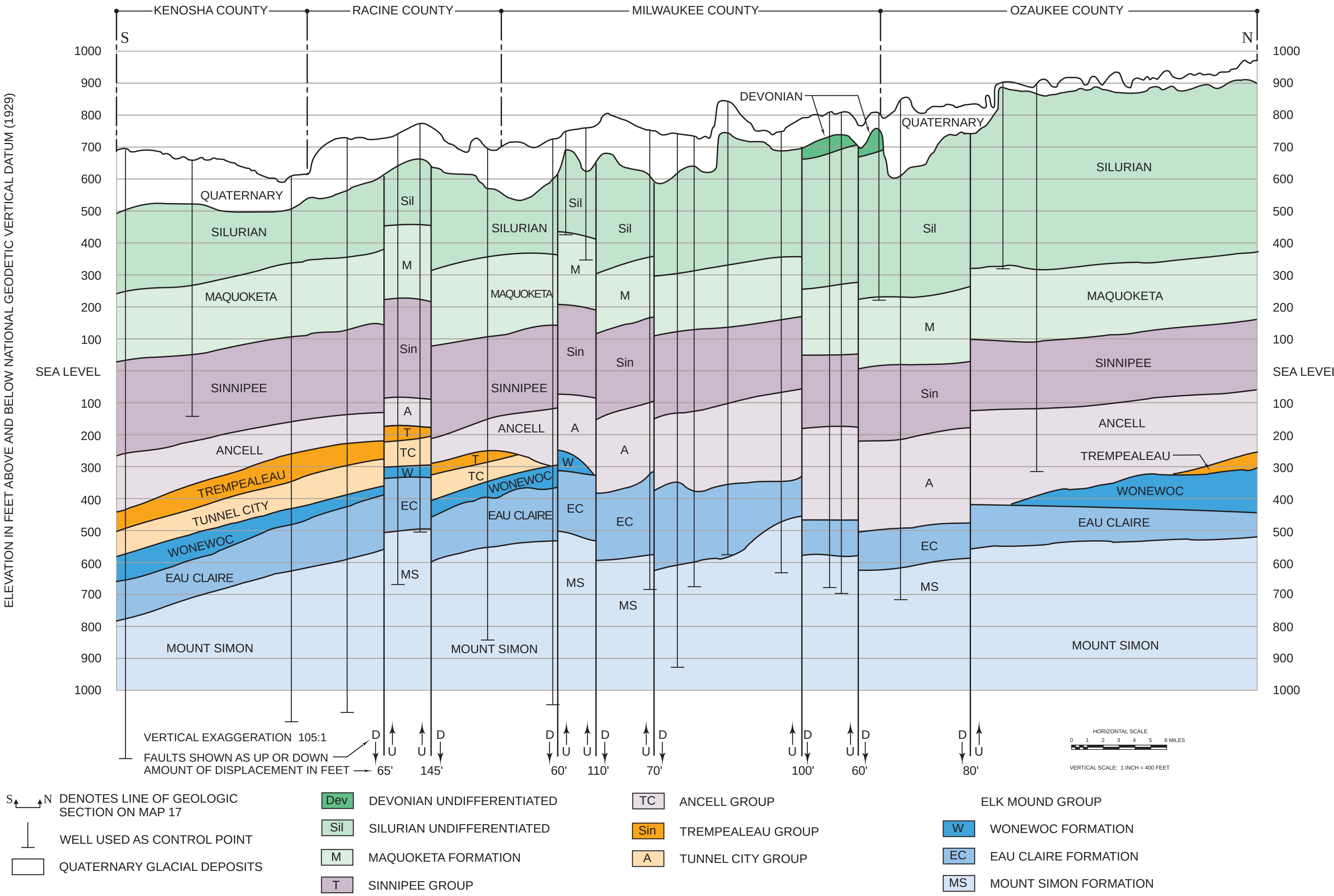


Source: Roger M. Peters, 1997.

Figure 11

GEOLOGIC CROSS-SECTION OF THE SOUTHEASTERN WISCONSIN REGION, SOUTH TO NORTH

CROSS SECTION CD ON MAP 17



Source: Roger M. Peters, 1997, and SEWRPC.

in southeastern Wisconsin are nearly vertical, it is rare that a well would cross a fault trace. There is only one well—in the City of Waukesha—supported by drill cuttings that is known to be located through a fault trace.

The west-east section shown in Figure 10 crosses a major fault zone, the Waukesha Fault, which passes through Waukesha County and trends northeastward into Lake Michigan is partly shown on Map 17. The Waukesha Fault is a potentially important hydrologic feature because it offsets major formation and aquifer boundaries, and may significantly influence deep groundwater flow systems.

The north-south section (Figure 11) crosses several east-west faults. The lateral extent of these faults are at present poorly known, and they are not shown on Map 17. These faults also displace lithologic contacts and may significantly influence deep groundwater movement.

Characteristics of the Bedrock Surface

Southeastern Wisconsin was differentially eroded before the deposition of Pleistocene age material, and the contact between bedrock and Pleistocene deposits is, therefore, irregular. The shape of the bedrock surface and the relationship of the bedrock surface to the land surface are portrayed on Maps 16 and 18. Map 18 shows the actual shape of the bedrock surface and its elevation above sea level based on the most recent available data in the Region. Map 16 is more complex, because it shows the depth to bedrock below the land surface, and takes into account the many hills and valleys caused by glacial moraines and rivers.

The most striking features of the bedrock surface, as shown on Maps 18 and 19, are several deep buried valleys, the bottoms of which are at elevations of between 750 feet and 350 feet above sea level. These buried valleys were part of a drainage system that covered much of the Region and parts of Jefferson, Rock, and Dane Counties. The valleys have been eroded down into the softer Maquoketa shale or underlying formations, and their development may have been influenced by faulting. The shape of the bottom of these bedrock valleys is poorly known because of their depth. There are only a few wells penetrating the deepest parts of the valleys. Although the valleys were probably originally formed by preglacial rivers, it is likely that subsequent glacial ice deepened and reshaped them.

The northern valley extends from northeastern Washington County southwest through northwestern Waukesha County into southern Jefferson County. The valley in southern Washington County cuts through the Silurian dolomite and Maquoketa shale into the Sinnipee Group. In Jefferson County, the valley turns west and joins the buried ancestral Rock River valley. At Lake Koshkonong the valley turns south and continues through Rock County into Illinois.

In the southern half of the Region, a long valley curves from southern Milwaukee and Waukesha Counties south through Walworth County into Illinois. The deepest part of the valley in Walworth County is named the Troy Valley. The valley in southern Milwaukee County likely served as an outlet for Lake Michigan during glacial periods. The southern valley is not a single, continuous valley. Instead, two distinct valleys that trend in nearly opposite directions are probably separated by a preglacial bedrock drainage divide. The position of this divide is unclear because there are not enough control points available to define it clearly.

Depth to Bedrock

Map 16 which shows the approximate depth to bedrock within the Region, broadly resembles Map 18 which shows bedrock elevations. Areas located over the deep bedrock valleys are where the bedrock is farthest from the land surface. Thicknesses of glacial materials in these buried valleys range from 250 feet to more than 450 feet. The areas where bedrock is closest to the land surface trend from northeast to southwest, from southeastern Washington County through northeastern Waukesha County; bedrock generally is found there at depths less than 25 feet. Numerous outcrops and large quarries are found in the Silurian dolomite, which is the uppermost bedrock formation there. Elsewhere along the same general trend, bedrock lies at depths of less than 50 feet; for example, at the Kettle Moraine in Waukesha County, the City of Whitewater in Walworth County, and parts of Washington and Ozaukee Counties.

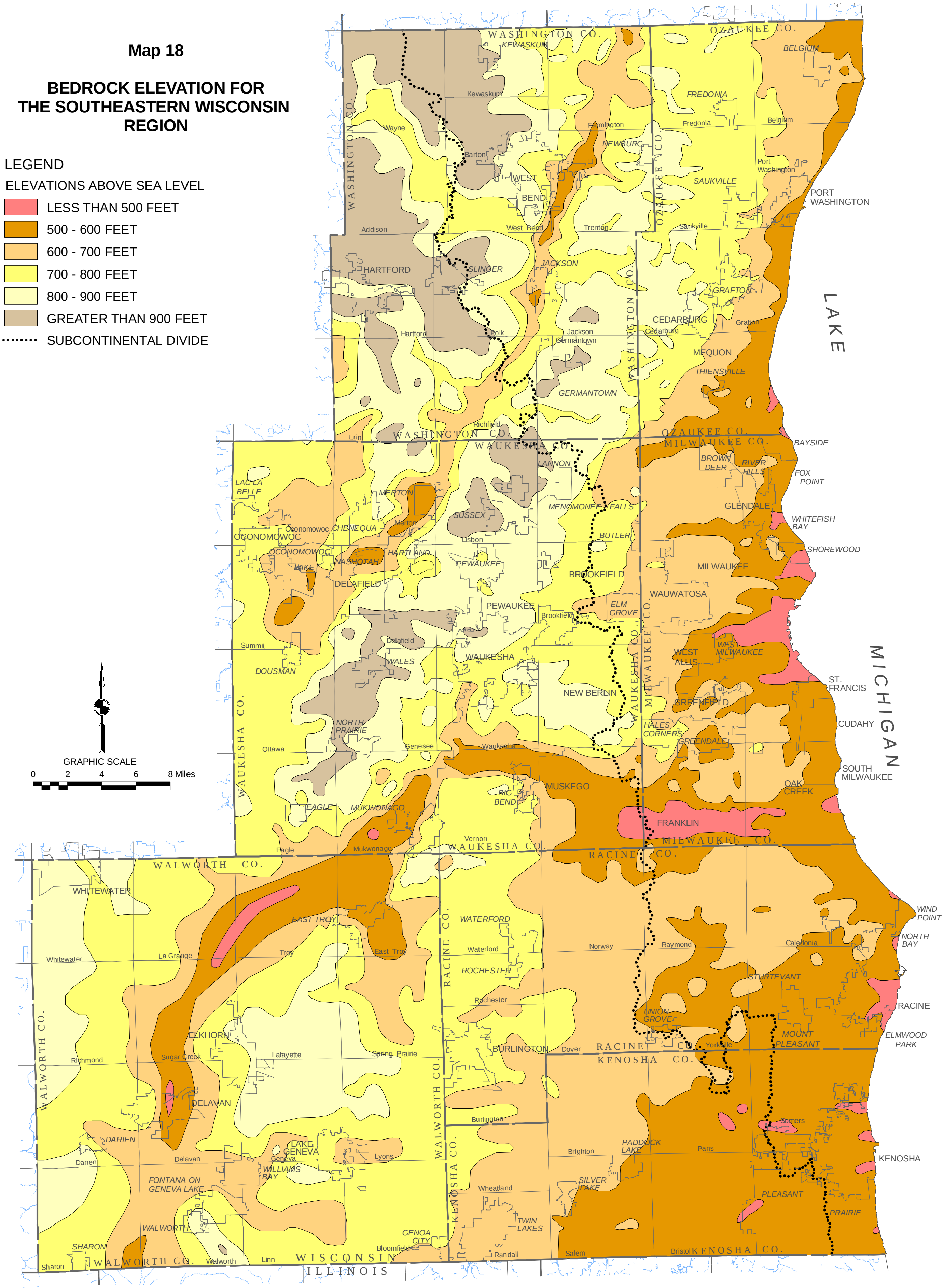
Map 18

BEDROCK ELEVATION FOR THE SOUTHEASTERN WISCONSIN REGION

LEGEND

ELEVATIONS ABOVE SEA LEVEL

- LESS THAN 500 FEET
- 500 - 600 FEET
- 600 - 700 FEET
- 700 - 800 FEET
- 800 - 900 FEET
- GREATER THAN 900 FEET
- SUBCONTINENTAL DIVIDE



Source: Wisconsin Geologic and Natural History Survey.

Map 19

APPROXIMATE EXTENT OF MAJOR PRE-GLACIAL BEDROCK VALLEYS IN THE SOUTHEASTERN WISCONSIN REGION

LEGEND

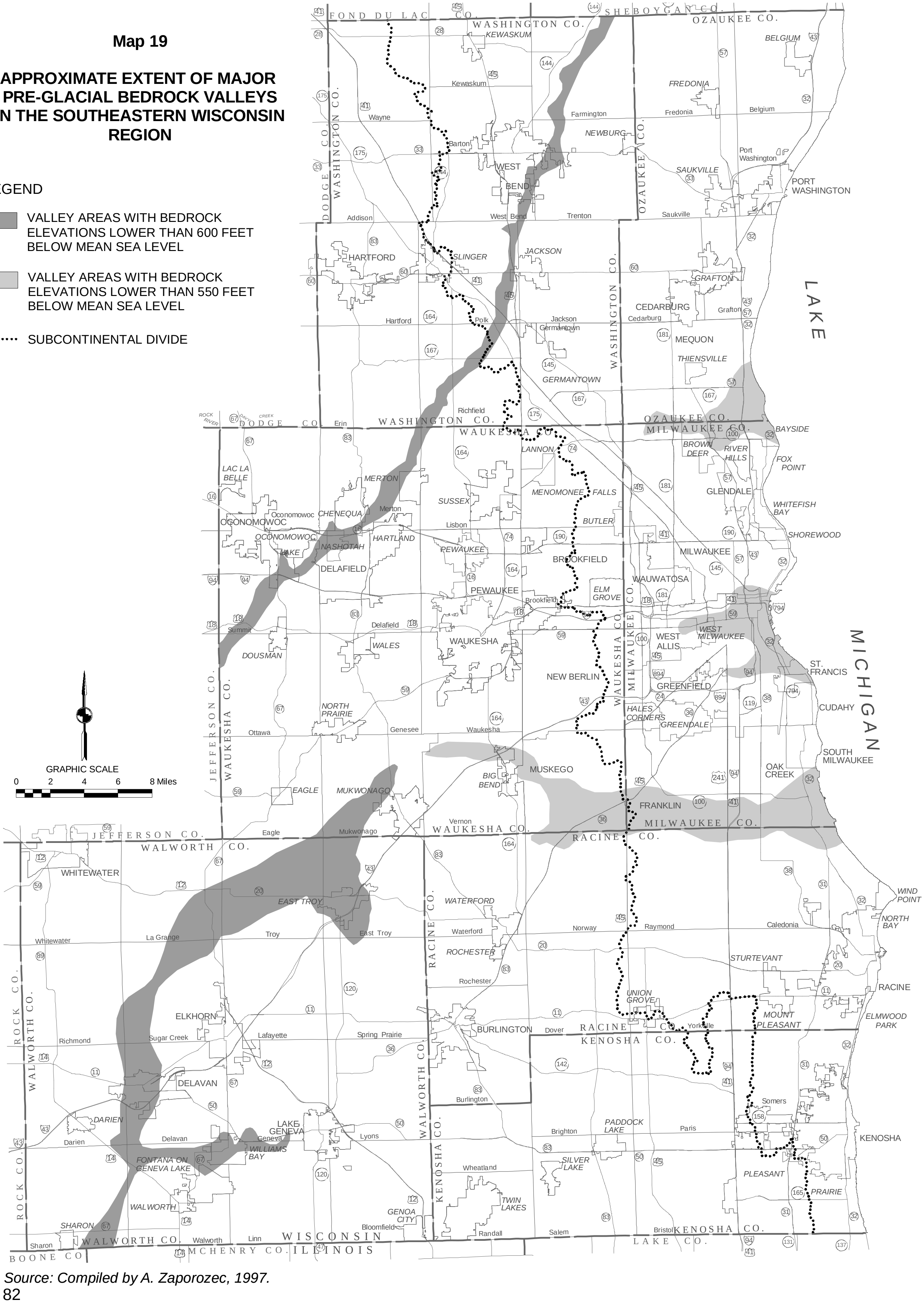
VALLEY AREAS WITH BEDROCK ELEVATIONS LOWER THAN 600 FEET BELOW MEAN SEA LEVEL

VALLEY AREAS WITH BEDROCK ELEVATIONS LOWER THAN 550 FEET BELOW MEAN SEA LEVEL

SUBCONTINENTAL DIVIDE

GRAPHIC SCALE

0 2 4 6 8 Miles



Source: Compiled by A. Zaporozec, 1997.

In most of the rest of southeastern Wisconsin, depth to bedrock ranges between 50 and 250 feet. This wide range of depth to bedrock is in large part caused by the many end moraines deposited during the last glacial period and the erosion of river valleys since then. There are only a few outcrops or areas where bedrock is less than 50 feet deep found in Racine and Kenosha Counties because of the thickness of glacial deposits. However, numerous outcrops are found in Milwaukee and Ozaukee Counties, where the Milwaukee, Menomonee, and Root Rivers and their tributaries have formed deep valleys in these same glacial deposits. In some cases, isolated outcrops have been reported in areas where overall bedrock surface is more than 25 feet deep.

Surface Water and Groundwater Resources

Surface water resources, consisting of lakes and streams and their associated wetlands and floodlands, form important elements of the natural resource base of the Southeastern Wisconsin Region. Their contribution to the economic development, recreational activity, and aesthetic quality of the Region is immeasurable. Lake Michigan is a major source of water for domestic, municipal, and industrial users in areas of the Region lying east of the subcontinental divide. Understanding the interaction of the surface water and groundwater resources is essential to sound water resource planning. Both the surface water and the groundwater are interrelated components of, in effect, a single hydrologic system. Accordingly, both these elements of the hydrologic system are described herein. The groundwater resources of the Region are hydraulically connected to the surface water resources inasmuch as the former provide the base flow of streams and contribute to inland lake levels. The groundwater resources constitute the major source of supply for domestic, municipal, and industrial water users in areas of the Region lying west of the subcontinental divide.

Surface Drainage and Surface Water

Because of the effects of glaciation, the surface drainage pattern of the Region is very complex. The land surface is complex as a result of being covered by glacial deposits containing thousands of closed depressions that range in size from potholes to large areas. Significant areas of the Region are covered by wetlands, and many streams are mere threads of water through these wetlands.

There are 12 major watersheds in the Region as shown on Map 20. Also shown on this map is the already referenced subcontinental divide that traverses the Region in a generally northwesterly-southeasterly direction.

About 1,680 square miles, or about 62 percent of the Region, are located west of the divide and drain to the Mississippi River system; the remaining 1,009 square miles, or 38 percent, drain to the Great Lakes-St. Lawrence River system. The subcontinental divide not only exerts a major physical influence on the overall drainage pattern of the Region, but also carries with it certain constraints on the diversion of water across the divide, and thereby constitutes an important consideration in water supply planning.

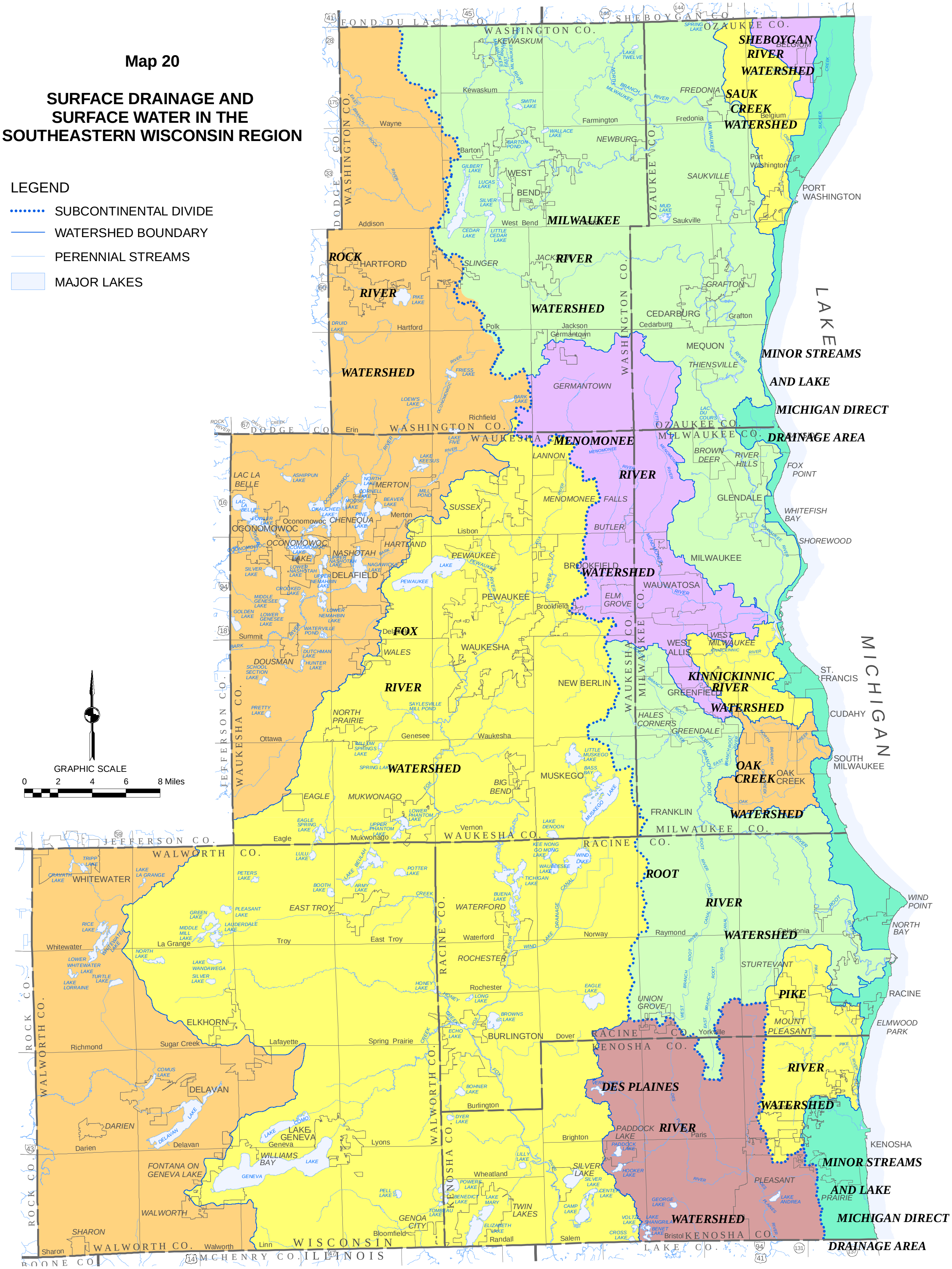
There are the 101 major lakes—lakes of 50 acres or more in area—and about 1,150 miles of perennial streams within the Region. In addition, the Region encompasses numerous lakes and ponds less than 50 acres in area and an extensive network of smaller, intermittent streams. The Region is bounded on the east by Lake Michigan, with about 77 miles of shoreline extending from the Wisconsin-Illinois border to the Ozaukee-Sheboygan county line.

The quality of many of the surface waters of the Region has been deteriorated by, among other factors, malfunctioning onsite sewage disposal facilities; municipal and industrial sewage treatment facility outfalls; inadequate soil conservation and other agricultural practices; construction site erosion; and urban runoff. Lakes and streams may also be adversely affected by the excessive development of lacustrine and riverine areas and the filling of peripheral wetlands.

Classifications for biological and recreational uses, as well as for public health and wildlife protection, have been developed for streams and lakes by the Wisconsin Department of Natural Resources and integrated into the regional water quality management plan developed by the Regional Planning Commission. The objectives for biological and recreational uses range from coldwater fishery and full recreational use to limited aquatic life and limited recreational use. Water use objectives for streams and lakes are set forth in Chapter NR 102 of the *Wisconsin Administrative Code*.

Map 20

SURFACE DRAINAGE AND SURFACE WATER IN THE SOUTHEASTERN WISCONSIN REGION



Source: SEWRPC.

In addition, the Department of Natural Resources has identified a limited number of streams and lakes as "outstanding" and "exceptional" resource waters. Outstanding resource waters have the highest value as a resource, excellent water quality, and high-quality fisheries; do not receive wastewater discharges; and proposed point source discharges will not be allowed in the future unless the quality of such a discharges meets or exceeds the quality of the receiving water. Within the Region, Bluff, Potawatomi, and Van Slyke Creeks, all in Walworth County, along with Lulu Lake in Walworth County and Spring Lake in Waukesha County have been classified as outstanding resource waters. Exceptional resource waters have excellent water quality and valued fisheries but already receive wastewater discharges or may in the future receive discharges necessary to correct environmental or public health problems. Within the Region, the East Branch of the Milwaukee River from the Long Lake outlet to STH 28 in Washington County; Genesee Creek above STH 59, the Mukwonago River from Eagle Springs Lake to Upper Phantom Lake, and the Oconomowoc River below North Lake to Okauchee Lake, all in Waukesha County, have also been classified as exceptional resource waters.

Groundwater Resources

Groundwater resources constitute another key element of the natural resource base of the Region. Groundwater not only sustains lake levels and wetlands and provides the base flows of streams in the Region, but also comprises a major source of water supply for domestic, municipal, and industrial water users.

Groundwater occurs within three major aquifers that underlie the Region. From the land's surface downward, they are: 1) the sand and gravel deposits in the glacial drift; 2) the shallow dolomite strata in the underlying bedrock; and 3) the deeper sandstone, dolomite, siltstone, and shale strata. Because of their proximity to the land surface and hydraulic interconnection, the first two aquifers are commonly referred to collectively as the "shallow aquifer," while the latter is referred to as the "deep aquifer." Within most of the Region, the shallow and deep aquifers are separated by the Maquoketa shale, which forms a relatively impermeable barrier between the two aquifers (see Figure 12).

Like surface water, groundwater is susceptible to depletion in quantity and to deterioration in quality as a result of urban and rural development within the Region. Consequently, comprehensive planning—and water supply system planning as an integral part of comprehensive planning—must appropriately consider the potential impacts of urban and rural development on this important resource. Land use planning must also take into account, as appropriate, natural conditions which may limit the use of groundwater as a source of water supply, including the relatively high levels of naturally occurring radium in groundwater in the deep sandstone aquifer, found in certain areas of the Region. Additional information on the groundwater system, including uses for water supply, is included in Chapter III.

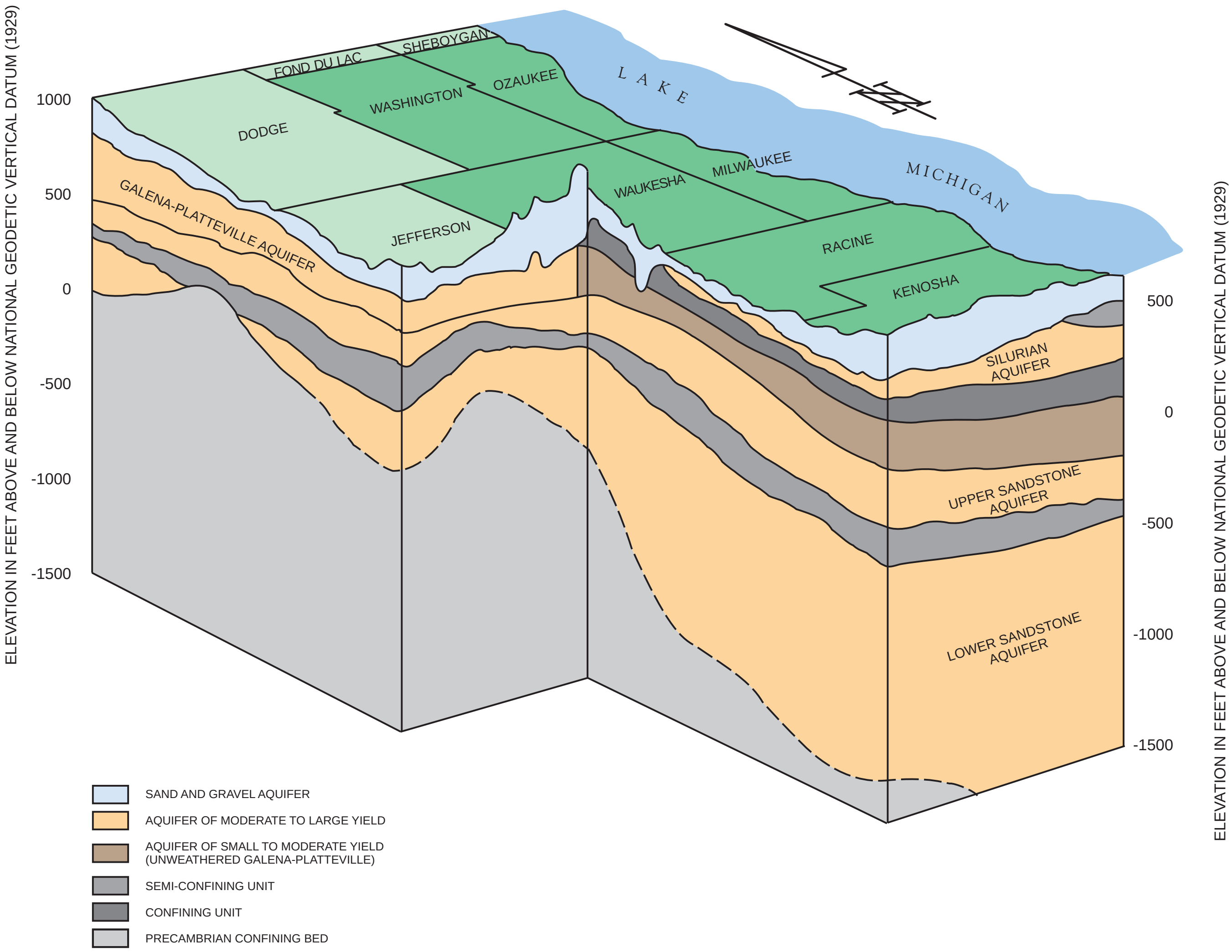
Springs

Springs constitute another important water resource feature within the Region, and are related to both the surface and groundwater resources. Springs are areas of groundwater discharge and often provide a positive impact on surface waters and may support unique vegetation and habitat. Since springs rely on groundwater flow, they may be subject to negative impacts from groundwater uses. Wisconsin Act 310, adopted in 2003, (Section 281.34 of the *Wisconsin Statutes*) includes provision for the protection of certain springs.

During 2007, the Wisconsin Wildlife Federation conducted a statewide compilation of all available recent and historic information on springs, creating a springs data base. That data base identified a total of 618 springs in the seven-county Southeastern Wisconsin Region, as shown on Map 21. The Federation data were supplemented by SEWRPC file data. Selected information on each spring is provided in Appendix A. The information included in this appendix is based upon historic information collected under three programs carried out from 1930 through 1985. The majority of the springs data for the Region was obtained from a Wisconsin Conservation Department survey carried out in all seven counties of the Region. Only a limited number of the locations of the springs have been field-checked, and some of the springs may no longer exist.

Figure 12

AQUIFER SYSTEMS IN SOUTHEASTERN WISCONSIN



Source: SEWRPC.

Vegetation

Vegetative characteristics have a direct impact on the amounts of stormwater runoff and infiltration which may be expected from sewer service areas. Thus the type of vegetation which is in place is an important consideration in water supply planning. It is important to note, however, that it is difficult to isolate the relative hydrologic effects of changes in vegetation from other accompanying activities, such as urban land use development and associated stormwater management facility development, or construction of agricultural drainage facilities.

Presettlement Vegetation

Historically, vegetational patterns in the Region were influenced by such factors as climate, soils, fire, topography, and natural drainage patterns. Historical records, particularly the records of the original U.S. Public Land Survey carried out within the Region in 1833 through 1836, indicate that large portions of southeastern Wisconsin once consisted of open, level plains containing orchard-like stands of oak and of prairies dominated by big blue-stem grass and colorful prairie forbs. Other portions of the Region were covered by mixed hardwood forests.

Map 21

LOCATION OF KNOWN SPRINGS IN THE SOUTHEASTERN WISCONSIN REGION: 2007

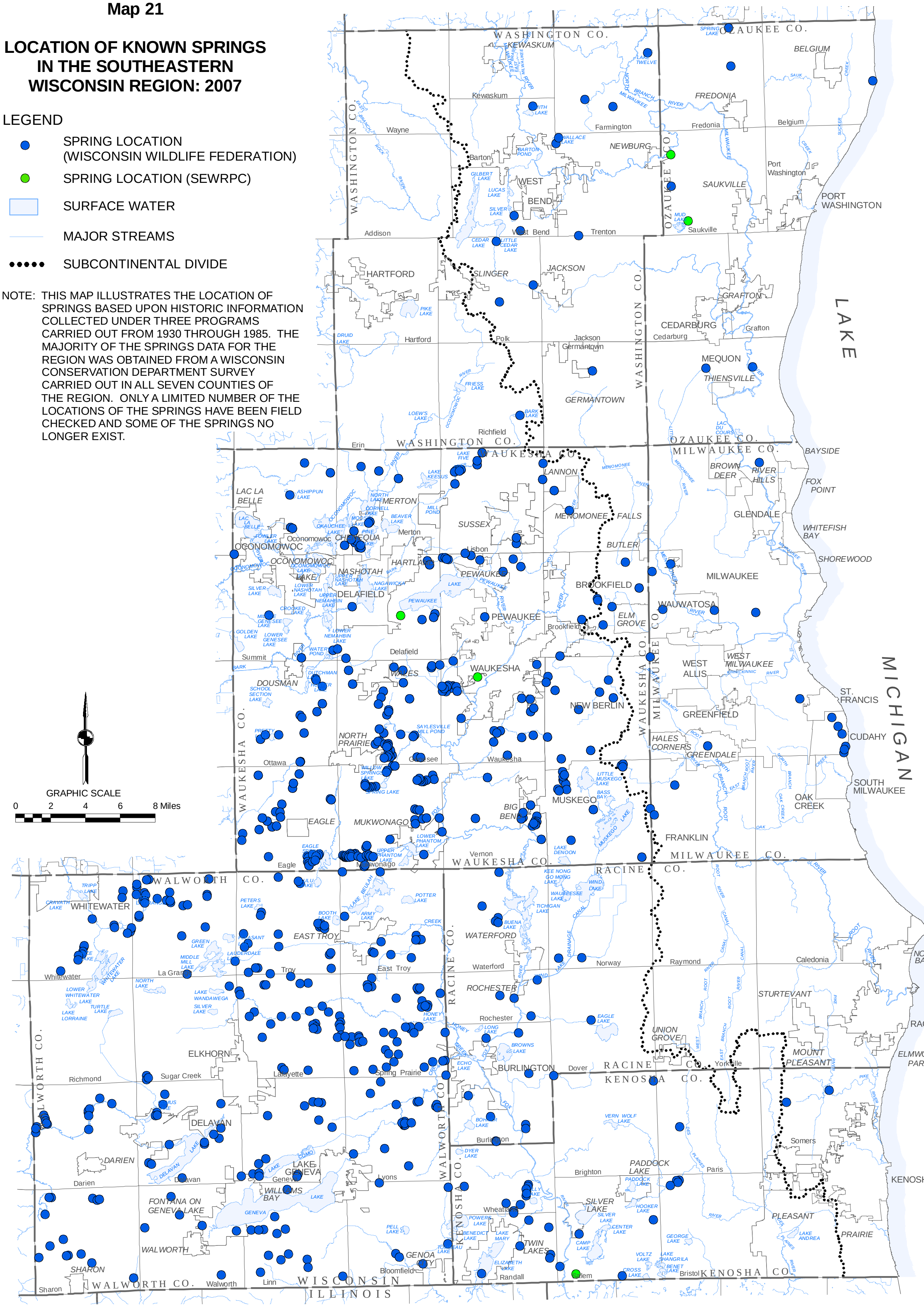
LEGEND

- SPRING LOCATION (WISCONSIN WILDLIFE FEDERATION)
- SPRING LOCATION (SEWRPC)
- SURFACE WATER
- MAJOR STREAMS
- SUBCONTINENTAL DIVIDE

NOTE: THIS MAP ILLUSTRATES THE LOCATION OF SPRINGS BASED UPON HISTORIC INFORMATION COLLECTED UNDER THREE PROGRAMS CARRIED OUT FROM 1930 THROUGH 1985. THE MAJORITY OF THE SPRINGS DATA FOR THE REGION WAS OBTAINED FROM A WISCONSIN CONSERVATION DEPARTMENT SURVEY CARRIED OUT IN ALL SEVEN COUNTIES OF THE REGION. ONLY A LIMITED NUMBER OF THE LOCATIONS OF THE SPRINGS HAVE BEEN FIELD CHECKED AND SOME OF THE SPRINGS NO LONGER EXIST.

GRAPHIC SCALE

0 2 4 6 8 Miles



Source: Wisconsin Wildlife Federation and SEWRPC.

Prairies
Prairies are largely treeless areas dominated by perennial native grasses. Prairies, which once covered extensive areas of southeastern Wisconsin, have been reduced to scattered remnants, primarily in the southern and western portions of the Region. The chief causes of the loss of prairies include their conversion to urban and agricultural use and the suppression of wildfires, which had served to constrain the advancing shrubs and trees that shade out the prairie plants. The remaining prairies in the Region have important ecological and scientific value. Many of the remaining prairies are encompassed within the natural areas and critical species habitat sites described later in this section.

Woodlands
Six woodland types are recognized as existing within the Region: northern upland hardwoods, southern upland hardwoods, northern lowland hardwoods, southern lowland hardwoods, northern lowland conifers, and northern upland conifers. The northern and southern upland hardwood types are the most common in the Region. The remaining stands of trees within the Region consist largely of even-aged mature, or nearly mature specimens, with insufficient reproduction and saplings to maintain the stands when the old trees are harvested or die of disease or age. Located largely on ridges and slopes and along lakes and streams, woodlands are a natural resource of immeasurable value. Woodlands enhance the natural beauty of, and are essential to the overall environmental wellbeing of, the Region.

As identified in the Commission regional land use inventory, upland woodlands encompassed about 183 square miles, or about 7 percent of the total area of the Region, in 2000. It should be noted that lowland wooded areas, such as tamarack swamps, are classified as wetlands in the land use inventory. Existing upland woodlands in the Region, as identified in the year 2000 land use inventory, are identified on Map 22.

Wetlands
Wetlands generally occur in depressions and near the bottom of slopes, particularly along lakeshores and stream banks, and on large land areas that are poorly drained.[13] Wetlands may, however, under certain conditions, occur on slopes and even on hilltops. Wetlands perform an important set of natural functions which include support of a wide variety of desirable, and sometimes unique, forms of plant and animal life; water quality protection; stabilization of lake levels and streamflows; reduction in stormwater runoff by providing areas for floodwater impoundment and storage; protection of shorelines from erosion; and provision of groundwater discharge areas.

As identified in the Commission regional land use inventory, wetlands in 2000 encompassed about 276 square miles, or about 10 percent of the total area of the Region. Those wetlands are shown on Map 22. It should be noted that, in addition to the wetlands shown on Map 22, certain other areas have been identified by the U.S. Natural Resources Conservation Service as farmed wetlands, which are subject to Federal wetland regulations.

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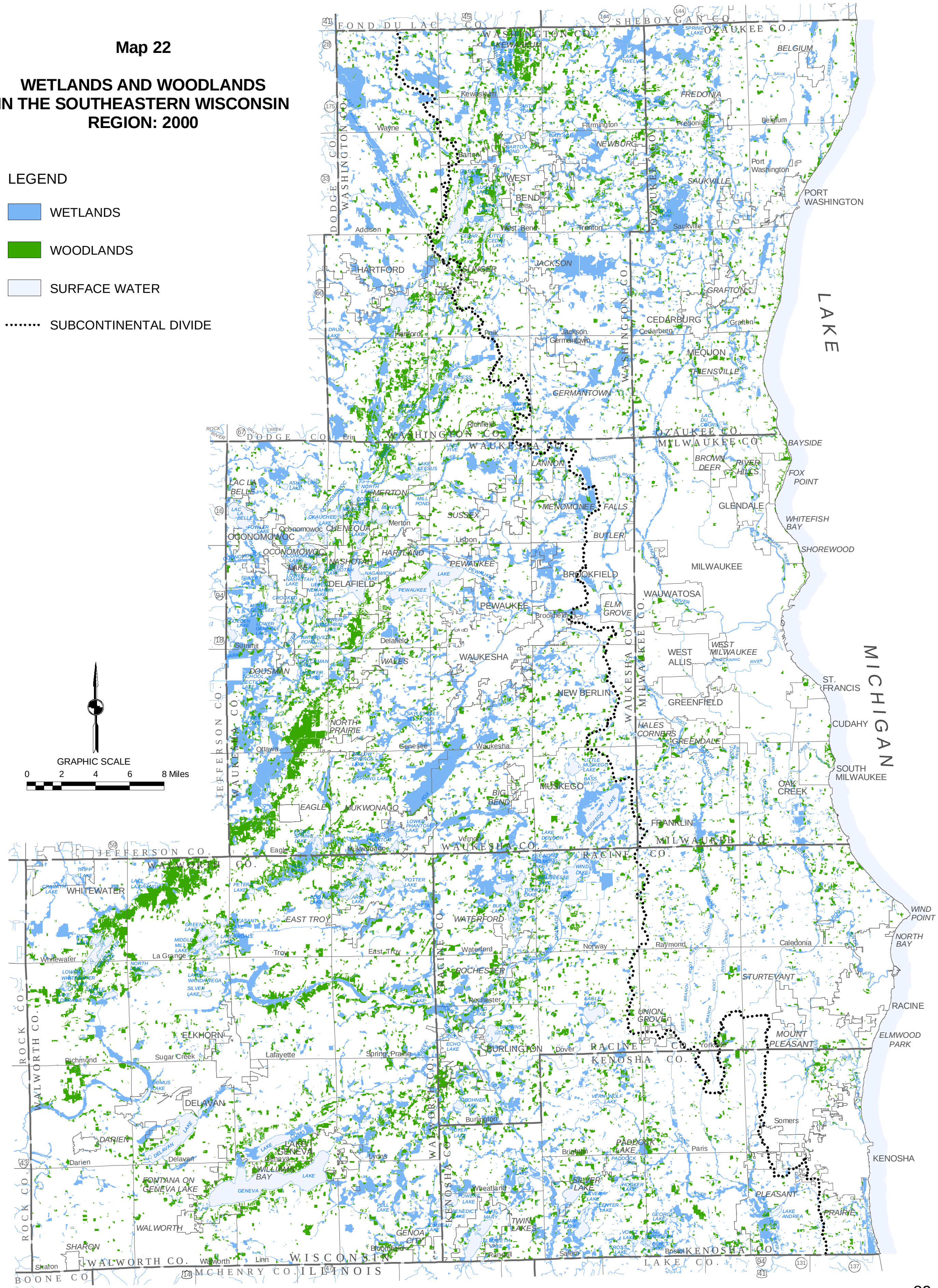
[13]*The definition of "wetlands" utilized by the Commission is the same as that utilized by the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency. Under this definition, wetlands are defined as areas that are inundated or saturated by surface water or groundwater at a frequency, and with a duration sufficient to support, and that under normal circumstance do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. This definition differs somewhat from the definition used by the Wisconsin Department of Natural Resources. Under that Department's definition, wetlands are areas where water is at, near, or above the land surface long enough to be capable of supporting aquatic or hydrophytic vegetation and which has soils indicative of wet conditions. As a practical matter, application of either the Department's definition or the EPA-Army Corps of Engineers-SEWRPC definition has been found to produce relatively consistent wetland identification and delineations in the majority of the situations in southeastern Wisconsin.*

Map 22

WETLANDS AND WOODLANDS IN THE SOUTHEASTERN WISCONSIN REGION: 2000



Source: SEWRPC.

Wetlands and their boundaries are continuously changing in response to changes in drainage patterns and climatic conditions. While wetland inventory maps provide a sound basis for areawide planning, detailed field investigations are often necessary to precisely identify wetland boundaries for individual tracts of land at a given point in time.

The area covered by wetlands in the Region declined by 5.6 square miles, or about 2 percent, between 1963 and 1990, and increased by about 7.0 square miles, or about 3 percent, between 1990 and 2000. These changes in wetland areas, like the changes in all land use categories, represents net changes within the Region. Thus, the changes in the wetland area reported between inventory years is the net result of decreases in certain areas of the Region, due, for example, to drainage or filling activity, and increases in other areas, due, for example, to the abandonment of agricultural drainage systems or to wetland restoration efforts.

When considering changes in groundwater use, and related surface water impacts, wetlands classified as fens[14] and related groundwater discharge-supported wetlands are important. Such environmentally sensitive areas are highly susceptible to changes in the groundwater hydrology. In 2007, there were 96 fens and related groundwater discharge-supported wetlands identified within the Region. The known fens and groundwater-supported wetlands in the Region as of are shown on Map 23 and listed in Table 25, along with the natural area significance classification of each.

Natural Areas and Critical Species Habitat Sites

A comprehensive inventory of “natural areas and critical species habitat sites” in the southeastern Wisconsin was completed by the Regional Planning Commission in 1994. The inventory sought to identify the most significant remaining natural areas, essentially, remnants of the pre-European settlement landscape, as well as other areas vital to the maintenance of endangered, threatened, and rare plant and animal species in the Region.

Natural areas are defined by the Commission as tracts of land or water so little modified by human activity, or sufficiently recovered from the effects of such activity, that they contain intact native plant and animal communities believed to be representative of the landscape before European settlement. Natural areas are classified into one of three categories: natural areas of statewide or greater significance (NA-1), natural areas of countywide or regional significance (NA-2), and natural areas of local significance (NA-3). Classification of an area into one of these three categories is based upon consideration of the diversity of plant and animal species and community types present; the structure and integrity of the native plant or animal community; the extent of disturbance from human activity; the commonness of the plant or animal community; the uniqueness of the natural features; the size of the site; and the educational value. A total of 447 natural areas were identified within the Region in 1994. In combination, these sites encompassed 90 square miles, or about 3 percent of the total area of the Region. The location of those natural area sites within the Region is shown on Map 24.

Critical species habitat sites consist of areas, located outside natural areas, which are important for their ability to support endangered, threatened, or rare plant or animal species. Such areas constitute “critical” habitat considered to be important to the survival of a species or group of species of special concern. A total of 142 critical species habitat sites were identified in the Region in 1994. Together, these critical species habitat sites encompassed 23 square miles, or less than 1 percent of the Region. These sites are also shown on Map 24. Most of the identified natural areas and critical species habitat sites in southeastern Wisconsin are located within the Commission-identified environmental corridors and isolated natural resource areas described below.[15]

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[14]*Fens are wetlands that are predominantly supported by groundwater discharge.*

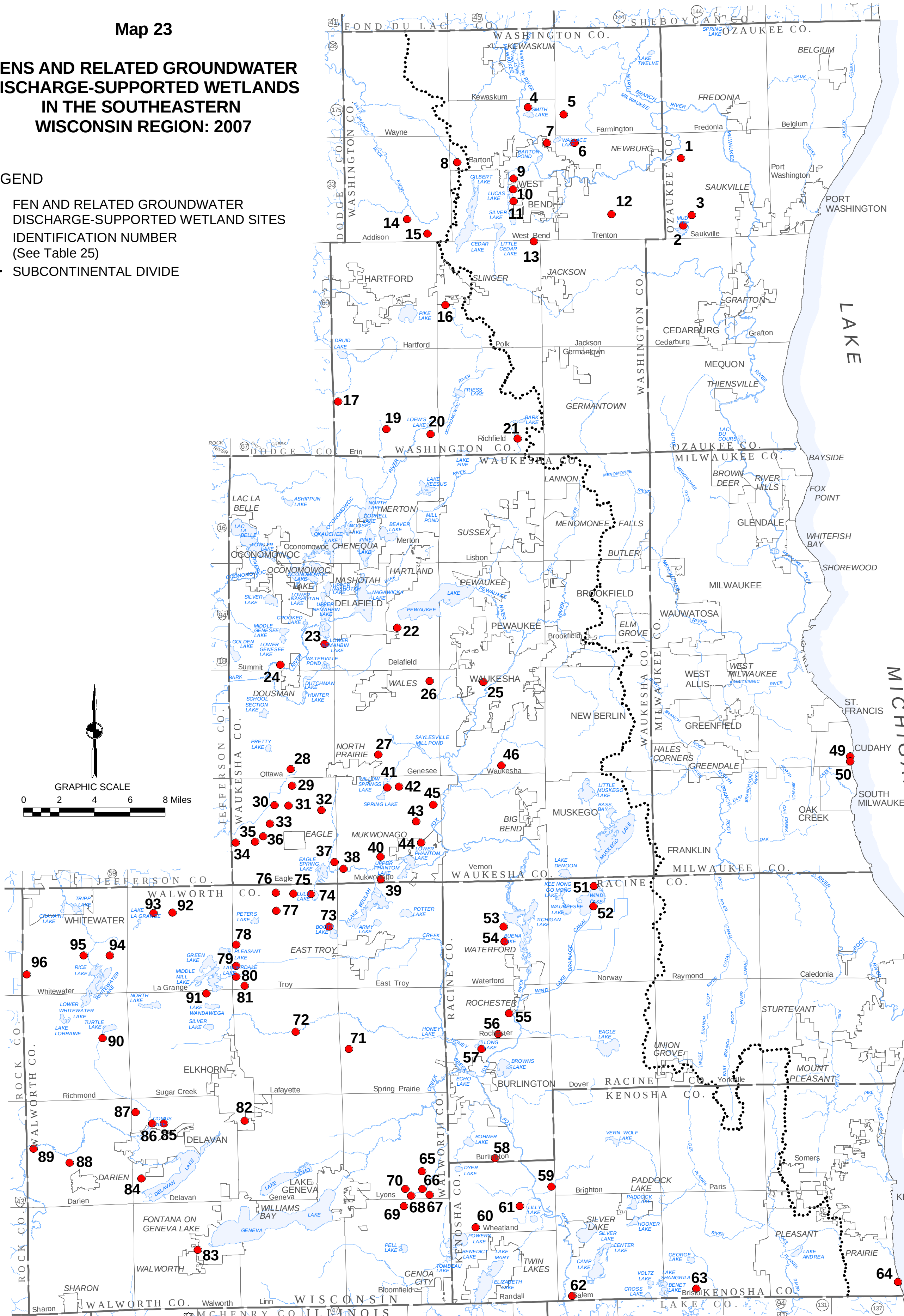
[15]*The inventory findings and a plan for the protection and management of such areas are presented in SEWRPC Planning Report No. 42,* A Regional Natural Areas and Critical Species Habitat Protection and Management Plan for Southeastern Wisconsin, *September 1997.*

Map 23

FENS AND RELATED GROUNDWATER DISCHARGE-SUPPORTED WETLANDS IN THE SOUTHEASTERN WISCONSIN REGION: 2007

LEGEND

- FEN AND RELATED GROUNDWATER DISCHARGE-SUPPORTED WETLAND SITES
- **15** IDENTIFICATION NUMBER (See Table 25)
- SUBCONTINENTAL DIVIDE



Source: SEWRPC.

Table 25

FENS AND RELATED GROUNDWATER DISCHARGE-SUPPORTED WETLANDS WITHIN THE SOUTHEASTERN WISCONSIN REGION: 2007

Identification Number on Map 23	Name	Classification[a]
1	Riveredge Swamp SNA	NA-1
2	Cedarburg Swamp SNA	NA-1
3	Cedarburg Bog SNA	NA-1
4	Smith Lake Fen	NA-1
5	Bellin Bog	NA-2
6	Sandy Knoll Wetlands	NA-3
7	Lac Lawrann Wetlands	NA-2
8	Kohlsville River Fen	NA-3[b]
9	University Fen	NA-3
10	Silver lake Bog Mat	NA-2
11	Paradise Lake Fen	NA-1
12	Camp Wowitan Wetlands	NA-3
13	Mud Lake Wetlands	NA-2
14	USH 41 Tamaracks	NA-3[b]
15	Aurora Road Fen	NA-1
16	Mud Lake Sedge Meadow	NA-2
17	Toland Swamp	NA-2
19	Beck Lake Tamaracks	NA-1
20	Loew's Lake Fen	NA-2
21	Colgate Fen and Meadow	NA-2
22	Pewaukee Lake Access Fen	NA-2
23	Breen's Bay Sedge Meadow	NA-3
24	Dousman Road Fen Meadow	NA-3[b]
25	Cambridge Avenue Fens	NA-3
26	Brown's Fen	NA-3
27	Yatzeck's Fen	NA-1
28	Ottawa Lake Fen SNA	NA-1
29	Eagle Shrub-Fen	NA-2
30	Kettle Moraine Fen SNA	NA-1
31	STH 67 Prairie-Fen	NA-1
32	Jericho Creek Fen	NA-3
33	Scuppernong Marsh Low Prairie	- -
34	Stute Springs	NA-3[b]
35	Grotjen's Fen	NA-2
36	Dead End Fen	NA-3[b]
37	Meyer Sedge Fen	NA-3[b]
38	Rainbow Springs Fen	NA-1
39	Lakewood Tamarack Fen	NA-1
40	Mukwonago Fen	NA-1
41	Spring Lake Sedge Meadow	NA-2
42	Dunlop Fed	NA-2
43	Vernon Prairie-Fen	NA-2
44	Vernon Fen	NA-2
45	Vernon Marsh Tamarack Fen	NA-2
46	Falk Fen	NA-2
49	Warnimont Park Fen-North SNA	NA-1
50	Warnimont Park Fen-South SNA	NA-1
51	Wind Lake Wet Meadow	NA-3
52	Wind Lake Shrub-Fen	NA-2
53	Tichigan Creek Fen	NA-3[b]
54	Tichigan Fen	NA-1
55	Cherry Lake Sedge Meadow SNA	NA-1
56	Brock Lake Fen	NA-2
57	Leda Lake Fen-Meadow	NA-2
58	Karcher Springs SNA	NA-1
59	Peterson Creek Sedge Meadow	NA-3
60	Powers Lake Tamarack Swamp	NA-3
61	New Munster SNA	NA-1
62	Stopa Fen	NA-1
63	Mud Lake Sedge Meadow	NA-2
64	Chiwaukee/Carol Beach Low Prairie/Panne Complex SNA	NA-1
65	Peterson Fen	NA-3
66	Lake Ivanhoe Fen-East	NA-2
67	Ivanhoe Creek Fen	NA-3
68	STH 50 Fen	NA-3
69	Lake Ivanhoe Sedge Meadow	NA-2
70	Lake Ivanhoe Fen-West	NA-2
71	Spring Prairie Fen	NA-2
72	Sugar Creek Fens	NA-3
73	Pickerel Lake Fen SNA	NA-1
74	Lulu Lake Fen/Sedge Meadow Complex	NA-1
75	Lulu Lake Fen SNA	NA-1
76	Baker Sedge Fen	NA-2
77	Bluff Road Fen Meadow	NA-2
78	Adams Fen and Marsh	NA-2
79	Leins Road Fen	NA-3
80	Honey Creek Fen	NA-3
81	Troy Fen	NA-3
82	Jackson Creek Wetlands	NA-3
83	Fontana Fen	NA-3
84	Delavan Prairie-Fen	NA-2
85	Turtle Creek Fen-East	NA-2
86	Spring Grove Fen	NA-2
87	Comus Lake Fen	NA-2
88	Creek Road Access Fen	NA-3
89	Turtle Creek Fen-West	NA-3
90	Turtle Lake Fen	NA-3[b]
91	Baywood Sedge Meadow	NA-3
92	Duffin Road Fen	NA-2
93	Connelly Fen	NA-3
94	Bluff Creek Fens SNA	NA-1
95	Clover Valley Fen SNA	NA-1
96	Rock Shrub-Fen	NA-3

[a]*NA-1 identifies Natural Area sites of statewide of greater significance.*
NA-2 identifies Natural Area sites of countywide or regional significance.
NA-3 identifies Natural Area sites of local significance.

[b]*Indicates proposed classification.*

Source: SEWRPC.

Map 24

NATURAL AREAS AND CRITICAL SPECIES HABITAT SITES IN THE SOUTHEASTERN WISCONSIN REGION: 1994

LEGEND

- NATURAL AREA OF STATEWIDE OR GREATER SIGNIFICANCE (NA-1)
- NATURAL AREA OF COUNTYWIDE OR REGIONAL SIGNIFICANCE (NA-2)
- NATURAL AREA OF LOCAL SIGNIFICANCE (NA-3)
- CRITICAL SPECIES HABITAT SITE
- PRIMARY ENVIRONMENTAL CORRIDOR

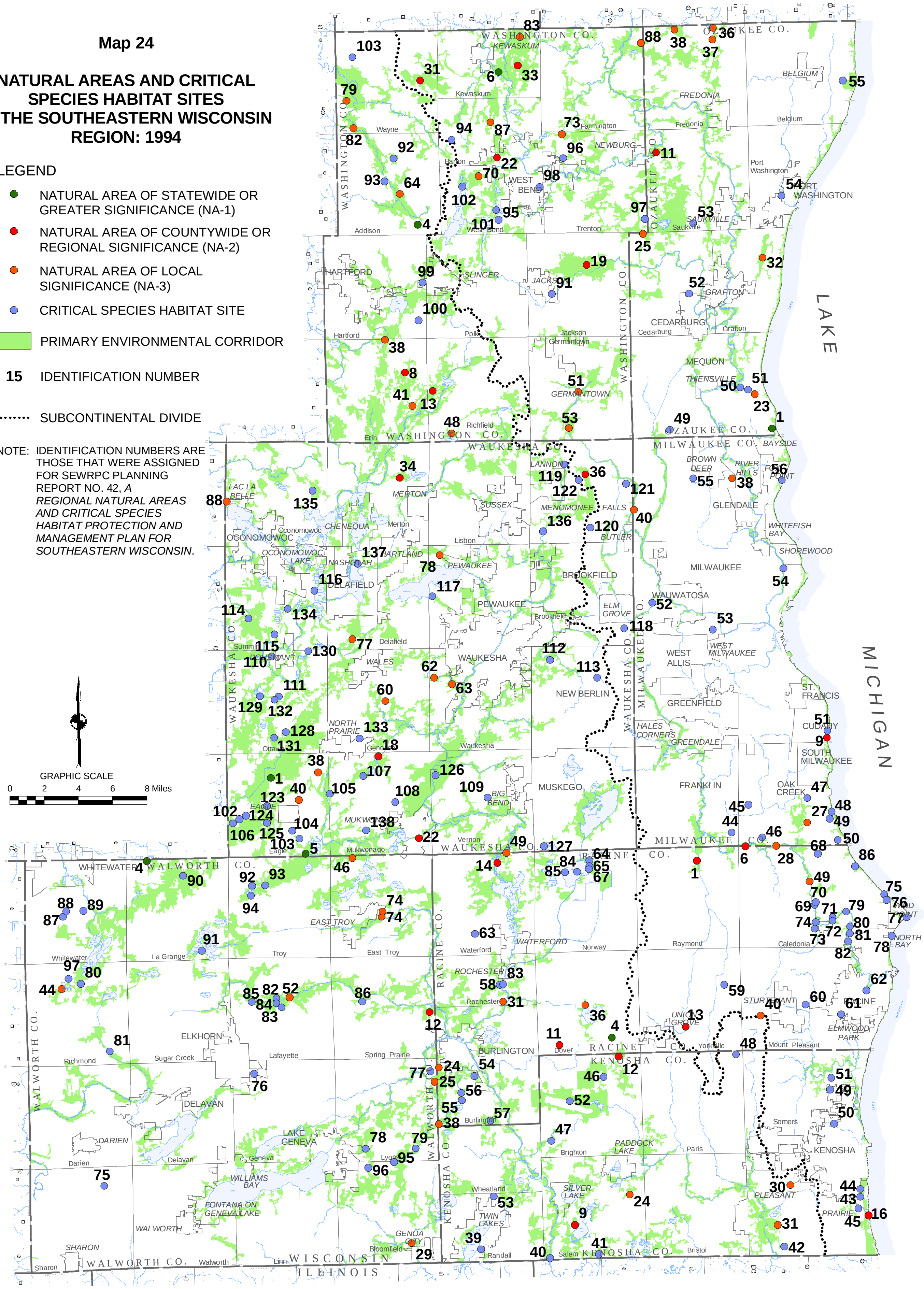
15 IDENTIFICATION NUMBER

SUBCONTINENTAL DIVIDE

NOTE: IDENTIFICATION NUMBERS ARE THOSE THAT WERE ASSIGNED FOR SEWRPC PLANNING REPORT NO. 42, *A REGIONAL NATURAL AREAS AND CRITICAL SPECIES HABITAT PROTECTION AND MANAGEMENT PLAN FOR SOUTHEASTERN WISCONSIN.*

GRAPHIC SCALE

0 2 4 6 8 Miles



Source: SEWRPC.

Environmental Corridors and Isolated Natural Resource Areas

One of the most important tasks completed under the regional planning program for southeastern Wisconsin has been the identification and delineation of areas those areas of the Region in which concentrations of the best remaining elements of the natural resource base occur. Preservation of such areas is important to both the maintenance of the overall environmental quality of the Region and to the continued provision of the amenities required to maintain a high quality of life for the resident population.

Under the regional planning program, seven elements of the natural resource base were considered essential to the maintenance of the ecological balance, natural beauty, and overall quality of life in southeastern Wisconsin: 1) lakes, rivers, and streams, and their associated shorelands and floodlands; 2) wetlands; 3) woodlands; 4) prairies; 5) wildlife habitat areas; 6) wet, poorly drained, and organic soils; and 7) rugged terrain and high-relief topography. In addition, there are five additional elements which, although not part of the natural resource base *per se*, are closely related to, or centered upon, that base and are a determining factor in identifying and delineating areas with recreational, aesthetic, ecological, and cultural value. These five additional elements are: 1) existing park and open space sites; 2) potential park and open space sites; 3) historic sites; 4) scenic areas and vistas; and 5) natural areas and critical species habitat sites.

The delineation of these 12 natural resource and natural resource-related elements on maps results, in most areas of the Region, in an essentially linear pattern of relatively narrow, elongated areas which have been termed "environmental corridors" by the Regional Planning Commission.[16] Primary environmental corridors include a variety of the aforementioned important natural resource and resource-related elements and are by definition at least 400 acres in size, two miles in length, and 200 feet in width. Secondary environmental corridors generally connect with the primary environmental corridors and are at least 100 acres in size and one mile in length. In addition, smaller concentrations of natural resource base elements that are separated physically from the environmental corridors by urban or agricultural land uses have also been identified. These areas, which are by definition at least five acres in size, are referred to as isolated natural resource areas.

The preservation of environmental corridors and isolated natural resource areas in essentially natural, open uses yields many benefits, including essential recharge and discharge of groundwater; maintenance of surface and groundwater quality; attenuation of flood flows and stages; maintenance of base flows of streams and watercourses; reduction of soil erosion; abatement of air and noise pollution; provision of wildlife habitat; protection of plant and animal diversity; protection of rare and endangered species; maintenance of scenic beauty; and provision of opportunities for recreational, educational, and scientific pursuits. Conversely, since these areas are generally poorly suited for urban development, their preservation in natural, open uses can help avoid serious and costly developmental problems.

Because of the many interacting relationships existing between living organisms and their environment, the destruction or deterioration of one important element of the total environment may lead to a chain reaction of deterioration and destruction of other elements. The drainage of wetlands, for example, may destroy fish spawning areas, wildlife habitat, groundwater recharge areas, and natural filtration and floodwater storage areas of interconnecting stream systems. The resulting deterioration of surface water quality may, in turn, lead to a deterioration of the quality of the groundwater which serves as a source of domestic, municipal, and industrial water supply, and upon which low flows of rivers and streams may depend. Similarly, destruction of ground cover may result in soil erosion, stream siltation, more rapid runoff, and increased flooding, as well as the destruction of wildlife habitat. Although the effect of any one of these environmental changes may not, in and of itself, be overwhelming, the combined effects may eventually lead to a serious deterioration of the underlying and sustaining natural resource base and of the overall quality of the environment for life. In addition to such

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[16]*A detailed description of the process of delineating environmental corridors in Southeastern Wisconsin is presented in the March 1981 issue (Volume 4, No. 2) of the* SEWRPC Technical Record*.*

environmental impacts, the intrusion of intensive urban land uses into such areas may result in the creation of serious and costly developmental problems, such as failing foundations for pavements and structures, wet basements, excessive operation of sump pumps, excessive clear-water infiltration into sanitary sewerage systems, and poor drainage.

Under the present Commission definition of environmental corridors, important groundwater recharge and discharge areas are not specifically included *per se* as one of the 12 natural resource and natural resource-related elements noted above which are mapped and evaluated in order to delineate environmental corridors. In many instances, however, the delineation of the environmental corridors using the Commission definition will include important groundwater recharge and discharge areas because of the relationship of such areas to the 12 elements used to define the environmental corridors. For example, the Kettle Moraine State Forest and environs, which is included within the primary environmental corridors, has been shown to be important for aquifer recharge. As part of the water supply planning program, the important groundwater recharge and discharge areas within the Region have been delineated. Once delineated, these areas were overlain with the environmental corridor delineations to determine commonality, and consideration given to the merits of expanding the delineated corridors to include important aquifer recharge and discharge areas.

Primary Environmental Corridors

As shown on Map 25, the primary environmental corridors within the Region are located primarily along major stream valleys, around major lakes, and along the Kettle Moraine. These primary environmental corridors contain almost all of the best remaining woodlands, wetlands, and wildlife habitat areas of the Region, and represent a composite of the best remaining elements of the natural resource base. The protection of the primary environmental corridors from additional intrusion by incompatible land uses, degradation, and destruction is one of the key objectives of the adopted regional land use plan. As indicated in Table 26, in 2000 primary environmental corridors encompassed about 462 square miles, or about 17 percent of the total area of the Region.

Secondary Environmental Corridors

As further shown on Map 25 secondary environmental corridors are generally located along the small perennial and intermittent streams within the Region. Secondary environmental corridors also contain a variety of resource elements, often remnant resources from primary environmental corridors which have been developed for intensive urban or agricultural purposes. Secondary environmental corridors facilitate surface water drainage, maintain pockets of natural resource features, and provide corridors for the movement of wildlife, as well as for the movement and dispersal of seeds for a variety of plant species. In 2000, secondary environmental corridors encompassed about 75 square miles, or about 3 percent of the total area of the Region.

Isolated Natural Resource Areas

In addition to the primary and secondary environmental corridors, other smaller pockets of wetlands, woodlands, surface water, or wildlife habitat exist within the Region. These pockets are isolated from the environmental corridors by urban development or agricultural use, and although separated from the environmental corridor network, these isolated natural resource areas have significant value. They may provide the only available wildlife habitat in an area, usually provide good locations for local parks, and lend unique aesthetic character and natural diversity to an area. Widely scattered throughout the Region, isolated natural resource areas in 2000 encompassed about 63 square miles, or about 2 percent of the total area of the Region.

AGRICULTURAL RESOURCE BASE

Agricultural land is an important factor in groundwater recharge, in that such lands are entirely pervious and, depending upon the soil and type and cropping practices, can have high recharge characteristics. Agricultural land in the Region has decreased significantly over the past four decades. It is estimated that lands devoted to agricultural use decreased by 22 percent between 1963 and 2000, including a decrease of about 8 percent during

Map 25

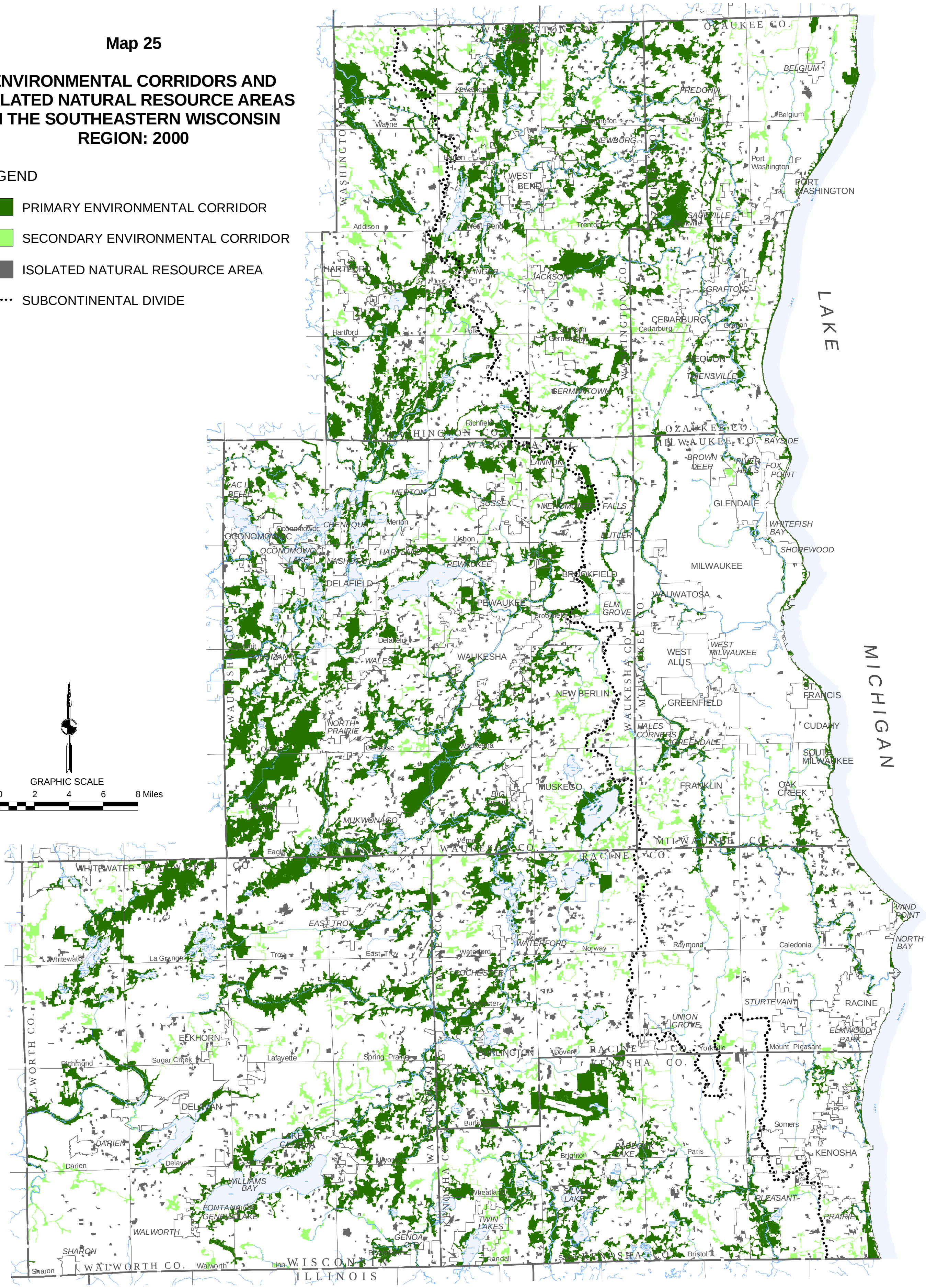
ENVIRONMENTAL CORRIDORS AND ISOLATED NATURAL RESOURCE AREAS IN THE SOUTHEASTERN WISCONSIN REGION: 2000

LEGEND

- PRIMARY ENVIRONMENTAL CORRIDOR
- SECONDARY ENVIRONMENTAL CORRIDOR
- ISOLATED NATURAL RESOURCE AREA
- SUBCONTINENTAL DIVIDE

GRAPHIC SCALE

0 2 4 6 8 Miles



Source: SEWRPC.

Table 26

ENVIRONMENTAL CORRIDORS AND ISOLATED NATURAL RESOURCE AREAS IN THE REGION BY COUNTY: 2000

County	Primary Environmental Corridors		Secondary Environmental Corridors		Isolated Natural Resource Areas		Total Environmental Corridors and Isolated Natural Resource Areas	
	Square Miles	Percent of County/ Region	Square Miles	Percent of County/ Region	Square Miles	Percent of County/ Region	Square Miles	Percent of County/ Region
Kenosha	43.8	15.8	10.0	3.6	6.0	2.2	59.8	21.5
Milwaukee	14.5	6.0	5.2	2.1	3.3	1.4	23.0	9.5
Ozaukee	32.2	13.8	7.6	3.2	5.6	2.4	45.4	19.4
Racine	35.5	10.4	10.8	3.2	12.0	3.5	58.3	17.1
Walworth	99.2	17.2	14.6	2.5	12.9	2.2	126.7	21.9
Washington	94.2	21.6	15.4	3.5	10.1	2.3	119.7	27.5
Waukesha	142.8	24.6	11.2	1.9	13.0	2.2	167.0	28.7
Region	462.2	17.2	74.8	2.8	62.9	2.3	599.9	22.3

Source: SEWRPC.

the 1990s.[17] Despite this decrease, a large portion of the total area of the Region remains in agricultural use, and agriculture remains an important component of the regional economy.

Based upon the Commission regional land use inventory, about 1,259 square miles, or about 47 percent of the total area of the Region, were in agricultural use in 2000. It should be noted that this figure includes lands actually used for agriculture—primarily cultivated lands and lands used for pasture—and excludes the wetland and woodland portions of existing farm units.

Map 26 shows the extent of agricultural land in the Region as identified in the year 2000 regional land use inventory, and further identifies those areas which are covered by highly productive soils—comprised of soils in agricultural capability Class I and Class II, as classified by the U.S. Natural Resources Conservation Service. Agricultural lands covered by Class I and Class II soils encompassed about 945 square miles, or about 75 percent of all agricultural land in the Region, in 2000. The adopted regional land use plan recommends the preservation of Class I and Class II soils to the maximum extent practicable.

EXISTING COMMUNITY ZONING PATTERN

As part of its comprehensive planning program for the Region the Commission maintains an inventory of county and municipal zoning ordinances in effect within the Region. The zoning inventory includes the preparation of a composite map showing the existing pattern of zoning throughout the Region. As part of this mapping effort, local zoning districts are converted to a uniform, areawide classification system suitable for areawide analysis, and the boundaries of the zoning districts are digitally mapped. It should be recognized that many local zoning ordinances provide for mixed-use districts. Such mixed-use districts include, among others, commercial districts that allow residential units to be located on upper stories or otherwise incorporated into permitted commercial structures; planned development districts that accommodate a mix of residential, neighborhood service, and retail uses; and business park districts which accommodate office buildings, research facilities, light manufacturing operations,

[17]*These estimates are based upon the Commission's regional land use inventories and discount the effect of the procedural shifts made as part of the year 2000 inventory, described earlier in this chapter.*

Map 26

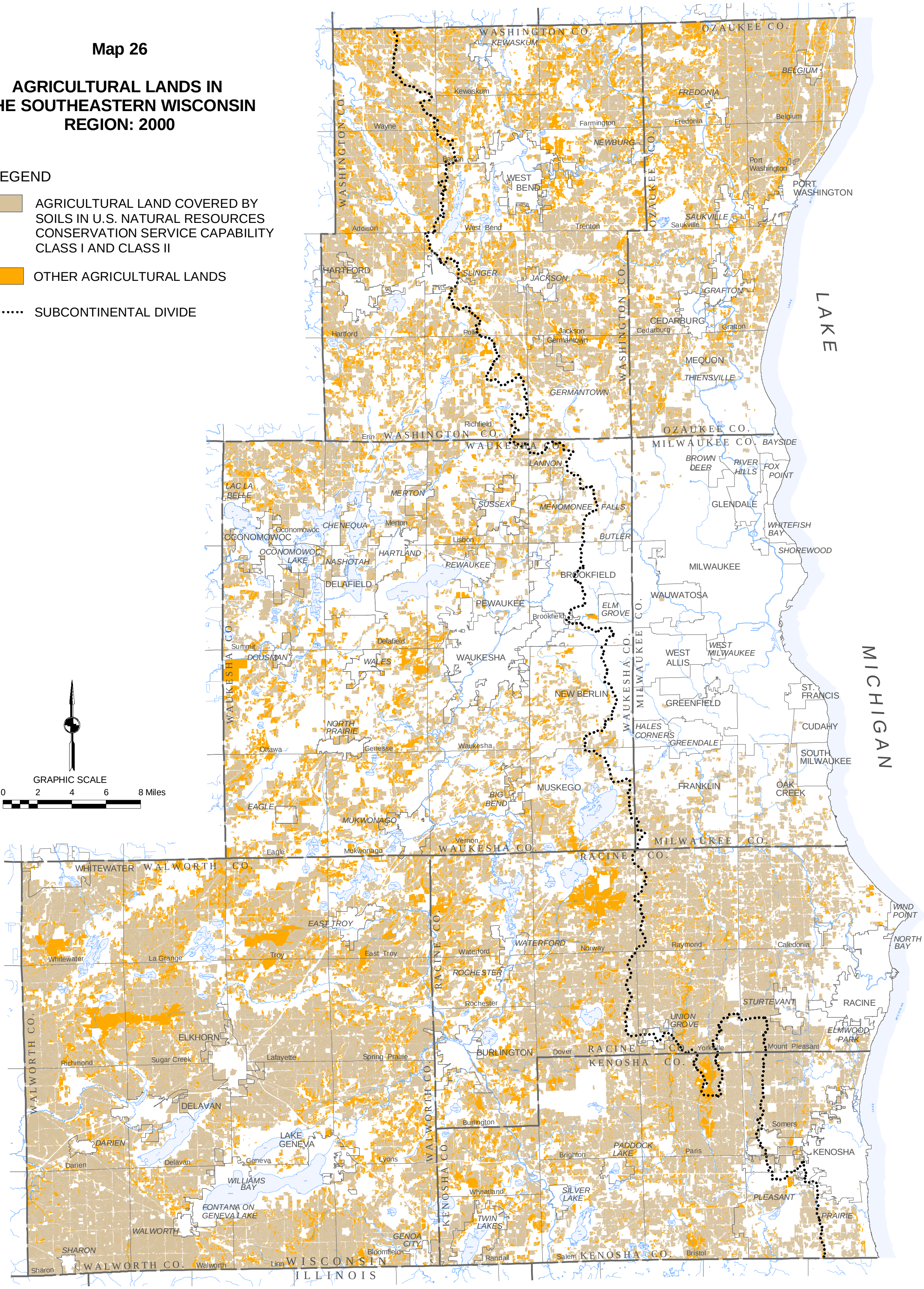
AGRICULTURAL LANDS IN THE SOUTHEASTERN WISCONSIN REGION: 2000

LEGEND

AGRICULTURAL LAND COVERED BY SOILS IN U.S. NATURAL RESOURCES CONSERVATION SERVICE CAPABILITY CLASS I AND CLASS II

OTHER AGRICULTURAL LANDS

SUBCONTINENTAL DIVIDE



Source: SEWRPC.

and service establishments. Under the Commission inventory the zoning districts concerned are placed into generalized categories based upon the predominant type of use permitted in the district.

The graphic summary of zoning within the Region, as in effect in 2000, is presented on Map 27, and a related quantitative analysis is presented in Table 27. In reviewing Map 27, it should be recognized that differences exist among the county and local units of government in terms of how they relate zoning and the local long-range land use plans and planning. In the application of zoning districts, some county and local units of government retain future urban areas—as designated in the county or local long-range land use plans—in agricultural, or agricultural holding districts, until such time as development is imminent and essential services and facilities are available. At that time, the lands concerned are rezoned into appropriate residential, commercial, and other urban districts in accordance with recommendations set forth in the land use plan concerned. In contrast, other county and local units of government place most, or all, areas proposed for future urban development in the county or local long-range land use plan in corresponding zoning districts.

As indicated in Table 27, about 584 square miles, or about 22 percent of the total area of the Region, have been placed in zoning districts which permit urban residential development, defined by the Commission as residential development at a density of more than one dwelling unit per five acres. This may be compared to about 362 square miles of existing residential land use within the Region in 2000. As further indicated in Table 27, lands in commercial and industrial zoning districts encompassed about 67 square miles, or 2.5 percent, and about 115 square miles, or about 4 percent of the total area of the Region, respectively, in 2000. This may be compared to about 30 square miles of existing commercial land use, and about 33 square miles of existing industrial land use within the Region in 2000. Increasingly, commercial and industrial zoning districts permit a mix of uses. Many commercial districts permit a mix of retail, service, and office uses. Many industrial districts permit a mix of light industry, research, and office uses.

In 2000, lands in governmental-institutional and recreational zoning districts combined encompassed about 124 square miles, or about 5 percent of the total area of the Region. This may be compared to about 84 square miles of such uses existing within the Region in 2000. Local zoning ordinances vary considerably in their treatment of governmental-institutional and recreational lands. Some ordinances incorporate exclusive governmental-institutional districts that are applied to schools, churches, and other institutional sites and exclusive recreational districts that are applied to public parks and open space uses. Others include broadly-defined “public” districts or combination institutional-park districts. Still other local zoning ordinances have no special districts for governmental-institutional and recreational uses, with such uses being permitted in residential and other zoning districts.

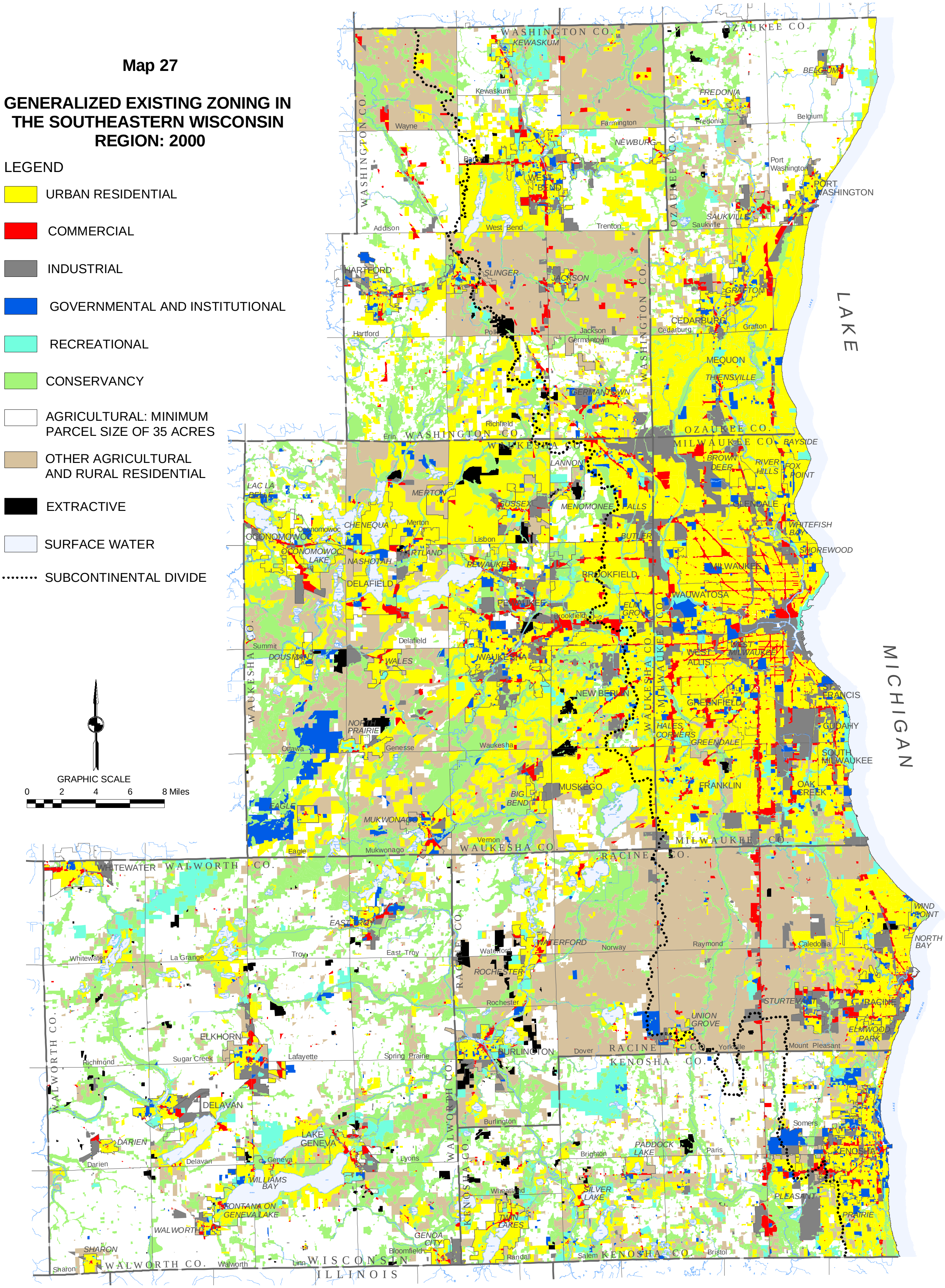
Lands in conservancy zoning districts encompassed about 440 square miles, or about 16 percent of the total area of the Region, in 2000. This includes about 343 square miles in lowland conservancy districts, and about 100 square miles in upland conservancy districts. Lowland conservancy districts prohibit nearly all types of structures and strictly limit the disturbance of natural conditions. For purposes of this inventory, lowland conservancy districts include shoreland-wetland zoning districts, other wetland zoning districts, and floodplain zoning districts which effectively preclude urban development. Upland conservancy districts are intended to protect upland woodlands, wildlife habitat, and other upland natural resource features. They typically limit land uses to conservancy uses, limited recreational uses, and residential development at a density of no more than one dwelling unit per five acres.

As defined by the Commission, “pure” agricultural zoning districts include those agricultural districts which establish a minimum parcel size of at least 35 acres. As indicated in Table 27, nearly 735 square miles, or about 27 percent of the Region, were in such agricultural zoning districts in 2000.

Also as defined by the Regional Planning Commission, rural-density residential zoning districts include districts which are specifically intended to accommodate residential development at a density of no more than one dwelling unit per five acres. Such zoning is generally intended to maintain rural character in areas that are not

Map 27

GENERALIZED EXISTING ZONING IN THE SOUTHEASTERN WISCONSIN REGION: 2000



Source: SEWRPC.

Table 27

GENERALIZED EXISTING ZONING IN THE REGION: 2000

Generalized Zoning Category	Square Miles	Percent of Total
Urban Residential Zoning Districts	584.3[a]	21.7
Commercial Zoning	67.1	2.5
Industrial Zoning[b]	114.6	4.3
Governmental-Institutional Zoning	57.9	2.1
Recreational Zoning	66.6	2.5
Extractive Zoning	21.2	0.8
Conservancy Zoning[c]	443.8	16.5
Agricultural Zoning		
Agricultural Zoning Districts—Minimum Parcels Size 35 Acres	734.6	27.3
Other Agricultural and Rural Residential Zoning Districts	534.6	19.9
Surface Water	65.1	2.4
Total	2,689.3	100.0

[a]*Includes 100.1 square miles of high-density (less than 6,000 square feet per dwelling); 167.9 square miles of medium-density (6,000 to 19,999 square feet per dwelling); 239.3 square miles of low-density (20,000 square feet to 1.49 acres per dwelling); 75.1 square miles of suburban-density (1.5 to 4.9 acres per dwelling); and 1.9 square miles of mobile home zoning.*

[b]*Includes 1.3 square miles of transportation, communication, and utility zoning.*

[c]*Includes 342.8 square miles of lowland conservancy zoning and 101.0 square miles of upland conservancy zoning.*

Source: SEWRPC.

envisioned to remain agricultural, and provide reasonable assurance that development can be sustained over the long term without urban facilities and services. Such zoning may require individual lots of five acres or larger, or may allow clustering of dwelling units on smaller lots, maintaining a density of no more than one dwelling unit per five acres for the development site overall. In Table 27 such districts have been combined with “other agricultural” zoning districts that permit parcel sizes of less than 35 acres. About 535 square miles, or 20 percent of the Region, were in such other agricultural and rural residential zoning districts in 2000. It should be recognized that residential development at a rural density of no more than one dwelling unit per five acres is also generally permitted in upland conservancy zoning districts. A more detailed description of zoning trends in the Region through 1985 is presented in Chapter VII of SEWRPC Planning Report No. 40, *A Regional Land Use Plan for Southeastern Wisconsin—2010*, dated January 1992. Changes in zoning between 1985 and 2000 are presented in SEWRPC Planning Report No. 48, *A Regional Land Use Plan for Southeastern Wisconsin: 2035*, dated June 2006.

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Chapter III

EXISTING WATER SUPPLY CONDITIONS IN THE REGION

INTRODUCTION

An extensive water supply infrastructure consisting of many public and individual private systems presently exists within the Southeastern Wisconsin Region to serve existing urban and rural land use development. This infrastructure has been under continuous development for over a period of about 135 years. Any sound water supply planning program must include an inventory and evaluation of the existing water supply systems. The inventory must identify the location, capacity, and service areas of the existing public and private water supply systems. The capabilities of these existing systems to be expanded, together with any deficiencies in these existing systems to meet present and probable future needs, must be identified as an important step toward the design of a recommended water supply plan and of alternatives thereto. Accordingly, an inventory and evaluation of the existing public and private water supply systems within the Region constituted an important early operational step in the regional water supply system planning program.

This chapter presents the results of this inventory and of a related inventory of locally prepared engineering reports and system plans for the existing water supply systems of the Region. The inventory is preceded by a section providing a historical perspective of the development of public water supply facilities within the Region. Also included in this chapter are data on water uses and descriptions of the sources of both groundwater and surface water supplies. In addition, areas of existing urban development not currently served by public water supply facilities are identified. For convenience in use, the inventory data are presented on a county-by-county basis, and are summarized on a regional basis.

HISTORICAL PERSPECTIVE OF WATER SUPPLY SYSTEMS IN SOUTHEASTERN WISCONSIN

Background

Throughout history, access to clean water has been fundamental to the health, safety, and general welfare of people, and essential to urban development. Although evidence exists that ancient civilizations developed methods to treat, store, and distribute water; it was not until the 19th Century that cities began to take systematic steps to ensure a ready supply of clean water.

The mid-19th Century brought the Industrial Revolution and the attendant rapid growth of cities throughout the United States and Europe. This rapid urban growth was often accompanied by the creation of overcrowded, unsanitary, and unsafe conditions. Prior to this period, most urban residents relied on neighborhood cisterns or shallow wells for their water supply. Rapid population growth in urban areas strained resources, including water supplies. Rain-dependent cisterns became unreliable, and surface waters were often grossly polluted. Waterborne diseases—among others, cholera, typhoid, dysentery, and other intestinal disorders—created numerous epidemics, and rapid building development without adequate water supply often led to inadequate fire protection. These conditions spurred public demand for reliable water system development.

The first municipally supplied water distribution system in the United States was developed in the City of Philadelphia during the early part of the 19th Century. At the time, Philadelphia was the largest city in the United States, and the system was built in response to pressing sanitation and fire protection needs. Prior to this, Philadelphians collected water through a series of private cisterns and wells located throughout the City, which were often contaminated by sewage from privies or other sources. Although few scientific studies had been conducted, some doctors and engineers believed that there was a direct link between water quality and disease outbreaks. The Philadelphia facility began operations in 1822, initiating further investigation and experimentation into municipal water facility development elsewhere.

The first permanent European settlement in the Region was established in 1795 as a trading post on the east side of the Milwaukee River, just north of what is now Wisconsin Avenue in the City of Milwaukee. The origins of most of the major cities and villages within the Region can be traced to the need to provide certain types of agricultural services, such as saw and grist mills. The location of these earliest urban activities was heavily influenced by the availability of water for power and transportation needs. The rapid settlement by Europeans of what is now the Southeastern Wisconsin Region began following the Indian cessations of 1829 and 1833, which transferred to the Federal government ownership of all of the lands that comprise the State of Wisconsin south of the Fox River and east of the Wisconsin River. After the end of the Blackhawk War of 1832, Federal surveyors began to survey, subdivide, and monument the Federal lands, and by 1836 the U.S. Public Land Survey had been completed within the Region. The subsequent sale of the public lands brought many settlers from New England, Germany, Austria, and Scandinavia. Initial urban development occurred along the Lake Michigan shoreline at the ports of Milwaukee, Port Washington, Racine, and Southport (now Kenosha), as these settlements were more directly accessible to immigration from the East Coast ports through the Erie Canal-Great Lakes transportation route.

Until about 1850, the Great Lakes provided the Region with its principal link to other portions of the developing nation. Thus, the early growth and development of the Milwaukee area was heavily dependent on waterborne commerce which, in turn, required safe harborage and good port facilities.

Industrial development began to occur rapidly following completion in 1855 of a railway connecting the Cities of Chicago and Milwaukee. Milwaukee became the most important manufacturing center in the Region, due in large part to the immigration of skilled artisans and mechanics from Germany. Nearly all of the City's major industrial plants can trace their beginnings to the small backyard shops of these immigrants. The rapidly expanding manufacturing establishments had their foundations in the raw materials supplied by the farms and forests within the study area, and the State; and fostered the rapid growth of the established urban centers of the study area.

During the 35-year period from 1910 to the end of World War II in 1945, the trend toward urban expansion continued, marked particularly by the increasing mechanization of farming and the introduction of automobile and truck transportation. With the development of a modern, all-weather, high-speed highway system, an affluent and mobile population has since 1960 been converting land from rural to urban use for residential, commercial, institutional, and transportation purposes within the study area at an unprecedented rate. Much of this urbanization occurred as the population in the Region migrated outward from the historic urban centers located on waterways, into the farmlands and woodlands of the more rural portions of the Region.

Water Supply Development in Southeastern Wisconsin

Many of the currently existing public water supply systems within the Southeastern Wisconsin Region were initially constructed in the latter part of the 19th and early part of the 20th Centuries in response to rapid population growth and attendant public health problems. The initial start-up date, as well as the dates of the most recent major upgrading or expansion for the public water supply systems in the Region, are identified in Table 28.

The City of Milwaukee developed the first municipal water supply system in the Region. Prior to this development, Milwaukee citizens acquired water primarily from springs, individual shallow wells, and horse-drawn water wagons operated by private vendors that collected water directly from Lake Michigan and distributed it to users. Due to rapid population growth and urbanization, these source of supply and means for distribution could not keep up with the need, and fear spread that a major fire would not be containable. Also, as the population grew, so did water pollution. Historic records indicate that by the 1860s, the rivers of the Milwaukee area were contaminated with raw sanitary sewage and industrial wastes; and waterborne diseases were endemic within the area. Plans to develop a public water supply system were initiated as early as 1857, but financing was not secured until 1868, when the City engaged the services of E.S. Chesbrough, Civil Engineer, to design a system, the operation of which began in 1874 with the development of the North Point pumping station.[1] Other cities within the Region located on Lake Michigan soon followed, with the Cities of Racine, South Milwaukee, and Kenosha water supply systems beginning operations in 1886, 1898, and 1894, respectively.

The earliest Lake Michigan water system facilities did little to improve water quality and concern grew over the safety of municipal water supplies. Typhoid and cholera epidemics were a public concern locally, as increasing amounts of sewage were discharged to Lake Michigan. The City of South Milwaukee constructed its water supply system in 1898, providing the first water treatment plant on the western Great Lakes. In 1910, the City of Milwaukee Water Works began treating water in the Kilbourn reservoir with hypochlorite of lime, and the next year, a semi-permanent treatment system was constructed at the North Point pumping station. This initiated further investigation into water treatment techniques, and by 1913, the Milwaukee Water Works created a laboratory to test and improve water quality. Cholera and other waterborne diseases, however, remained endemic in the area into the early 1930s. The Linnwood Avenue water treatment plant was placed into operation in 1939, ensuring, for the first time, a safe water supply of uniform quality for the residents of the City of Milwaukee.

Unlike the Lake Michigan shore communities, interior communities within southeastern Wisconsin developed more slowly during the latter half of the 19th Century. The City of Waukesha had become known for its springs and artesian wells, the waters of which were then believed to have “curative” powers. This led to the development of a number of spas within the Waukesha area, to the development of numerous water bottling plants with national markets, and the proposed sale of Waukesha mineral water at the 1893 Chicago World’s Fair. It was not until late in the 19th Century that manufacturing began to flourish at commercial centers inland, attracting large numbers of factory workers. This industrial-based growth necessitated the development of permanent, reliable, safe water supplies. Some of the earliest inland groundwater supply systems within the Region included those for the City of Burlington in Racine County (1890); the City of Hartford in Washington County (1895); the Cities of Delavan, Elkhorn, and Lake Geneva in Walworth County (1893, 1898, and 1890, respectively); the Cities of Oconomowoc and Waukesha in Waukesha County (1900 and 1886, respectively), and the City of Cedarburg in Ozaukee County (1901). Innovations in well pumping technology and equipment also encouraged municipal system development throughout the Region.

Over the past century, as municipalities and water demand grew, changes also occurred in the delivery of municipal water service. Numerous public water utilities which began as groundwater providers, converted to purchasing Lake Michigan surface water from other sources. For example, the City of Wauwatosa Water Utility relied on groundwater from its inception in 1897 until it entered into agreement with the Milwaukee Water Works

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[1]*Elmer W. Becker,* A Century of Milwaukee Water*, Milwaukee Water Works, 1974, p. 3.*

Table 28

DATE OF START UP AND LATEST UPGRADING FOR THE PRIMARY MUNICIPAL SUPPLIERS[a] OF WATER IN SOUTHEASTERN WISCONSIN: 2004

Water Utility Facility Name	Initial Year of Operation	Year of Most Recent Upgrade
Kenosha County		
City of Kenosha Water Utility	1894	1998
Village of Paddock Lake Municipal Water Utility	1960	2005
Town of Bristol Utility District No. 1	1968	2000
Town of Bristol Utility District No. 3	2001	2001
Milwaukee County		
City of Cudahy Water Utility	1954	1973
City of Franklin Water Utility[b]	1977	2004
City of Milwaukee Water Works	1874	1997
City of Oak Creek Water and Sewer Utility	1961	1999
City of South Milwaukee Water Utility	1898	1991
North Shore Water Utility	1963	2003
Ozaukee County		
City of Cedarburg Light & Water Commission	1901	2004
City of Port Washington Water Utility	1948	1996
Village of Belgium Water Utility	1969	2005
Village of Fredonia Municipal Water Utility	1938	1996
Village of Grafton Water and Wastewater Commission	1932	2004
Village of Saukville Municipal Water Utility	1942	2000
Racine County		
City of Burlington Water Utility	1890	2004
City of Racine Water and Wastewater Utility	1886	2004
Village of Union Grove Municipal Water Utility	1940	2005
Village of Waterford Water Utility	1952	2006
North Cape Sanitary District	1958	1993
Walworth County		
City of Delavan Water and Sewerage Commission	1893	2001
City of Elkhorn Light and Water Commission	1898	2005
City of Lake Geneva Municipal Water Utility	1890	2005
City of Whitewater Municipal Water Utility	1912	1997
Village of Darien Water Works and Sewer System	1968	2005
Village of East Troy Municipal Water Utility	1908	2004
Village of Fontana Municipal Water Utility	1949	2005
Village of Genoa City Municipal Water Utility	1922	1998
Village of Sharon Waterworks and Sewer System	1915	2004
Village of Walworth Municipal Water and Sewer Utility	1911	2006
Village of Williams Bay Municipal Water Utility	1931	2006
Country Estates Sanitary District	2001	2002
Lake Como Sanitary District No. 1	1999	1999
Pell Lake Sanitary District No. 1	1999	1999
Town of East Troy Sanitary District No. 3	1976	1994
Town of Troy Sanitary District No. 1	1957	1997
Washington County		
City of Hartford Water Utilities	1895	1999
City of West Bend Water Utility	1908	2005
Village of Germantown Water Utility	1965	2003
Village of Jackson Water Utility	1968	1999
Village of Kewaskum Municipal Water Utility	1929	2002
Village of Slinger Utilities	1911	2003
Allenton Sanitary District	1960	2000

Table 28 (continued)

Water Utility Facility Name	Initial Year of Operation	Year of Most Recent Upgrade
Waukesha County		
City of Brookfield Municipal Water Utility	1960	2004
City of Delafield Municipal Water Utility	1994	1999
City of Muskego Public Water Utility	1985	2006
City of New Berlin Water Utility	1966	2005
City of Oconomowoc Utilities	1900	2004
City of Pewaukee Water and Sewer Utility	1930	2005
City of Waukesha Water Utility	1886	2005
Village of Butler Public Water Utility	1965	1966
Village of Dousman Water Utility	1970	2001
Village of Eagle Municipal Water Utility	1953	2004
Hartland Municipal Water Utility	1933	2006
Village of Menomonee Falls Water Utility	1925	1999
Mukwonago Municipal Water Utility	1913	2001
Village of Pewaukee Water Utility	1930	1999
Village of Sussex Water Utility	1976	2006
Town of Brookfield Sanitary District No. 4	1988	2005

[a]*Information is provided in this table for those municipal water utilities which own and operate sources of supply, including wells and surface water treatment plants.*

[b]*As of 1997, the City of Franklin Water Utility purchased its water supply from the City of Oak Creek Water and Sewer Utility.*

Source: Municipal water utilities, Wisconsin Public Service Commission, and SEWRPC.

in 1955 to purchase Lake Michigan water. Similarly, the Village of Greendale Water Utility which began operation in 1936, also converted in 1965, again purchasing water from the Milwaukee Water Works. The Villages of Fox Point and Whitefish Bay originally purchased water from the Milwaukee Water Works, but then, in cooperation with the City of Glendale, in 1963 developed their own surface water supply system, overseen by the North Shore Water Commission.[2]

Although municipal water supply systems continued to emerge and expand throughout the 20th Century, numerous industries and individual residences continued to rely on private wells, and the use of private wells within the Region expanded greatly. Prior to the 1880s, a number of public and private shallow wells were in use within the Region, primarily used for domestic or agricultural purposes. Between 1880 and 1920, the number of wells and groundwater use within the Region dramatically increased, particularly by industries—such as breweries, tanneries, and food processing—in Milwaukee County. At the same time, well technology improved, providing increased pump capacity and allowing deeper wells to be constructed. Studies indicate that well pumpage in Milwaukee County peaked between 1950 and 1960, during the height of post-war industrialization. After this, groundwater use began to diminish in Milwaukee County, while it began to expand in other portions of the Region, particularly in commercial or industrial centers such as the Cities of Waukesha, Cedarburg and West Bend.[3]

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[2]*Elmer W. Becker,* A Century of Milwaukee Water Milwaukee Water Works, *1974, p. 168-180.*

[3]*J.H. Green and R.D. Hutchinson,* Ground-water Pumpage and Water Level Changes in the Milwaukee-Waukesha Area Wisconsin, 1950-1961, *Geological Survey Water Supply Paper 1809-I, 1965.*

History of Groundwater Aquifer Levels and Impacts of Pumping

The regional aquifer simulation model for southeastern Wisconsin was used to estimate water levels in the aquifers of the Region under conditions before large-scale pumping began, and through time as pumping increased.[4] This model accounts for pumping in both the Region and adjacent counties, and in northeastern Illinois.

Prior to 1870, no significant groundwater extraction was done within the Region. Such extraction in southeastern Wisconsin began around 1864. The simulated predevelopment water levels and piezometric pressure represent average predevelopment conditions up to 1864. The simulated water table configuration in Figure 13 indicates predevelopment conditions in the shallow part of the flow system. The contours simulated by the flow model reflect the strong influence of topography and the surface water network on the variations in the water table. The simulated piezometric pressures in the deep sandstone aquifer formation shown in Figure 13 represent predevelopment conditions at the top of the deep sandstone aquifer.

Withdrawals from shallow and deep wells gradually changed the groundwater flow system between 1864 and 2000. In 1950, as shown in Figure 14, deep well pumping centered on Milwaukee, with appreciable shallow well pumping along the Rock River in central Rock County. By 2000, also as shown in Figure 14, the deep pumping center had moved to central and eastern Waukesha County, with appreciable shallow pumping in Rock, Washington, and Ozaukee Counties. The total high-capacity pumping in the Region, Dodge and Jefferson Counties, and eastern Rock County, increased from negligible pumping in 1864, to 37 million gallons per day (mgd) in 1950, to 113 mgd in 2000.

The effects of pumping are different for the shallow and deep aquifers underlying the Region. Pumping from the shallow aquifer generally causes little regional drawdown because local surface water features—streams, lakes, and wetlands—help to offset the withdrawal. Often the major effect of pumping from shallow wells is to reduce the amount of groundwater discharge to local surface water features. As shown in Figure 15, drawdowns in the Silurian dolomite portions of the shallow aquifer are estimated to occur mainly in Ozaukee County and parts of eastern Washington, northeastern Waukesha, and northern Milwaukee Counties. Simulated drawdowns in the Silurian dolomite between 1864 and 2000, approach 200 feet around high-capacity wells at the pumping center in central Ozaukee County. The drawdown cone is also relatively deep in southern Ozaukee County where domestic wells in areas served by public sanitary sewers do not return discharge to the groundwater through onsite sewage disposal systems, and, therefore, result in a net loss of water to the Silurian dolomite aquifer. Since 1999, We Energies-Water Services Division has provided a Lake Michigan-based water supply to expanding portions of the City of Mequon and the Villages of Bayside and Thiensville. This source supply replaces some of the groundwater based supplies previously used in these areas. This change may be expected to mitigate or potentially reverse the historic drawdown of the shallow aquifer in this area.

Increased drawdown over time has been more dramatic in the deep sandstone aquifer where a single drawdown cone has developed. In the early 19th Century, wells driven into the deep aquifer in the Waukesha area were artesian—that is, flowing under their own internal pressure. By 1950, pumping centered in the Milwaukee area produced a regional cone of depression with maximum drawdown in the deep sandstone aquifer piezometric surface of up to about 300 feet as shown in Figure 16. By 2000, increased pumping, especially in Waukesha County, together with decreased pumping in Milwaukee County, moved the center of the regional cone of depression about nine miles west, with the maximum drawdown approaching 500 feet. The cone of depression extends not only to the west below the western portions of the Southeastern Wisconsin Region, but also under Lake Michigan to the east. The effect of pumping in northeastern Illinois is especially evident in the drawdown contours shown for Kenosha, Racine, and Walworth Counties.

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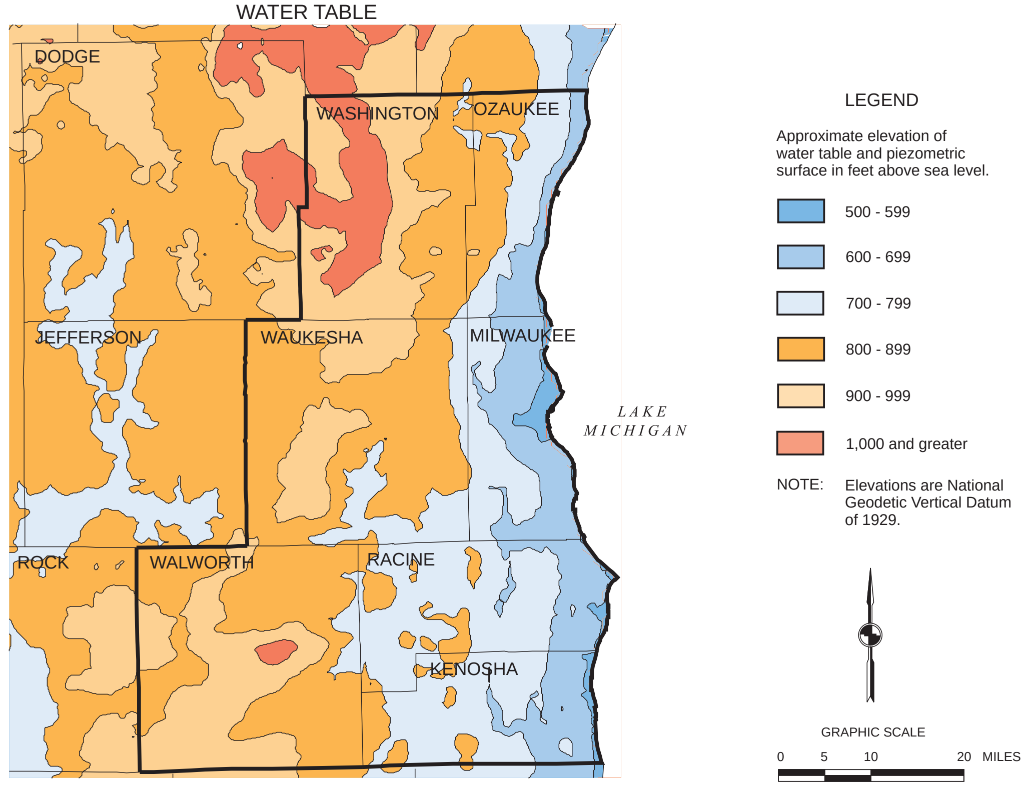
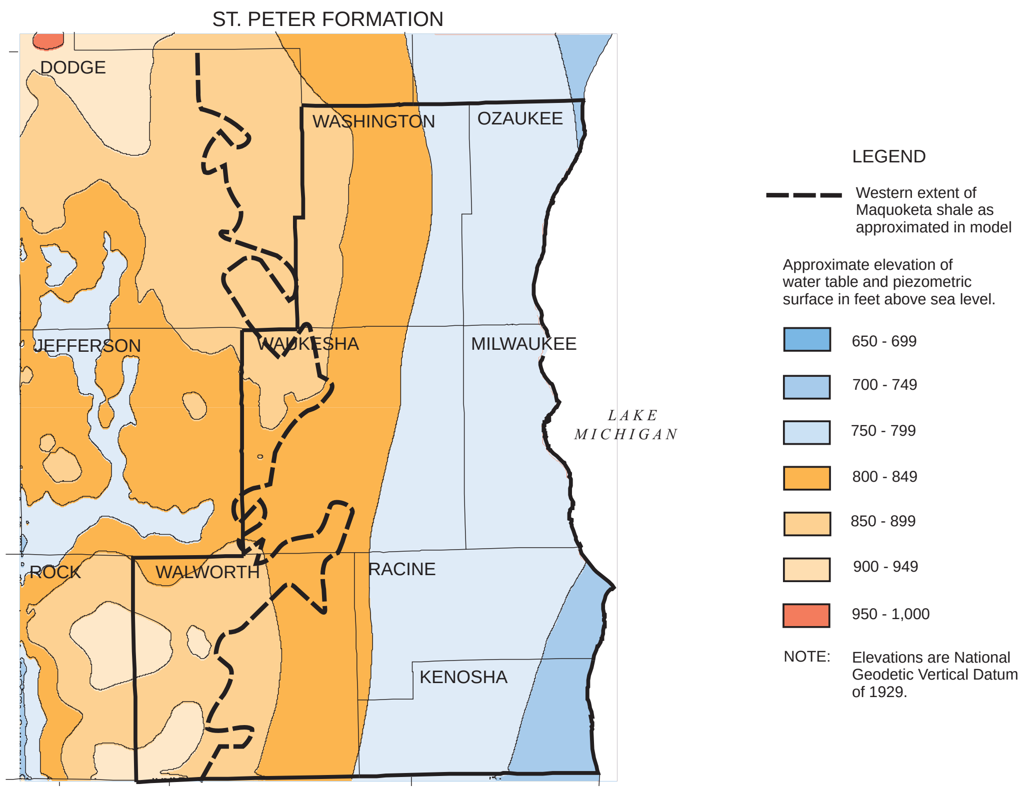
[4]*SEWRPC Technical Report No. 41, A* Regional Aquifer Simulation Model for Southeastern Wisconsin, *June 2005.*

Figure 13

SIMULATED WATER LEVELS AND APPROXIMATE POTENTIOMETRIC SURFACES UNDER PREDEVELOPMENT CONDITIONS IN SOUTHEASTERN WISCONSIN

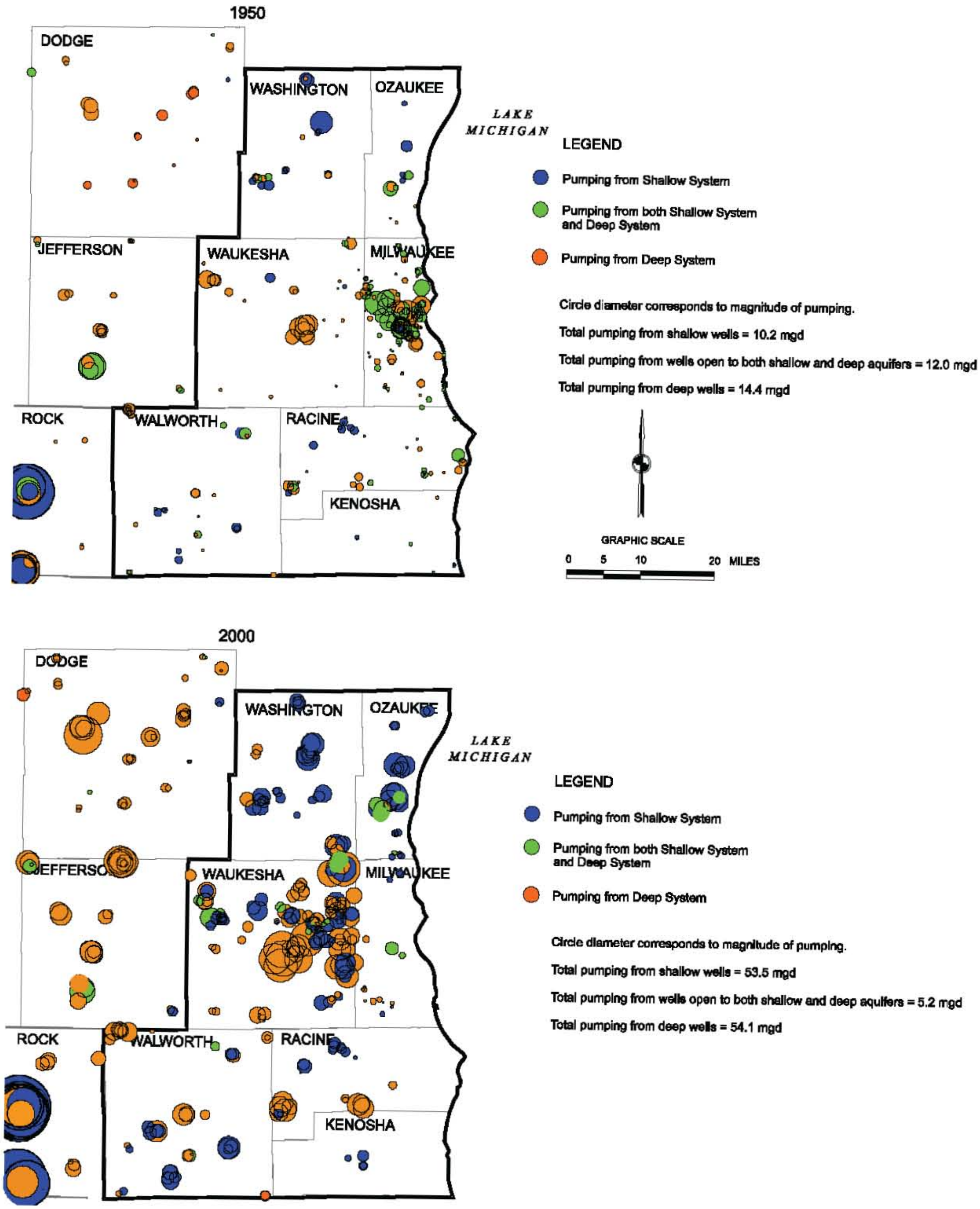




Source: U.S. Geological Survey and Wisconsin Geological and Natural History Survey and SEWRPC.

Figure 14

DISTRIBUTION OF PUMPING FROM SHALLOW AND DEEP AQUIFER SYSTEMS: 1950 AND 2000

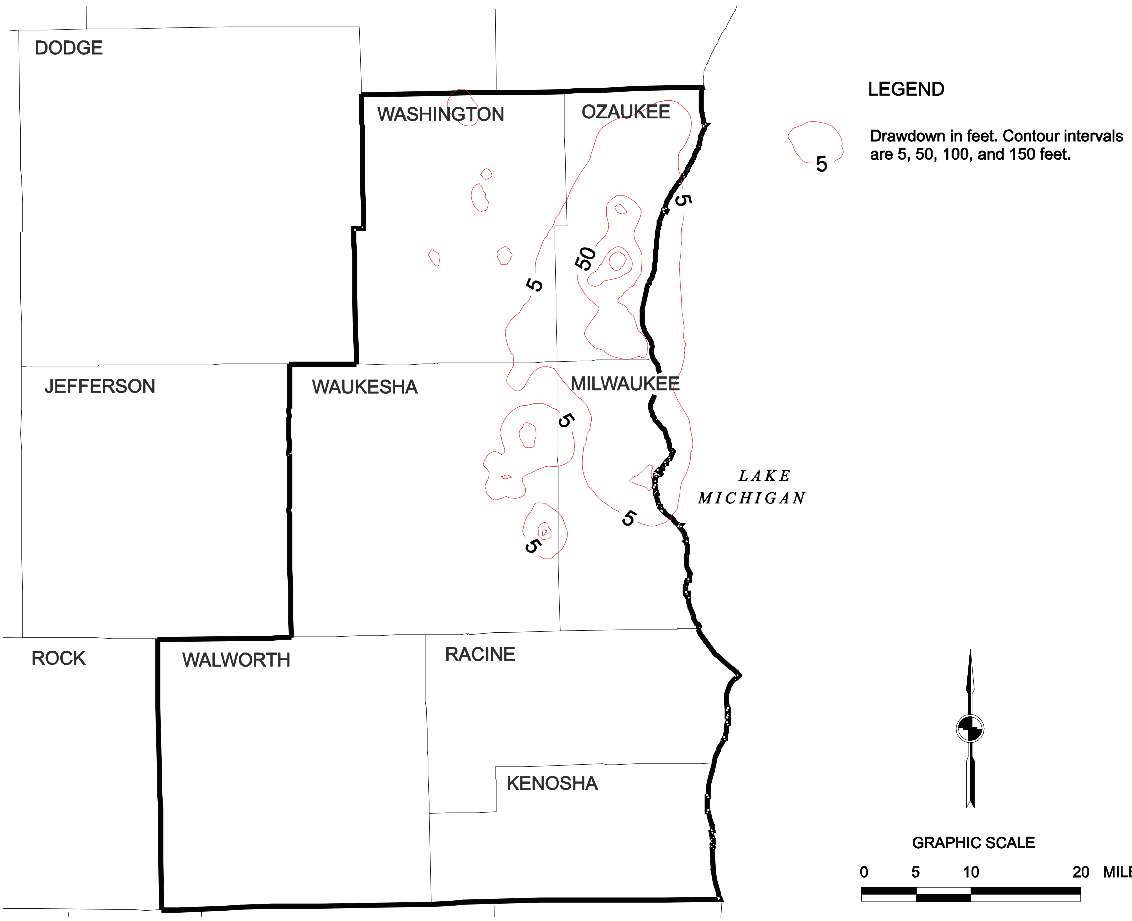


NOTE: The map for 2000 does not illustrate private wells in southeastern Ozaukee County (City of Mequon) that are present in the model after 1960. They are estimated to discharge 3.0 mgd from the shallow part of the flow system in 2000. The map also does not illustrate the effects of the deep sanitary tunnel system in Milwaukee County that is present in the model after 1990. It is estimated to discharge about 2.8 mgd from the shallow part of the flow system in 2000.

Source: U.S. Geological Survey and Wisconsin Geological and Natural History Survey.

Figure 15

SIMULATED DRAWDOWN IN THE SHALLOW SILURIAN DOLOMITE AQUIFER FROM PREDEVELOPMENT CONDITIONS TO THE YEAR 2000



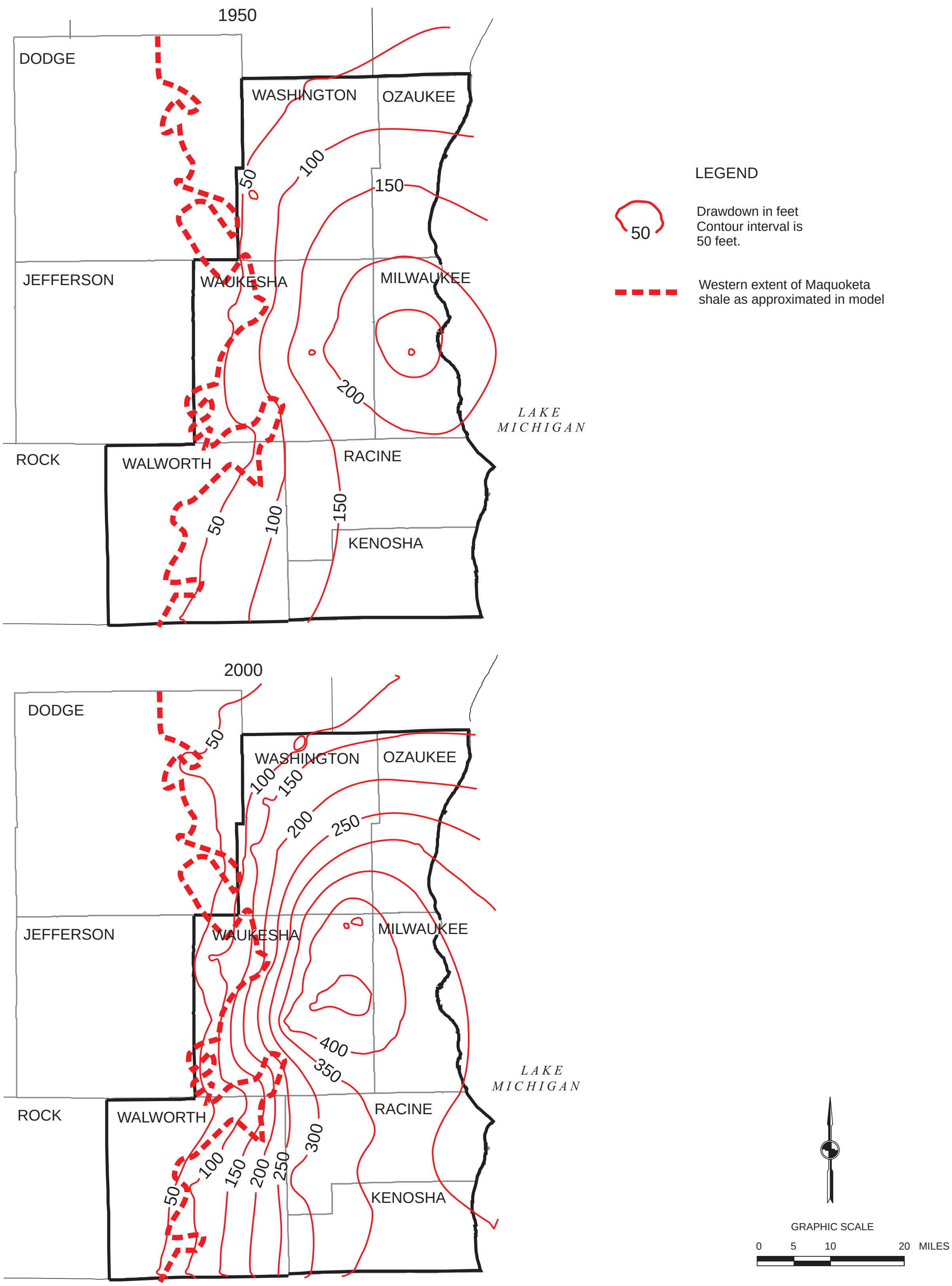
NOTE: The simulation modeling analyses used to develop the drawdown estimates illustrated on this figure do not specifically account for most of the private individual—private, onsite—well pumping occurring in the study area. Most of the water pumped by such systems is returned to the aquifer via onsite sewage disposal systems. The modeling does, however, specifically account for the private individual well pumping in the City of Mequon where most of the water has historically not been returned to the aquifer due to the availability of a public sanitary sewer system.

Source: U.S. Geological Survey and Wisconsin Geological and Natural History Survey.

Hydrographs of simulated water levels through time also show the evolution of drawdown at selected locations. Figure 17 shows water levels in the deep sandstone aquifer at five locations along a line from Watertown to Milwaukee, following the approximate regional southeastward dip of the geologic units concerned. Watertown and Oconomowoc are located far from the major pumping centers and beyond the most westward extent of the Maquoketa shale. At these locations, the sandstone aquifer piezometric surface shows little change from 1864 to 2000. The locations noted as Pewaukee, Elm Grove, and Milwaukee are close to pumping centers in areas where the deep sandstone aquifer is confined by the Maquoketa shale. The hydrograph of Milwaukee water levels shows a steep decline from 1864 until about 1950, after which the decline slowed. Modeling results indicate that the rate of decline in Pewaukee and Elm Grove water levels has also slowed, but only slightly. There is still an appreciable downward trend in these areas.

Figure 16

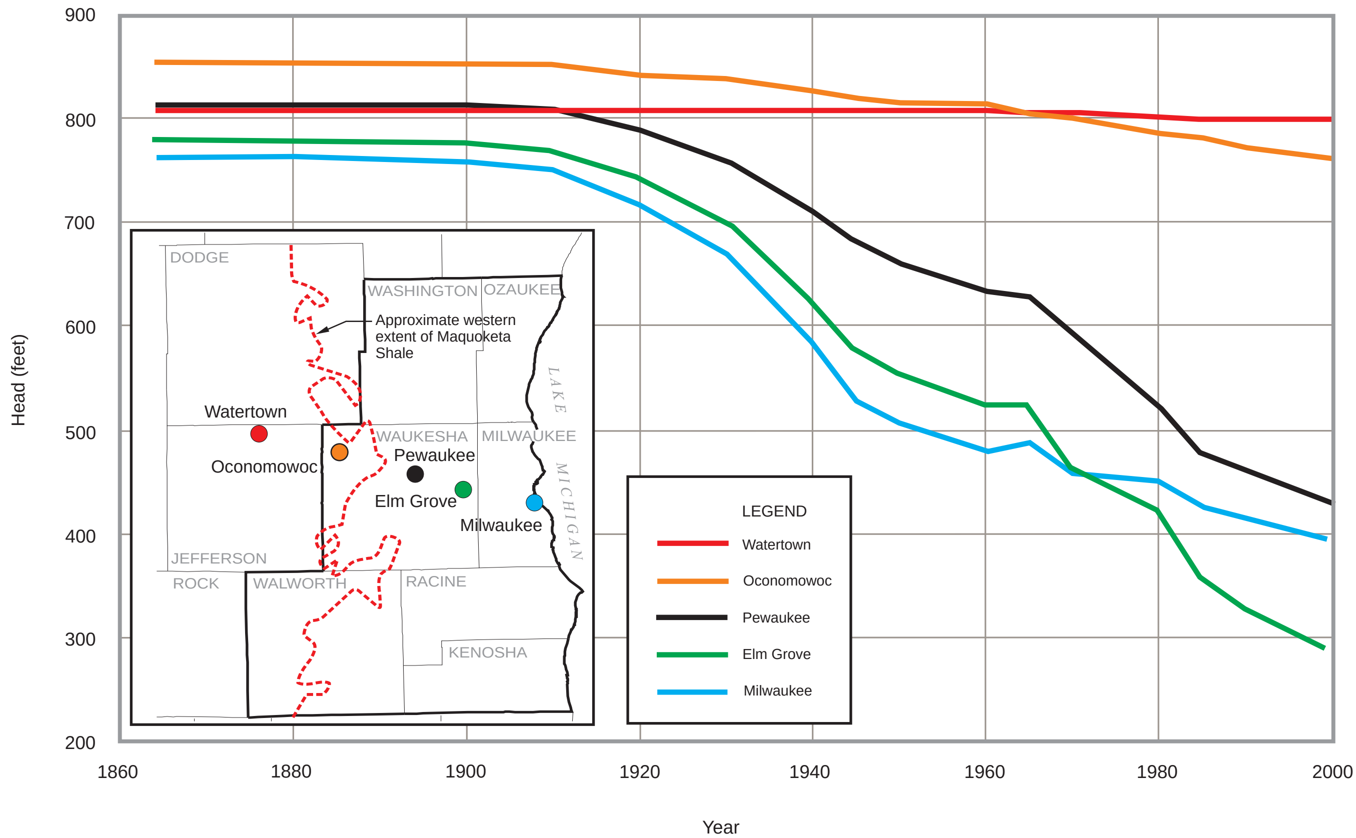
SIMULATED DRAWDOWN IN THE DEEP SANDSTONE AQUIFER FROM PREDEVELOPMENT CONDITIONS: 1950 AND 2000



Source: U.S. Geological Survey and Wisconsin Geological and Natural History Survey.

Figure 17

PIEZOMETRIC SURFACE IN THE DEEP SANDSTONE AQUIFER AT SELECTED LOCATIONS: 1860 TO 2000



NOTE: Curves represent simulated hydraulic heads (in feet above sea level) near the top of the deep aquifer (St. Peter Formation).

Source: U.S. Geological Survey and Wisconsin Geological and Natural History Survey.

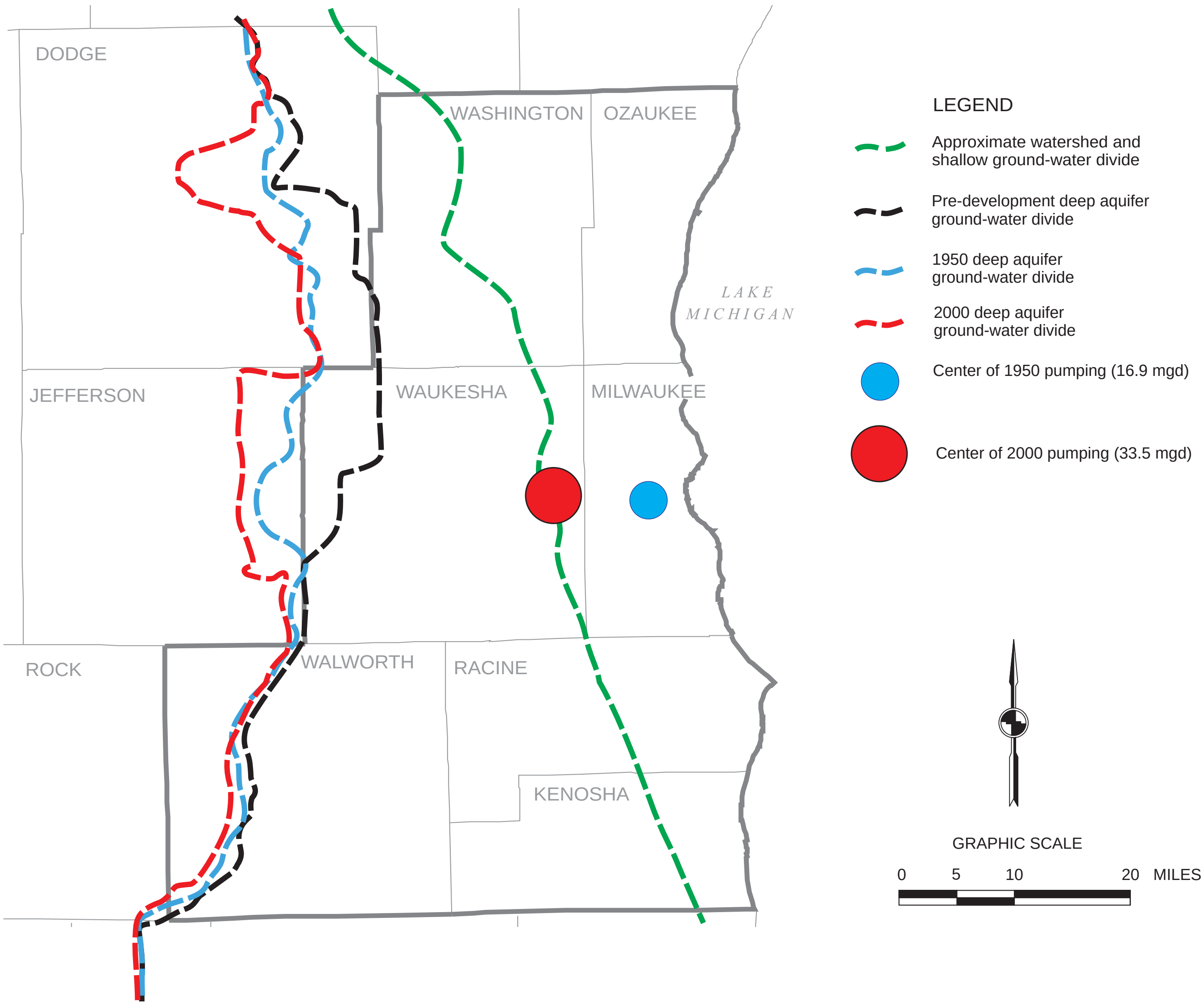
In southeastern Wisconsin, there was no correspondence between the groundwater divides in the deep sandstone aquifer and the subcontinental surface water divide. Pumping from the deep aquifer in southeastern Wisconsin has shifted the groundwater divide in that aquifer to the west, compared with predevelopment conditions, as shown in Figure 18.

INVENTORY PROCEDURES

The water supply inventories conducted under the water supply planning program included the collection and collation of pertinent information on existing water supply facilities, water supply service areas, water use, water quality, and locally prepared water supply system plans and reports. The delineation of the areas served by public water supply systems were based upon updated Commission inventories included in the Commission geographic information data base. The inventory of existing water supply facilities was focused primarily on the location and capacities of surface water intake and treatment facilities, wells, and storage facilities. Water supply system maps were obtained, where available. The system maps and supplemental site-specific data were used in system evaluations and analyses concerning water transmission capacities and pressure zones. The water supply facility and water use inventory data were initially obtained from the U.S. Geological Survey (USGS), Wisconsin Department of Natural Resources (WDNR), and the Public Service Commission of Wisconsin (PSC) data bases. Those data were verified and then entered into a data base established for the water supply planning program.

Figure 18

LOCATION OF PUMPING CENTERS AND GROUNDWATER DIVIDES IN THE DEEP SANDSTONE AQUIFER: PREDEVELOPMENT, 1950, AND 2000 CONDITIONS



Source: U.S. Geological Survey and Wisconsin Geological and Natural History Survey.

For the public water supply systems, the data obtained from the WDNR and PSC data bases together with the mapped water service areas were provided to each water utility owning and operating sources of supply, including wells and surface water treatment plants, for review and revision, as appropriate. Data on water quality and on locally prepared engineering reports and water supply system plans were provided by the water utilities. The WDNR and PSC data bases used were for the years 2000 and 2005. For the public water supply systems, data on water use were also collated for the years 1997 through 2004. In addition, longer-term water use data were obtained from the USGS. Inventory data on water use is presented for the years 2000, 2004, and 2005, with the year 2000 being the base year for the regional water supply planning program. Detailed population and household level and land use data are available for that base year. In addition, the water use data were reviewed for the last two years for which the data were available, as of mid-2006. Those years being 2004 and 2005. These two years presented a range of precipitation conditions, with 2004 having higher than average precipitation, and 2005 having lower than average precipitation, especially during the growing seasons, thus, placing the year 2000 data within a range.

Data are also presented in this chapter on the self-supplied water systems within the Region. The data presented include the location and selected information on self-supplied residential other-than-municipal community systems, and on self-supplied industrial, commercial, institutional, recreational, agricultural, other irrigation, and thermoelectric-power-generation water supply systems. Information is also presented on private domestic wells. The information presented is based upon a review of the existing 2005 WDNR data base on self-supplied systems. It is recognized that some of the data on the self-supplied systems lacks currency. The data for the residential other-than-municipal community water supply system is kept relatively current. However, no periodic reporting is required for most of the self-supplied industrial, commercial, institutional, recreational, agricultural, and other irrigation wells. As such, some of the self-supplied systems reported may no longer be in service and there may be a limited number of new wells which are not included in the data base. In cases where these situations were known to the Commission staff, the data reported were adjusted accordingly. The data on estimated pumpage are typically based upon very limited data—typically including normal and maximum approved daily pumpage. For groundwater modeling purposes under the regional water supply planning program, further investigations were made to develop estimates of self-supplied water system pumpage. As of 2007, the WDNR was in the process of updating the data base concerned. For future uses of the self-supplied water supply system data, it is recommended that updated information be obtained from the WDNR.

DEFINITION OF TERMINOLOGY

In presenting the findings of the inventory of the existing water supply systems in the Region, a definition of the terminology used is essential in order to provide a common frame of reference. Accordingly, a glossary of water supply-related terms, adopted for use in presenting the inventory findings, evaluations, and analyses, alternative plans, and recommended plan set forth in this report, is provided in Appendix B of this report.

WATER SUPPLY SOURCES

Water supply resources, consisting of surface waters in lakes and streams and in the associated wetlands and floodlands, and of the groundwater aquifers underlying the Region, form important elements of the natural resource base of the Southeastern Wisconsin Region. The contribution of these resources to the social and economic development of the Region, to recreational activities within the Region, to the ecology of the Region, and to the aesthetic quality of the Region is immeasurable. Lake Michigan is a major source of water for municipal and industrial users in the most intensely developed areas of the Region lying east of the subcontinental divide. The underlying groundwater aquifers constitute a major source of supply for domestic, municipal, and industrial water users in areas of the Region lying west of the subcontinental divide, as well as for some areas of the Region lying east of the subcontinental divide, primarily in Ozaukee and Washington Counties. As documented in Chapter II, as of 2000, about 1,197,000 persons, or about 62 percent of the total resident population of the Region, were served by public water supply utilities using Lake Michigan as the source of supply. About 364,000 persons, or about 19 percent of the total resident population of the Region, were served by public utilities using groundwater as the source of supply. In addition, about 370,000 persons, or about another 19 percent of the total resident population of the Region, were served by private—primarily onsite—domestic water supply systems using groundwater as a source of supply.

Understanding the interaction of the surface water and groundwater resources of the Region is essential to sound water supply system planning. The surface and groundwater of the Region are interrelated components of, in effect, a single hydrologic system. The groundwater resources of the Region are hydraulically connected to the surface water resources inasmuch as the former provide the base flow of streams, and the water levels of wetlands and inland lakes. Surface waters interact with groundwater in three basic ways: surface waters gain water from inflow of groundwater; lose water from outflow to groundwater; or both gain and lose water from and to groundwater, depending upon the reaches and locations involved and other factors, such as precipitation patterns.

The development and use of groundwater supply sources—such as wells for municipal or irrigation purposes—will have impacts on the surface water system. Thus, the analyses of existing conditions, and the evaluation of alternative and recommended plans developed under this planning program explicitly recognize the existence of such impacts. The surface water system of the Region is described in Chapter II of this report, while the associated surface water use objectives and classifications are described in Chapter V.

The uses of surface water and groundwater as a source of water supply have changed over time in the Southeastern Wisconsin Region. Data on water use are periodically collected by the USGS under a cooperative program with the WDNR. The resulting water use data have been documented in five reports prepared by the USGS and summarized in SEWRPC Technical Report No. 37, *Groundwater Resources of Southeastern Wisconsin*, June 2002, and in preliminary 2005 data developed by the USGS in 2007. The USGS data indicate that, in 2005, water users in the Region withdrew about 291 mgd of water from surface and groundwater sources, not including water used for thermoelectric-power production (see Table 29). Of that amount, about 95 mgd, or about 33 percent, was comprised of groundwater, and about 196 mgd, or about 67 percent, was comprised of surface water, the latter being comprised almost entirely of Lake Michigan water.

Total water use within the Region for all purposes, except thermoelectric-power-generation, fluctuates somewhat from year-to-year. However, total use has been relatively stable since 1979, with an increase of just under 10 percent from 1979 to 2000 (see Table 29 and Figure 19). Between 1979 and 2005, total water use in the Region remained virtually unchanged. This compares to an increase in population within the Region of about 12 percent over this same period. While total water use in the Region has been relatively stable, the proportion of ground and surface water in this total use has been changing. From 1979 to 2005, the use of groundwater increased by about 17 percent, from about 81 to about 95 mgd, while the use of surface water decreased by about 9 percent, from 214 to 196 mgd (see Table 28 and Figure 19).

As shown in Figure 20, total use of water on a per capita basis within the Region has also fluctuated over time. Total per capita water use within the Region increased from 167 to 184 gallons per capita per day from 1979 to 1985, and declined steadily to 147 gallons per capital per day in 2005. As shown in Figure 20, this pattern of change in per capita use varied somewhat by county. Additional water use data for 2005 are presented in subsequent sections of this report. The data are organized by category of use and by county.

Groundwater Supply

Aquifer Characteristics

As indicated in Table 30, the individual hydrogeologic units within the Region differ widely in their ability to yield water to wells. From the standpoint of groundwater occurrence, all rock formations that underlie the Region can be classified either as aquifers or as confining beds. An aquifer is a rock formation or sand and gravel unit that will yield water in a useable quantity to a well or spring. A confining bed, such as shale or siltstone, is a rock formation unit having relatively low permeability that restricts the movement of groundwater either into or out of adjacent aquifers and does not yield water in useable amounts to wells and springs.

The aquifers of southeastern Wisconsin extend to depths, reaching in excess of 2,000 feet in the eastern parts of the Region. As indicated in Table 30, the rock formations underlying the Region may be grouped into five aquifers, two confining units, and two semi-confining beds (see Figure 12 in Chapter II). The aquifers are, in descending order, the Quaternary sand and gravel; Silurian dolomite; Galena-Platteville; upper sandstone; and lower sandstone. The confining beds are the Maquoketa Formation and the Precambrian crystalline rock.

The shaly Antrim Formation and siltstone and shaly dolomite of the Milwaukee Formation constitute the uppermost semi-confining bed; and silty dolomite and fine-grained dolomitic sandstone of the St. Lawrence Formation-Tunnel City Group, the lower semi-confining bed in parts of the Region.

The aquifer systems in southeastern Wisconsin can be divided into two types: unconfined water table aquifers and semi-confined or confined deep aquifers. Water-table conditions generally prevail in the Quaternary deposits and Silurian dolomite aquifer above the Maquoketa Formation and in the Galena-Platteville aquifer west of the

Table 29

TRENDS IN TOTAL WATER USE IN THE SOUTHEASTERN WISCONSIN REGION BY COUNTY: 1979-2005 IN MILLION GALLONS PER DAY[a]

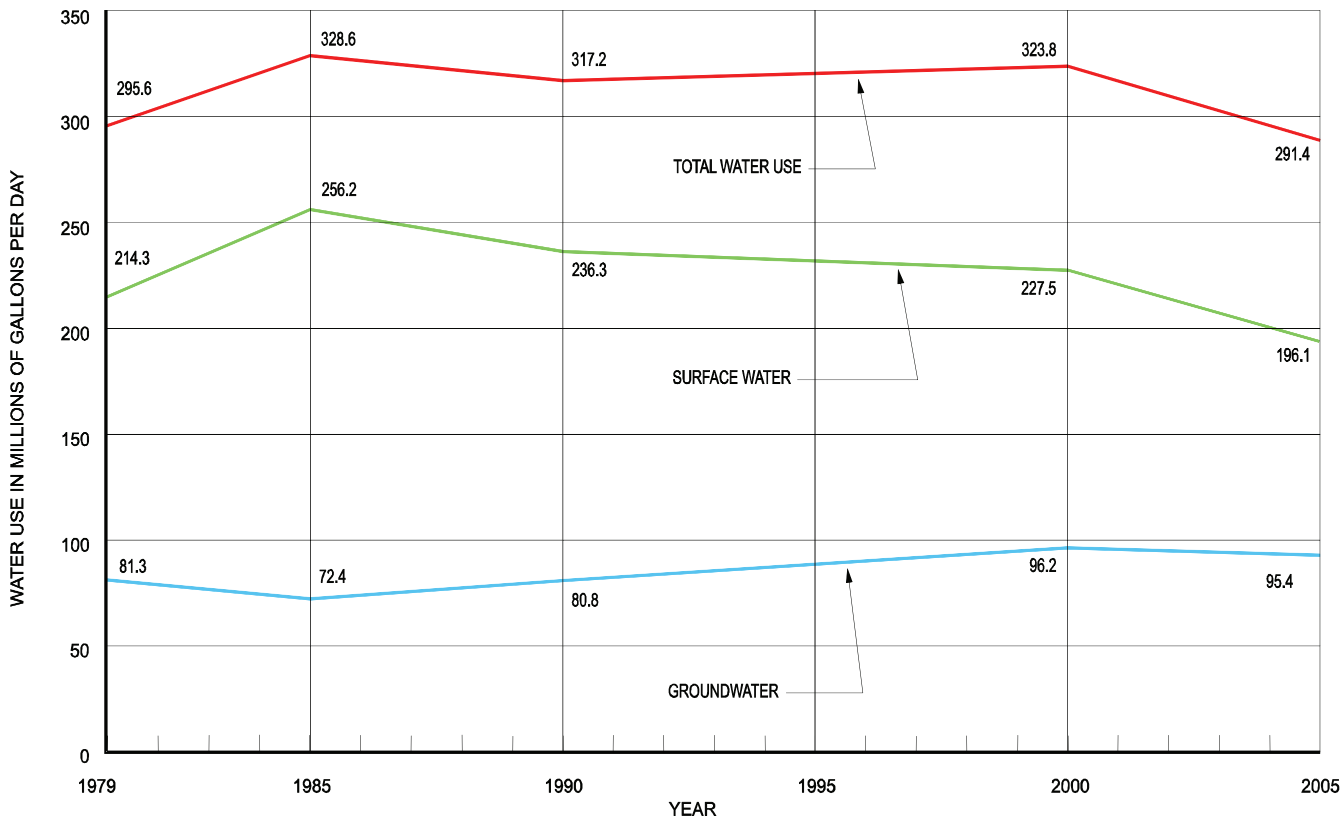
County	1979			1985			1990			2000			2005		
	Surface Water	Groundwater	Total	Surface Water	Groundwater	Total	Surface Water	Groundwater	Total	Surface Water	Groundwater	Total	Surface Water	Groundwater	Total
Kenosha..........	17.81	3.42	21.23	17.87	2.54	20.41	20.41	2.56	22.97	16.04	2.69	18.73	17.43	3.87	21.30
Milwaukee.......	172.47	10.18	182.65	213.26	9.91	223.17	184.96	6.17	191.13	183.22	6.32	189.54	143.92	6.81	150.73
Ozaukee	1.19	6.66	7.85	1.15	6.33	7.48	1.43	6.66	8.09	1.52	7.80	9.32	1.40	9.27	10.67
Racine............	22.55	7.69	30.24	22.55	7.28	29.83	29.32	8.85	38.17	26.24	13.63	39.87	27.01	13.47	40.48
Walworth.........	0.14	9.89	10.03	1.16	9.14	10.30	0.08	16.07	16.15	0.07	14.95	15.02	0.53	14.81	15.34
Washington.....	0.15	10.11	10.26	0.06	9.37	9.43	0.08	9.76	9.84	0.08	13.30	13.38	0.19	13.09	13.28
Waukesha.......	0.02	33.37	33.39	0.12	27.84	27.96	0.04	30.78	30.82	0.35	37.56	37.91	5.59	34.06	39.65
Total	214.33	81.32	295.65	256.17	72.41	328.58	236.32	80.85	317.17	227.52	96.25	323.77	196.07	95.38	291.45

[a]*Includes all water uses within each county, except water use for thermoelectric-power generation.*

Source: U.S. Geological Survey.

Figure 19

TRENDS IN WATER USE IN THE SOUTHEASTERN WISCONSIN REGION: 1979-2005 (IN MILLION GALLONS PER DAY)[a]



[a]*Includes all water uses within the Region, except water use for thermoelectric-power-generation.*

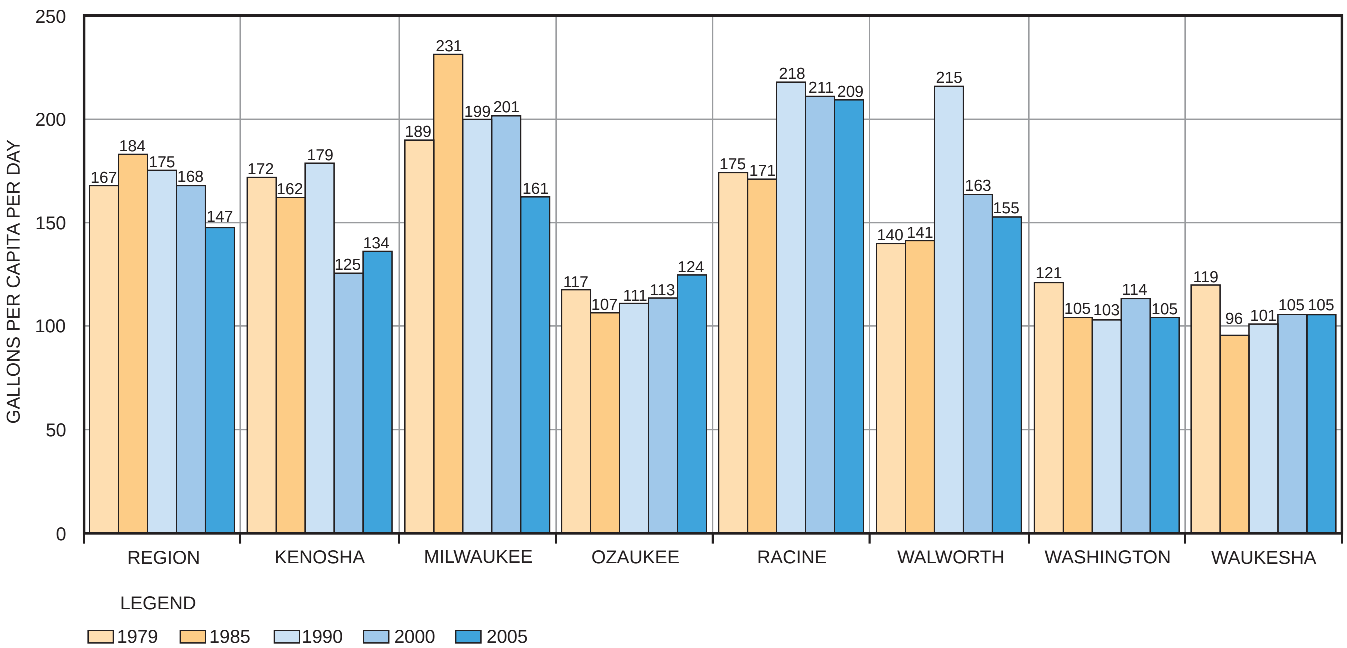
Source: U.S. Geological Survey and SEWRPC.

Maquoketa Formation (see Map 28 and Figure 21). These aquifers are interconnected and are commonly referred to collectively as the “shallow aquifer.” These shallow aquifers provide water for most private domestic wells and some municipal wells within the Region. In 1996, approximately 200 registered wells were in use for municipal water supply by water utilities in the Region. Of these, 61 percent were supplied by groundwater from the shallow aquifer.

In the deep sandstone aquifer beneath the Maquoketa Formation, the water can be under artesian pressure. Deep high-capacity wells in the eastern and central part of the Region extract millions of gallons per day from the sandstone aquifer, creating a decline in water pressure within this aquifer that extends throughout most of the Region, except into the western part of Walworth County. Heavy pumping on the high-capacity wells has caused the gradual, steady decline in the artesian pressure and a reversal of the predevelopment, upward flow of groundwater. Flowing wells, still common within the Region in the late 1880s, ceased flowing at the beginning of the 1900s. The piezometric surface of the sandstone aquifer has been gradually declining and is now lower than the water table throughout most of the Region. On the average, water levels in deep observation wells have been declining at the rate of about four feet per year in the Milwaukee-Racine-Kenosha area, and five feet per year around the City of Waukesha since the beginning of record in the late 1940s.

Figure 20

HISTORIC PER CAPITA TOTAL WATER USE IN THE SOUTHEASTERN WISCONSIN REGION: 1979-2000
GALLONS PER PERSON PER DAY



NOTE: The development of water use data on a per capita basis is most useful when considered for the residential component of water use, as well as for total water use as is presented in this figure. Municipal residential water use is relatively consistent between counties, ranging in 2005 from 66 gallons per capita per day in Walworth County to 72 gallons per capita per day in Waukesha County. Data on residential water uses for 2000, 2004, and 2005 are presented by county in subsequent sections of this chapter.

Source: U.S. Geological Survey and SEWRPC.

For purposes of this study, the aquifers in southeastern Wisconsin are more simply divided into shallow and deep. The shallow aquifer system is comprised of two or three aquifers, depending on its location relative to the Maquoketa shale bedrock subcrop (see Map 28). Where the Maquoketa formation is present, the shallow aquifer system consists of the Silurian dolomite aquifer and the overlying sand and gravel aquifer. There, the Maquoketa Formation is the lower limit of the shallow aquifer system. In the westernmost parts of Waukesha and Walworth Counties where the Maquoketa Formation is not present, the shallow aquifer system consists of the sand and gravel aquifer, Galena-Platteville aquifer, and upper sandstone aquifer, and its lower boundary is the St. Lawrence semi-confining unit (see Figure 12 in Chapter II). Thus, the deep aquifer is defined as the lower sandstone aquifer in areas where the Maquoketa formation is absent. Recharge to the aquifers underlying the Region is derived almost entirely from precipitation. Much of the groundwater in the shallow aquifer originates from precipitation that has fallen and infiltrated within a radius of about 20 miles from where it is found in the aquifer. The deeper sandstone aquifer is recharged by downward leakage of water through the Maquoketa Formation from the overlying aquifers or by infiltration of precipitation beyond the location in the Region where the sandstone aquifer is not overlain by the Maquoketa Formation and is unconfined.

More-detailed description of the areal extent and lithology of aquifers and confining units noted above and including water table depth and elevation mapping can be found in SEWRPC Technical Report No. 37, *Groundwater Resources of Southeastern Wisconsin,* June 2002.

Table 30

HYDROGEOLOGIC UNITS OF SOUTHEASTERN WISCONSIN

Geologic Age	Rock Unit		Hydrogeologic Unit	Water Yield
Quaternary	Undifferentiated		Sand and gravel aquifer	Small to large yields; thick sections yield several hundred gallons per minute
Devonian	Antrim Fm.[1]		Semi-confining unit	Yields little water
	Milwaukee Fm.[1]			
	Thiensville Fm.[1]		Silurian dolomite aquifer	Small to large yields (10s – 100s gpm) depending upon lithology and number and size of solution channels and fractures. Main water-producing units: Thiensville, basal member of Racine, and Mayville (Rovey and Cherkauer, 1994a)
Silurian	Waubekee Fm.[1]			
	Racine Fm.[2]			
	Waukesha Fm.[2]			
	Brandon Bridge beds[2]			
	Byron Fm.[2]			
	Mayville Fm.[2]			
Ordovician	Maquoketa Fm.[2]		Confining unit	Yields little or no water
	Sinnipee Group	Galena Fm.	Galena-Platteville aquifer	Yields little water where overlain by Maquoketa Formation. Commonly yields a few 10s of gpm west of Maquoketa
		(Decorah Fm.)[3]		
		Platteville Fm.		
	Ancell Group	(Glenwood Fm.)[3]	Upper sandstone aquifer	Moderate to large yields (100-500 gpm)
		St. Peter Fm.		
	Prairie du Chien Group	Shakopee Fm.[2]		Small yields (10s of gpm)
		Oneota Fm.[2]		
Cambrian	Trempealeau Group	Jordan Fm.[2]		Moderate yields (100s gpm)
		St. Lawrence Fm.[2]	Semi-confining unit	Yields little water
	Tunnel City Group			Yields little water
	Elk Mound Group	Wonewoc Fm.[2]	Lower sandstone aquifer	Moderate to large yields (100s – 1,000s of gpm)
		Eau Claire Fm.		
		Mt. Simon Fm.		
Precambrian	Undifferentiated		Confining unit	Yields little or no water

NOTES: Fm. = Formation; gpm = gallons per minute; [1]only in eastern Milwaukee and Ozaukee Counties; [2]not always present under the entire Region; [3] thin or locally absent.

Source: Wisconsin Geological and Natural History Survey.

Groundwater Quality

Knowledge of the chemical character of groundwater and its variations is necessary for effective water supply system planning. The data available for the Region are provided in SEWRPC Technical Report No. 37, *Groundwater Resources of Southeastern Wisconsin*, June 2002. Those data were summarized from publications of the U.S. Geological Survey, the Wisconsin Geological and Natural History Survey, the Wisconsin Department of Natural Resources, University of Wisconsin student theses, and the Southeastern Wisconsin Regional Planning Commission itself.

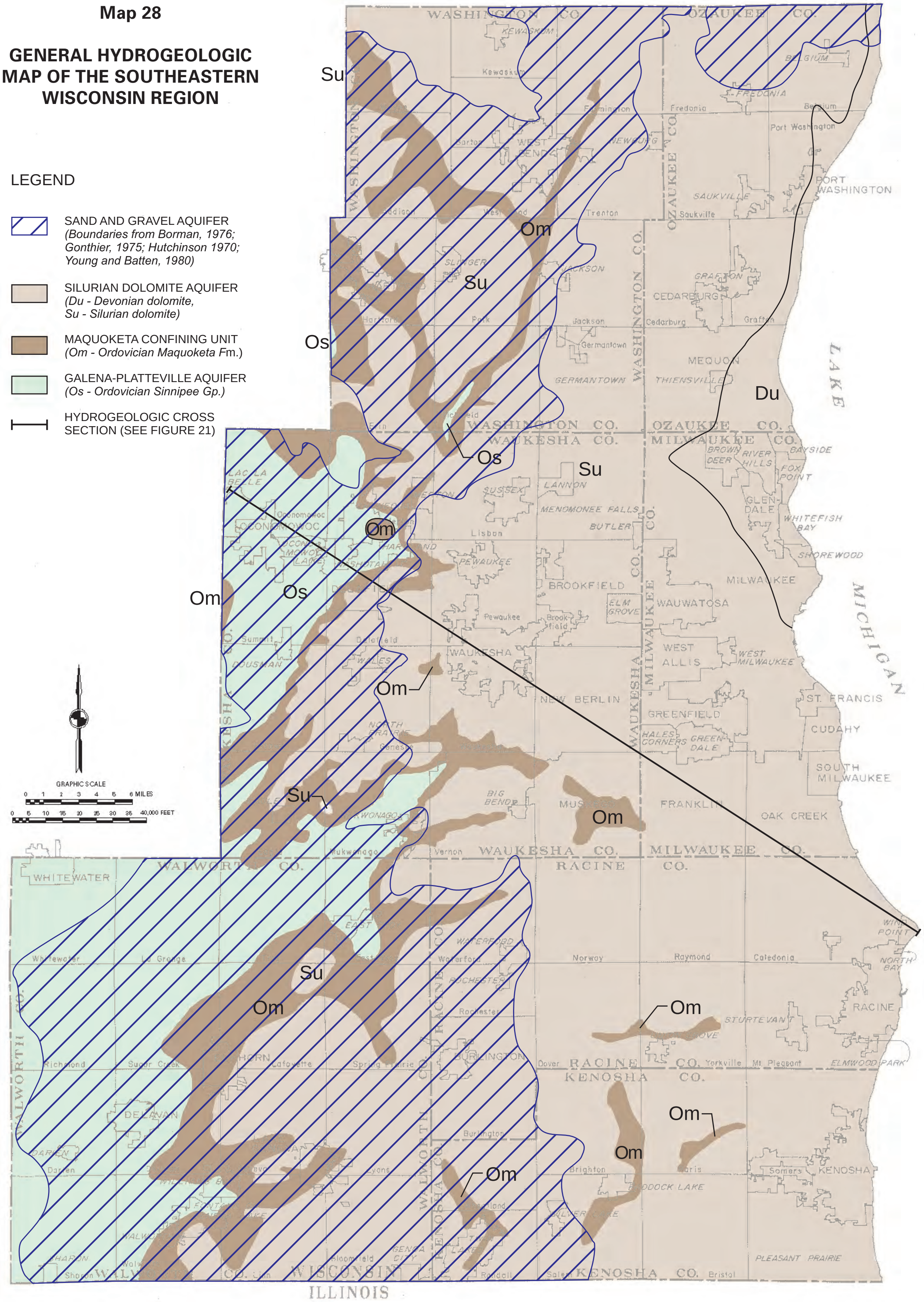
The chemical composition of groundwater largely depends on the composition and physical properties of the soil and rock formations it has been in contact with, the residence time of the water, and the antecedent water quality. The chemical composition of groundwater in the Region is primarily a result of its movement through, and the interaction with, Pleistocene unconsolidated materials and Paleozoic rock formations. The latter contain large

Map 28

GENERAL HYDROGEOLOGIC MAP OF THE SOUTHEASTERN WISCONSIN REGION

LEGEND

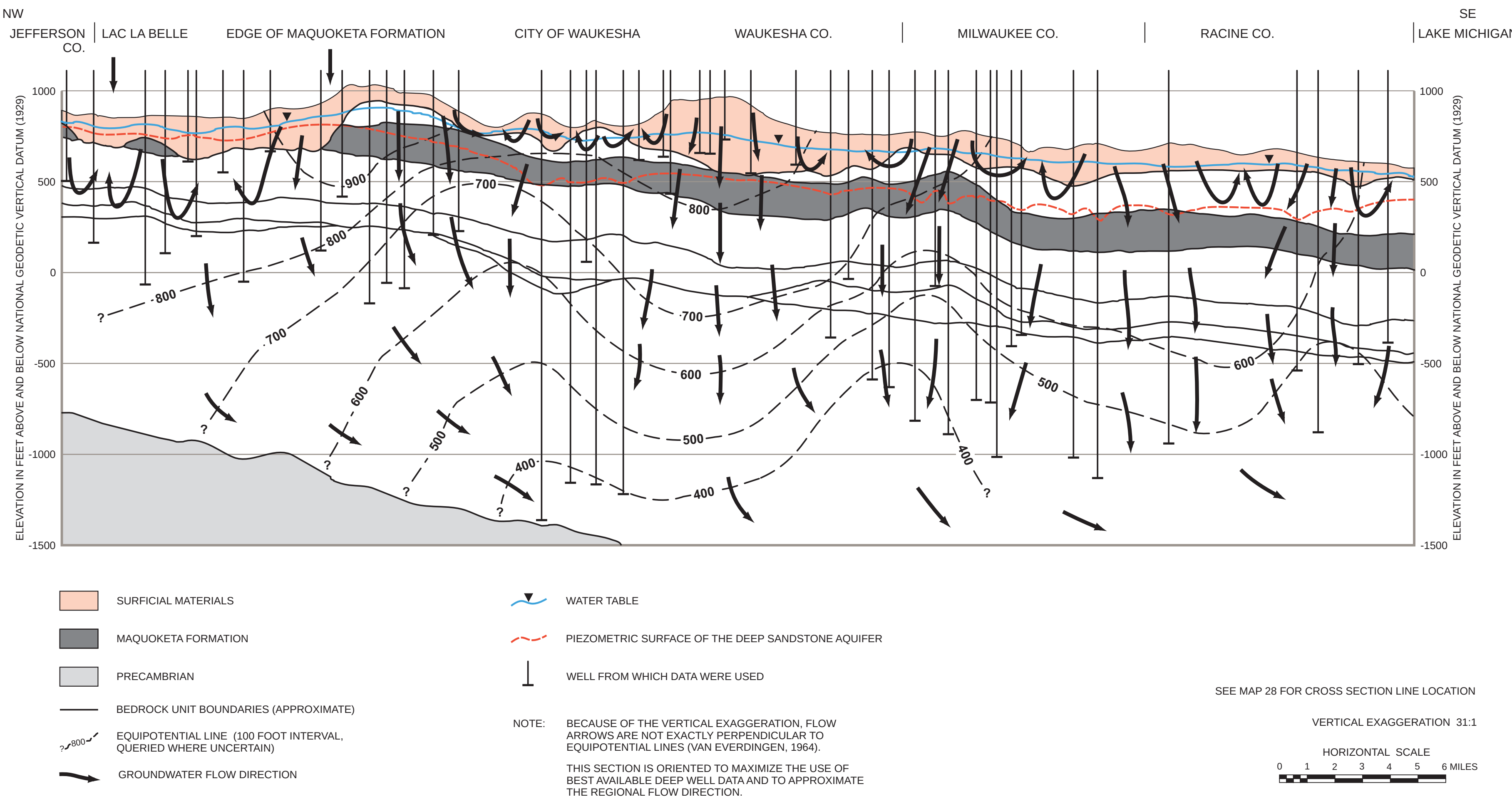
- SAND AND GRAVEL AQUIFER *(Boundaries from Borman, 1976; Gonthier, 1975; Hutchinson 1970; Young and Batten, 1980)*
- SILURIAN DOLOMITE AQUIFER *(Du - Devonian dolomite, Su - Silurian dolomite)*
- MAQUOKETA CONFINING UNIT *(Om - Ordovician Maquoketa Fm.)*
- GALENA-PLATTEVILLE AQUIFER *(Os - Ordovician Sinnipee Gp.)*
- HYDROGEOLOGIC CROSS SECTION (SEE FIGURE 21)



Source: Wisconsin Geological and Natural History Survey.

Figure 21

**SCHEMATIC HYDROGEOLOGIC CROSS-SECTION FROM
LAC LA BELLE, WAUKESHA COUNTY, TO WIND POINT, RACINE COUNTY: APPROXIMATE 1990 CONDITIONS**



Source: Wisconsin Geological and Natural History Survey.

amounts of dolomite—$CaMg(CO_3)_2$—that is dissolved by water passing through the rock formations. In general, groundwater quality tends to be relatively uniform within a given aquifer, both spatially and temporally, but major differences in groundwater quality exist within the Region. The current quality of groundwater in both the shallow and deep aquifers underlying the Region is generally good and suitable for most uses, although localized water quality problems occur in some areas. The exceptions to this is the concentration of radium exceeding drinking water standards which occurs in portions of the deep sandstone aquifer underlying the Region and the concentration of arsenic exceeding drinking water standards in isolated areas generally in the sand and gravel aquifer.

Groundwater in the Region contains all the major ions that commonly dominate the composition of natural waters: calcium (Ca^{2+}), magnesium (Mg^{2+}), and sodium (Na^{+}) cations and bicarbonate (HCO_3^{-}), sulfate (SO_4^{2-}) and chloride (Cl^{-}) anions. The areal distribution and predominance of these major ions can be used to classify the groundwater into hydrochemical facies, i.e., the chemical type of water. Groundwater may be classified as a calcium-magnesium-bicarbonate (Ca-Mg- HCO_3) type in most of the Region. The water chemistry of the shallow and deep aquifer systems underlying the Region are very similar. The most pronounced geochemical changes occur in the confined parts of the deep aquifer system. From the western edge of the Maquoketa shale east toward Lake Michigan, water chemistry changes sequentially from Ca-Mg-HCO_3 to Ca-Na-SO_4-$C1$ to Na-SO_4-Cl type.[5]

Dissolved Solids

Dissolved solids concentration and hardness are good initial indicators of water quality. Concentrations of dissolved solids are primarily in the 300 to 400 milligrams per liter (mg/l) range within the Region. The recommended maximum concentration for drinking water of 500 mg/l is exceeded only locally in isolated areas, primarily in the east-central part of the Region. The dissolved-solids concentration generally increases from west to east, generally in the direction of groundwater movement, and with depth and increased thickness of the aquifer. Available data show negligible differences between individual aquifers on a Regional basis:

- Sand and gravel aquifer: generally 300 to 400 mg/l; locally may exceed 400 mg/l;

- Silurian dolomite aquifer: generally 100 to 300 mg/l along the Lake Michigan shore; 400 to 500 mg/l in Ozaukee, Milwaukee, and eastern Waukesha County; otherwise 300 to 400 mg/l; and

- Sandstone aquifer: generally 300 to 400 mg/l in the west, increasing toward the east to more than 600 mg/l; 200 to 300 mg/l in western Waukesha and northern Walworth and Racine Counties.

Map 29 shows the distribution of dissolved-solids concentration in the Silurian dolomite aquifer, the prevalent shallow aquifer in the Region. The map also shows those wells for which available data indicate concentrations above 1,000 mg/l. Water containing high dissolved solids is occasionally reported by drillers of new deeper wells in the aquifer. Water containing more than 1,000 mg/l of dissolved solids is considered brakish water. The highest concentration of dissolved solids documented within the Region was a composite sample from a well tapping the Silurian dolomite, Galena-Platteville dolomite, and St. Peter Sandstone aquifers in northeastern Milwaukee County: ML 413 to 6,690 mg/l.

Hardness

As shown on Map 30, hardness in the groundwater underlying the Region is generally high due to the dominance of calcium-magnesium cations in the groundwater. Hardness is reported in terms of equivalent concentration of calcium carbonate ($CaCO_3$), in milligrams per liter. No Federal or State standards for hardness have been

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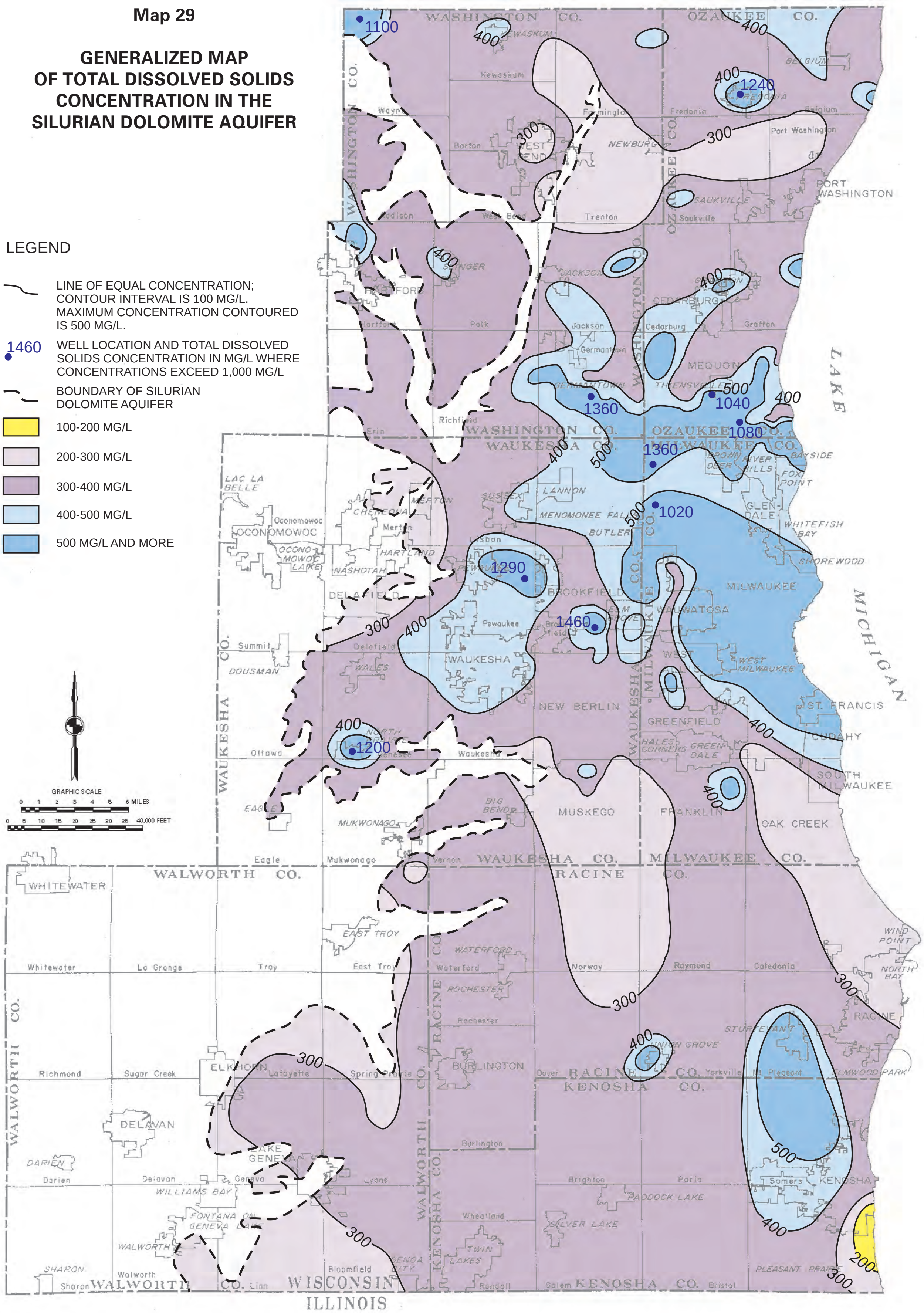
[5]*D.I. Siegel,* Geochemistry of the Cambrian-Ordovician Aquifer System in the Northern Midwest, United States, *(Regional Aquifer-System Analysis report), U.S. Geological Survey Professional Paper 1405-D, 1989.*

Map 29

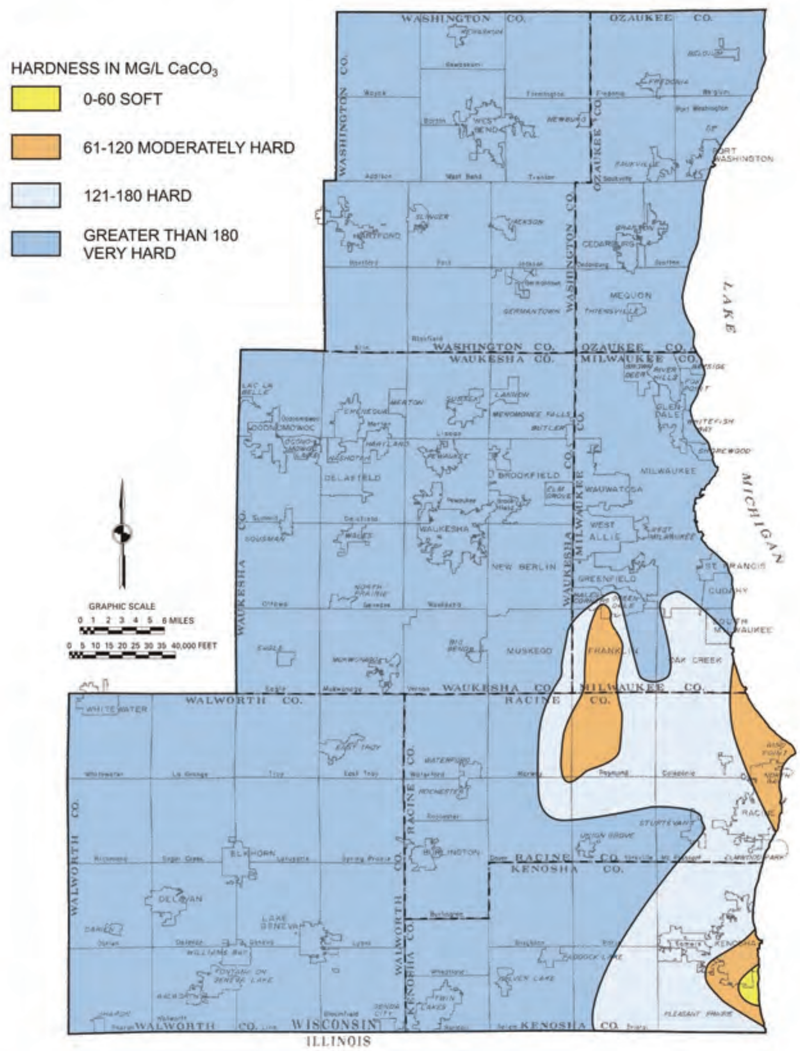
GENERALIZED MAP OF TOTAL DISSOLVED SOLIDS CONCENTRATION IN THE SILURIAN DOLOMITE AQUIFER



Source: Wisconsin Geological and Natural History Survey and U.S. Geological Survey.

Map 30

**AREAL DISTRIBUTION OF HARDNESS OF GROUNDWATER
IN THE SHALLOW AQUIFERS OF SOUTHEASTERN WISCONSIN**



Source: Wisconsin Geological and Natural History Survey.

promulgated, but water with a hardness of less than 100 mg/l $CaCO_3$ is generally considered as suitable for domestic uses. Water having more than 180 mg/l $CaCO_3$ is considered very hard, and softening is required for most purposes. Hardness does vary somewhat between aquifers:[6]

- Sand and Gravel Aquifer: Hardness levels in the shallow aquifer is variable in the Region, varying from 164 mg/l $CaCO_3$ in Racine County to 353 mg/l $CaCO_3$ in Waukesha County.

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[6]*P.A. Kammerer, Jr.,* Groundwater Quality Atlas of Wisconsin, *U.S. Geological Survey and University of Wisconsin-Extension, Wisconsin Geological and Natural History Survey, Information Circular 39-1981.*

- Silurian Dolomite Aquifer: Mean hardness levels varied from 241 mg/l $CaCO_3$ in Kenosha County to 722 mg/l $CaCO_3$ in Ozaukee County.

- Sandstone Aquifer: Mean hardness levels varied from 154 mg/l $CaCO_3$ in Kenosha County to from 350 to 390 mg/l $CaCO_3$ in Milwaukee, Ozaukee, Washington, and Waukesha Counties.

Hardness in the Silurian dolomite aquifer generally ranges from 180 mg/l to 360 mg/l $CaCO_3$.

The hardest water is found in northern Milwaukee County and northeastern Waukesha County with values exceeding 360 mg/l. Hardness in excess of 360 mg/l, or even 500 mg/l $CaCO_3$ is common in wells in the Villages of Brown Deer and Menomonee Falls, and the Cities of Brookfield, Glendale, and Milwaukee. Wells ML 408 and ML 413 in the Village of River Hills have measured hardness exceeding 1,500 mg/l. The eastern parts of Racine and Kenosha Counties have groundwater in the shallow aquifer containing less than 180 mg/l of hardness, with less than 120 mg/l in the northeastern corner of Racine County and southeastern corner of Kenosha County.

Trace Elements
Concentrations of some constituents, normally found in trace amounts, exceeded accepted limits in some areas of the Region and may limit the usefulness of groundwater for certain purposes. Barium concentrations may exceed the limit of one mg/l in a 30-mile broad band running through the western part of Washington County, most of Waukesha County, eastern Walworth County, and western Racine and Kenosha Counties. The higher barium concentrations may be attributed to a zone of reducing conditions in the confined aquifer system, extending from northeastern Illinois to Wisconsin. Radium concentrations (226Ra and 228Ra combined) in some parts of the confined deep aquifer system exceed the current drinking water standard. The sources of the high radium concentrations in the groundwater may be attributed to the occurrence of uranium and thorium in the matrix of sandstones.

Water Quality Concerns
Some water quality problems are caused by natural factors, which cannot be controlled. For example, the abundant dolomite material in the Region releases calcium and magnesium, which form about one-half of all ions in groundwater and are the principal components of hardness. Therefore, as shown on Map 30, hardness is objectionably high in the groundwater underlying most of the Region, and softening is required for almost all water uses.

The deep aquifer water in some parts of the Region contains saline water, that is, water with dissolved solids concentrations greater than 1,000 mg/l. But, saline water also can occur in the shallow aquifer system through hydraulic connection between the deep and shallow aquifer systems. Dissolved solids levels in excess of 1,000 mg/l have been documented[7] in southeastern Ozaukee County and northeastern Milwaukee County. Several areas in southwestern Ozaukee, northeastern Waukesha, and northern Milwaukee Counties have been reported,[8] where saline water is suspected or has been found to be beneath the shallow aquifer system. Some locations of wells in the shallow aquifer system containing more than 1,000 mg/l of dissolved solids are shown on Map 29.

Naturally occurring radioactivity in groundwater, including radium and radon, has become a concern in Wisconsin in recent years. The State initiated several studies to examine the occurrence and extent of these naturally occurring contaminants. Radon does not appear to be a water-related problem in the shallow aquifer of

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[7]*R.W. Ryling,* A Preliminary Study of the Distribution of Saline Water in the Bedrock Aquifers of Eastern Wisconsin, *Wisconsin Geological and Natural History Survey, Information Circular 5, 1961.*

[8]*P.A. Kammerer, Jr.,* Ground-Water Flow and Quality in Wisconsin's Shallow Aquifer System, *U.S. Geological Survey Water-Resources, Investigations Report 90-4171, 1995.*

southeastern Wisconsin. The source of radium in groundwater is the naturally occurring radium content of certain types of rock formations in the deep sandstone aquifer. There are a number of water supply systems in the Region which reported one or more exceedances of the current five picocuries per liter EPA and State maximum contaminant level (MCL) standard for radium (combined Radium-226 and Radium-228). Based on the consumer confidence reports for 2006 issued by the WDNR, during the six-year period from January 1, 2002 through December 31, 2006, seven municipal water utilities and two "other-than-municipal community" water systems in the Region using groundwater as a source of supply reported at least one sample which had radium levels exceeding the MCLs. In addition, during the same time period, 10 municipal water utilities and four "other-than-municipal community" water systems in the Region using groundwater as a source of supply reported at least one exceedence of the 15 picocuries per liter USEPA and State MCL for gross alpha particle activity, excluding radon and uranium. Although most of the exceedances of the radium standard have occurred in wells open to Cambrian sandstone formations, hydraulic connection between the deep and shallow aquifer systems and the upward migration of groundwater in some areas can bring the water with elevated concentrations of radium into shallow aquifers.

Another naturally occurring element, arsenic (As), is also of concern because selected municipal and private water supplies exceed a new Federal and State MCL standard of 10 micrograms per liter. Data from the WDNR Groundwater Reporting Network (GRN) databases indicate that during the period from January 1, 1998 through December 31, 2006, 1,243 wells in the Region were tested for arsenic. Arsenic was detected in 781, or about 63 percent of these wells, with concentrations exceeding the MCL in 63, or about 5 percent, of wells tested. The State preventive action limit of 1.0 microgram per liter was exceeded in 610, or about 49 percent, of wells tested. It is important to note that because the GRN databases do not include data from monitoring wells associated with some actions such as USEPA Superfund sites and some groundwater remediation actions, these percentages may not be representative of the extent of arsenic contamination in groundwater in the Region. In Wisconsin, arsenic has been found in several different geologic units, including igneous rocks of the Precambrian shield, Paleozoic sedimentary rocks, and Quaternary glacial deposits. Two distinct mechanisms related to differences in mineralogy appear to promote the release of arsenic into groundwater.[9] In one mechanism, oxidation of sulfide-containing minerals releases arsenic. This oxidation may have occurred at some time in the geologic past or may be due to the introduction of oxygen as a result of the water levels in wells dropping to levels at or just below the sulfide-rich zones. In the other mechanism, arsenic bound to iron-hydroxide minerals is reductively released to groundwater under conditions of low dissolved oxygen. In the Region, arsenic is associated with iron-hydroxide minerals in Quaternary glacial deposits. A recent study that examined a core through the Quaternary aquifer taken near Lake Geneva and sediment samples from previous drilling efforts in this area showed that these minerals are widely dispersed throughout the aquifer.[10] Because dissolved oxygen concentrations in the deep Quaternary aquifer tend to be low, deeper drilling into this aquifer is unlikely to reach water with lower arsenic concentrations.

Contaminants resulting from human activities, causing groundwater quality problems in the Region, include bacteria, viruses, prions, nitrate, pesticides, and volatile organic compounds (VOCs). These can affect the quality of water in private wells, but generally do not constitute a major problem.

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[9]*M.B. Gotkowitz, J.A. Simo, and M. Schreiber,* Geologic and Geochemical Controls on Arsenic in Groundwater in Northeastern Wisconsin, *Final Report submitted to the Wisconsin Department of Natural Resources, Wisconsin Geological and Natural History Survey Open File Report 2003-01, 2003.*

[10]*Tara L. Root,* Controls on Arsenic Concentrations in Groundwater from Quaternary and Silurian Units in Southeastern Wisconsin, *Ph.D. Dissertation, University of Wisconsin, 2005.*

The coliform bacteria test has traditionally been used to measure the sanitary condition of well water. Although coliform bacteria are not known to usually cause disease, their presence in well-water samples may be an indication that more harmful bacteria also exist in a well. Bacteria can be introduced into wells from septic tanks, leaking sanitary sewer lines, feedlots, and manure pits and piles. Their presence usually indicates an improperly constructed well or a well too shallow for local conditions, such as thin soil or fractured bedrock. Coliform bacteria have been detected in, on average, 15 percent of the private wells in the Region, although there is a wide geographic and seasonal variability. In shallow, fractured bedrock aquifers, such as dolomite in the Town of Lisbon, Waukesha County, up to 73 percent of wells have been tested "unsafe." Protected aquifer wells average less that 6 percent unsafe.[11] Overall, coliform detection rates are three times higher in late summer months than midwinter.[12] *E. coli*, the coliform most strongly associated with fecal contamination, is found in fewer than 2.6 percent of private wells.[13] Well bacterial contamination may not always be caused by poor aquifer conditions or substandard well construction. Incidental sources, such as insects under well caps, careless pump work, and iron biofilms are believed responsible for many coliform detects. By way of comparison, 3.7 percent of public water systems in the Region experienced confirmed total coliform contamination in 2005.[14]

Enteric viruses constitute another potential biological contaminant of groundwater. These pathogens are capable of causing a number of diseases including hepatitis A and gastroenteritis. They have been shown to be capable of moving considerable distances in the subsurface environment. Horizontal migration of viruses of about one quarter mile in glacial till and one mile in fractured limestone has been reported.[15] Viruses can persist and remain infective for several months in soils and groundwater when temperatures are low and soil is moist.[16] Enteric viruses are shed by infected individuals in quantities of billions to tens of billions per gram feces and have an infectious dose on the order of tens to hundreds of viral particles,[17] so that even high reductions in virus concentration during transport could result in infectious virus being present in potable groundwater. A recent study which surveyed 50 private wells on a quarterly basis throughout the State of Wisconsin found that 8 percent of wells tested positive for the presence of at least one enteric virus.[18] Contamination appears to have been transient, since none of the wells was positive for virus in two sequential samples. The authors argued that the study results

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[11]*Sharon Shaver,* Investigation of Bacteriological Water Quality in Private Water Supply Wells in Waukesha County*, WDNR Report 1996. Data from WDNR Groundwater Retrieval Network (GRN) and Waukesha County Environmental Health Department.*

[12]*Jon Standridge, Wisconsin State Laboratory of Hygiene data; Sharon Shaver, Ozaukee County GRN Data, 1990-1995.*

[13]*Centers for Disease Control,* A Survey of the Quality of Water Drawn for Domestic Wells in Nine Midwestern States*, 1994.*

[14]*Charles A. Czarkowski, WDNR Drinking Water & Groundwater Expert, Public Water System database.*

[15]*B.H. Keswick and C. P. Gerba, "Viruses in Groundwater,"* Environmental Science and Technology*, Volume 14, 1980; J.B. Robertson and S.C. Edberg, "Natural Protection of Spring and Well Drinking Water Against Surface Microbial Contamination. I. Hydrogeological Parameters,"* Critical Reviews in Microbiology*, Volume 23, 1997.*

[16]Ibid.; *M.V. Yates, C. P. Gerba, and L. M. Kelley, "Virus Persistence in Groundwater,"* Applied and Environmental Microbiology*, Volume 49, 1985.*

[17]*B.N. Fields and others,* Fields Virology*, Volume 1, 3rd edition, Lippincott, 1996.*

[18]*Mark A. Borchardt and others, "Incidence of Enteric Viruses in Groundwater from Household Wells in Wisconsin,"* Applied and Environmental Microbiology*, Volume 69, 2003.*

may represent an upper limit to the incidence of viral contamination of private wells in the State, because the wells examined were chosen based on their proximity to subdivisions served by septic tanks and to sites at which high volumes of septage were applied to the land. In addition, the methodology used in the study does not distinguish between infective and noninfective viral particles. Concurrent tests from the same wells for the presence of enteric viruses using cell culture techniques, which detect only infective virus, detected no virus. The study also found that water quality indicators, such as total coliform bacteria, *E. coli*, and nitrate were not correlated with detections of viruses, making them poor predictors of viral contamination. While the small number of wells in which enteric viruses were detected makes any conclusions as to factors contributing to viral contamination tentative, the wells in which viruses were detected shared a few characteristics. All four of these wells were relatively new and complied with State codes, suggesting that current well construction practices may not prevent virus contamination. All of the contaminated wells were located in subdivisions served by septic systems. Most of the contaminated wells were located in coarse-textured soils. This is consistent with rates of virus transport being higher in sand and gravel than in finer-textured soils.[19]

Prions are an inanimate disease agent that may constitute an additional potential contaminant of groundwater. These pathogens are responsible for a family of degenerative neurological disease known as transmissible spongiform encephalopathies, including variant Creutzfeldt-Jakob disease in humans, bovine spongiform encephalopathy in cattle, chronic wasting disease in deer and elk, and scrapie in sheep and goats. Prions are thought to be distorted forms of proteins naturally present in neural and other body tissues of animals.[20] They can persist in soils for at least three years[21] and are highly resistant to physical and chemical agents, such as heat, ultraviolet light, ionizing radiation, chemical disinfectants, and organic solvents.[22] Little is known about their fate in water and wastewater treatments systems. While they bind strongly to some soil minerals, this does not appear to reduce their infectivity.[23] Little is known about their movement through soil and groundwater, though as particulates, their movement through geological media is likely to be affected by the same processes that influence the behavior of other particulate infectious agents such as bacteria and viruses. No data are available on the presence of prions in groundwater. The risks to groundwater posed by prions are uncertain. These risks are thought to be highest in situations where large numbers of infected animals are destroyed and buried to control the spread of animal diseases and where overland flow transports material from carcasses in fields or prion-contaminated animal-based fertilizers directly into poorly-constructed wells.

In Wisconsin, nitrate-nitrogen is the most commonly found groundwater contaminant that exceeds the State drinking water standard of 10 mg/l. Nitrate can enter groundwater from many sources, including nitrogen-based fertilizers, animal waste storage facilities, feedlots, septic tanks, and municipal and industrial wastewater and sludge disposal sites. Data from the WDNR GRN databases suggest that nitrate contamination is a relatively

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[19]*Ann Azadpour-Kelley, Barton S. Faulkner, and Jin-Song Chen, "Movement and Longevity of Viruses in the Subsurface," U.S. Environmental Protection Agency National Risk Management Laboratory, EPA/540/5-03/500, April, 2003.*

[20]*V.P.J. Gannon, "Control of Zoonotic Waterborne Pathogens in Animal Reservoirs," In J.A. Cotruvo and others,* Waterborne Zoonoses: Identification, Causes and Control, *IWA Publishing, London, 2004.*

[21]*P. Brown and D.C. Gajdusek, "Survival of Scrapie Virus After 3 Years' Internment,"* Lancet, *Volume 337, 1991.*

[22]*D.M. Taylor, "Inactivation of Transmissible Degenerative Encephalopathy Agents: A Review,"* Veterinary Journal, *Volume 159, 2000.*

[23]*C.J. Johnson and others, "Prions Adhere to Soil Minerals and Remain Infectious,"* Public Library of Science Pathogens, *Volume 2, 2006.*

minor problem in the Region. In samples collected from 4,857 wells in the Region during the period January 1, 1998 through December 31, 2006, nitrate-nitrogen was found to exceed the enforcement standard of 10 mg/l in about 3 percent of wells and the preventive action limit of two mg/l in about 17 percent of wells. The exceedence rate for the enforcement standard was found to range from about 0.3 percent in Ozaukee County to about 6.2 percent in Walworth County. It is important to note that because the GRN databases do not include data from some actions such as USEPA Superfund sites and some contaminated groundwater remediation actions, these percentages may underestimate the extent of nitrate-nitrogen contamination in groundwater in the Region.

Pesticide contamination of groundwater results primarily from agricultural field applications, spills, misuse, or improper storage and disposal of pesticides. In 1992 the Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP) initiated a rural well sampling program for testing of atrazine, the most widely used triazine herbicide in Wisconsin for weed control, primarily in corn plantation. Triazine was detected in 63 of the 263 samples collected by DATCP in all of the counties within southeastern Wisconsin, except Milwaukee.[24] However, none of the samples were found to exceed the State drinking water standard. Data from the WDNR GRN databases indicate that during the period January 1, 1998 through December 31, 2006, wells in the Region were sampled for 26 different pesticides. The number of wells sampled varied by compound, ranging between one and 838, with an average number of 347. Most of these compounds were detected in fewer than 15 percent of the wells sampled. Nine of these compounds were compared to State preventive action limits and enforcement standards. Only one pesticide was found to exceed either of these standards. Pentachlorophenol, an insecticide and fungicide, exceeded the preventive action limit of 0.1 micrograms per liter in slightly more than 1 percent of the wells sampled. As previously noted, the GRN databases do not include data from monitoring wells associated with some actions such as USEPA Superfund sites and some contaminated groundwater remediation actions. Thus, these percentages may underestimate the extent of pesticide contamination in groundwater in the Region.

The presence in certain locations of volatile organic chemicals (VOCs) is also a cause of concern. Sources of VOCs include landfills, leaking underground storage tanks, and spills of hazardous substances. Data from the WDNR GRN databases indicate that during the period January 1, 1998 through December 31, 2006, wells in the Region were sampled for 88 different VOCs. The number of wells sampled varied by compound, ranging between one and 2,175 with an average number of 1,234. Most compounds were detected in less than 10 percent of the wells sampled. For most compounds, State preventive action limits and enforcement standards were exceeded in less than 1 percent of the wells sampled. As previously noted, the GRN databases do not include data from monitoring wells associated with some actions such as USEPA Superfund sites and some contaminated groundwater remediation actions. Thus, these percentages may underestimate the extent of VOC contamination in groundwater in the Region.

Groundwater in the Region has also been examined for concentrations of inorganic compounds of public health and welfare concern and for values of groundwater indicator parameters. Data from the WDNR GRN databases indicate that during the period January 1, 1998 through December 31, 2006, wells in the Region were sampled for 48 different inorganic compounds and indicator parameters. The number of wells sampled varied by compound and indicator parameter, ranging between one and 1,880 with an average number of 583. On average, each compound or indicator parameter was detected in about 66 percent of wells sampled. Of these compounds and indicator parameters, 24 were compared to State preventive action limits and enforcement standards. Methodologies for establishing preventive action limits have been issued for an additional 10 of these compounds and indicator parameters; however, these standards were not computed in the GRN databases. Preventive action limits were exceeded in at least some wells in the Region for 21 inorganic compounds and indicator parameters. The fraction of wells sampled that exceeded preventative action limits varied among the compounds and parameters, ranging from less than 1 percent to 68 percent with an average value of about 9 percent. Enforcement standards were exceeded for at least some wells in the Region for 18 inorganic compounds and indicator parameters. The

[24]*Charles A. Czarkowski, WDNR Drinking Water & Groundwater Expert, Public Water System database.*

fraction of wells sampled that exceeded enforcement standards also varied among the compounds and parameters, ranging from less than 1 percent to 56 percent with an average value of about 4 percent. As previously noted, the GRN databases do not include data from some actions such as USEPA Superfund sites and some contaminated groundwater remediation actions. Thus, these percentages may underestimate the extent of inorganic compound contamination in groundwater in the Region.

Natural sources of chloride in potable water, other than weathering of minerals, include atmospheric deposition and connate water. Human and animal wastes, salt used for snow and ice removal, and salt used in water softening contributed to wastewater are important sources of chloride in some areas. Because chloride is, itself, a possible contaminant, and is also found in contaminants, such as wastewater and animal wastes, it is potentially useful as a general indicator of groundwater contamination when it is present in greater-than-ambient concentrations.

Chloride concentrations in water from the aquifer systems in southeastern Wisconsin are commonly low. State secondary drinking water standards specify a maximum concentration of 250 mg/l for chloride in drinking water. The standard is based on aesthetic (taste) considerations.

Concentrations of chloride in water from the shallow aquifer is generally from 10 to 30 mg/l in the Region.[25] However, limited areas of the Silurian Dolomite aquifer have naturally occurring chloride concentrations which exceed 100 mg/l. In addition, isolated areas of the sand and gravel aquifer have been found to have levels exceeding the 250 mg/l standard due to contamination sources. Chloride concentrations in surface waters in the Region have been found to be increasing. However, no specific data on trends in the concentration of chloride in groundwater are available for the Southeastern Wisconsin Region.

Data were obtained from the WDNR on areas of special well casing requirements, which indicate the presence of contaminants. The special well casing requirement program was created under Chapter NR 812 of the *Wisconsin Administrative Code* to provide additional protection of drinking water quality in areas where aquifers are known to be contaminated. Special well casing requirement areas, based on detected or suspected contaminants, designated by the WDNR in the Region in 2005 are listed in Table 31 and the locations of the special well casing requirement areas are shown on Map 31. The most often found contaminants were VOCs and bacteria. Other contaminants included petroleum products, nitrates, and landfill leachate.

Surface Water Supply

Nearly all of the surface water supply in the Region is from Lake Michigan, with some use of other surface waters for limited purposes. These include a few instances of water use from the Milwaukee River for intermittent recharge of the groundwater associated with building foundation maintenance, and for cooling of buildings primarily in the central business district of Milwaukee, and with water used from the Menomonee River for thermoelectric-power-generation purposes. In addition, other surface waters are intermittently used for such purposes as irrigation of agricultural lands or golf courses and for ski-hill snowmaking. Such uses are typically seasonal and are limited by WDNR permit to daily pumping periods of withdrawal related to maintenance of minimum stream flows or lake levels. In some cases, these limited uses are for emergency drought condition situations. A review of the WDNR files dating back to 1970, indicates these limited surface water withdrawals could potentially involve, or have involved, those surface waters noted in Table 32. In addition to the permitted uses of the inland surface waters, there are also ongoing unregulated uses of surface water by riparian landowners. These uses are varied, but primarily include lawn and garden watering and boat or vehicle washing.

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[25]*P.A. Kammerer, Jr., Investigations Report 90-4171,* op. cit.

Table 31

SELECTED CHARACTERISTICS OF THE SPECIAL WELL CASING REQUIREMENT AREAS IN SOUTHEASTERN WISCONSIN: 2005

Identification Number on Map 31	Location	Contaminant Found	Soil Type	Geologic Formation	Casing Recommendation
			Washington County		
1	Town of Wayne Sections 26, 27, 34, and 35	Gasoline	Loam	Pleistocene sand and gravel, alluvial sand	150 feet
2	Town of Barton Section 27 SE 1/4	VOC	Mucky peat, loam	Alluvial sand and silt, outwash sand and gravel	60 feet into bedrock
3	Town of Barton Sections 3, 4, 9, and 10	VOC, vinyl chloride	Loam, silt loam, mucky peat	Gravel; gravelly, silty sand; peat and muck	To base of Maquoketa shale
4	Town of West Bend Sections 15 and 16	VOC, vinyl chloride	Silt loam, loam	- -	Casing to base of Maquoketa shale
5	Town of West Bend Section 27 SE 1/4	Methane gas	Silt loam, loam	Sand and gravel	Bedrock well
6	Town of Polk Section 20 SE 1/4	VOC	Loam, gravel pit	Outwash sand and gravel	210 feet
7	Town of Jackson Sections 21, 22, 27, and 28	Bacteria, nitrate, gasoline	Loam, silt loam	Clayey, sandy silt; lacustrine silt and sand	120 feet, plus sampling
8	Town of Jackson Section 27 NE 1/4 NW 1/4 Section 28 NE 1/4	Bacteria, nitrate, gasoline	Silt loam	- -	220 feet
9	Town of Richfield Sections 12 and 13	Gasoline, VOC	Silt loam, silty clay loam	- -	100 feet into bedrock
10	Town of Richfield Section 36 SE 1/4	Gasoline	Silt Loam, silty clay loam	- -	220 feet
11	Village and Town of Germantown Sections 9 and 10	Gasoline	Silt loam	Gravelly, clayey, sandy silt	100 feet
12	Village and Town of Germantown Sections 9 and 10	Bacteria, nitrate, gasoline	Silt loam	Gravelly, clayey, sandy silt	80 feet
13	AREA DROPPED	- -	- -	- -	- -
14	Village of Germantown Sections 29 and 30	Gasoline	Sand loam, silt loam, mucky peat	- -	150 feet
15	Village of Germantown Section 31 SW 1/4	Gasoline	Loam	- -	220 feet
			Ozaukee County		
16	Town of Cedarburg Section 14 SW 1/4	VOC, petroleum, gasoline	Silt loam	- -	130 feet
17	City and Town of Cedarburg Sections 21, 22, 23, and 26	VOC	Loam, silt loam	- -	Special sampling
18	Village and Town of Grafton Section 25	VOC	Silt loam	- -	Special sampling
19	Village of Thiensville Sections 14,15, 22, and 23	VOC	Loam	Outwash sand and gravel	160 feet
20	Village of Thiensville Section 22, 23	VOC	Loam	Outwash sand and gravel	140 feet
			Waukesha County		
21	Town of Merton Section 19	VOC	Silt loam	Gravelly sand	Top of bedrock
22	Village of Sussex and Town of Lisbon Sections 22, 24, 25, 26, 28, 33, 34, 35, and 36	Bacteria, gaso-line, turbidity	Silt loam	Sandy till; gravelly sand; silt, clay	100 to 220 feet or special approval
23	Town of Lisbon within 0.5 mile of quarry or rock outcrops	Bacteria	- -	Silurian Dolomite	100 feet or special approval

Table 31 (continued)

Identification Number on Map 31	Location	Contaminant Found	Soil Type	Geologic Formation	Casing Recommendation
			Waukesha County (continued)		
24	Town of Lisbon Section 1 NE 1/4	Gasoline	Silt loam	- -	220 feet
25	Village of Menomonee Falls Section 6, NW 1/4	Gasoline	Silt loam	- -	220 feet
26	Villages of Menomonee Falls and Lannon within 0.5 mile of quarries or rock outcrops	Bacteria	- -	- -	100 feet or special approval
27	City of Pewaukee Sections 1 and 2	Bacteria	Silt loam, loam	Sandy till, gravelly sand	100 feet
28	City of Pewaukee Section 12 SE 1/4	Bacteria	Silt loam	Sandy till	135 feet
29	Town of Delafield Sections 21, 22, 27, and 28	Leachate, VOC	Loam, silt loam	Gravelly sand, sandy till	To base of Maquoketa shale
30	Town of Genesee Sections 23, 24, 25, 26, 35, and 36	Bacteria	Silt loam, loam, muck	Silurian Dolomite	200 feet
31	City of Brookfield Section 7, SW 1/4 and NW 1/4 Section 18, NW 1/4	Bacteria	Silt loam, loam	Creviced bedrock	135 feet of casing
32	Village of Lannon Sections 8, 18, 19, and 20	Bacteria	Silt loam, loam	Silurian Dolomite	100 feet
33	City of Muskego Sections 17, 18, 19, and 20	VOC, leachate	Varies	Sand and gravel	Special sampling and site-specific casing requirements
			Milwaukee County		
34	Village of River Hills Section 6 SE 1/4	Naturally occurring tar and asphaltum	Silt loam	Top of Silurian Dolomite	200 feet if tar and Asphaltum are present
35	City Franklin Section 6 NE 1/4	Petroleum	Silt loam	Silty till	Greater than 40 feet into bedrock
			Walworth County		
36	Town of East Troy Sections 10 and 11	Bacteria, detergents	Silt loam	- -	80 feet
37	Town of East Troy Sections 15, 16, 21, and 22	Leachate	Loam, silt loam	- -	To top of bedrock

NOTE: VOC = Volatile Organic Compound.

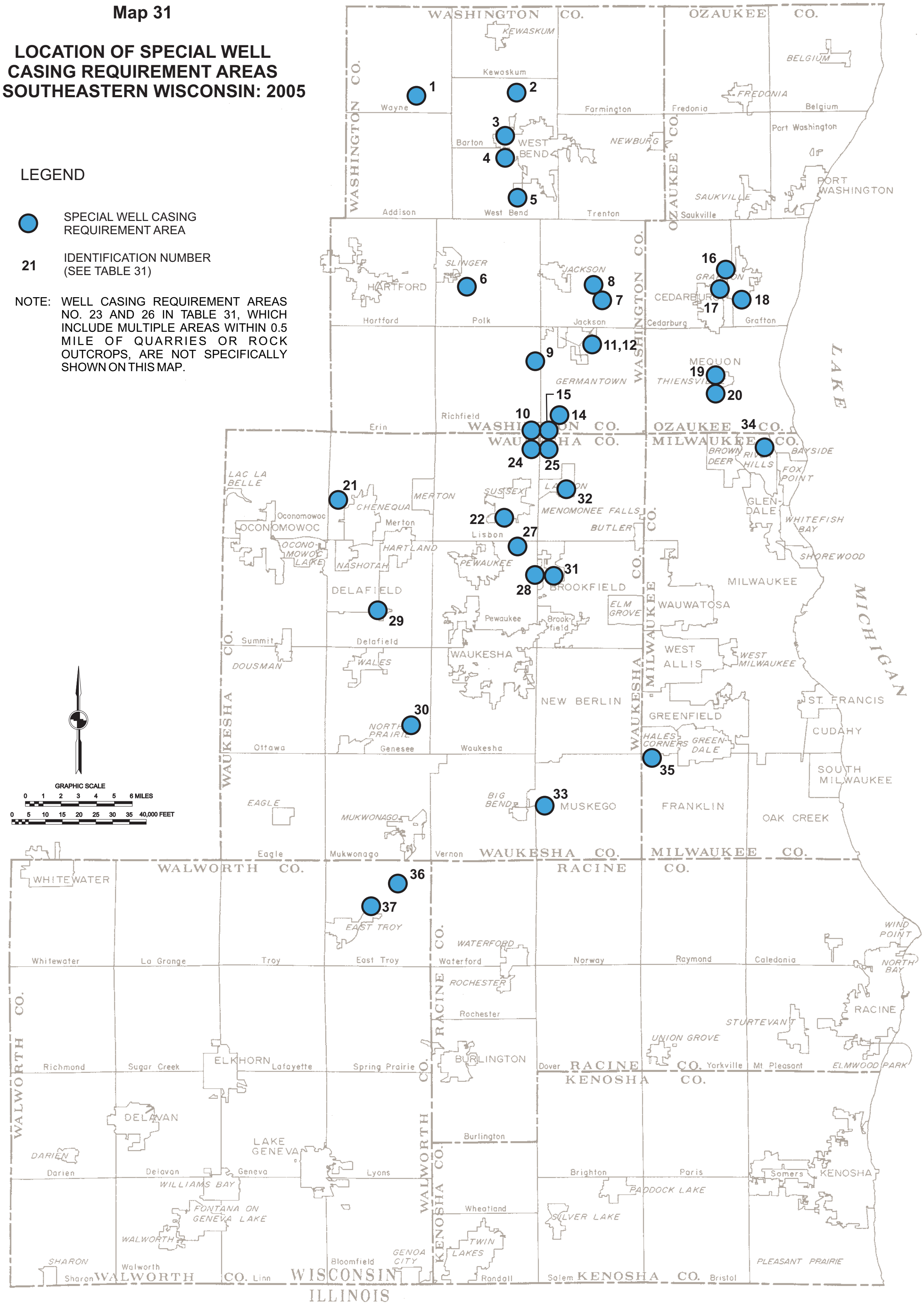
Source: Wisconsin Department of Natural Resources.

Lake Michigan, the primary source of surface water supply in the Region, is the sixth largest lake in the world by volume. It is the only one of the Great Lakes located entirely within the United States, as the other four Great Lakes form part of the border between the United States and Canada. The basic hydrographic and morphometric characteristics of Lake Michigan are presented in Table 33.

The level of Lake Michigan fluctuates, but is generally at the same elevation as Lake Huron at their connection through the Straits of Mackinac. Table 32 and Figure 22 include selected water level data for Lake Michigan. The level of Lake Michigan at Milwaukee has fluctuated from a recorded all time instantaneous low of 575.5 NGVD 1929 on January 23, 1926 to a record all time instantaneous high of 584.3 NGVD 1929 on March 9, 1987. The primary outlet of Lake Michigan through Lake Huron—that of the entire Great Lakes system—is the St. Lawrence River. A significant diversion occurs in the Chicago area with an approved diversion rate of 2,070 million gallons per day. About 60 percent of the diversion is used for water supply purposes, in part, to reduce

Map 31

LOCATION OF SPECIAL WELL CASING REQUIREMENT AREAS IN SOUTHEASTERN WISCONSIN: 2005



Source: Wisconsin Department of Natural Resources.

Table 32

INLAND SURFACE WATER WHERE STATE PERMITS HAVE BEEN ISSUED FOR WATER WITHDRAWALS OR DIVERSIONS: 1970-2004

County	Number of Permits	Surface Water Impacts
Kenosha	9	Des Plaines River, Pike River, Pike Creek, Barnes Creek, Center Creek
Milwaukee	6	Menomonee River, Milwaukee River, Burnham Canal, South Menomonee Canal, Root River, Little Menomonee River
Ozaukee	5	Little Menomonee River, Milwaukee River
Racine	34	Eagle Creek, Fox River, Goose Lake Canal, Kilbourn Road Ditch, Pike River, Root River, Wind Lake Canal, Wind Lake
Walworth	16	Darien Creek, Delavan Lake, Honey Creek, Lake Geneva, Mill Lake, Potawatomi Creek, Sugar Creek, Turtle Creek, White River
Washington	8	Cedar Lake, Little Cedar Creek, Menomonee River, Milwaukee River
Waukesha	23	Ashippun River, Bark River, Beaver Lake, Big Muskego Lake, Eagle Springs Lake tributary, Fox River, Genesee Creek, Mukwonago River, Pewaukee Lake, Saylesville Creek, Scuppernong Creek, Zion Creek

Source: Wisconsin Department of Natural Resources.

Table 33

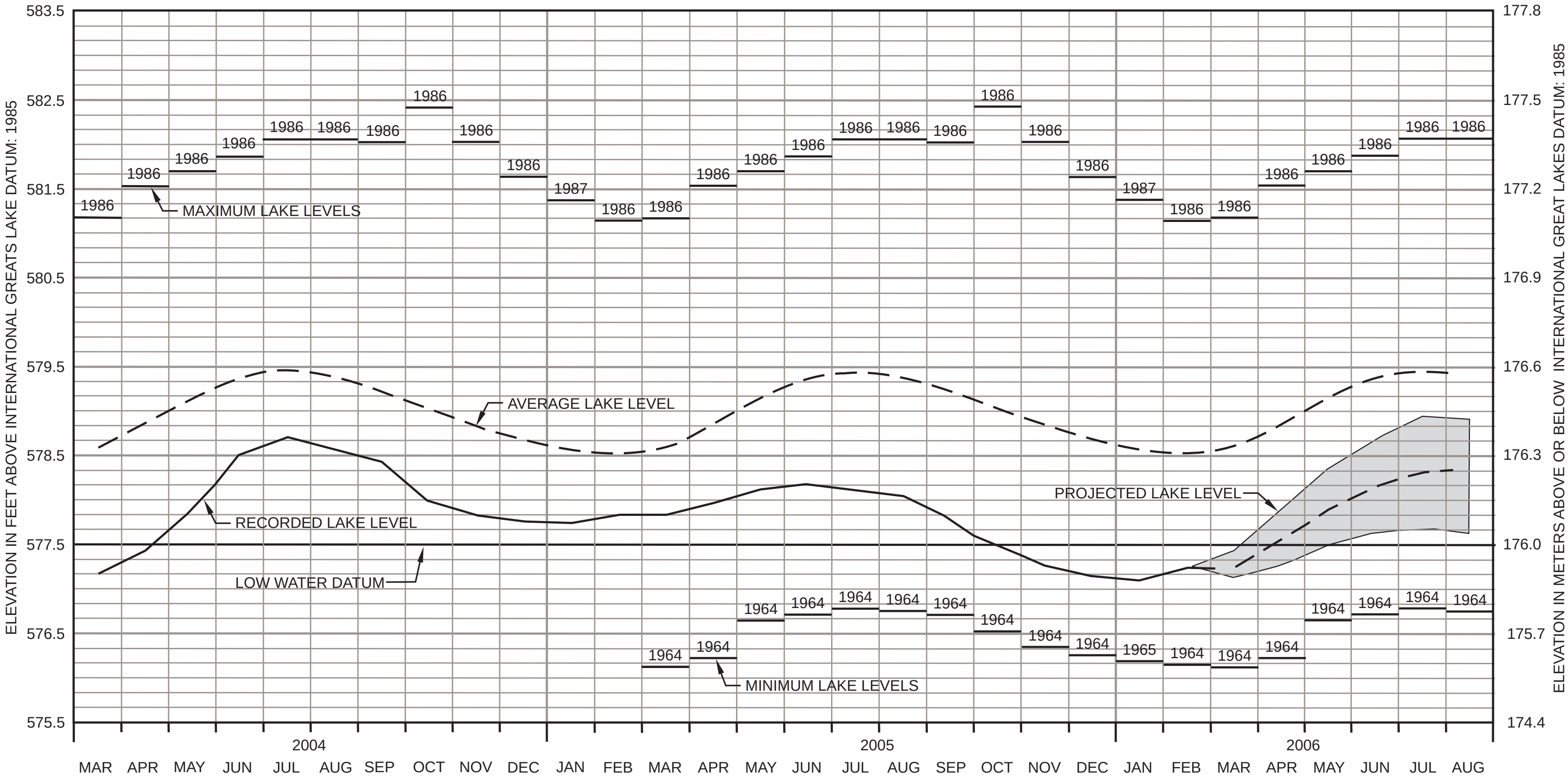
HYDROLOGY AND MORPHOMETRY OF LAKE MICHIGAN

Parameter	Measurement
Surface Area	22,300 square miles
Length	307 miles
Width	118 miles
Land Drainage Area	45,600 square miles
Average Depth	279 feet
Maximum Depth	925 feet
Volume	1,180 cubic miles
Shoreline Length	1,638 miles
Residence Time	99 years
Elevation (feet above NGVD-1929) at Milwaukee	
Lowest Annual Mean Low Water Level (1964)	577.1
Lowest Monthly Mean Low Water Level (February 1964)	576.8
Highest Annual Mean High Water Level (1986)	582.5
Highest Monthly Mean High Water Level (October 1986)	583.2

Source: National Oceanic and Atmospheric Administration, Great Lakes Commission, and SEWRPC.

Figure 22

LAKE LEVEL ELEVATION CHART: MARCH 2006



NOTE: The levels in this figure are shown in both feet and meters above or below Chart Datum (577.5 feet or 176.0 meters). Chart Datum, also known as Low Water Datum, is a reference plane on each of the Great Lakes to which water depth and Federal navigation improvement depths on navigation charts are referred. All elevations and plots shown in this figure are referenced to International Great Lakes Datum 1985 (IGLD 1985). IGLD 1985 has its zero base at Rimouski, Quebec, near the mouth of the St. Lawrence River (approximate sea level).

Source U.S. Army Corps of Engineers and SEWRPC.

pumping of the deep sandstone aquifer. The remaining portion of the diversion is used for a variety of other usages, included diverted stormwater, lockage operations, leakages through control works, and maintaining sanitary and navigation conditions in the Chicago River and its related canal and tributary system.

The residence time of Lake Michigan, or the time required for a volume equivalent to the full lake volume to enter the Lake, is estimated at 99 years. Thus, about 1 percent of the lake volume is replaced every year. The volume of the Lake is about 1,180 cubic miles, or about 1,270,000,000 million gallons. Based upon a replacement of 1 percent of the volume each year, the average daily inflow and rainfall, less evaporation to the Lake, would be 35,000 million gallons per day.

Diversions of water to and from the Great Lakes and Lake Michigan are an important consideration with respect to fluctuations in lake water levels and with respect to water use determinations. Based upon a year 2000 International Joint Commission report, the long-term diversions into the Great Lakes total about 3,600 mgd, while diversions out of the Great Lakes total about 2,100 mgd,[26] resulting in a net diversion into the Great Lakes of about 1,500 mgd. For Lake Michigan itself, there was a net outflow of about 2,100 mgd, as reported by a year 2000 U.S. Geological Survey report.[27] The water budget of Lake Michigan is reported by the U.S. Geological Survey to be as follows:

APPROXIMATE AVERAGE LONG-TERM WATER BUDGET FOR LAKE MICHIGAN

Inflows (mgd)		Outflows (mgd)	
Precipitation	34,250	Evaporation	26,500
Direct Surface Runoff	5,690	Outflow to Lake Huron	33,610
Groundwater Discharge to Streams Entering the Lake	20,680	Surface Water Withdrawals	4,850
Groundwater Discharge Direct to the Lake	1,745	Groundwater Withdrawals from Basin	1,360
Diversions into the Lake	32	Diversions Out of the Lake	2,070
Return Flow from Water Users	3,880		
Total	66,277	Total	68,390

Lake Michigan provides a high-quality source of supply for public water supply systems. The water taken from offshore deep water intakes is amenable to treatment by conventional methods, such as chemical addition, flocculation, sedimentation, and filtration and disinfection. Finished water utilizing these processes typically meets, and generally exceeds, Federal and State drinking water quality requirements. Some of the utilities have installed tertiary-level treatment units, such as microfiltration and ozonation in order to safeguard against microorganisms, such as *Cryptosporidium* and *Giardia*. Examples of raw water and finished water quality characteristics reported by selected water treatment plants in the Region are included in Appendix C of this report.

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[26]*International Joint Commission,* Protection of the Water of the Great Lakes, Final Report to the Governments of Canada and the United States*, February 22, 2000.*

[27]*Norman G. Grannemann, Randall J. Hunt, James R. Nicholas, Thomas E. Reilly, and Thomas C. Winter,* The Importance of Ground Water in the Great Lakes Region*, U.S. Geological Survey Water-Resources Investigations Report 00–4008, 2000.*

In 2000, a total of about two billion gallons per day of surface water was withdrawn from Lake Michigan or it's estuaries for thermoelectric-power-generation purposes within southeastern Wisconsin.[28] This is about nine times the amount of water that was withdrawn for all other uses in the Region combined. Most water used for thermoelectric-power-generation is for "once-through" cooling or for cooling tower make-up water. Most of the water used is returned to the Lake. There are four power plants located within the study area which draw water from Lake Michigan or its estuaries. Three of these plants typically use open-cycle cooling systems which withdraw water from Lake Michigan, pass it through heat exchangers, and then return the water to the Lake or related estuary system. These facilities are reported to typically return nearly all of the cooling water used to the source.[29] A small percentage of the water is used for various power plant equipment, such as air pollution emission reduction equipment and auxiliary cooling systems. This applies to the We Energies Port Washington Power Plant, the existing and proposed Oak Creek power plants, and the Valley Power Plant. Because of its distance from Lake Michigan, the Pleasant Prairie power plant uses two mechanical draft cooling towers to transfer heat to the atmosphere through a wet evaporative-cooling process. The Pleasant Prairie plant withdraws about 11 million gallons of water per day, almost all of which is evaporated. The majority of the water is used as make-up water for evaporation losses in the plant cooling tower system. The amount of water reported by the U.S. Geological Survey to be withdrawn from Lake Michigan in 2005 for thermoelectric-power-generation was about 1.4 billion gallons per day. This amount of water withdrawn from Lake Michigan and then largely returned may be compared to the total average daily lake inflow of about 35 billion gallons per day.

INVENTORY FINDINGS—KENOSHA COUNTY

Existing Municipal Water Supply Systems

In 2005, six municipal water supply utility systems provided water to about 34 square miles of service area, or about 12 percent of the area of Kenosha County. These systems served a population of about 116,800 persons, or about 74 percent of the resident population in Kenosha County. Two of the water supply systems, the Village of Paddock Lake system and the Town of Bristol Utility No. 1 system, rely on groundwater as a source of supply. Four of the water supply systems rely on Lake Michigan as the source of supply, including the Kenosha Water Utility, which owns and operates a treatment plant with two primary intakes and one emergency intake. The water supply systems serving the Town of Bristol Utility District No. 3, the Village of Pleasant Prairie Water Utility, and the Town of Somers Water Utility purchase treated Lake Michigan water from the Kenosha Water Utility. The existing service areas of these systems are shown on Map 32 and selected characteristics of each system are presented in Table 34.

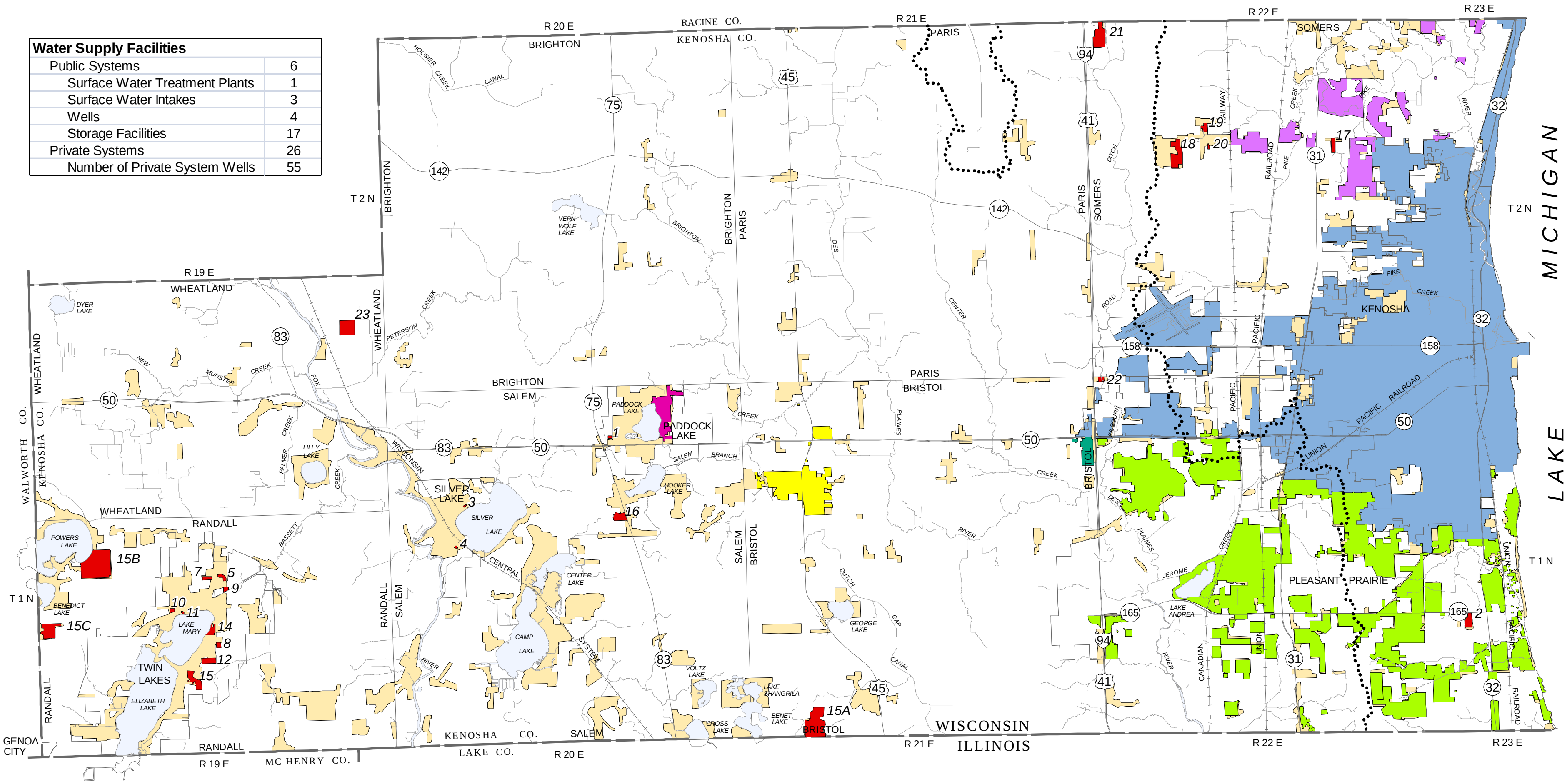
In 2005, the total storage capacity for the six municipal water systems operating in Kenosha County was approximately 32 million gallons, divided among the 17 elevated tanks and standpipes, as listed in Table 34. As the largest water provider, the Kenosha Water Utility maintained nine elevated tanks and standpipes, with a total storage capacity of about 19.2 million gallons. Based on Wisconsin Public Service Commission annual reports for the year 2005, approximately 17.6 million gallons per day of water were pumped for use in the six municipal systems concerned. As shown in Table 35, the water use totaled about 12.2 mgd for residential, commercial, industrial, institutional, or other urban uses, with the remaining 5.4 mgd of total pumpage being used for purposes such as water production and system maintenance, or being unaccounted-for water. Overall, about 6.4 mgd, or about 52 percent of total municipal water used, was for single- and two-family residential units; about 3.4 mgd, or about 28 percent, for commercial and multi-family residential, institutional, and miscellaneous uses; and about 1.6 mgd, or about 13 percent, was for industrial uses. The remaining 0.8 mgd, or about 7 percent, was used for other municipal purposes. Based upon the population served and reported water use, residential water consumption within the six water supply systems was approximately 67 gallons per person per day in 2005. When

[28]*U.S. Geological Survey,* Water Use in Wisconsin, 2000, *Open File Report 02-356.*

[29]*Wisconsin Energy Corporation,* 2003 Performance Report.

Map 32

MUNICIPAL AND OTHER-THAN-MUNICIPAL COMMUNITY WATER SUPPLY SYSTEMS IN KENOSHA COUNTY: 2005



Water Supply Facilities	
Public Systems	6
Surface Water Treatment Plants	1
Surface Water Intakes	3
Wells	4
Storage Facilities	17
Private Systems	26
Number of Private System Wells	55

LEGEND

SURFACE WATER-SUPPLIED SYSTEMS AND SERVICE AREAS

- KENOSHA WATER UTILITY
- PLEASANT PRAIRIE WATER UTILITY
- TOWN OF SOMERS WATER UTILITY
- TOWN OF BRISTOL UTILITY DISTRICT NO. 3
- SUBCONTINENTAL DIVIDE

GROUNDWATER-SUPPLIED SYSTEMS AND SERVICE AREAS

- PADDOCK LAKE MUNICIPAL WATER UTILITY
- TOWN OF BRISTOL UTILITY DISTRICT NO. 1
- 23 AREA SERVED BY OTHER-THAN-MUNICIPAL COMMUNITY WATER SYSTEMS USING GROUNDWATER. IDENTIFICATION NUMBER CORRESPONDS WITH APPENDIX D
- EXTENT OF URBAN DEVELOPMENT NOT SERVED BY PUBLIC OR PRIVATE WATER SUPPLY SYSTEMS: INCLUDES URBAN DEVELOPMENT AS IDENTIFIED IN THE REGIONAL PLANNING COMMISSION HISTORIC URBAN GROWTH RING ANALYSIS

GRAPHIC SCALE

0 1 2 3 4 Miles

0 5,000 10,000 15,000 20,000 Feet

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

Table 34

SELECTED CHARACTERISTICS OF EXISTING MUNICIPAL WATER SUPPLY SYSTEMS WITHIN KENOSHA COUNTY: 2005

Water Supply System	Class[a]	Estimated Area Served (square miles)	Estimated Population Served[b]	Source of Supply[c]	Number of Wells	Total Well Pumpage Capacity (mgd)	Well Aquifer[d]	Number of Lake Water Intakes	Treatment Processes[e]	Surface Treatment Plant Capacity (mgd)	Number of Storage Facilities	Total Storage Capacity (gallons x 1,000)	2005 Annual Average Pumpage (mgd)	2005 Maximum Daily Pumpage (mgd)	10-Year Maximum Daily Pumpage (mgd)	Spent Water Receiving System
City of Kenosha Water Utility.............	AB	23.1	103,100	S	- -	- -	- -	2, plus 1 emergency	CH, C, S, F, MC, FL, CC	42	9	19,200	15.28	27.41	27.41	Lake Michigan
Village of Paddock Lake Municipal Water Utility	D	0.2	1,000	G	2	0.79	SG	- -	H, P	- -	1	10	0.07	0.18	0.58	Brighton Creek
Village of Pleasant Prairie Water Utility	AB	8.7	9,200	SP	- -	- -	- -	- -	- -	- -	6	12,200	1.91	- -[f]	- -[f]	Lake Michigan[g]
Town of Bristol Utility District No. 1	D	0.7	1,400	G	2	1.30	SG, S	- -	H, F, P	- -	1	100	0.24	0.40	0.75	Bristol Creek
Town of Bristol Utility District No. 3	D	0.1	- -	SP	- -	- -	- -	- -	- -	- -	- -	250	0.02	- -[f]	- -[f]	Lake Michigan
Town of Somers Water Utility District	C	1.4	2,100	SP	- -	- -	- -	- -	- -	- -	- -	- -	0.08	- -[f]	- -[f]	Lake Michigan
Total	- -	34.2	116,800	- -	4	2.09	- -	2, plus 1 emergency	- -	42	17	31,760	17.60	27.99	28.74	- -

NOTE: N/A indicates data not available.

[a]*The municipal water and combined water and sewer utilities are based upon the number of customers as follows: Class AB 4,000 or more customers; Class C from 1,000 to less than 4,000 customers; and Class D less than 1,000 customers.*

[b]*Population based upon Wisconsin Department of Natural Resources data base adjusted to 2004 Wisconsin Department of Administration Civil Division estimates and SEWRPC data, where appropriate.*

[c]*The following abbreviations are used:*

G = Groundwater
S = Surface Water (Lake Michigan)
SP = Surface Water Purchased (Lake Michigan)

[d]*The following abbreviations are used:*

SG = Sand and Gravel
SD = Silurian Dolomite
GP = Galena-Platteville Dolomite
S = Sandstone
M = Multiple Aquifers

[e]*Code for treatment processes:*

CH = Pre-Sedimentation Chemical Addition
S = Sedimentation
C = Coagulation
F = Filtration
MC = Micro-Filtration
FL = Fluoridation
D = Disinfection
CC = Corrosion Control
I = Ion Exchange
P = Phosphate Addition (sequestering)
SH = Sodium Hypochlorite Chemical Addition
H = Hypochlorination

[f]*Included in Kenosha Water Utility pumpage values.*

[g]*Until 2010, a portion of the spent water continues to be discharged to a tributary to the Des Plaines River (Pleasant Prairie Creek).*

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

Table 35

SUMMARY OF MUNICIPAL WATER USE IN KENOSHA COUNTY: 2000, 2004, AND 2005

Year	Average Annual Water Uses										Percent Unaccounted for Water[g]
	Residential Water Use[a]			Industrial Water Use		Commercial, Institutional, and Multi-Family Residential[a]		Other Municipal[e] Water Uses (gallons per day X 1,000)	Total Municipal Water Use[b]		
	Total[c] (gallons per day X 1,000)	Per Person[d] (gallons per capita per day)	Per Acre[d] (gallons per acre per day)	Total[c] (gallons per day X 1,000)	Per Acre (gallons per acre per day)	Total[c] (gallons per day X 1,000)	Per Acre (gallons per acre per day)		Total[c] (gallons per day X 1,000)	Per Person[f] (gallons per capita per day)	
2000	5,619	61	836	1,926	2,416	3,160	836	366	11,071	100	12
2004[h]	5,746	61	826	1,601	2,007	3,253	860	401	11,001	95	12
2005[I]	6,404	67	843	1,646	1,926	3,387	843	762	12,199	104	9

[a]*Residential category includes population associated with single-family and two-family housing units, plus some larger multi-family housing where individual water meters are used for each unit. Other multi-family units are included in the commercial water use category.*

[b]*Includes all water specifically accounted for.*

[c]*As reported in annual reports submitted to the Public Service Commission of Wisconsin.*

[d]*Reported residential water use excludes that associated with multiple-unit dwellings where a single meter serves three or more housing units. That water use is classified as commercial under the Public Service Commission of Wisconsin reporting system. The unit water uses presented on a per capita and per acre basis were calculated by adjusting the population and residential land area to be consistent with this reporting procedure.*

[e]*Includes uses for fire protection services, sales to public authorities, sales to irrigation customers and interdepartmental sales.*

[f]*Estimated based upon total residential population served.*

[g]*Water not specifically accounted for as a percent of total pumpage.*

[h]*2004 population and land use was approximated by increasing the 2000 population and land use amounts by 3.4 percent.*

[i]*2005 population and land use was approximated by increasing the 2000 population and land use amounts by 4.6 percent.*

Source: Public Service Commission of Wisconsin and SEWRPC.

accounting for all municipal water uses, the average water consumption was about 104 gallons per person per day. In 2005, the amount of water which was unaccounted-for ranged from 7 to 13 percent, with an average of 9 percent of the water pumped for the utilities in Kenosha County. Thus, unaccounted-for water was not included in the computed per capita consumption rates. It should be noted that the residential water use reported by the water utilities excludes that associated with the use of water by multiple-unit dwelling units with a single meter serving three or more units. Those uses are included with commercial water uses. Thus, the calculation of the water uses on a per capita and per acre basis for the residential and commercial categories were made by adjusting the population and acreage considered under these categories to reflect this reporting requirement.

The total water used in the six municipal systems in 2005 was about 10 percent more than used in 2000 and about 11 percent more than used in 2004. This increase was due largely to an increase in residential use of from 11 to 14 percent, compared to 2004 and 2000, respectively.

Municipal Water Supply System Interconnection and Intermunicipal Service Provisions

The City of Kenosha Water Utility water treatment plant is the only municipal source of water supply for the greater Kenosha area. The Kenosha Water Utility provides water on both a retail and wholesale basis for use in different portions of the Village of Pleasant Prairie and the Town of Somers and provides wholesale water service to the Town of Bristol Utility District No. 1. Because of these water supplier arrangements, there are a number of connections between the Kenosha Water Utility water supply system and its three customer communities. There were no other known water supply system interconnections or intermunicipal service provisions in Kenosha County outside of the greater Kenosha area in 2005.

Municipal Water Supply Water Conservation Measures

Water conservation measures reported to be in place or under development by the water utilities in Kenosha County include the ongoing development of a water conservation policy and a public information program by the Kenosha Water Utility. In addition, while not specifically reported, all of the utilities may be expected to be working to improve efficiency and minimize water losses in their systems. Such measures include meter testing for accuracy, leak detection programs, and repair of water main breaks and leaks. In addition, all of the water supply utilities within southeastern Wisconsin have water metering in place, have billing systems based upon usage, and are governed by the State plumbing code which limits flow rates and volumes for plumbing fixtures.

Proposed Municipal Water Supply System Modifications and Expansion Plans

The inventory revealed that, as of 2005, there were locally proposed water supply system modification and expansion plans for the Kenosha Water Utility system; the Villages of Paddock Lake and Pleasant Prairie systems; the Town of Bristol Utility District Nos. 1 and 3 systems, and the Town of Somers system. Those plans are summarized in the subsequent paragraphs.

It should be noted that the sanitary sewer service area plans and related amendments to the regional water quality management plan listed in the reports for the utilities noted below were prepared under the regional water quality management planning program cooperatively being carried out by the WDNR and SEWRPC. These plans and amendments specifically address current and planned sanitary sewer service areas. However, these reports do, as appropriate, address the need to coordinate water and sewer service to respect the rules and regulations relating to the diversion of Lake Michigan as a water supply source. These plans also serve as a surrogate for the identification of an urban services area for water supply, as well as sanitary sewer service.

City of Kenosha, Village of Pleasant Prairie, Town of Bristol Utility District No. 3, and Town of Somers

There has been a long-standing coordinated water supply and sanitary sewerage system planning program for the planned urban service areas of the City of Kenosha, the Village of Pleasant Prairie, the Town of Bristol Utility District No. 3, and the Town of Somers. The integration of water supply and sanitary sewerage services for these areas is particularly important because the subcontinental divide traverses the planned urban service area. The available plans and reports related to water supply and sewerage system planning include the following:

1. A report entitled *A Coordinated Sanitary Sewer and Water Supply Plan for the Greater Kenosha Area*, prepared by Ruekert & Mielke, Inc., dated October 1991.

2. A letter report amending the 1991 plan for the greater Kenosha area prepared by Ruekert & Mielke, Inc., dated March 2001.

3. A report entitled *Draft Water Connection Fee Report for the Town of Somers, Kenosha County, Wisconsin*, prepared by Crispell-Snyder, Inc., dated June 2005.

4. A report entitled *Amendment to the Regional Water Quality Management Plan—2010, Greater Kenosha Area*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the local units of government involved, dated March 1996.

5. A report entitled *Amendment to the Regional Water Quality Management Plan, Greater Kenosha Area*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the local units of government concerned, dated December 2001.

6. A report entitled *Amendment to the Regional Water Quality Management Plan, Greater Kenosha Area*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the local units of government concerned, dated June 2007.

A review of the aforelisted plans indicates that, as of 2005, the water utilities and communities involved have plans in place to provide water supply and sanitary sewer service to an 84-square-mile urban service area, as shown on Map 33. Intermunicipal agreements were in place to carry out the plan recommendations. The entire service area is proposed to be served by water supply provided by the Kenosha Water Utility water treatment plant which uses Lake Michigan as a source of supply, with the spent water being conveyed as sanitary sewage to the Kenosha Water Utility sewage treatment plant which discharges treated effluent to Lake Michigan.

Review of the plans for the Kenosha Water Utility system indicate that the water treatment plant capacity existing in 2005 was adequate to meet the needs of the planned service area until at least the design year 2015. Potential new regulations could have an impact on the need for future plant upgrading.

Village of Paddock Lake Municipal Water Utility

Plans for the Village of Paddock Lake system were documented in the following reports:

1. A report entitled *Engineering Report for West Side Water System, Village of Paddock Lake, Kenosha County, Wisconsin*, prepared by Baxter & Woodman, Inc., dated October 2004.

2. A report entitled *Addendum to Engineering Report for West Side Water System, Village of Paddock Lake, Kenosha County, Wisconsin*, prepared by Baxter & Woodman, Inc., dated December 2004.

3. A report entitled *Sewer Service Area for the Town of Salem Utility District No. 1, Village of Paddock Lake and Town of Bristol Utility Districts Nos. 1 and 1B, Kenosha County, Wisconsin*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the local units of government concerned, including the Village of Paddock Lake, dated October 1986 and amended June 2005.

A review of the aforelisted local plans indicates that the Village of Paddock Lake water supply system is proposed to be expanded by upgrading the existing facilities and constructing two new wells and a new elevated storage tank. The plans recommend that existing Well No. 1 serving the east side of the Village be modified to provide a capacity of 560 gallons per minute (gpm). Two new wells, associated pumping stations, and a new storage tank are to be provided for the west side of the Village, with a capacity of 560 gpm. The new facilities are proposed to serve new urban development expected to occur west of the current development in the Village. The plan also calls for extension of the water distribution system treatment facilities.

Town of Bristol Utility District No. 1

Plans for the Town of Bristol Utility District No. 1 system were documented in the following reports:

1. A report entitled *Amendment to the Regional Water Quality Management Plan, Town of Bristol Utility District No. 1*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the local units of government concerned, dated December 2005.

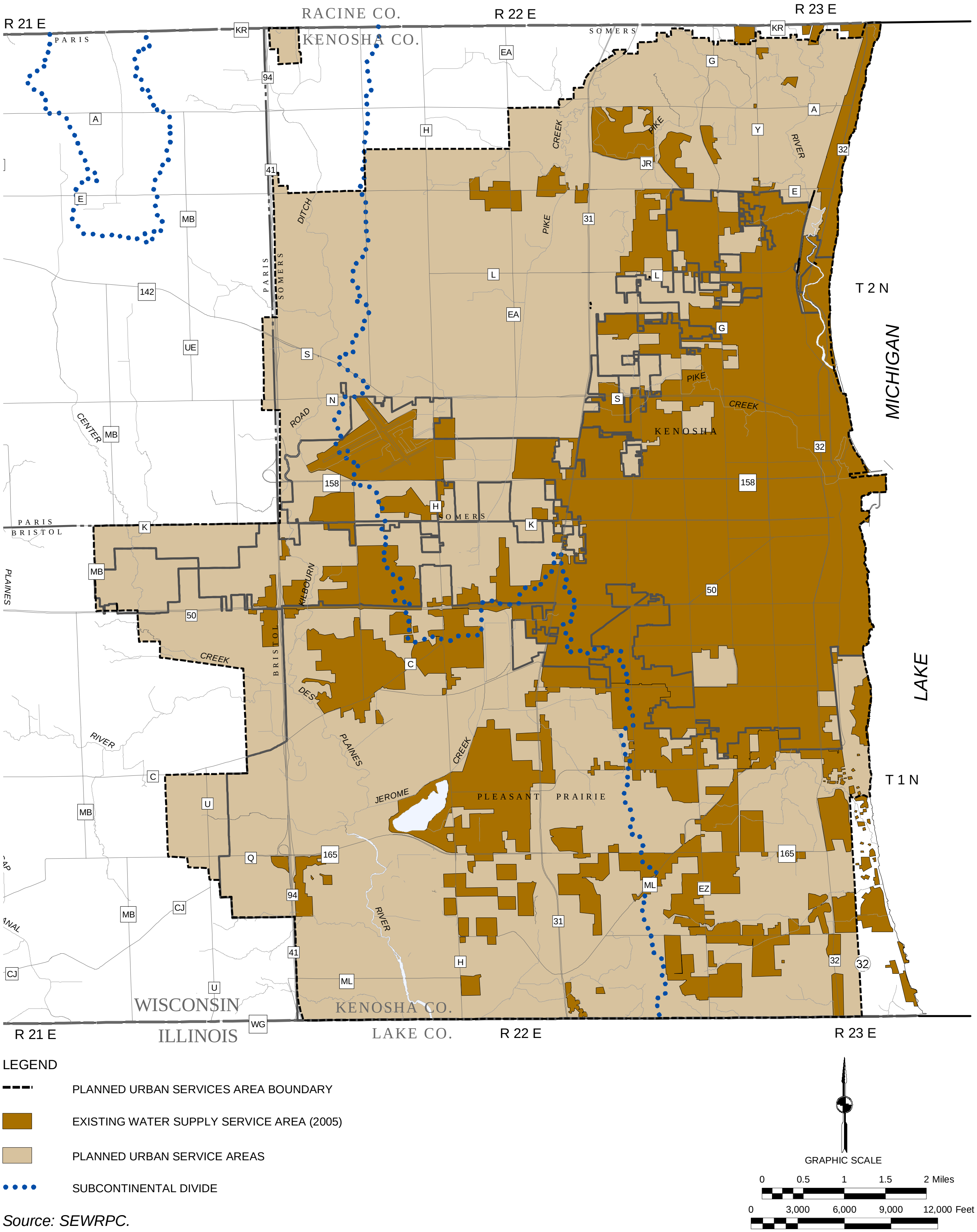
2. A report entitled *Comprehensive Waste System Report, Town of Bristol*, prepared by Strand Associates, Inc., dated November 1995.

3. A report entitled *Report for the Task 2 Geophysical Exploration Program for the Town of Bristol, Wisconsin*, prepared by Layne Geosciences, dated February 2006.

4. A report entitled *Sewer Service Area for the Town of Salem Utility District No. 1, Village of Paddock Lake and Town of Bristol Utility Districts Nos. 1 and 1B, Kenosha County, Wisconsin*, dated October 1986 and amended December 2005.

Map 33

GREATER KENOSHA AREA EXISTING 2005 AND PLANNED URBAN SERVICES AREA



Source: SEWRPC.

A review of the aforelisted local plans indicates that the Town of Bristol system is proposed to be expanded by the addition of a new well to be located south of STH 50 and north of 81st Street in the vicinity of USH 45. A future storage facility is also planned. The new facilities are proposed to serve new urban development located north and east of the current service area.

Existing Residential and Other-than-Municipal Community Systems

In 2005, there were 26 existing privately owned water, self-supplied, systems operating in Kenosha County which provide water supply services to primarily residential land uses, such as subdivisions, apartment or condominium developments, and mobile home parks, and to some institutional uses. Such systems are generally categorized by the WDNR as “other-than-municipal community systems.” These systems served a residential population of about 2,800 persons, or about 1.8 percent of the 2005 Kenosha County resident population. Of the 26 systems, seven are classified as high-capacity systems, and 19 are classified as low-capacity systems that combined, rely on 51 low-capacity wells, three high-capacity wells, and one well of unknown capacity as a source of supply. The existing service areas of these systems are shown on Map 32. Selected characteristics of each system are presented in Table D-1 in Appendix D.

Existing Industrial Water Supply Systems

In 2005, there were nine existing privately owned, self-supplied, water systems operating in Kenosha County which provide water for industrial land uses. Of these, four are classified as high-capacity and five are classified as low-capacity systems. These systems all utilize groundwater as a source of supply through seven low-capacity and five high-capacity wells. The locations of these systems are shown on Map 34. Selected characteristics of each system are presented in Table D-2 in Appendix D.

Existing Commercial Water Supply Systems

In 2005, there were 151 existing privately owned, self-supplied, water systems operating in Kenosha County which provide water for commercial land uses. Of these, eight are classified as high-capacity systems and 143 are classified as low-capacity systems. These systems all utilized groundwater as a source of supply through 155 low-capacity wells and five high-capacity wells. The locations of these systems are shown on Map 34. Selected characteristics of each system are presented in Table D-3 in Appendix D.

Existing Institutional and Recreational Water Supply Systems

In 2005, there were 58 existing privately owned, self-supplied, water systems operating in Kenosha County which provided water for institutional and recreational land uses. Of these, 18 are classified as high-capacity systems and 40 are classified as low-capacity systems. These systems all utilized groundwater as a source of supply through 74 low-capacity wells and eight high-capacity wells and seven wells of unknown capacity. The locations of these systems are shown on Map 34. Selected characteristics of each system are presented in Table D-4 in Appendix D.

Existing Agricultural Water Supply Systems

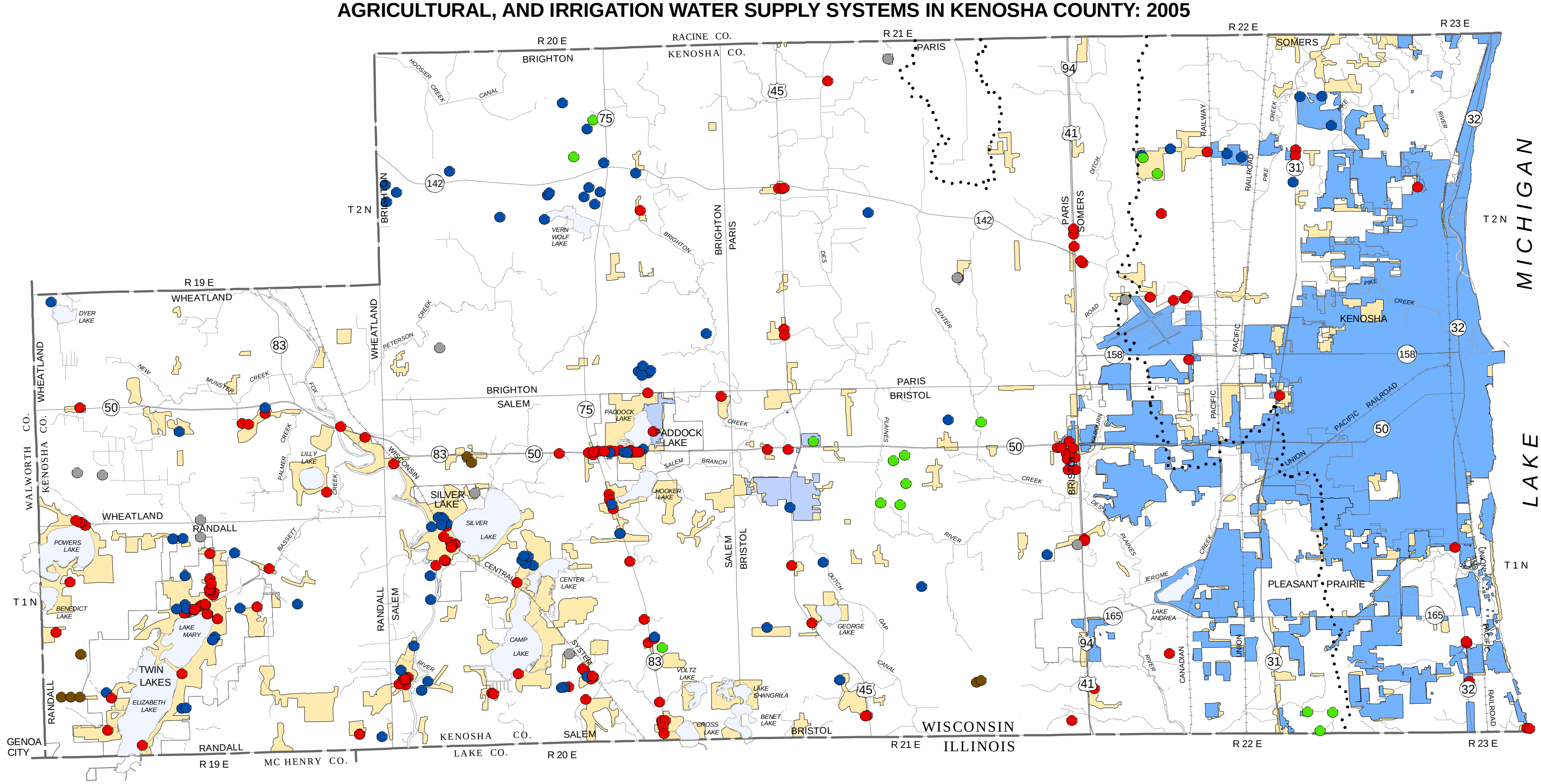
In 2005, there were four existing privately owned, self-supplied, water systems operating in Kenosha County which provided water for irrigation and other purposes for agricultural land uses. All four systems are classified as high-capacity systems and all utilize groundwater as a source of supply through eight high-capacity wells. The locations of these systems are shown on Map 34. Selected characteristics of each system are presented in Table D-5 in Appendix D.

Existing Irrigation Water Supply Systems

In 2005, there were seven existing privately owned, self-supplied, water systems operating in Kenosha County which provided irrigation water for land uses other than agricultural uses, such as golf courses. All seven systems are classified as high-capacity systems and all utilize groundwater as a source of supply through 15 high-capacity wells. The locations of these systems are shown on Map 34. Selected characteristics of each system are presented in Table D-6 in Appendix D.

Map 34

SELF-SUPPLIED INDUSTRIAL, COMMERCIAL, INSTITUTIONAL AND RECREATIONAL, AGRICULTURAL, AND IRRIGATION WATER SUPPLY SYSTEMS IN KENOSHA COUNTY: 2005



LEGEND

SELF-SUPPLIED WATER SYSTEM WELLS

- INDUSTRIAL
- COMMERCIAL
- INSTITUTIONAL AND RECREATIONAL
- IRRIGATION
- AGRICULTURAL

- AREA SERVED BY PUBLIC WATER UTILITY USING SURFACE WATER
- AREA SERVED BY PUBLIC WATER UTILITY USING GROUNDWATER
- EXTENT OF URBAN DEVELOPMENT NOT SERVED BY PUBLIC OR PRIVATE WATER SUPPLY SYSTEMS: INCLUDES URBAN DEVELOPMENT AS IDENTIFIED IN THE REGIONAL PLANNING COMMISSION HISTORIC URBAN GROWTH RING ANALYSIS
- SUBCONTINENTAL DIVIDE

GRAPHIC SCALE

0 1 2 3 4 Miles

0 5,000 10,000 15,000 20,000 Feet

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

Existing Thermoelectric-Power-Generation Water Supply Systems

In 2005, there were two existing facilities operating in Kenosha County which provided cooling water for thermoelectric-power-generation facilities. These facilities included the Pleasant Prairie Power Plant, a coal-based generating facility located in the Village of Pleasant Prairie, and the Paris Generating Station, a combustion turbine generating facility in the Town of Paris. The Pleasant Prairie Power Plant utilizes about 11 million gallons of water per day obtained from Lake Michigan. The majority of the water is used as make-up water for evaporation losses on the plant cooling tower system. The Paris Generating Station facility utilizes groundwater obtained through one well which has a maximum capacity of 600 gallons per minute. This well was finished in the sandstone aquifer. The amount of water used varies annually depending upon the need for the intermittent operation of the peaking facility. The water use estimated at the time of permitting was 36,000 gallons per day. There are two primary water uses at the Paris Generating Station: 1) water spray injection into the combustion turbines for control of nitrogen oxides; and 2) an inlet air cooling system, used to enhance the combustion turbine generating capacity during warmer weather, cooling the intake air by passing it over coils containing recirculating cold water produced in an onsite refrigeration system.

Existing Self-Supplied Residential Water Systems

As of the year 2005, there were about 39,000 persons, or about 25 percent of the total resident year 2005 population of Kenosha County, served by private domestic wells. As shown on Map 32, there were a number of areas classified as having urban-density development which were served by private wells. These were located primarily around inland lakes. Assuming an average use of 65 gallons per capita per day, the private domestic wells within the County may be expected to withdraw about 2.5 million gallons per day from the shallow groundwater aquifer. It is estimated that 60 percent of the households served by private domestic wells are served by public sanitary sewer systems. Thus, the water withdrawn from the groundwater system for about 60 percent of the private domestic wells, or about 1.5 million gallons per day, was discharged to the surface water system, such as to the Fox River, Bassett Creek, or Lake Michigan, as treated sanitary sewage. Approximately 90 percent of the remaining 40 percent of the water withdrawn by private wells, or about 0.9 million gallons per day, was returned to the groundwater aquifer via onsite sewage disposal systems.

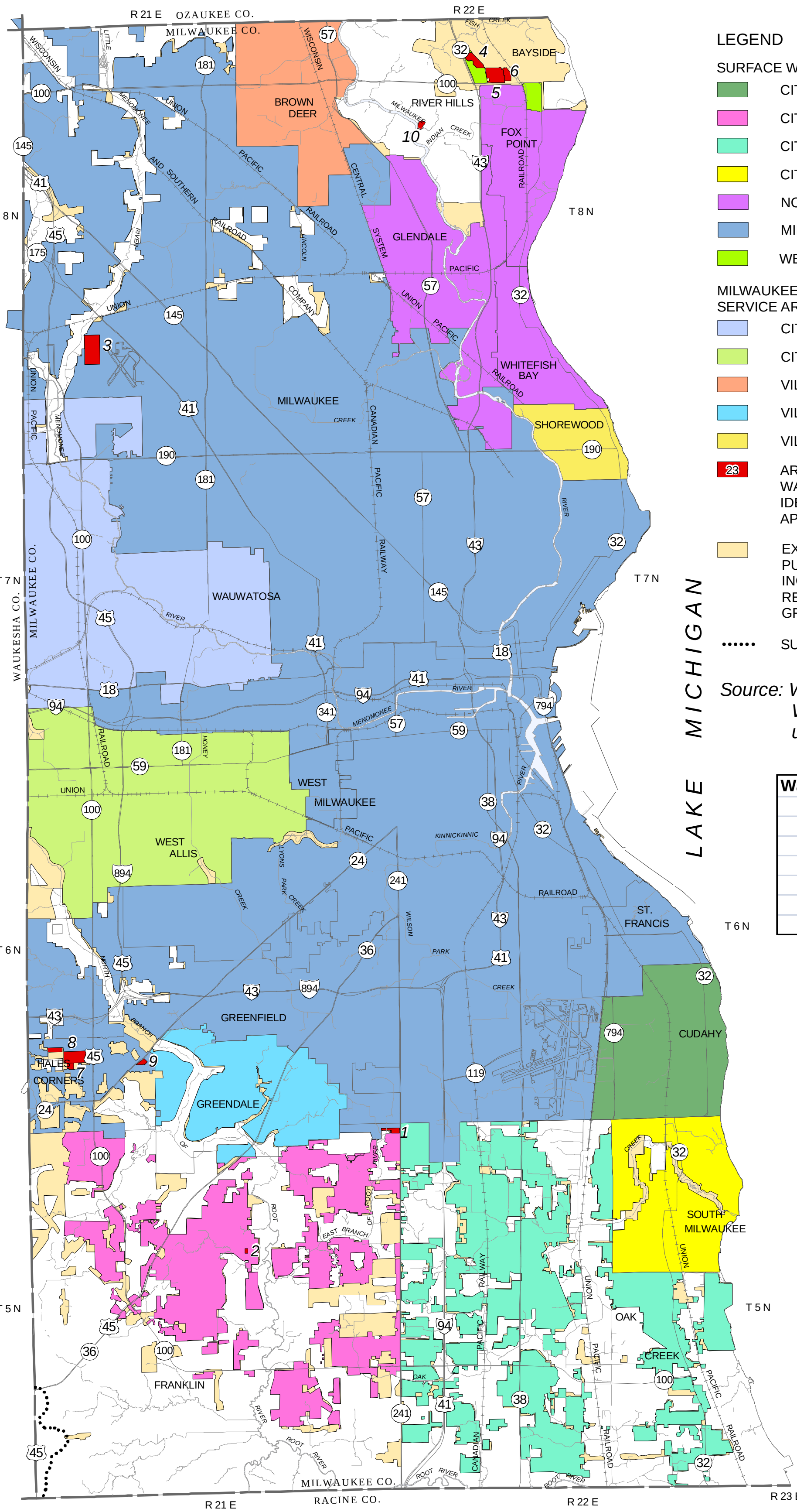
INVENTORY FINDINGS—MILWAUKEE COUNTY

Existing Municipal Water Supply Systems

In 2005, 14 municipal water supply utility systems provided water to about 182 square miles of service area, or about 75 percent of the area of Milwaukee County. These systems served a population of about 921,000 persons, or about 98 percent of the residential population in Milwaukee County. All of the water supply systems in Milwaukee County rely on Lake Michigan as the source of supply, either directly or indirectly through wholesale or resale purchase. Five municipal water utilities operate and maintain a total of six Lake Michigan surface water treatment facilities in Milwaukee County. The City of Milwaukee Water Works, which owns and operates two water treatment plants, each with one intake, is the largest supplier of treated surface water in the Region, and provides water on a retail or wholesale basis to a number of municipal water systems in Milwaukee County and adjacent counties. The City of Cudahy Water Utility owns and operates a water treatment plant with two intakes which also provide water to three private industries. The City of Oak Creek Water and Sewer Utility owns and operates a water treatment plant with two intakes, one of which is used only for emergency purposes; and provides water to the City of Franklin Water Utility, and to portions of two utilities serving the Village of Caledonia, Racine County. The North Shore Water Commission, which is a contract Commission comprised of three separate water utilities—the City of Glendale Water Utility, the Village of Fox Point Water Utility, and the City of Whitefish Bay Water Utility—owns and operates a water treatment facility and one intake. We Energies-Water Services purchases treated surface water from the North Shore Water Commission and provides service to portions of the Village of Bayside. The City of South Milwaukee owns and operates a water treatment facility and one intake, and does not provide retail or wholesale service to any other municipality or entity. The existing service areas of these systems are shown on Map 35 and selected characteristics of each system are presented in Table 36.

Map 35

MUNICIPAL AND OTHER-THAN-MUNICIPAL COMMUNITY WATER SUPPLY SYSTEMS IN MILWAUKEE COUNTY: 2005



LEGEND

SURFACE WATER-SUPPLIED SYSTEMS AND SERVICE AREAS

- CITY OF CUDAHY WATER UTILITY
- CITY OF FRANKLIN WATER UTILITY
- CITY OF OAK CREEK WATER AND SEWER UTILITY
- CITY OF SOUTH MILWAUKEE WATER UTILITY
- NORTH SHORE WATER COMMISSION
- MILWAUKEE WATER WORKS RETAIL
- WE ENERGIES BAYSIDE WATER UTILITY

MILWAUKEE WATER WORKS WHOLESALE MUNICIPALITIES AND SERVICE AREAS

- CITY OF WAUWATOSA WATER UTILITY
- CITY OF WEST ALLIS WATER UTILITY
- VILLAGE OF BROWN DEER PUBLIC WATER UTILITY
- VILLAGE GREENDALE WATER UTILITY
- VILLAGE OF SHOREWOOD MUNICIPAL WATER UTILITY
- 23 AREA SERVED BY OTHER-THAN-MUNICIPAL, COMMUNITY WATER SYSTEMS USING GROUNDWATER. IDENTIFICATION NUMBER CORRESPONDS WITH APPENDIX D
- EXTENT OF URBAN DEVELOPMENT NOT SERVED BY PUBLIC OR PRIVATE WATER SUPPLY SYSTEMS: INCLUDES URBAN DEVELOPMENT AS IDENTIFIED IN THE REGIONAL PLANNING COMMISSION HISTORIC URBAN GROWTH RING ANALYSIS
- SUBCONTINENTAL DIVIDE

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

Water Supply Facilities	
Public Systems	14
Surface Water Treatment Plants	6
Surface Water Intakes	8
Wells	0
Storage Facilities	45
Private Systems	10
Number of Private System Wells	19

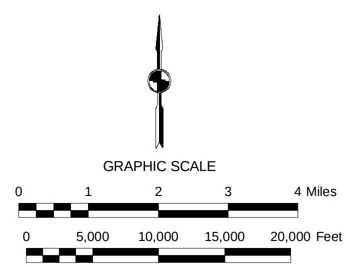


Table 36

SELECTED CHARACTERISTICS OF EXISTING MUNICIPAL WATER SUPPLY SYSTEMS WITHIN MILWAUKEE COUNTY: 2005

Water Supply System	Class[a]	Estimated Area Served (square miles)	Estimated Population Served[b]	Source of Supply[c]	Number of Wells	Total Well Pumpage Capacity (mgd)	Well Aquifer[d]	Number of Lake Water Intakes	Treatment Processes[e]	Surface Treatment Plant Capacity (mgd)	Number of Storage Facilities	Total Storage Capacity (gallons x 1,000)	2005 Annual Average Pumpage (mgd)	2005 Maximum Daily Pumpage (mgd)	10-Year Maximum Daily Pumpage (mgd)	Spent Water Receiving System
City of Cudahy Water Utility	AB	4.8	18,300	S	- -	- -	- -	2	CH, S, F, FL, H, D, CC	6.0	2	2,500	4.21	6.47	8.24	Lake Michigan
City of Franklin Water Utility	C	8.3	24,400	SP	- -	- -	- -	- -	- -	- -	7	3,268	2.94	- -	- -	Lake Michigan
City of Glendale Water Utility[f]	AB	6.0	13,000	SP	- -	- -	- -	- -	CH, C, D, S, F	18.0[f]	4	4,856	1.80	4.29	- -	Lake Michigan
City of Milwaukee Water Works[g]	AB	106.5	647,200[h]	S	- -	- -	- -	2	CH, C, D, S, F, FL, O, CC	275.0 Linnwood; 105.0 Howard Avenue	8	117,000	122.08[i]	186.15[j]	218.00[j]	Lake Michigan
City of Oak Creek Water and Sewer Utility	AB	12.5	29,000	S	- -	- -	- -	2	CH, C, D, S, F, FL	20.0[k]	4	7,088	4.90[i]	8.26[j]	15.66[j]	Lake Michigan
City of South Milwaukee Water Utility	AB	4.3	21,400	S	- -	- -	- -	1	CH, C, D, S, F, MC, F, FL, CC	8.0[l]	3	3,500	2.51	4.19	5.09	Lake Michigan
City of Wauwatosa Water Utility	AB	12.9	46,300	SP	- -	- -	- -	- -	- -	- -	6	10,200	5.59	- -	- -	Lake Michigan
City of West Allis Water Utility	AB	10.6	60,500	SP	- -	- -	- -	- -	- -	- -	3	7,000	6.86	- -	- -	Lake Michigan
Village of Bayside, We Energies	- -	0.3	500	SP	- -	- -	- -	- -	- -	- -	- -	- -	0.06	- -	- -	Lake Michigan
Village of Brown Deer Public Water Utility	AB	4.4	11,800	SP	- -	- -	- -	- -	- -	- -	1	2,000	1.45	- -	- -	Lake Michigan
Village of Fox Point Water Utility[f]	C	2.9	6,900	SP	- -	- -	- -	- -	CH, C, D, S, F	- -	1	1,500	0.71	2.01	- -	Lake Michigan
Village of Greendale Water Utility	AB	4.3	14,100	SP	- -	- -	- -	- -	- -	- -	3	2,190	1.53	- -	- -	Lake Michigan
Village of Shorewood Municipal Water Utility	C	1.6	13,500	SP	- -	- -	- -	- -	- -	- -	0	- -	1.33	- -	- -	Lake Michigan
Village of Whitefish Bay Water Utility[f]	AB	2.1	13,900	SP	- -	- -	- -	1	CH, C, D, S, F		3	5,990	1.47	3.01	- -	Lake Michigan
Total	- -	181.5	920,800	- -	- -	- -	- -	8	- -	432.0	45	167,092	157.44	248.38	246.99	- -

[a] *The municipal water and combined water and sewer utilities are based upon the number of customers as follows: Class AB = 4,000 or more customers; Class C = from 1,000 to less than 4,000 customers; and Class D = less than 1,000 customers.*

[b] *Population based upon Wisconsin Department of Natural Resources data base adjusted to 2004 Wisconsin Department of Administration Civil Division estimates and SEWRPC data, where appropriate.*

[c] *The following abbreviations are used:*

G = Groundwater
SP = Surface Water Purchased (Lake Michigan)
S = Surface Water (Lake Michigan)

[d] *The following abbreviations are used:*

SG = Sand and Gravel
SD = Silurian Dolomite
GP = Galena-Platteville Dolomite
S = Sandstone
M = Multiple Aquifers

[e] *Code for treatment processes:*

CH = Pre-Sedimentation Chemical Addition
S = Sedimentation
C = Coagulation
F = Filtration
MC = Micro-Filtration
FL = Fluoridation
D = Disinfection
CC = Corrosion Control
I = Ion Exchange
P = Phosphate Addition (sequestering)
SH = Sodium Hypochlorite Chemical Addition
H = Hypochlorination
O = Ozone Filtration

[f] *The North Shore Water Commission owns and operates a water treatment plant which provides water to the City of Glendale Water Utility, the Village of Fox Point Water Utility, and the Village of Whitefish Bay Water Utility.*

[g] *Within Milwaukee County, the City of Milwaukee Water Works provides retail water service to the Cities of Greenfield, and St. Francis; the Village of Hales Corners, and the far northeastern portion of the City of Franklin. The City of Milwaukee Water Works provides wholesale water service to the Cities of Wauwatosa and West Allis and the Villages of Brown Deer, Greendale, and Shorewood. The Village of West Milwaukee receives billing services from the City of Milwaukee Water Works but maintains its own distribution system.*

[h] *Population served is that within the retail service area of the City of Milwaukee Water Works and the Village of West Milwaukee.*

[i] *Excludes water sold to communities outside of Milwaukee County.*

[j] *Includes total water pumped, including that sold to communities outside of Milwaukee County.*

[k] *During 2009, the City of Oak Creek Sewer and Water Utility initiated construction on a water treatment plant expansion designed to bring the plant capacity up to 28.0 mgd. The Utility is also considering preparation of a rerating analysis of the water treatment plant which could result in a rerated plant capacity of 35.0 mgd upon completion of the 2009 plant expansion.*

[l] *During 2009, the City of South Milwaukee Water Utility completed a new membrane filter water treatment plant with a capacity of 6.0 mgd.*

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

In 2005, the total storage capacity for the 14 municipal water systems operating in Milwaukee County was approximately 167 million gallons, divided among the 45 storage facilities, as listed in Table 36. Based on Wisconsin Public Service Commission annual reports for the year 2005, and as shown in Table 36, approximately 157 million gallons per day of water were pumped for use in the 14 municipal systems concerned. As shown in Table 37, the water use totaled about 113.8 mgd for residential, commercial, industrial, institutional, or other urban uses, with the remaining 43.6 mgd of total pumpage being used for purposes, such as water production and system maintenance, or being unaccounted-for water. Overall, about 51.6 mgd, or about 45 percent of total municipal water used, was for single- and two-family residential units; about 31.2 mgd, or about 27 percent, for commercial, multi-family residential, institutional, and miscellaneous uses; and about 22.9 mgd, or about 20 percent, was for industrial uses. The remaining 8.1 mgd, or about 7 percent, was used for other municipal purposes. Based upon the population served and reported water use, residential water consumption within the 14 water supply systems was approximately 71 gallons per person per day in 2005. When accounting for all municipal water uses, the average water consumption was about 124 gallons per person per day. In 2005, the amount of water which was unaccounted-for ranged from 2 to 18 percent, with an average of 12 percent of the water pumped for the utilities in Milwaukee County. This unaccounted-for water was not included in the computed per capita consumption rates. It should be noted that the residential water use reported by the water utilities excludes that associated with the use of water by multiple-unit dwelling units with a single meter serving three or more units. Those uses are included with commercial water uses. Thus, the calculation of the water uses on a per capita and per acre basis for the residential and commercial categories were made by adjusting the population and acreage considered under these categories to reflect this reporting requirement.

The water used in the 14 municipal systems in Milwaukee County during 2005 was about 2 percent higher than in 2004, but about 10 percent lower than in 2000. This increase from 2004 to 2005 was due largely to an increase in residential water use of about 3 percent. The reduction from 2000 was due largely to reductions in industrial use of about 25 percent from 2000 to 2005.

Municipal Water Supply System Interconnections and Intermunicipal Service Agreements

The City of Milwaukee Water Works treats and sells water on both a wholesale and retail basis to numerous supply systems within Milwaukee County and within portions of Waukesha and Ozaukee Counties. The City of Milwaukee Water Works wholesale customers within Milwaukee County include the Cities of Wauwatosa and West Allis and the Villages of Brown Deer, Greendale, and Shorewood. Municipal retail customers of the City of Milwaukee Water Works include the Cities of Greenfield, St. Francis, and a portion of the City of Franklin, as well as to the City of Milwaukee itself; and the Village of Hales Corners. The Village of West Milwaukee has a unique arrangement with the City of Milwaukee Water Works, as it receives billing services from the City of Milwaukee Water Works but maintains its own distribution system. Municipal wholesale customers outside of Milwaukee County include We Energies-Water Services for the City of Mequon and Village of Thiensville, the City of New Berlin, the Village of Butler, and the Village of Menomonee Falls.

Currently, several of the water utilities which have water supply treatment plants in Milwaukee have interconnection with each other in order to provide for system redundancy and emergency provisions. Such system interconnections exist with one connection each between the Milwaukee Water Works and the North Shore Water Utility, the City of Cudahy Water Utility, and the City of Oak Creek Water Utility; two connections between the City of Cudahy Water Utility and the City of South Milwaukee Water Utility; and four connections between the City of Oak Creek Water Utility and the City of South Milwaukee Water Utility.

Municipal Water Supply Water Conservation Measures

Water conservation measures reported to be in place by the water utilities in Milwaukee County which have water treatment plants include the City of Milwaukee practice of providing assistance to water users in identifying and eliminating leaks in internal plumbing systems, the conduct of a comprehensive leak survey, and efforts to reduce the length of the filter backwash cycles at the water treatment plants. The City of Oak Creek has implemented water treatment plant modifications which reduce the water which is used in water production. The City of Franklin has instituted restrictions providing for typical odd-even address sprinkling restrictions from May through September. In addition, while not specifically reported, all of the utilities may be expected to be working

Table 37

SUMMARY OF MUNICIPAL WATER USE IN MILWAUKEE COUNTY: 2000, 2004, AND 2005

Year	Average Annual Water Uses										Percent Unaccounted-for Water[h]
	Residential Water Use[a,b]			Industrial Water Use		Commercial, Institutional, and Multi-Family Residential[a,b]		Other Municipal[b,f] Water Uses (gallons per day X 1,000)	Total Municipal Water Use[b,c]		
	Total[d] (gallons per day X 1,000)	Per Person[e] (gallons per capita per day)	Per Acre[e] (gallons per acre per day)	Total[d] (gallons per day X 1,000)	Per Acre (gallons per acre per day)	Total[d] (gallons per day X 1,000)	Per Acre (gallons per acre per day)		Total[d] (gallons per day X 1,000)	Per Person[g] (gallons per capita per day)	
2000	51,938	72	1,280	30,453	5,324	35,423	1,515	6,872	124,686	136	8
2004[i]	50,006	69	1,222	22,561	3,901	30,938	1,312	7,705	111,210	121	12
2005[j]	51,645	71	1,260	22,891	3,948	31,160	1,321	8,128	113,824	124	12

[a]*Residential category includes population associated with single-family and two-family housing units, plus some larger multi-family housing where individual water meters are used for each unit. Other multi-family units are included in the commercial water use category.*

[b]*Excludes water sold to communities outside Milwaukee County.*

[c]*Includes all water specifically accounted for.*

[d]*As reported in annual reports submitted to the Public Service Commission of Wisconsin.*

[e]*Reported residential water use excludes that associated with multiple-unit dwellings where a single meter serves three or more housing units. That water use is classified as commercial under the Public Service Commission of Wisconsin reporting system. The unit water uses presented on a per capita and per acre basis were calculated by adjusting the population and residential land area to be consistent with this reporting procedure.*

[f]*Includes uses for fire protection services, sales to public authorities, sales to irrigation customers and interdepartmental sales.*

[g]*Estimated based upon total residential population served.*

[h]*Water not specifically accounted for as a percent of total pumpage.*

[i]*2004 population and land use was approximated by decreasing the 2000 population by 0.1 percent. Land use did not change.*

[j]*2005 population and land use was approximated by decreasing the 2000 population by 0.2 percent. Land use did not change.*

Source: Public Service Commission of Wisconsin and SEWRPC.

to improve efficiency and minimize water losses in their systems. Such measures include meter testing for accuracy, leak detection programs, and repair of water main breaks and leaks. In addition, all of the water supply utilities within southeastern Wisconsin have water metering in place, have billing systems based upon usage, and are governed by the State plumbing code which limits flow rates and volumes for plumbing fixtures.

Proposed Municipal Water Supply System Modifications and Expansion Plans

The inventory revealed that, as of 2005, locally proposed water supply system modification and expansion plans existed for the water supply service areas in Milwaukee County. Those plans are summarized in the subsequent paragraphs.

It should be noted that the sanitary sewer service area plans and related amendments to the regional water quality management plan listed for the utilities noted below were prepared under the regional water quality management planning program cooperatively being carried out by the WDNR and SEWRPC. These plans and amendments specifically address current and planned sanitary sewer service areas. However, these reports serve as a surrogate for the identification of an urban services area for water supply, as well as sanitary sewer service.

Milwaukee Metropolitan Sewerage District

There has been a long-standing coordinated sanitary sewerage system planning program for the planned urban service areas within Milwaukee County carried out by the WDNR, SEWRPC, and the Milwaukee Metropolitan Sewerage District (MMSD). The integration of water supply and sanitary sewerage services for these areas is particularly important, because portions of the sewer service area for the MMSD, include communities which are traversed by the subcontinental divide. Planning related to sanitary sewerage systems and related sewer service areas has been conducted as part of the continuing regional water quality management planning program. In addition, the MMSD has conducted facilities planning designed to carry out its sanitary sewerage system and water quality management responsibilities, which are collectively referred to as the Milwaukee water pollution abatement program. In 2007, the MMSD completed facilities planning to extend the facilities plan to the year 2020. That planning is being conducted in coordination with a SEWRPC update of the regional water quality management plan for the watersheds located within, or partially within, the MMSD service area. The planning area for the current MMSD facilities planning effort includes all of Milwaukee County, plus portions of surrounding counties. The long-term planned sewer service area for the MMSD includes all of Milwaukee County, except the City of South Milwaukee, and includes portions of the surrounding counties. The findings and recommendations of sewer service area planning conducted for areas in Milwaukee County are documented in the following reports:

1. A report entitled *Sanitary Sewer Service Area for the City of Franklin, Milwaukee County, Wisconsin*, October 1990, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the City of Franklin and the Milwaukee Metropolitan Sewerage District.

2. A report entitled *Sanitary Sewer Service Area for the City of Oak Creek, Milwaukee County, Wisconsin*, July 1994, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the City of Oak Creek and the Milwaukee Metropolitan Sewerage District.

A review of the aforelisted reports indicates that, as of 2005, the two cities concerned have plans in place to provide water supply and sanitary sewer service to all of the urban service areas within their corporate limits. The entire urban service area within all of Milwaukee County is proposed to be served by water supply provided by the existing water treatment plants which use Lake Michigan as a source of supply, with the spent water being conveyed as sanitary sewage to the MMSD sewage treatment plants which discharge treated effluent to Lake Michigan.

City of Franklin Water Utility

The City of Franklin Water Utility purchases nearly all of its water from the City of Oak Creek Water and Sewer Utility. A small area—about 0.2 square mile—located in the northeastern portion of the City receives retail service from the City of Milwaukee. A review of the water supply inventory information provided by the City of Franklin Water Utility indicates that there are future plans for construction of a 2.0 million gallon elevated storage tank adjacent to the existing W. Puetz Road storage facility. In addition, in the longer term, an additional storage facility is expected to be needed in the City’s west service zone and would be located in the vicinity of STH 100. In addition, the Franklin Water Utility is considering possible additional system interconnections with both the Milwaukee Water Works and the Village of Greendale Water Utility for purposes of system redundancy and emergency use.

City of Oak Creek Water Utility

The City of Oak Creek Water and Sewer Utility owns and operates a Lake Michigan surface water intake and treatment plant. Plans for the Oak Creek Water and Sewer Utility system are documented in the aforenoted sanitary sewer service area plan for the City of Oak Creek, and in the following report:

1. A report entitled *Water System Study; Project Summary*, prepared by Kaempfer & Associates, Inc., dated March 2002.

A review of the aforenoted water system study indicates that the City of Oak Creek system is updating its 2020 facilities plan to ensure that the system will be capable of meeting projected growth and expansion. This update is in response to new urban development located in the City of Oak Creek, as well as in other water utilities that the Oak Creek Water and Sewer Utility supplies, including the City of Franklin, the Crestview Sanitary District, and the Town of Caledonia Water Utility District No. 1. The study recommends that the water supply facilities be expanded and upgraded to provide a capacity of 28 mgd. The water treatment plant could ultimately provide a capacity of 48 mgd. During 2009, the City of Oak Creek Sewer and Water Utility initiated construction on a water treatment plant expansion designed to bring the treatment plant capacity up to 28 mgd. The Utility is also considering the preparation of a rerating analysis of the water treatment plant which could result in a plant capacity of 35 mgd upon completion of the 2009 expansion.

The aforenoted water system study recommends continued use of Well No. 3 as an aquifer storage and recovery (ASR) well and the conversion of up to five additional wells to ASR wells. In addition, the study recommends the addition of emergency storage at the water treatment plant, the construction of electrical system improvements at the water treatment plant, and distribution system improvements.

City of South Milwaukee Water Utility

The City of South Milwaukee Water Utility owns and operates a Lake Michigan surface water intake and treatment plant. The City water utility has no specific plans for capacity expansion. However, the water utility is implementing plans to upgrade its treatment facilities by conversion to membrane filtration. During 2009, the City completed construction of a new membrane filter water treatment plant with a capacity of 6.0 million gallons per day.

Existing Residential and Other-than-Municipal Community Systems

In 2005, there were 10 existing privately owned water, self-supplied, systems operating in Milwaukee County which provide water supply services to primarily residential land uses, such as subdivisions, apartment or condominium developments, and mobile home parks. Such systems are generally categorized by the WDNR as “other-than-municipal community systems.” These systems served a year 2005 resident population of about 3,000 persons, or about 0.3 percent of the Milwaukee County year 2005 resident population. Of the 10 systems, seven were classified as high-capacity systems, and three as low-capacity systems. All of these systems utilized groundwater as a source of supply through eight low-capacity and 11 high-capacity wells. The location of these systems are shown on Map 35. Selected characteristics of each system are presented in Table D-1 in Appendix D.

Existing Industrial Water Supply Systems

In 2005, there were 13 existing privately owned, self-supplied, water systems operating in Milwaukee County which provide water for industrial land uses. Of these, nine were classified as high-capacity systems and four as low-capacity systems. These systems all utilize groundwater as a source of supply through five low-capacity wells and nine high-capacity wells. The locations of these systems are shown on Map 36. Selected characteristics of each system are presented in Table D-2 in Appendix D.

Existing Commercial Water Supply Systems

In 2005, there were 49 existing privately owned, self-supplied, water systems operating in Milwaukee County which provide water for commercial land uses. All of these systems were classified as low-capacity systems, and utilized groundwater as a source of supply through 51 low-capacity wells. The locations of these systems are shown on Map 36. Selected characteristics of each system are presented in Table D-3 in Appendix D.

Existing Institutional and Recreational Water Supply Systems

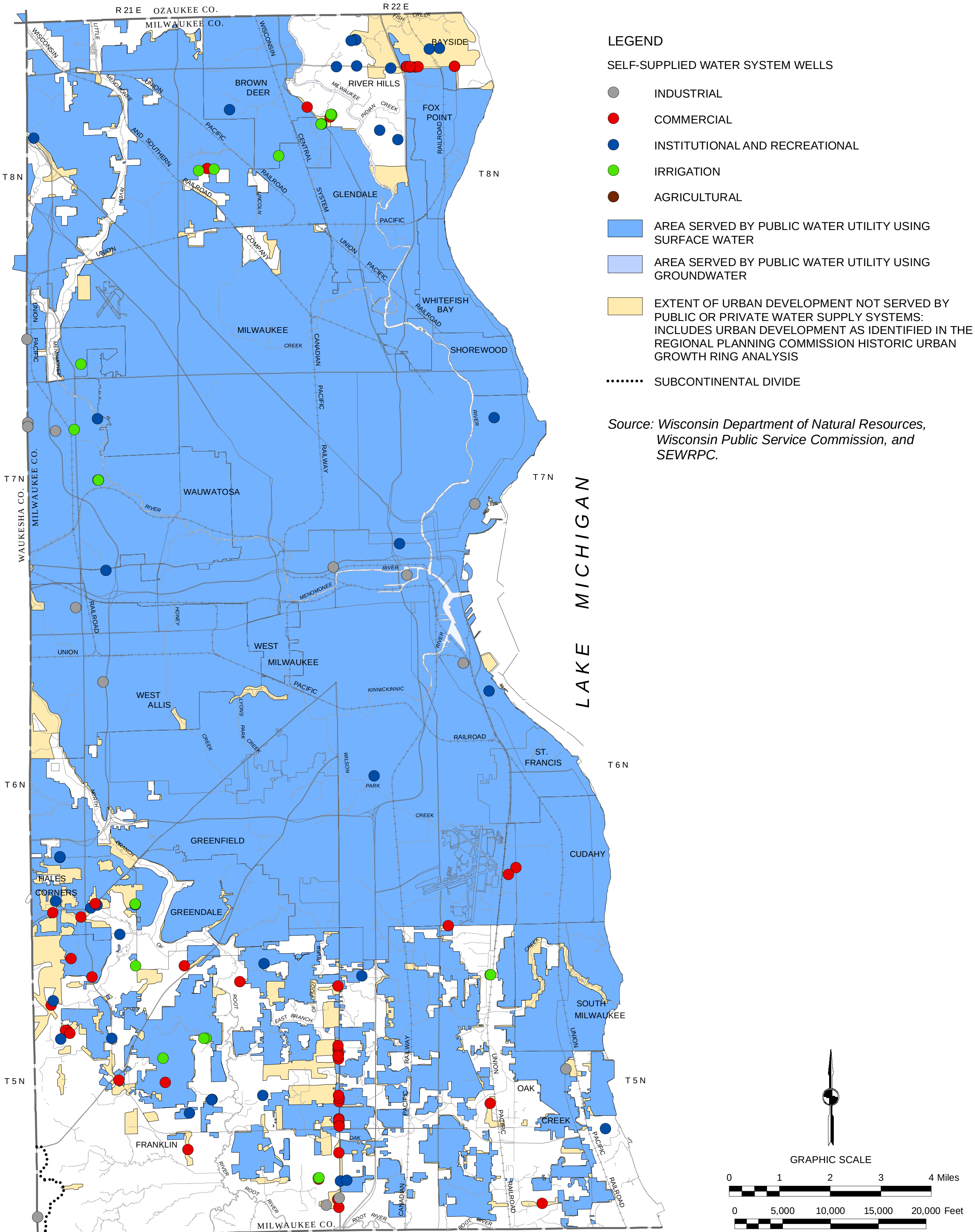
In 2005, there were 34 existing privately owned, self-supplied, water systems operating in Milwaukee County which provided water for institutional and recreational land uses. Of these, 16 are classified as high-capacity systems and 18 are classified as low-capacity systems. These systems all utilized groundwater as a source of supply through 23 low-capacity wells and 17 high-capacity wells. The locations of these systems are shown on Map 36. Selected characteristics of each system are presented in Table D-4 in Appendix D.

Existing Agricultural Water Supply Systems

In 2005, there were no existing privately owned, self-supplied, water systems operating in Milwaukee County which provided water for irrigation and other agricultural purposes.

Map 36

SELF-SUPPLIED INDUSTRIAL, COMMERCIAL, INSTITUTIONAL AND RECREATIONAL, AGRICULTURAL, AND IRRIGATION WATER SUPPLY SYSTEMS IN MILWAUKEE COUNTY: 2005



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

Existing Irrigation Water Supply Systems

In 2005, there were 14 existing privately owned, self-supplied, water systems operating in Milwaukee County which provided irrigation water for land uses other than agricultural uses, such as golf courses. All of these systems are classified as high-capacity systems. These systems utilized groundwater as a source of supply through 21 high-capacity wells. The locations of these systems are shown on Map 36. Selected characteristics of each system are presented in Table D-6 in Appendix D.

Existing Thermoelectric-Power-Generation Water Supply Systems

In 2005, there were three existing electric power generation facilities operating in Milwaukee County which utilize water for coal-based thermoelectric-power-generation; the Valley Power Plant located in the City of Milwaukee, the Milwaukee County Power Plant located on the Milwaukee County Grounds in the City of Wauwatosa and the Oak Creek Power Plant located on the shore of Lake Michigan in the City of Oak Creek. The Valley Power Plant is a co-generation facility, providing both electricity and steam for the City of Milwaukee's heating system. The Valley Power Plant circulates about 160 million gallons of water per day obtained from the Menomonee River and returned to the South Menomonee Canal. The Milwaukee County Power Plant is a co-generation facility providing steam, chilled water, and some of the electricity for the Milwaukee Regional Medical Center. The Milwaukee County Power Plant utilizes purchased surface water. The water use at the plant is relatively low due to its size and the use of closed loop cooling towers. The existing Oak Creek Power Plant draws cooling water from Lake Michigan and uses an open cycle cooling system which passes the water over heat exchangers and then returns the water to its source. The plant is authorized by WDNR permit to utilize 1.8 billion gallons per day of Lake water. The power plant is currently undergoing an expansion and is expected to use up to 2.2 billion gallons per day of Lake water upon completion of that expansion. Nearly all the water withdrawn is returned to the Lake with a very small percentage being used for various power plant components other than heat exchanging, such as air emission reduction equipment.

Existing Self-Supplied Residential Water Systems

As of the year 2005, there were about 15,000 persons, or about 2.0 percent of the total resident year 2005 population of Milwaukee County, served by private domestic wells. As shown on Map 35, there were a number of areas outside of the municipal water utility service within Milwaukee County that are classified as having urban-density development, and were served by private wells. These were located primarily in the far northern and southern portions of the County, and include portions of the City of Franklin, the City of Oak Creek, and the Village of Bayside, as well as other municipalities. All residents in the Village of River Hills rely on private wells; however, the Village is developed at a primarily, rural density. Assuming an average use of 65 gallons per capita per day, these private domestic wells would withdraw about 1.0 million gallons per day from the shallow groundwater aquifer. It is estimated that 90 percent of the households served by private domestic wells are served by public sanitary sewer systems (MMSD). Thus, the water withdrawn from the groundwater system for about 90 percent of the private domestic wells, or about 0.9 million gallons per day, was discharged to Lake Michigan as treated sanitary sewage. The majority—approximately 90 percent—of the remaining 10 percent of the water withdrawn by private wells, or about 0.1 million gallons per day, was returned to the groundwater aquifer via onsite sewage disposal systems.

INVENTORY FINDINGS—OZAUKEE COUNTY

Existing Municipal Water Supply Systems

In 2005, seven municipal water supply utility systems provided water to about 17.7 square miles of service area, or about 8 percent of the area of Ozaukee County. These systems served a population of about 49,200 persons, or about 57 percent of the residential population in Ozaukee County. Two of the water supply systems in Ozaukee County rely on Lake Michigan as the source of supply, either directly or indirectly through the wholesale or retail purchase of water. The City of Port Washington Water Utility which owns and operates a surface water treatment plant with two intakes, is the largest supplier of treated surface water in Ozaukee County. We Energies-Water Services, which purchases treated surface water from the City of Milwaukee Water Works, supplies water to portions of the City of Mequon and the Village of Thiensville. In 2005, the total population served by the We

Energies-Water Services and the Port Washington surface water supply systems was approximately 18,300, accounting for approximately 37 percent of the total population supplied with municipal water. The remaining five systems, and 63 percent of the population served, rely on groundwater as the source of supply. The existing service areas of these systems are shown on Map 37 and selected characteristics of each system are presented in Table 38.

In 2005, the total storage capacity for the seven municipal water systems operating in Ozaukee County was approximately 6.3 million gallons, divided among the 23 storage facilities, as listed in Table 38. Based on Wisconsin Public Service Commission annual reports for the year 2005, approximately 6.7 million gallons per day of water were pumped for use in the seven municipal systems including 2.1 million gallons of surface water. As shown in Table 39, water use totaled about 5.7 mgd for residential, commercial, industrial, institutional, or other urban uses, with the remaining 1.0 mgd of total pumpage being used for purposes, such as water production and system maintenance, or being unaccounted-for water. Overall, about 2.9 mgd, or about 50 percent of total municipal water used, was for single- and two-family housing units residential purposes; about 1.0 mgd, or about 17 percent, for commercial, multi-family residential, institutional, and miscellaneous uses; and about 1.7 mgd, or about 29 percent, was for industrial uses. The remaining 0.2 mgd, or about 4 percent, was used for other municipal purposes. Based upon the population served and reported water use, residential water consumption within the seven water supply systems was approximately 68 gallons per person per day in 2005. When accounting for all municipal water uses, the average water consumption was about 117 gallons per person per day. In 2005, the amount of water which was unaccounted-for ranged from 4 to 23 percent, with an average of 12 percent of the water pumped for the utilities in Ozaukee County. This unaccounted-for water was not included in the computed per capita consumption rates. It should be noted that the residential water use reported by the water utilities excludes that associated with the use of water by multiple-unit dwelling units with a single meter serving three or more units. Those uses are included with commercial water uses. Thus, the calculation of the water uses on a per capita and per acre basis for the residential and commercial categories were made by adjusting the population and acreage considered under these categories to reflect this reporting requirement.

The total water use in the seven municipal systems in 2005 was nearly the same as in 2004, and about 3 percent higher than in 2000. That increase over the year 2000 is consistent with the population growth in the area served.

Municipal Water Supply System Interconnection and Intermunicipal Service Provisions

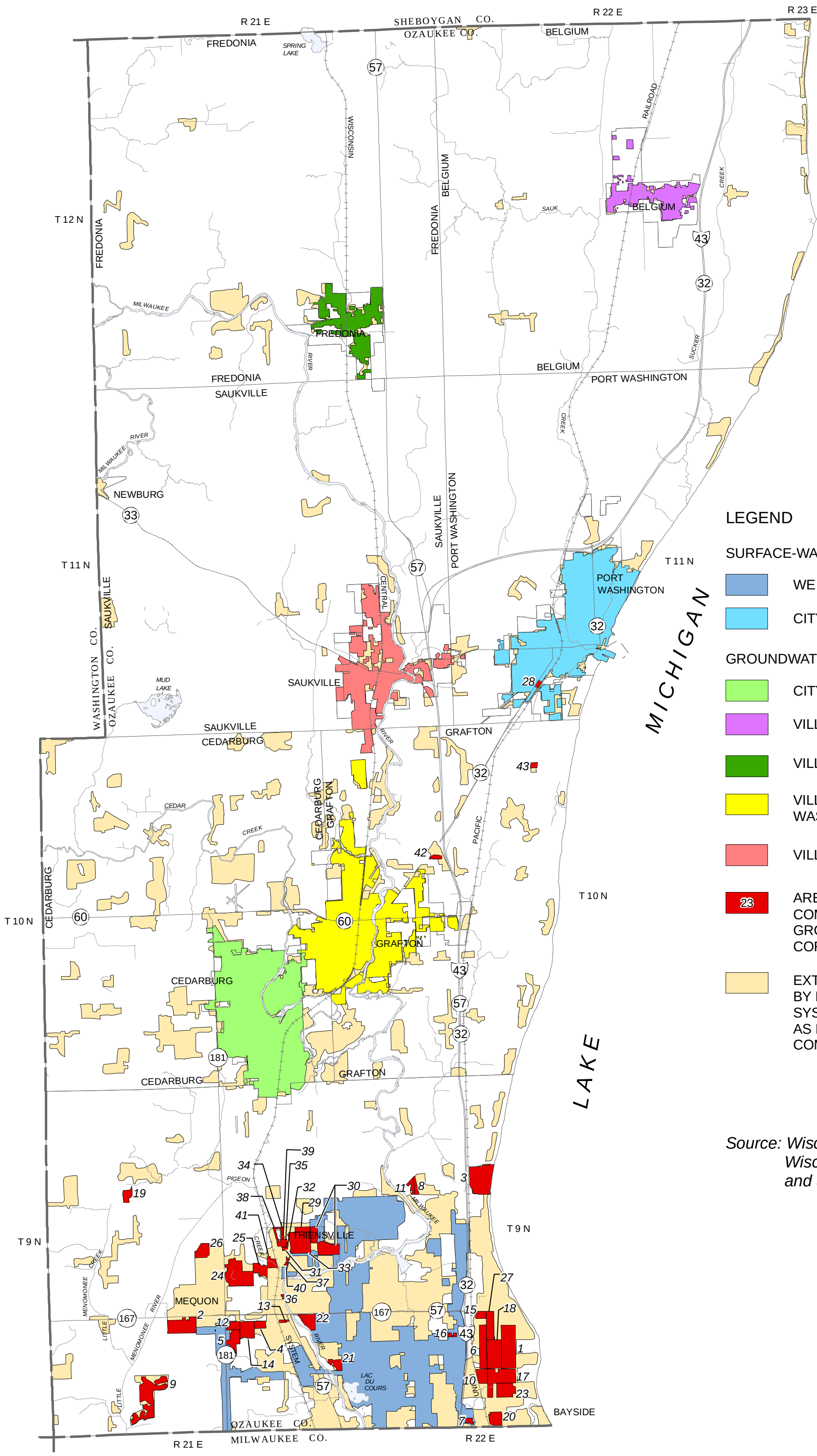
As previously reported, We Energies-Water Services, which purchases treated surface water from the City of Milwaukee Water Works, supplies water to portions of the City of Mequon and the Village of Thiensville. The We Energies-Water Services water supply is connected to the City of Milwaukee system. The We Energies-Water Services system serving the City of Mequon and Village of Thiensville is also interconnected for emergency use purposes with the We Energies-Water Services system serving portions of the Village of Bayside and is supplied by the North Shore Water Commission’s system. In addition, the City of Cedarburg and Village of Grafton have a water supply system interconnection at one location in order to provide system redundancy and emergency provisions.

Municipal Water Supply Water Conservation Measures

Water conservation measures reported to be in place or under development by the water utilities in Ozaukee County include the Village of Grafton’s use of a typical odd-even address sprinkling restriction which are put in place annually from June 15th through September 15th. The City of Cedarburg and the Village of Saukville have the ability to institute the same restrictions, but do so only when potential supply problems become evident. The Village of Saukville has instituted a public education program focused on Village newsletter articles providing information on water conservation measures for landscape watering, leakage detection, and water softener, appliance and plumbing fixture efficiency practices. In addition, while not specifically reported, all of the utilities may be expected to be working to improve efficiency and minimize water losses in their systems. Such measures include meter testing for accuracy, leak detection programs, and repair of water main breaks and leaks. In addition, all of the water supply utilities within southeastern Wisconsin have water metering in place, have billing systems based upon usage, and are governed by the State plumbing code which limits flow rates and volumes for plumbing fixtures.

Map 37

MUNICIPAL AND OTHER-THAN-MUNICIPAL COMMUNITY WATER SUPPLY SYSTEMS IN OZAUKEE COUNTY: 2005



Water Supply Facilities	
Public Systems	7
Surface Water Treatment Plants	1
Surface Water Intakes	2
Wells	20
Storage Facilities	23
Private Systems	43
Number of Private System Wells	67

LEGEND

SURFACE-WATER SUPPLIED SYSTEMS AND SERVICE AREAS

- WE ENERGIES
- CITY OF PORT WASHINGTON WATER UTILITY

GROUNDWATER-SUPPLIED SYSTEMS AND SERVICE AREAS

- CITY OF CEDARBURG LIGHT AND WATER COMMISSION
- VILLAGE OF BELGIUM WATER UTILITY
- VILLAGE OF FREDONIA MUNICIPAL WATER UTILITY
- VILLAGE OF GRAFTON WATER AND WASTEWATER COMMISSION
- VILLAGE OF SAUKVILLE MUNICIPAL WATER UTILITY
- 23 AREA SERVED BY OTHER-THAN-MUNICIPAL COMMUNITY WATER SYSTEMS USING GROUNDWATER. IDENTIFICATION NUMBER CORRESPONDS WITH APPENDIX D
- EXTENT OF URBAN DEVELOPMENT NOT SERVED BY PUBLIC OR PRIVATE WATER SUPPLY SYSTEMS: INCLUDES URBAN DEVELOPMENT AS IDENTIFIED IN THE REGIONAL PLANNING COMMISSION HISTORIC URBAN GROWTH RING ANALYSIS

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

GRAPHIC SCALE

0 1 2 3 4 Miles

0 5,000 10,000 15,000 20,000 Feet

Table 38

SELECTED CHARACTERISTICS OF EXISTING MUNICIPAL WATER SUPPLY SYSTEMS WITHIN OZAUKEE COUNTY: 2005

Water Supply System	Class[a]	Estimated Area Served (square miles)	Estimated Population Served[b]	Source of Supply[c]	Number of Wells	Total Well Pumpage Capacity (mgd)	Well Aquifer[d]	Number of Lake Water Intakes	Treatment Processes[e]	Surface Treatment Plant Capacity (mgd)	Number of Storage Facilities	Total Storage Capacity (gallons x 1,000)	2005 Annual Average Pumpage (mgd)	2005 Maximum Daily Pumpage (mgd)	10-Year Maximum Daily Pumpage (mgd)	Spent Water Receiving System
City of Cedarburg Light & Water Commission	AB	3.3	11,400	G	5	5.10	SD	- -	H, CC, F	- -	3	1,250	1.42	2.54	2.59	Cedar Creek
City of Mequon Water Utility (We Energies-Water Services)	D	5.1	7,500	SP	- -	- -	- -	- -	- -	- -	- -	- -	0.95	- -[f]	- -[f]	Lake Michigan
City of Port Washington Water Utility.......................................	AB	3.0	10,800	S	- -	- -	- -	2	S, C, CC, F, D, H	4	3	1,850	1.20	2.96	2.96	Lake Michigan
Village of Belgium Water Utility	C	0.6	1,900	G	3	2.46	SD	- -	H, P	- -	4	535	0.29	0.65	7.41	E. Branch Belgium Creek
Village of Fredonia Municipal Water Utility.......................................	D	0.7	2,100	G	2	1.29	SD	- -	H, CL	- -	3	380	0.19	1.07	0.67	Milwaukee River
Village of Grafton Water and Wastewater Commission	C	3.4	11,300	G	6	4.85	S, SD, SH	- -	CC, H, F	- -	5	846	1.38	2.72	2.72	Milwaukee River
Village of Saukville Municipal Water Utility.......................................	C	1.6	4,200	G	4	3.93	SD	- -	D, P, F	- -	5	1,450	1.31	1.91	1.50	Milwaukee River
Total	- -	17.7	49,200	- -	20	17.63	- -	2	- -	4	23	6,311	6.74	11.85	17.85	- -

NOTE: N/A indicates data not available.

[a]*The municipal water and combined water and sewer utilities are based upon the number of customers as follows: Class AB 4,000 or more customers; Class C from 1,000 to less than 4,000 customers; and Class D less than 1,000 customers.*

[b]*Population based upon Wisconsin Department of Natural Resources data base adjusted to 2004 Wisconsin Department of Administration Civil Division estimates and SEWRPC data, where appropriate.*

[c]*The following abbreviations are used:*

G = Groundwater
S = Surface Water (Lake Michigan)
SP = Surface Water Purchased (Lake Michigan)

[d]*The following abbreviations are used:*

SG = Sand and Gravel
SD = Silurian Dolomite
GP = Galena-Platteville Dolomite
S = Sandstone
M = Multiple Aquifers
SH = Shale

[e]*Code for treatment processes:*

CH = Pre-Sedimentation Chemical Addition
S = Sedimentation
C = Coagulation
F = Filtration
MC = Micro-Filtration
FL = Fluoridation
D = Disinfection
CC = Corrosion Control
I = Ion Exchange
P = Phosphate Addition (sequestering)
SH = Sodium Hypochlorite Chemical Addition
H = Hypochlorination

[f]*Included in City of Milwaukee pumpage data.*

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

Table 39

SUMMARY OF MUNICIPAL WATER USE IN OZAUKEE COUNTY: 2000, 2004, AND 2005

Year	Average Annual Water Uses										Percent Unaccounted-for Water[g]
	Residential Water Use[a]			Industrial Water Use		Commercial, Institutional, and Multi-Family Residential[a]		Other Municipal[e] Water Uses (gallons per day X 1,000)	Total Municipal Water Use[b]		
	Total[c] (gallons per day X 1,000)	Per Person[d] (gallons per capita per day)	Per Acre[d] (gallons per acre per day)	Total[c] (gallons per day X 1,000)	Per Acre (gallons per acre per day)	Total[c] (gallons per day X 1,000)	Per Acre (gallons per acre per day)		Total[c] (gallons per day X 1,000)	Per Person[f] (gallons per capita per day)	
2000	2,571	66	581	1,999	4,163	808	425	197	5,575	123	12
2004[h]	2,784	67	553	1,834	3,660	955	523	172	5,745	119	12
2005[i]	2,882	68	572	1,659	3,219	977	469	215	5,733	117	12

[a]*Residential category includes population associated with single-family and two-family housing units, plus some larger multi-family housing where individual water meters are used for each unit. Other multi-family units are included in the commercial water use category.*

[b]*Includes all water specifically accounted for.*

[c]*As reported in annual reports submitted to the Public Service Commission of Wisconsin.*

[d]*Reported residential water use excludes that associated with multiple-unit dwellings where a single meter serves three or more housing units. That water use is classified as commercial under the Public Service Commission of Wisconsin reporting system. The unit water uses presented on a per capita and per acre basis were calculated by adjusting the population and residential land area to be consistent with this reporting procedure.*

[e]*Includes uses for fire protection services, sales to public authorities, sales to irrigation customers and interdepartmental sales.*

[f]*Estimated based upon total residential population served.*

[g]*Water not specifically accounted for as a percent of total pumpage.*

[h]*2004 population and land use was approximated by increasing the 2000 population and land use amounts by 3.7 percent.*

[i]*2005 population and land use was approximated by increasing the 2000 population and land use amounts by 5.0 percent.*

Source: Public Service Commission of Wisconsin and SEWRPC.

Proposed Municipal Water Supply System Modifications and Expansion Plans

The inventory revealed that, as of 2005, locally proposed water supply system modification and expansion plans existed for a number of the water utilities in the County. It should be noted that all of Ozaukee County is located east of the subcontinental divide. Thus, return flow of spent water is not an issue with regard to the use of Lake Michigan as a source of supply. The findings and recommendations of local plans are summarized in subsequent paragraphs.

It should be noted that the sanitary sewer service area plans and related amendments to the regional water quality management plan listed for the utilities noted below were prepared under the regional water quality management planning program cooperatively being carried out by the WDNR and SEWRPC. These plans and amendments specifically address current and planned sanitary sewer service areas. However, they also serve as a surrogate for the identification of an urban services area for water supply, as well as sanitary sewer service.

City of Cedarburg Light & Water Commission and Village of Grafton Water and Wastewater Commission

The City of Cedarburg and the Village of Grafton have conducted sanitary sewer service area planning on a cooperative basis. In addition, the two community water utilities conducted cooperative studies for well siting and the evaluation of the potential for a Lake Michigan water supply. Because of the close proximity of these two communities and the historic cooperative planning efforts, plan proposals are reported herein for the two water utilities. The available plans and reports related to water supply and, as appropriate, sewer service areas, include the following:

1. A report entitled *Water System Study; Prepared for the Grafton Water and Wastewater Utility*, prepared by Earth Tech, Inc. dated December 2001.

2. A report entitled, Appendix A, *Lake Michigan Water Supply Evaluation,* prepared by Earth Tech, Inc., dated December 2002.

3. A report entitled *Task 1.0 Geological Reconnaissance Study to Identify Potential High-capacity Well Sites, City of Cedarburg and Village of Grafton, Wisconsin,* prepared by Layne-Northwest, dated March 2005.

4. A report entitled *Sanitary Sewer Service Areas for the City of Cedarburg and the Village of Grafton, Ozaukee County, Wisconsin,* prepared and adopted by the Southeastern Wisconsin Regional Planning Commission and the communities involved, dated June 1996.

Review of the aforelisted plans and additional information provided by the two water utilities involved indicates that, as of 2005, the City of Cedarburg Light & Water Commission was taking measures to ensure that system capacity will be able to meet projected future demand, by performing a well siting study for a new well, Well No. 7. In addition, preliminary planning was being initiated for a potential water storage tower and booster station to serve newly annexed lands north of the City. The Grafton Water and Wastewater Commission has identified the need for a new well to be located on the east side of the Village.

The preliminary study noted in Item 2 above, considered the option of providing Lake Michigan as a source of supply. Three alternative plans for the provision of such a supply were considered:

- Connection of the Village system to an existing surface water supply system—either the City of Port Washington system or the We Energies-Water Services system which serves the City of Mequon and the Village of Thiensville;

- Development of a new surface water treatment plant and intake to serve the Village of Grafton; and

- Development of a new regional surface water treatment plant and intake to serve the City of Cedarburg and the Village of Grafton.

Based upon an evaluation and review of the three alternative plans, the following conclusions and recommendations were made in the aforelisted report, dated December 2002:

- With the addition of one well, the current groundwater supply in the Grafton area should be adequate through the year 2020 planning period. The current rate of decline in groundwater level should not remove an existing well from service until approximately 2050, which may be beyond the service life of some wells. The first well to require replacement will likely be Well No. 4, although its unstable water levels make its useful life difficult to predict;

- A Lake Michigan source of supply is a viable long-term source of water supply given Grafton's location, rate and direction of growth, and the high quality and abundance of the Lake supply;

- The most cost effective option for obtaining a Lake water supply for the Grafton area appears to be the construction of a new water treatment plant and intake by the Village, preferably with some level of regional cooperation; and

- If the preferred Lake water option were implemented, the cost of service impact to an average Grafton customer would be an increase of approximately 14 percent, or $6.97 per quarter, over the cost of continuing to rely solely on groundwater supply. The year 2010 projected quarterly costs to an average water customer under the three main alternatives discussed may be summarized as follows:

Alternative		Year 2010 Projected Average Quarterly Cost
1.	Purchase all water from Port Washington system:	$74.30
2.	Construct a surface water treatment plant and intake:	55.37
3.	Continue the current groundwater supply:	48.40

City of Port Washington Water Utility
Plans for the City of Port Washington Water Utility system were documented in the following reports:

1. A report entitled *City of Port Washington Water System Update: 2006*, prepared by Bonestroo, Rosene, Anderlik & Associates, Inc., dated December 2006.

2. A report entitled *Amendment to the Regional Water Quality Management Plan, City of Port Washington*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission and the City of Port Washington, dated December 2003.

The aforelisted plans recommend that the City of Port Washington Water Utility expand its water supply system in a phased manner to accommodate future water demands. The needed water system improvements identified include an additional storage facility located on the south side of the City, and distribution system improvements. The water treatment plant capacity was judged to be adequate to serve the Port Washington water service area through the year 2023.

Village of Saukville Water Utility
Plans for the Village of Saukville Municipal Water Utility system were documented in the following reports:

1. A report entitled *Water System Master Plan Update*, prepared by Ruekert & Mielke, Inc., Inc., dated August 2003.

2. A report entitled *Amendment to the Regional Water Quality Management Plan*, *Village of Saukville*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission and the Village of Saukville, dated September 2001.

A review of the aforelisted local plans indicates that the Village of Saukville Municipal Water Utility will have to undertake measures to increase capacity and improve system efficiency. These measures include the acquisition of a site and the construction of a new test well for a proposed Well No 6. In addition, the plan recommends water distribution system improvements.

Village of Fredonia Municipal Water Utility
Plans for the Fredonia Municipal Water Utility consist of the following:

1. A report entitled *Sewer Service Area for the Village of Fredonia, Ozaukee County, Wisconsin*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission and the Village of Fredonia, dated March 2004.

A review of additional information provided by the Village of Fredonia Municipal Water Utility indicates that the Utility intends to develop a new well. The initial sites being considered for the well are located northwest of the Village near Fredonia-Kohler Road and east of STH 57 on land recently annexed to the Village.

Existing Residential and Other-than-Municipal Community Systems
In 2005, there were 43 existing privately owned, self-supplied, water systems operating in Ozaukee County which provide water supply services to primarily residential land uses, such as subdivisions, apartment or condominium

developments, and mobile home parks. Such systems are generally categorized by the WDNR as “other-than-municipal community systems.” These systems served a year 2005 resident population of about 8,000 persons, or about 9 percent of the Ozaukee County resident population. Of the 43 systems, 33 are classified as high-capacity systems, and 30 are classified as low-capacity systems that combined, rely on 29 low-capacity wells and 38 high-capacity wells as a source of supply. The location of these systems are shown on Map 37. Selected characteristics of each system are presented in Table D-1 in Appendix D.

Existing Industrial Water Supply Systems
In 2005, there were 14 existing privately owned, self-supplied, water systems operating in Ozaukee County which provide water for industrial land uses. Of these, five are classified as high-capacity systems and nine are classified as low-capacity systems. These systems all utilize groundwater as a source of supply through 12 low-capacity wells and seven high-capacity wells. The locations of these systems are shown on Map 38. Selected characteristics of each system are presented in Table D-2 in Appendix D.

Existing Commercial Water Supply Systems
In 2005, there were 125 existing privately owned, self-supplied, water systems operating in Ozaukee County which provide water for commercial land uses. Of these, eight are classified as high-capacity systems and 117 are classified as low-capacity systems. These systems all utilized groundwater as a source of supply through 136 low-capacity wells and six high-capacity wells. The locations of these systems are shown on Map 38. Selected characteristics of each system are presented in Table D-3 in Appendix D.

Existing Institutional and Recreational Water Supply Systems
In 2005, there were 83 existing privately owned, self-supplied, water systems operating in Ozaukee County which provided water for institutional and recreational land uses. Of these, 19 are classified as high-capacity systems and 64 are classified as low-capacity systems. These systems all utilized groundwater as a source of supply through 86 low-capacity wells, 11 high-capacity wells, and two wells with an unknown capacity. The locations of these systems are shown on Map 38. Selected characteristics of each system are presented in Table D-4 in Appendix D.

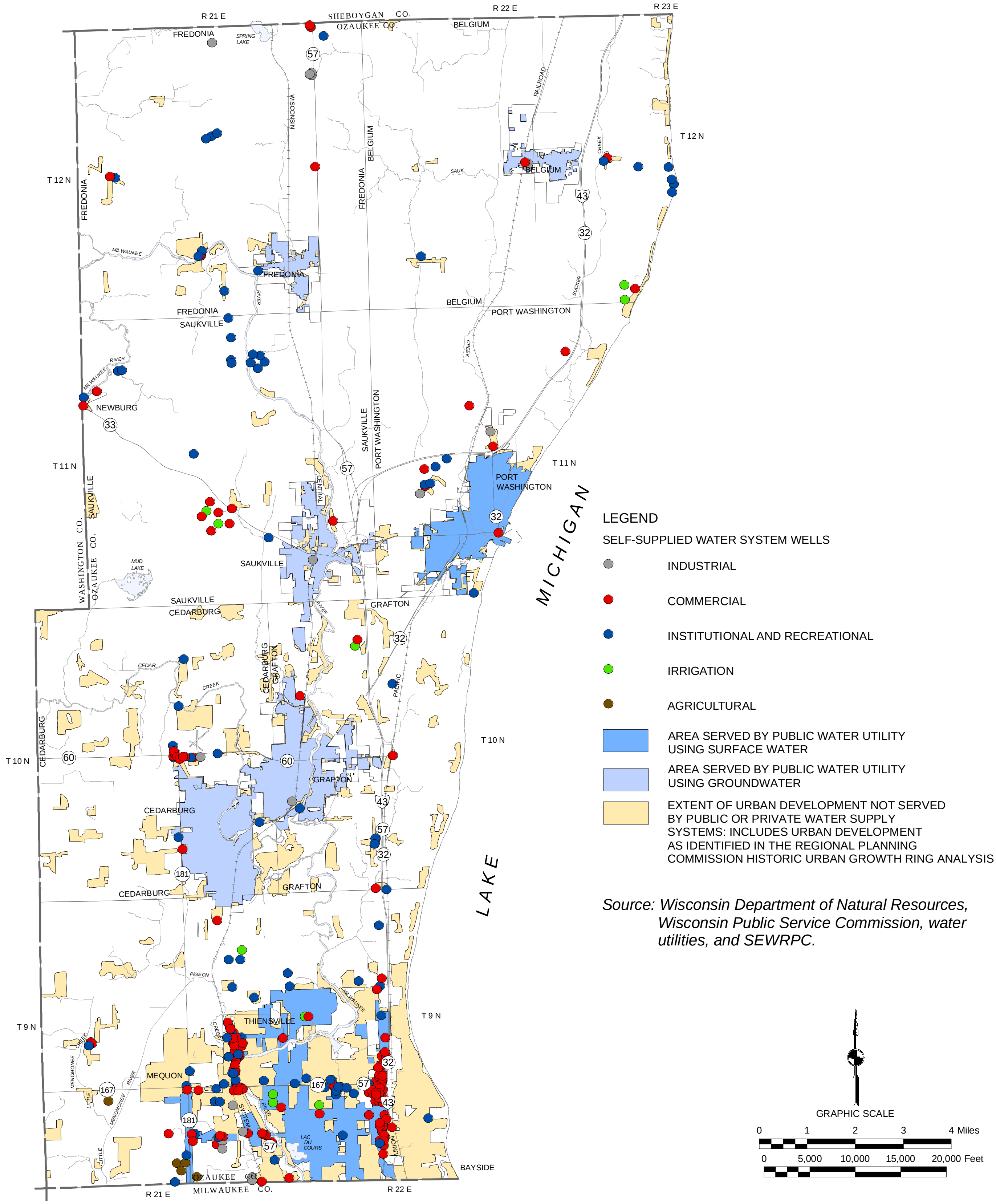
Existing Agricultural Water Supply Systems
In 2005, there were three existing privately owned, self-supplied, water systems operating in Ozaukee County which provided water for irrigation and other agricultural purposes. All three systems are categorized as high-capacity and all utilized groundwater as a source of supply through five high-capacity wells. The locations of these systems are shown on Map 38. Selected characteristics of each system are presented in Table D-5 in Appendix D.

Existing Irrigation Water Supply Systems
In 2005, there were seven existing privately owned, self-supplied, water systems operating in Ozaukee County which provided irrigation water for land uses other than agricultural uses, such as golf courses. All seven systems are categorized as high-capacity systems and all utilized groundwater as a source of supply through 10 high-capacity wells. The locations of these systems are shown on Map 38. Selected characteristics of each system are presented in Table D-6 in Appendix D.

Existing Thermoelectric-Power-Generation Water Supply Systems
In 2005, the Port Washington Power Plant, located in the City of Port Washington, began conversion from a coal-fired thermoelectric-power-generation facility to an intermediate load natural gas-fired thermoelectric-power-generation facility. This facility draws water from Lake Michigan and uses an open cycle cooling system which passes the water over heat exchangers and then returns the water to its source. Based upon a 2001 Wisconsin Department of Natural Resources WPDES permit record, the average total water withdrawal rate from the Lake for cooling the proposed facility is estimated to be 561,000 gpm, or about 808 mgd. Of this total, approximately 508,000 gpm would be passed through the condensers and other heat exchange equipment. Another 34,000 gpm would be used to enhance the combustion turbine generation capacity during warmer weather by cooling the

Map 38

SELF-SUPPLIED INDUSTRIAL, COMMERCIAL, INSTITUTIONAL AND RECREATIONAL, AGRICULTURAL, AND IRRIGATION WATER SUPPLY SYSTEMS IN OZAUKEE COUNTY: 2005



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

intake air by passing it over coils containing once-through circulating lake water. The remaining 19,000 gpm will be used for auxiliary cooling systems and the water supply for the spray backwash system for the intake traveling water screens.

The Port Washington power plant's existing water intake structure was designed with a capacity of 565,000 gpm, or about 813 mgd, which is expected to be adequate for the proposed new plant configuration. We Energies reported that during the period 1996 through 1998, the average and maximum flow rates through the cooling system were 293,000 gpm and 440,000 gpm, respectively. Two new 150,000-gallon demineralized water storage tanks are proposed to be constructed to store water for use as steam-cycle makeup. The existing demineralizer plant, consisting of two trains, each with a capacity of 150 gpm, would be used to produce demineralized water for the new facility. The existing municipal water supply source would be used for potable uses, back-up fire protection, and for providing makeup to the demineralizer system.

Existing Self-Supplied Residential Water Systems

As of the year 2005, there were about 29,000 persons, or about 33 percent of the total resident year 2005 population of Ozaukee County, served by private domestic wells. As shown on Map 37, there were a number of areas within Ozaukee County classified as having urban-density development which were served by private wells. Most of these areas were located in the southern portions of the County, primarily within the City of Mequon, and to a lesser extent, in areas near the City of Cedarburg and the Village of Grafton. Assuming an average use of 65 gallons per capita per day, these private domestic wells would withdraw about 1.9 million gallons per day from the shallow groundwater aquifer. It is estimated that 52 percent of the households served by private domestic wells were also served by public sanitary sewer systems. Thus, the water withdrawn from the groundwater system for about 52 percent of the private domestic wells, or about 1.0 million gallons per day, was discharged to the surface water system, Lake Michigan, as treated sanitary sewage. The majority—approximately 90 percent—of the remaining water withdrawn by private wells, or about 0.8 million gallons per day, was returned to the groundwater aquifer via onsite sewage disposal systems.

INVENTORY FINDINGS—RACINE COUNTY

Existing Municipal Water Supply Systems

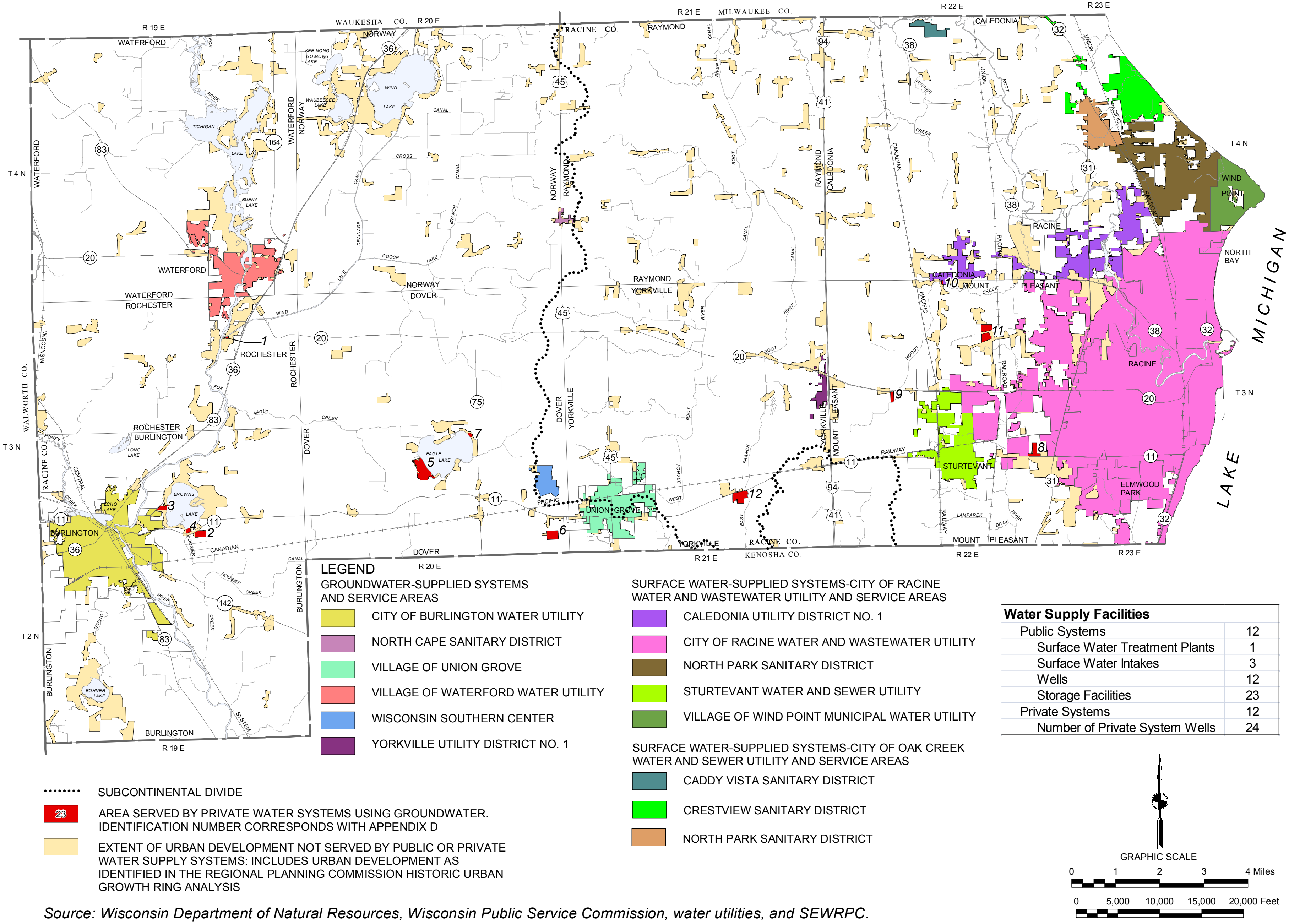
In 2005, 12 municipal water supply utility systems provided water to about 38 square miles of service area, or about 11 percent of the area of Racine County. These systems served a population of about 147,000 persons, or about 76 percent of the residential population in Racine County. Seven of the water supply systems in Racine County rely on Lake Michigan as the source of supply, either directly or indirectly through wholesale or retail purchase, and the remainder rely on groundwater as the source of supply. The City of Racine Water and Wastewater Utility, which owns and operates a surface water treatment plant with three intakes, is the largest supplier of treated surface water in Racine County, and provides retail and wholesale water to several municipal water systems within the County. The City of Oak Creek Water and Sewer Utility, located in Milwaukee County, provides treated Lake Michigan surface water to portions of the Village of Caledonia on a wholesale basis. The existing service areas of these systems are shown on Map 39 and selected characteristics of each system are presented in Table 40.

In addition to the 12 municipal water supply systems, there is an additional public water service supplier, the Wisconsin Department of Health and Family Services, Southern Wisconsin Center, located in the Town of Dover. The Southern Wisconsin Center, an institution, serves approximately 950 residents. This system is classified as "other-than-municipal community water system" by the Wisconsin Department of Natural Resources, but is not required to provide annual reports to the Public Service Commission of Wisconsin, and therefore, information about their usage is excluded from Table 40.

In 2005, the total storage capacity for the 12 municipal water systems operating in Racine County was approximately 20.6 million gallons, divided among the 23 storage facilities, as listed in Table 40. Based on Wisconsin Public Service Commission annual reports for the year 2005, approximately 29.7 million gallons per day of water

Map 39

MUNICIPAL AND OTHER-THAN-MUNICIPAL COMMUNITY WATER SUPPLY SYSTEMS IN RACINE COUNTY: 2005



Water Supply Facilities	
Public Systems	12
Surface Water Treatment Plants	1
Surface Water Intakes	3
Wells	12
Storage Facilities	23
Private Systems	12
Number of Private System Wells	24

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

Table 40

SELECTED CHARACTERISTICS OF EXISTING MUNICIPAL WATER SUPPLY SYSTEMS WITHIN RACINE COUNTY: 2005

Water Supply System	Class[a]	Estimated Area Served (square miles)	Estimated Population Served[b]	Source of Supply[c]	Number of Wells	Total Well Pumpage Capacity (mgd)	Well Aquifer[d]	Number of Lake Water Intakes	Treatment Processes[e]	Surface Treatment Plant Capacity (mgd)	Number of Storage Facilities	Total Storage Capacity (gallons x 1,000)	2005 Annual Average Pumpage (mgd)	2005 Maximum Daily Pumpage (mgd)	10-Year Maximum Daily Pumpage (mgd)	Spent Water Receiving System
City of Burlington Water Utility	AB	3.5	10,300	G	4	6.16	S	- -	D, H	- -	5	3,400	2.24	3.76	3.76	Fox River
City of Racine Water and Wastewater Utility, Including Village of Mt. Pleasant Water Users	AB	21.9	102,100	S	- -	- -	- -	3	CH, S, C, MC, F, D, H	60	8	12,846	22.78	37.31	39.1	Lake Michigan
Village of Sturtevant Water and Sewer Utility[j]	AB	1.6	5,900	SP	- -	- -	- -	- -	CH, S, C, MC, F, D, H	- -	2	1,000	0.79	- -[f]	- -[f]	Lake Michigan
Village of Union Grove Water Utility	C	1.5	4,500	G	3	3.63	SD, S	- -	D, H, Z	- -	2	618	0.53	0.88	1.56	W. Branch Root River Canal
Village of Waterford Water and Sewer Utility	AB	1.4	4,500	G	3	2.79	SD, SG, S	- -	None	- -	2	600	0.51	1.04	1.10	Fox River
Village of Wind Point Municipal Water Utility	D	1.2	1,800	SP	- -	- -	- -	- -	- -	- -	- -	- -	0.30	- -[h]	- -[h]	Lake Michigan
Caddy Vista Sanitary District[k]	D	0.2	800	SP	- -	- -	- -	- -	- -	- -	- -	- -	0.04	- -[f]	- -[f]	Lake Michigan
Village of Caledonia Water Utility District No. 1[k]	C	2.0	3,700	SP	- -	- -	- -	- -	- -	- -	1	750	0.60	- -[h]	- -[h]	Lake Michigan
Crestview Sanitary District[l]	D	1.3	3,900	SP	- -	- -	- -	- -	- -	- -	1	100	0.47	- -[h]	- -[h]	Lake Michigan
North Park Sanitary District No. 1[l]	C	3.4	9,200	SP	- -	- -	- -	- -	- -	- -	- -	- -	1.18	- -[f,h]	- -[f,h]	Lake Michigan
North Cape Sanitary District	D	0.1	100	G	1	- -	SD	- -	None	- -	1	490	0.01	N/A	- -	Groundwater via septic tanks
Town of Yorkville Water Utility District No. 1	D	0.2	100	G	1	1.60	S	- -	D, H, CC	- -	1	750	0.23	1.24[i]	1.24[i]	Hoods Creek
Total	- -	38.3	146,900	- -	12	14.18	- -	3	- -	60	23	20,554	29.68	44.23	46.76	- -

NOTE: N/A indicates data not available.

[a] *The municipal water and combined water and sewer utilities are based upon the number of customers as follows: Class AB 4,000 or more customers; Class C from 1,000 to less than 4,000 customers; and Class D less than 1,000 customers.*

[b] *Population based upon Wisconsin Department of Natural Resources data base adjusted to 2004 Wisconsin Department of Administration Civil Division estimates and SEWRPC data, where appropriate.*

[c] *The following abbreviations are used:*

G = Groundwater
SP = Surface Water Purchased (Lake Michigan)
S = Surface Water (Lake Michigan)

[d] *The following abbreviations are used:*

SG = Sand and Gravel
SD = Silurian Dolomite
GP = Galena-Platteville Dolomite
S = Sandstone
M = Multiple Aquifers
SH = Shale

[e] *Code for treatment processes:*

CH = Pre-Sedimentation Chemical Addition
S = Sedimentation
C = Coagulation
F = Filtration
MC = Micro-Filtration
FL = Fluoridation
Z = Zeolite Softening
SA = Spray Aeration
I = Ion Exchange
P = Phosphate Addition (sequestering)
SH = Sodium Hypochlorite Chemical Addition
H = Hypochlorination
D = Disinfection
CC = Corrosion Control
PA = Packed Tower Aeration
TA = Slat Tray Aeration

[f] *Included in pumpage values for Racine Water Utility.*

[g] *Included in pumpage values for North Park Sanitary District.*

[h] *Included in pumpage values for Oak Creek Water and Sewer Utility.*

[i] *Includes golf course watering.*

[j] *As of 2007, the Village of Sturtevant Water Utility was purchased by the City of Racine Water and Wastewater Utility and is served by the City Utility on a retail basis. The Village of Sturtevant continues to own and operate its sewer utility facilities.*

[k] *As of 2006, the Caddy Vista Sanitary District and the Village of Caledonia Utility District No. 1 have been combined into the Caledonia West Utility District.*

[l] *As of 2007, the Crestview Sanitary District and the North Park Sanitary District have been combined into the Caledonia East Utility District.*

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

Table 41

SUMMARY OF MUNICIPAL WATER USE IN RACINE COUNTY: 2000, 2004, AND 2005

Year	Average Annual Water Uses										Percent Unaccounted-for Water[g]
	Residential Water Use[a]			Industrial Water Use		Commercial, Institutional, and Multi-Family Residential Use[a]		Other Municipal[e] Water Uses (gallons per day X 1,000)	Total Municipal Water Use[b]		
	Total[c] (gallons per day X 1,000)	Per Person[d] (gallons per capita per day)	Per Acre[d] (gallons per acre per day)	Total[c] (gallons per day X 1,000)	Per Acre (gallons per acre per day)	Total[c] (gallons per day X 1,000)	Per Acre (gallons per acre per day)		Total[c] (gallons per day X 1,000)	Per Person[f] (gallons per capita per day)	
2000	7,804	63	832	10,235	7,483	3,701	829	1,126	22,866	156	12
2004[h]	7,789	62	818	8,766	6,331	3,703	818	1,113	21,371	146	14
2005[i]	8,420	67	879	8,295	5,925	3,885	851	1,191	21,791	148	13

[a]*Residential category includes population associated with single-family and two-family housing units, plus some larger multi-family housing where individual water meters are used for each unit. Other multi-family units are included in the commercial water use category.*

[b]*Includes all water specifically accounted for.*

[c]*As reported in annual reports submitted to the Public Service Commission of Wisconsin.*

[d]*Reported residential water use excludes that associated with multiple-unit dwellings where a single meter serves three or more housing units. That water use is classified as commercial under the Public Service Commission of Wisconsin reporting system. The unit water uses presented on a per capita and per acre basis were calculated by adjusting the population and residential land area to be consistent with this reporting procedure.*

[e]*Includes uses for fire protection services, sales to public authorities, sales to irrigation customers and interdepartmental sales.*

[f]*Estimated based upon total residential population served.*

[g]*Water not specifically accounted for as a percent of total pumpage.*

[h]*2004 population and land use was approximated by increasing the 2000 population and land use amounts by 0.1 percent.*

[i]*2005 population and land use was approximated by increasing the 2000 population and land use amounts by 0.4 percent.*

Source: Public Service Commission of Wisconsin and SEWRPC.

were pumped for use in the 12 municipal systems concerned. As shown in Table 41, the water use totaled about 21.8 mgd for residential, commercial, industrial, institutional, or other urban uses, with the remaining 7.9 mgd of total pumpage being used for purposes, such as water production and system maintenance, or being unaccounted-for water. Overall, about 8.4 mgd, or about 39 percent of total municipal water used, was for single- and two-family housing units residential purposes; about 3.9 mgd, or about 18 percent, for commercial, multi-family residential, institutional, and miscellaneous uses; and about 8.3 mgd, or about 38 percent, was for industrial uses. The remaining 1.2 mgd, or about 5 percent, was used for other municipal purposes. Based upon the population served and reported water use, residential water consumption within the 12 water supply systems was approximately 67 gallons per person per day in 2005. When accounting for all municipal water uses, the average water consumption was about 148 gallons per person per day. In 2005, the amount of water which was unaccounted-for ranged from 2 to 19 percent, with an average of 13 percent of the water pumped for the utilities in Racine County. This unaccounted-for water was not included in the computed per capita consumption rates. It should be noted that the residential water use reported by the water utilities excludes that associated with the use of water by multiple-unit dwelling units with a single meter serving three or more units. Those uses are included with commercial water uses. Thus, the calculation of the water uses on a per capita and per acre basis for the residential and commercial categories were made by adjusting the population and acreage considered under these categories to reflect this reporting requirement.

The water used in the 12 municipal systems in Racine County during 2005 was about the same as used in 2004 and about 5 percent less than used during 2000. The reduction in water use between 2000 and 2004-2005 was largely due to a reduction in industrial water use over that period.

Municipal Water Supply System Interconnection and Intermunicipal Service Provisions
The City of Racine Water and Wastewater Utility treatment plant is the principal municipal source of water supply for the greater Racine area. The City of Racine Water and Wastewater Utility provides water on a wholesale basis for use in the Village of Wind Point and for portions of the Village of Caledonia and on a retail basis to the Village of Mt. Pleasant. During 2007, the Village of Sturtevant Water Utility was purchased by the City of Racine Water and Wastewater Utility and is now served by the City utility as a retail customer. Because of these water supplier arrangements, there are a number of connections between the City of Racine Water and Wastewater Utility water supply system and its customer communities.

There are no other known water supply system interconnections or intermunicipal service provisions in Racine County outside of the greater Racine area.

Municipal Water Supply Water Conservation Measures
Water conservation measures reported to be in place or under development by the water utilities in Racine County include the ongoing development of water conservation policies and public information programs by the restrictions on outdoor watering in the City of Burlington and the ability of the City of Racine to impose water use restrictions on the use of water during emergency periods. In addition, while not specifically reported, all of the utilities may be expected to be working to improve efficiency and minimize water losses in their systems. Such measures include meter testing for accuracy, leak detection programs, and repair of water main breaks and leaks. In addition, all of the water supply utilities within southeastern Wisconsin have water metering in place, have billing systems based upon usage, and are governed by the State plumbing code which limits flow rates and volumes for plumbing fixtures.

Proposed Municipal Water Supply System Modifications and Expansion Plans
The inventory revealed that, as of 2005, locally proposed water supply system modification and expansion plans existed for the City of Racine and City of Burlington; the Village of Sturtevant, Village of Union Grove, Village of Wind Point, and Village of Waterford systems, the Town of Caledonia Utility District No. 1, Caddy Vista Sanitary District, Crestview Sanitary District, North Park Sanitary District, and Yorkville Utility District No 1. Those plans are summarized in subsequent paragraphs.

It should be noted that the sanitary sewer service area plans and related amendments listed for the utilities below were prepared under the regional water quality management planning program cooperatively being carried out by the WDNR and SEWRPC. These plans and amendments specifically address current and planned sanitary sewer service areas. However, these reports do, as appropriate, address the need to coordinate water and sewer service to respect the rules and regulations relating to the diversion of Lake Michigan as a water supply source. These plans also serve as a surrogate for the identification of an urban services area for water supply, as well as sanitary sewer service.

The City of Racine, Village of Caledonia, Village of Mt. Pleasant,
Village of Sturtevant, Village of Wind Point, and Town of Yorkville
Plans for the Racine Water and Wastewater Utility were documented in the following reports:

1. A report entitled *A Water Supply System Plan for the Greater Racine Area*, prepared by Ruekert & Mielke, Inc., dated October 2002.

2. A report entitled *A Coordinated Sanitary Sewer and Water Supply System Plan for the Greater Racine Area*, prepared by Alvord Burdick & Howson and Applied Technologies, Inc., dated September 1992.

3. A report entitled *Sanitary Sewer Service Area for the City of Racine and Environs, Racine County, Wisconsin*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the local units of government concerned, dated June 2003.

4. A report entitled *Amendment to the Regional Water Quality Management Plan, Town of Caledonia*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the then Town of Caledonia and City of Racine, dated December 2005.

A review of the aforelisted plans indicates that, as of 2005, the water utilities and communities involved have plans in place to provide water supply and sanitary sewer service to an about 70-square-mile urban service area, as shown on Map 40. The entire service area is proposed to be served by water supply provided by the Racine Water and Wastewater Utility water treatment plant and the City of Oak Creek Water Utility, both of which use Lake Michigan as a source of supply, with the spent water being conveyed as sanitary sewage to the Racine Water and Wastewater Utility sewage treatment plant which discharges treated effluent to Lake Michigan.

The 2002 system plan described and evaluated two alternative water supply plans for the provision of water supply services to the greater Racine area through the year 2030. Under one alternative plan, the Racine Water and Wastewater Utility would continue to provide a combination of wholesale and retail service to the local water utilities located east of IH 94 in the same manner as currently provided. In addition, over time the Town of Yorkville Utility District No. 1 would be provided with water from the Racine Water and Wastewater Utility. Under a second alternative plan, the Racine Water and Wastewater Utility would provide retail water service to all of the local units of government in the greater Racine area.

The 2002 system plan recommends the second alternative providing for full retail service by the Racine Water and Wastewater Utility. The recommended plan includes water supply facility improvements with estimated capital costs of $43.9 million for construction of water distribution system extensions and transmission mains, and $11.2 million to construct pumping and storage facilities.

During 2004, the City of Racine conducted performance tests on its water filtration system. The results of that testing was rerating the filtration capacity of the plant from 40 mgd up to 60 mgd. The Wisconsin Department of Natural Resources approved the rerating up to 60 mgd.

City of Burlington Water Utility

Plans for the City of Burlington Water Utility system were documented in the following reports:

1. A report entitled *Amendment to the Report on Water System Study*, prepared by Kapur & Associates, Inc., dated June 2005

2. A report entitled *Task 1.0 Geological Reconnaissance Study to Identify Potential High-Capacity Well Sites, City of Burlington, WI*, prepared by Layne-Northwest, dated September 2003.

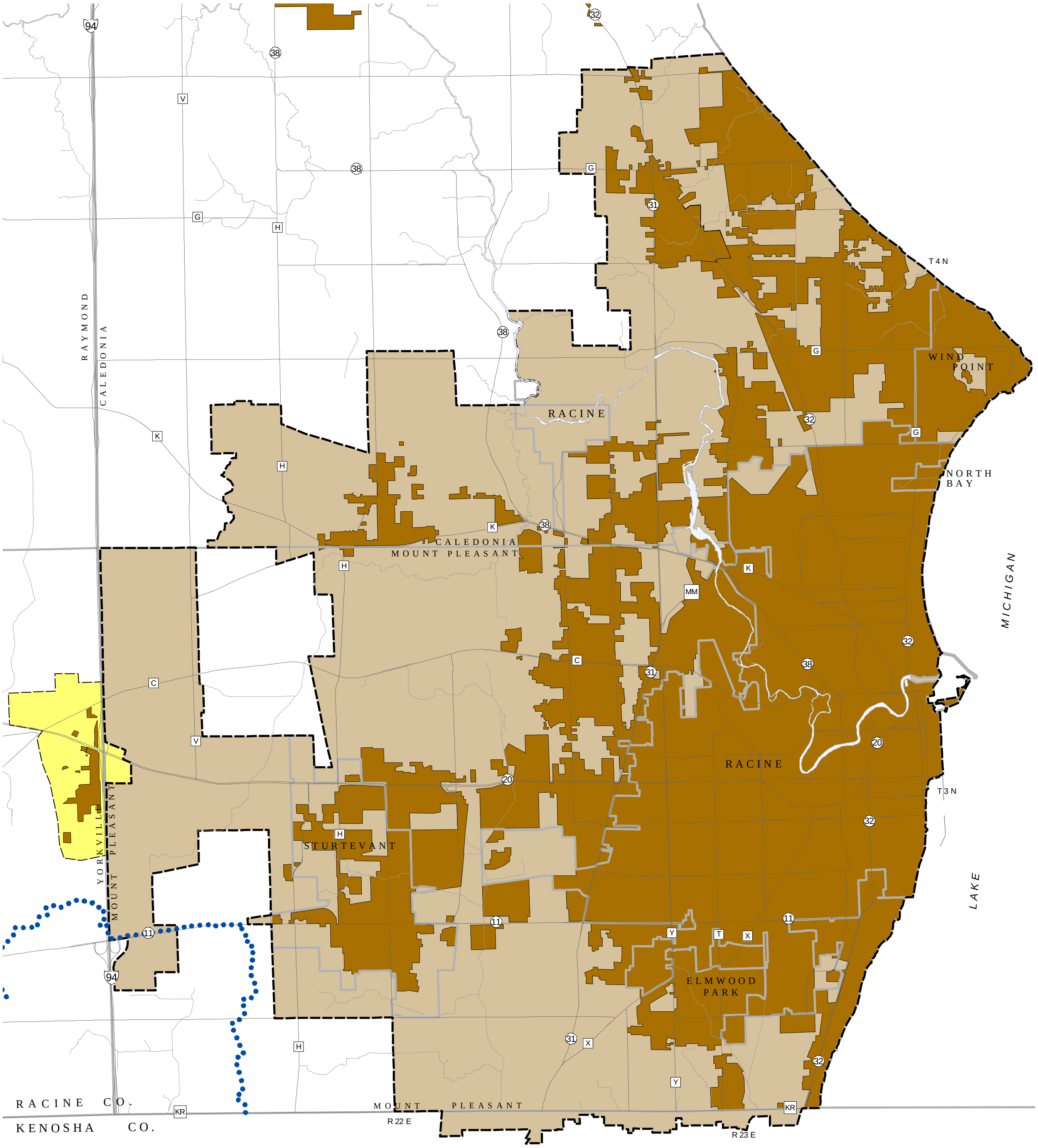
3. A report entitled *Results of the Task 2.0 and 3.0 Groundwater Exploration Program to Locate a Municipal Well Site, City of Burlington, Wisconsin*, dated August 2004.

4. A report entitled *Sanitary Sewer Service Area for the City of Burlington and Environs, Racine County, Wisconsin*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the City of Burlington, dated December 2001 and amended September 2002.

A review of the aforelisted local plans indicates that the Burlington Municipal Waterworks completed a comprehensive water system performance evaluation in 1998; has continued to monitor and evaluate the performance of the system; and is currently taking steps to address issues identified in the plans. Specifically, the utility in 2006 completed construction of a new well with a capacity of about 1,000 gallons per minute, and a new 500,000 gallon underground storage tank.

Map 40

GREATER RACINE AREA EXISTING 2005 AND PLANNED URBAN SERVICES AREA



LEGEND

- PLANNED URBAN SERVICES AREA BOUNDARY
- EXISTING WATER SUPPLY SERVICE AREA (2005)
- GREATER RACINE PLANNED URBAN SERVICE AREAS
- TOWN OF YORKVILLE PLANNED URBAN SERVICE AREAS
- SUBCONTINENTAL DIVIDE

GRAPHIC SCALE

0 0.5 1 1.5 2 Miles

0 3,000 6,000 9,000 12,000 Feet

Source: SEWRPC.

Village of Union Grove Municipal Water Utility
Plans for the Village of Union Grove Municipal Water Utility system were documented in the following reports:

1. A report entitled *Comprehensive Water System Analysis Update*, prepared by Crispell-Snyder, Inc., dated September 2005.

2. A report entitled *Sanitary Sewer Service Area for the Village of Union Grove and Environs, Racine County, Wisconsin*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Village of Union Grove, dated August 1990.

A review of the aforelisted local plans indicates that the Village of Union Grove Water Utility has recently completed a system performance evaluation and is taking steps to ensure its ability to meet future demand. The utility has taken steps to ensure compliance with USEPA water quality standards in regard to radium levels in raw water. Ion exchange systems have been designed for the three wells with, or having the potential for, radium exceedances. In the case of Well Nos. 4 and 5, the ion exchange facility has been installed. In the case of Well No. 3, monitoring is being continued to ascertain the need for the facilities as the radium levels are slightly below the standard. In addition, the Village water system evaluation identified the need for one additional well with a capacity of 800 gallons per minute and the construction of an additional 500,000 gallon elevated storage facility to serve the Village needs through the year 2020.

Village of Waterford Water Utility
Plans for the Village of Waterford Water Utility system were documented in the following report:

1. A report entitled *Sanitary Sewer Service Area for the Waterford/Rochester Area, Racine County, Wisconsin*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the local units of government involved, including the Village of Waterford, dated April 1996 and amended a number of times, with the latest amendment being dated June 2005.

Additional information provided by the Village of Waterford Water Utility indicates that one high-capacity well, Well No. 2, is proposed to be abandoned, while two new wells, Well Nos. 4 and 5, are to be brought on line for use in 2006. The changes are being made to provide adequate capacity and to meet water quality standards concerning radium.

Caddy Vista Sanitary District
Plans for the Caddy Vista system were documented in the following report:

1. A report entitled *Amendment to the Regional Water Quality Management Plan, Caddy Vista Sanitary District*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Caddy Vista Sanitary District, dated June 2005.

No specific plans were known to be proposed for the Caddy Vista Sanitary District water supply system.

Existing Residential and Other-than-Municipal Community Systems
In 2005, there were 12 existing privately owned water, self-supplied, systems operating in Racine County which provide water supply services to primarily residential land uses, such as subdivisions, apartment or condominium developments, and mobile home parks. Such systems are generally categorized by the WDNR as “other-than-municipal community systems.” These systems served a residential population of about 1,600 persons, or less than 1 percent of the Racine County year 2005 resident population. Of the 12 systems, five are high-capacity and seven are low-capacity systems. Each of the 12 systems utilized groundwater as a source of supply through 20 low-capacity and four high-capacity wells. The existing service areas of these systems are shown on Map 39. Selected characteristics of each system are presented in Table D-1 in Appendix D.

Existing Industrial Water Supply Systems

In 2005, there were 14 existing privately owned, self-supplied, water systems operating in Racine County which provide water for industrial land uses. Of these, nine are high-capacity systems and five are low-capacity systems. These systems all utilize groundwater as a source of supply through 19 low-capacity wells and 12 high-capacity wells. The locations of these systems are shown on Map 41. Selected characteristics of each system are presented in Table D-2 in Appendix D.

Existing Commercial Water Supply Systems

In 2005, there were 113 existing privately owned, self-supplied, water systems operating in Racine County which provide water for commercial land uses. Of these, four are high-capacity systems and 109 are low-capacity systems. These systems all utilized groundwater as a source of supply through 132 low-capacity wells and one high-capacity well. The locations of these systems are shown on Map 41. Selected characteristics of each system are presented in Table D-3 in Appendix D.

Existing Institutional and Recreational Water Supply Systems

In 2005, there were 53 existing privately owned, self-supplied, water systems operating in Racine County which provided water for institutional and recreational land uses. Of these, 14 are high-capacity systems and 39 are low-capacity systems. These systems all utilized groundwater as a source of supply through 70 low-capacity wells and two high-capacity wells. The locations of these systems are shown on Map 41. Selected characteristics of each system are presented in Table D-4 in Appendix D.

Existing Agricultural Water Supply Systems

In 2005, there were 15 existing privately owned, self-supplied, water systems operating in Racine County which provided water for irrigation and other purposes for agricultural land uses. All 15 systems are high-capacity systems and all utilized groundwater as a source of supply through 29 high-capacity wells. The locations of these systems are shown on Map 41. Selected characteristics of each system are presented in Table D-5 in Appendix D.

Existing Irrigation Water Supply Systems

In 2005, there were three existing privately owned, self-supplied, water systems operating in Racine County which provided irrigation water for land uses other than agricultural uses, such as golf courses. Of these, two are high-capacity systems and one is a low-capacity system. These systems all utilized groundwater as a source of supply through three low-capacity and two high-capacity wells. The locations of these systems are shown on Map 41. Selected characteristics of each system are presented in Table D-6 in Appendix D.

Existing Self-Supplied Residential Water Systems

As of the year 2005, there were about 44,700 persons, or about 23 percent of the total resident year 2005 population of Racine County, served by private domestic wells. As shown on Map 40, numerous areas having urban development densities outside of the municipal water utility service boundaries within Racine County were served by private wells. Assuming an average use of 65 gallons per capita per day, these private domestic wells would withdraw about 2.9 million gallons per day from the shallow groundwater aquifer. It is estimated that 55 percent of the households served by private domestic wells are served by public sanitary sewer systems. Thus, the water withdrawn from the groundwater system for about 55 percent of the private domestic wells, or about 1.6 million gallons per day, was discharged to the surface water system as treated sanitary sewage. The majority, approximately 90 percent, of the remaining 45 percent of the water withdrawn by private wells, or about 1.2 million gallons per day, was returned to the groundwater aquifer via onsite sewage disposal systems.

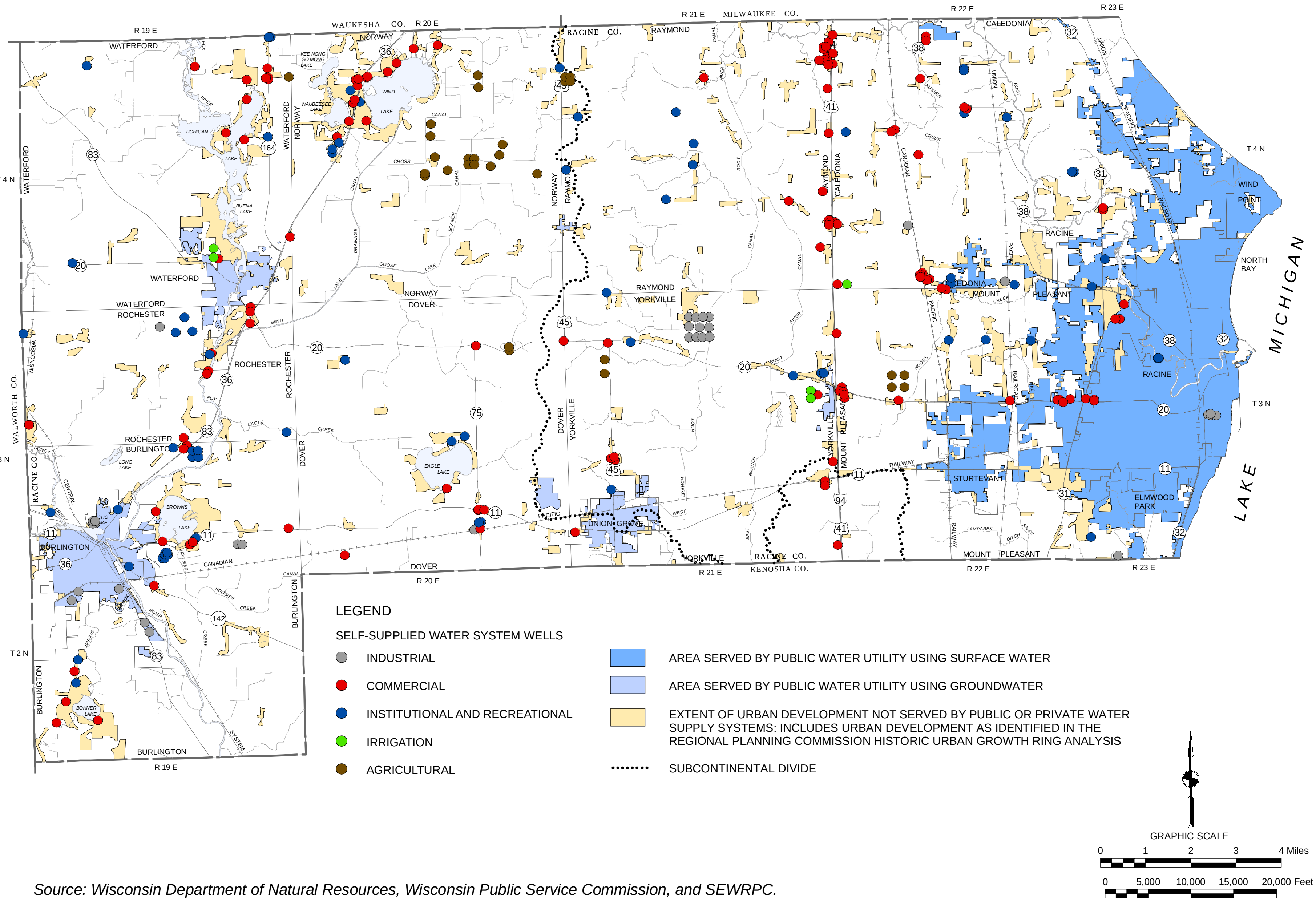
INVENTORY FINDINGS—WALWORTH COUNTY

Existing Municipal Water Supply Systems

In 2005, 16 municipal water supply utility systems provided water to about 23 square miles of service area, or about 4 percent of the area of Walworth County. These systems served a population of about 59,000 persons in 2005, or about 60 percent of the residential population in Walworth County. All of the water supply systems in

Map 41

SELF-SUPPLIED INDUSTRIAL, COMMERCIAL, INSTITUTIONAL AND RECREATIONAL, AGRICULTURAL, AND IRRIGATION WATER SUPPLY SYSTEMS IN RACINE COUNTY: 2005



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

Walworth County rely on groundwater as the source of supply. The Whitewater Municipal Water Utility is the largest supplier of treated groundwater in Walworth County serving about 14,000 total residents, including about 2,800 residents residing in Jefferson County, outside of the Region. In 2005, Whitewater pumped approximately 2.0 million gallons per day. In contrast, the Town of East Troy Sanitary District No. 3, the smallest water utility, serving about 40 residents, pumped about 3,700 gallons per day. The existing service areas of these systems are shown on Map 42 and selected characteristics of each system are presented in Table 42.

In 2005, the total storage capacity for the seven municipal water systems operating in Walworth County was approximately 13.5 million gallons, divided among the 38 storage facilities, as listed in Table 42. As the largest water provider, the Whitewater Municipal Water Utility maintained four storage facilities, with a total storage capacity of about 2.4 million gallons. Based on Wisconsin Public Service Commission annual reports for the year 2005, approximately 8.4 million gallons per day of water were pumped for use in the 16 municipal systems concerned. As shown in Table 43, water use totaled about 6.6 mgd for residential, commercial, industrial, institutional, or other urban uses, with the remaining 1.8 mgd of total pumpage being used for purposes such as water production and system maintenance, or being unaccounted-for water. Overall, about 3.0 mgd, or about 45 percent of total municipal water used, was for single- and two-family housing units residential purposes; about 1.7 mgd, or about 25 percent, for commercial, multi-family residential, institutional, and miscellaneous uses; and about 1.4 mgd, or about 21 percent, was for industrial uses. The remaining 0.6 mgd, or about 9 percent, was used for other municipal purposes. Based upon the population served and reported water use, residential water consumption within the 16 water supply systems was approximately 66 gallons per person per day in 2005. When accounting for all municipal water uses, the average water consumption was about 112 gallons per person per day. In 2005, the amount of water which was unaccounted-for ranged from 2 to 23 percent, with an average of 12 percent of the water pumped for the utilities in Walworth County. Thus, unaccounted-for water was not included in the computed per capita consumption rates. It should be noted that the residential water use reported by the water utilities excludes that associated with the use of water by multiple-unit dwelling units with a single meter serving three or more units. Those uses are included with commercial water uses. Thus, the calculation of the water uses on a per capita and per acre basis for the residential and commercial categories were made by adjusting the population and acreage considered under these categories to reflect this reporting requirement.

The water used in the 16 municipal systems in Walworth County during 2005 was about 10 percent higher than was used in 2004 and about 6 percent higher than was used during 2000. Residential water use on a per capita basis and commercial water uses remained nearly constant over the years noted. However, industrial water use varied in a manner similar to total water use over the period considered.

Municipal Water Supply System Interconnection

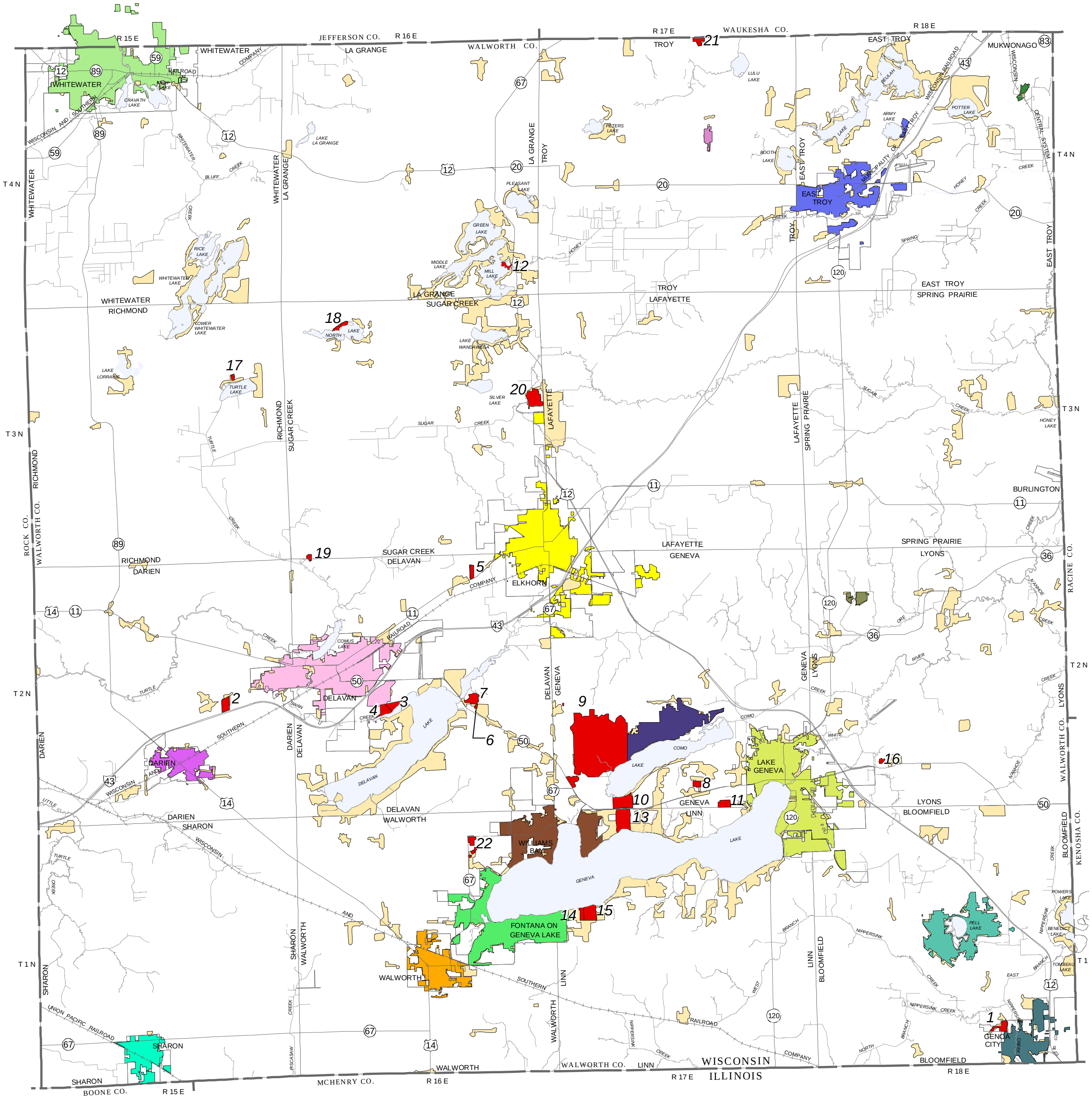
As of 2006, only one water system interconnection was known to exist in Walworth County, between the Fontana Municipal Water Utility and the Walworth Municipal Water and Sewer Utility. These two utilities have a reciprocal emergency water service agreement.

Municipal Water Supply Water Conservation Measures

Water conservation measures reported to be in place or under development by the water utilities in Walworth County include the ongoing development of water conservation policies and programs and public information programs by the Cities of Lake Geneva and Whitewater, Villages of East Troy, Fontana-on-Lake Geneva, and Walworth. These programs typically included lawn watering restrictions and notification of homeowners with unusually large usage as a warning of possible leakage. The City of Lake Geneva has a water softener rebate program to provide incentives to convert from timer-based to on-demand-based softening. The Country Estates Sanitary District installed meters in the residences in 2002. In addition, while not specifically reported, all of the utilities may be expected to be working to improve efficiency and minimize water losses in their systems. Such measures include meter testing for accuracy, leak detection programs, and repair of water main breaks and leaks. In addition, all of the water supply utilities within southeastern Wisconsin have water metering in place, have billing systems based upon usage, and are governed by the State plumbing code which limits flow rates and volumes for plumbing fixtures.

Map 42

MUNICIPAL AND OTHER-THAN-MUNICIPAL COMMUNITY WATER SUPPLY SYSTEMS IN WALWORTH COUNTY: 2005



LEGEND

GROUNDWATER-SUPPLIED SYSTEMS AND SERVICE AREAS

- COUNTRY ESTATES SANITARY DISTRICT
- DARIEN WATER WORKS AND SEWER SYSTEM
- DELAVAN WATER AND SEWERAGE COMMISSION
- ELKHORN LIGHT AND WATER COMMISSION
- FONTANA MUNICIPAL WATER UTILITY
- LAKE COMO SANITARY DISTRICT NO. 1
- LAKE GENEVA MUNICIPAL WATER UTILITY
- PELL LAKE SANITARY DISTRICT NO. 1
- SHARON WATERWORKS AND SEWER SYSTEM
- TOWN OF EAST TROY SANITARY DISTRICT NO. 3
- TROY SANITARY DISTRICT NO. 1
- VILLAGE OF EAST TROY MUNICIPAL WATER UTILITY
- VILLAGE OF GENOA CITY MUNICIPAL WATER UTILITY
- WALWORTH MUNICIPAL WATER AND SEWER UTILITY
- WHITEWATER MUNICIPAL WATER UTILITY
- WILLIAMS BAY MUNICIPAL WATER UTILITY

23 AREA SERVED BY PRIVATE WATER SYSTEMS USING GROUNDWATER. IDENTIFICATION NUMBER CORRESPONDS WITH APPENDIX D

EXTENT OF URBAN DEVELOPMENT NOT SERVED BY PUBLIC OR PRIVATE WATER SUPPLY SYSTEMS: INCLUDES URBAN DEVELOPMENT AS IDENTIFIED IN THE REGIONAL PLANNING COMMISSION HISTORIC URBAN GROWTH RING ANALYSIS

Water Supply Facilities	
Public Systems	16
Surface Water Treatment Plants	0
Surface Water Intakes	0
Wells	44
Storage Facilities	38
Private Systems	22
Number of Private System Wells	29

GRAPHIC SCALE

0 1 2 3 4 Miles

0 5,000 10,000 15,000 20,000 Feet

Source: Wisconsin Public Service Commission, water utilities, and SEWRPC.

Table 42

SELECTED CHARACTERISTICS OF EXISTING MUNICIPAL WATER SUPPLY SYSTEMS WITHIN WALWORTH COUNTY: 2005

Water Supply System	Class[a]	Estimated Area Served (square miles)	Estimated Population Served[b]	Source of Supply[c]	Number of Wells	Total Well Pumpage Capacity (mgd)	Well Aquifer[d]	Number of Lake Water Intakes	Treatment Processes[e]	Surface Treatment Plant Capacity (mgd)	Number of Storage Facilities	Total Storage Capacity (gallons x 1,000)	2005 Annual Average Pumpage (mgd)	2005 Maximum Daily Pumpage (mgd)	10-Year Maximum Daily Pumpage (mgd)	Spent Water Receiving System
City of Delavan Water and Sewerage Commission[f]	AB	2.8	8,200	G	4[f]	4.20	SG, S	- -	G, F, FL, P, PA	- -	5	2,300	1.13	2.55	2.47	Turtle Creek
City of Elkhorn Light and Water Commission	AB	2.6	8,600	G	4	4.25	S	- -	F, H, SA, I, FL, TA	- -	3	1,000	1.12	1.93	- -	Turtle Creek
City of Lake Geneva Municipal Water Utility	AB	3.2	8,000	G	4	7.29	SG	- -	F, G, H, P, FL, TA	- -	5	2,260	1.45	2.86	3.00	Groundwater system
City of Whitewater Municipal Water Utility[g]	AB	3.2	11,200[f]	G	5	7.63	S	- -	F, H, FL	- -	4	2,400	1.99	3.79	3.79	Whitewater Creek
Village of Darien Water Works and Sewer System	C	0.7	1,600	G	2	1.18	S, SG	- -	G, F, SQ, TA	- -	1	100	0.12	0.38	- -	Turtle Creek
Village of East Troy Municipal Water Utility	C	1.5	3,900	G	3	1.87	SG, S, GP	- -	H, FL	- -	2	850	0.65	1.04	1.26	Honey Creek
Village of Fontana Municipal Water Utility	C	2.0	1,800	G	4	3.04	SG, S	- -	F, H	- -	3	2,120	0.40	1.10	1.13	Piscasaw Creek
Village of Genoa City Municipal Water Utility	C	0.8	2,400	G	3	1.40	SG, S	- -	G, F, P, FL, TA	- -	3	660	0.22	0.53	- -	Nippersink Creek
Village of Sharon Waterworks and Sewer System	C	0.7	1,500	G	2	1.44	S, SG	- -	G, SQ, FL	- -	1	250	0.12	0.17	0.32	Little Turtle Creek
Village of Walworth Municipal Water and Sewer Utility	C	1.0	2,600	G	2	1.25	SG	- -	H	- -	1	500	0.49	0.78	9.90	Piscasaw Creek
Village of Williams Bay Municipal Water Utility	C	1.5	2,600	G	3	4.10	SG, S	- -	C, F, FC, G, PH, S, LS, TA, FL	- -	5	550	0.32	0.82	- -	Turtle Creek
Pell Lake Sanitary District No. 1	AB	1.3	3,900	G	2	1.15	S	- -	I, G, P, FL, Z	- -	1	300	0.23	0.40	0.40	N. Branch Nippersink Creek
Town of East Troy Sanitary District No. 3	D	<0.1	40	G	1	0.60	S	- -	None	- -	1	3	<0.01	0.01	0.02	Groundwater system
Lake Como Sanitary District No. 1	D	1.1	2,200	G	2	1.48	SD	- -	H	- -	1	200	0.14	0.27	0.69	Turtle Creek
Country Estates Sanitary District	D	0.1	500	G	2	1.15	SD	- -	H, Z	- -	1	50	0.02	0.51	0.14	White River
Troy Sanitary District No. 1	D	0.1	100	G	1	- -	GP	- -	None	- -	1	4	<0.01	<0.01	- -	Groundwater system
Total	- -	22.6	59,140	- -	44	42.03	- -	- -	- -	- -	38	13,547	8.42	17.15	- -	- -

NOTE: N/A indicates data not available.

[a] *The municipal water and combined water and sewer utilities are based upon the number of customers as follows: Class AB 4,000 or more customers; Class C from 1,000 to less than 4,000 customers; and Class D less than 1,000 customers.*

[b] *Population based upon Wisconsin Department of Natural Resources data base adjusted to 2004 Wisconsin Department of Administration Civil Division estimates and SEWRPC data, where appropriate.*

[c] *The following abbreviations are used:*

G = Groundwater
S = Surface Water (Lake Michigan)
SP = Surface Water Purchased (Lake Michigan)

[d] *The following abbreviations are used:*

SG = Sand and Gravel
SD = Silurian Dolomite
GP = Galena-Platteville Dolomite
S = Sandstone
M = Multiple Aquifers
SH = Shale

[e] *Code for treatment processes:*

CH = Pre-Sedimentation Chemical Addition
S = Sedimentation
C = Coagulation
F = Filtration
MC = Micro-Filtration
FL = Fluoridation
Z = Zeolite Softening
PH = pH Adjustment
LS = Lime Soda Ash Addition
FC = Flocculation
P = Polyphosphate Inhibitor (Corrosion Control)
SQ = Sequestration (Iron or Manganese Removal)
I = Ion Exchange
G = Gaseous Chlorination
SH = Sodium Hypochlorite Chemical Addition
H = Hypochlorination
PA = Packed Tower Aeration
TA = Slat Tray Aeration
SA = Spray Aeration

[f] *During 2009, the City of Delavan Water Utility began development of a fifth well (Well No. 7).*

[g] *Walworth County portion only. In 2005, the City of Whitewater population was estimated to be 14,000, of which 2,800 persons reside in Jefferson County.*

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

Table 43

SUMMARY OF MUNICIPAL WATER USE IN WALWORTH COUNTY: 2000, 2004, AND 2005

Year	Average Annual Water Uses										Percent Unaccounted-for Water[g]
	Residential Water Use[a]			Industrial Water Use		Commercial, Institutional, Multi-Family Residential, and Miscellaneous Water Use[a]		Other Municipal[e] Water Uses (gallons per day X 1,000)	Total Municipal Water Use[b]		
	Total[c] (gallons per day X 1,000)	Per Person[d] (gallons per capita per day)	Per Acre[d] (gallons per acre per day)	Total[c] (gallons per day X 1,000)	Per Acre (gallons per acre per day)	Total[c] (gallons per day X 1,000)	Per Acre (gallons per acre per day)		Total[c] (gallons per day X 1,000)	Per Person[f] (gallons per capita per day)	
2000	2,566	64	471	1,270	1,954	1,789	562	626	6,251	117	15
2004[h]	2,766	63	459	1,029	1,480	1,720	511	525	6,040	104	13
2005[i]	2,975	66	508	1,372	1,934	1,686	494	606	6,639	112	12

[a]*Residential category includes population associated with single-family and two-family housing units, plus some larger multi-family housing where individual water meters are used for each unit. Other multi-family units are included in the commercial water use category.*

[b]*Includes all water specifically accounted for.*

[c]*As reported in annual reports submitted to the Public Service Commission of Wisconsin.*

[d]*Reported residential water use excludes that associated with multiple-unit dwellings where a single meter serves three or more housing units. That water use is classified as commercial under the Public Service Commission of Wisconsin reporting system. The unit water uses presented on a per capita and per acre basis were calculated by adjusting the population and residential land area to be consistent with this reporting procedure.*

[e]*Includes uses for fire protection services, sales to public authorities, sales to irrigation customers and interdepartmental sales.*

[f]*Estimated based upon total residential population served.*

[g]*Water not specifically accounted for as a percent of total pumpage into distribution system.*

[h]*2004 population and land use was approximated by increasing the 2000 population and land use amounts by 6.0 percent.*

[i]*2005 population and land use was approximated by increasing the 2000 population and land use amounts by 7.6 percent.*

Source: Public Service Commission of Wisconsin and SEWRPC.

Proposed Municipal Water Supply System Modifications and Expansion Plans

The inventory revealed that, as of 2005, there were locally proposed specific water supply system modification and expansion plans for the utilities in the City of Delavan and the Villages of East Troy, Walworth, and Williams Bay systems. Other utilities have ongoing maintenance activities and planned urban service areas which have been documented in plans and related documents. Those plans are summarized in the subsequent paragraphs.

It should be noted that the sanitary sewer service area plans and related amendments listed for the utilities below were prepared under the regional water quality management planning program cooperatively being carried out by the WDNR and SEWRPC. These plans and amendments specifically address current and planned sanitary sewer service areas. However, these reports also serve as a surrogate for the identification of an urban services area for water supply, as well as sanitary sewer service.

City of Delavan Water and Sewerage Commission

Plans for the City of Delavan Water and Sewerage Commission water utility system were documented in the following reports:

1. A report entitled *Water System Planning Report with Amendment #1*, produced by Baxter & Woodman Consulting Engineers, Inc., dated July 1999.

2. A report entitled *Report for the Task 2, Time Domain Electromagnetic Induction Survey for the City of Delavan, Wisconsin*, prepared by Layne-Northwest, Inc., and dated June, 2005.

3. A report entitled *Sanitary Sewer Service Area for the Walworth County Metropolitan Sewerage District*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in

cooperation with Walworth County; the Cities of Delavan and Elkhorn; the Village of Williams Bay; the Towns of Darien, Delavan, Geneva, Lafayette, Linn, Sugar Creek, and Walworth; the Delavan Lake Sanitary District; the Geneva National Sanitary District; the Town of Walworth Utility District No. 1; and the Walworth County Metropolitan Sewerage District, dated November 1991.

4. A report entitled *Amendment to the Regional Water Quality Management Plan, Walworth County Metropolitan Sewerage District—Delavan-Delavan Lake Sanitary Sewer Service Area*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Town of Delavan, the Walworth County Metropolitan Sewerage District, and Delavan Lake Sanitary District, dated March 1998.

A review of the available information for the Delavan Water and Sewerage Commission water system indicates that a well siting study was undertaken in anticipation of the addition of a new, high-capacity well which was deemed necessary to ensure that projected 2020 growth water demands will be met. The water system planning report identified a need for a new well, an additional 500,000 gallon storage facility, and a booster pumping station. It was also proposed to create a new, higher pressure zone in the area west of Turtle Creek Drive to accommodate development on higher level ground than exists in the rest of the urban service area. The plan also recommends the abandonment, in the future, of the existing 150,000 gallon downtown elevated storage tank. In 2004, the City enacted an ordinance creating a wellhead protection overlay zoning district to protect water supplies within its service area by prohibiting specified land uses within portions of the City of Delavan and the Town of Darien. Well No. 4 is currently being treated to remove trichloroethylene contaminants from an industrial site. During 2009, the City of Delavan Water and Sewerage Commission began development of a fifth well, Well No. 7, to be located at the end of Elmhurst Avenue on the northeast side of the City.

City of Elkhorn Light and Water Utility

Plans for the City of Elkhorn Light and Water utility system were documented in the following reports:

1. A report entitled *Sanitary Sewer Service Area for the Walworth County Metropolitan Sewerage District*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with Walworth County; the Cities of Delavan and Elkhorn; the Village of Williams Bay; the Towns of Darien, Delavan, Geneva, Lafayette, Linn, Sugar Creek, and Walworth; the Delavan Lake Sanitary District; the Geneva National Sanitary District; the Town of Walworth Utility District No. 1; and the Walworth County Metropolitan Sewerage District, dated November 1991.

2. A report entitled *Amendment to the Regional Water Quality Management Plan, Walworth County Metropolitan Sewerage District—Elkhorn Sanitary Sewer Service Area*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with Walworth County, the City of Elkhorn, the Town of Lafayette, and the Walworth County Metropolitan Sewerage District, dated September 2004.

No specific plans for expansion and modification are known to be proposed for the Elkhorn Light and Water Utility water system.

City of Lake Geneva Municipal Water Utility

Plans for the City of Lake Geneva Municipal Water Utility system were documented in the following reports:

1. Letter reports prepared by Water Well Solutions dated November 2, 2005, and January 9, 2006, describing inspection and maintenance recommendations for the Lake Geneva water supply system.

2. A report entitled *Sanitary Sewer Service Area for the City of Lake Geneva and Environs*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the City of Lake Geneva, dated December 1992.

3. A report entitled *Amendment to the Regional Water Quality Management Plan, City of Lake Geneva*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the City of Lake Geneva, dated December 2004.

A review of the available information for the City of Lake Geneva Municipal Water Utility water system indicates that the utility was considering measures to protect water resources within its service area. In 1998, the City enacted an ordinance creating a wellhead protection overlay zoning district prohibiting specified land uses within portions of the City of Lake Geneva. The City of Lake Geneva water system management program is focused on system maintenance. During 2005 and 2006, the Utility conducted major maintenance activities on Well Nos. 3, 4, and 5, including upgrading of Well No. 4 and pump motor replacements for Well Nos. 4 and 5. The maintenance program is planned to be continued as needed. During 2006, the Water Utility constructed a new 200,000 gallon elevated storage tank south of USH 12 near the northern limits of the City.

Whitewater Municipal Water Utility

Plans for the City of Whitewater Municipal Water Utility system were documented in the following reports:

1. A report entitled *Sanitary Sewer Service Area for the City of Whitewater*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the City of Whitewater, dated March 1995.

2. A report entitled *Amendment to the Regional Water Quality Management Plan, City of Whitewater*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the City of Whitewater, dated September 2003.

No specific plans for expansion and modification were known to be proposed for the Whitewater Municipal Water Utility water system.

Darien Water Works and Sewer System

Plans for the Darien Water Works and Sewer System were documented in the following reports:

1. A report entitled *Sanitary Sewer Service Area for the Village of Darien*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Village of Darien, dated July 1992.

2. A report entitled *Amendment to the Regional Water Quality Management Plan, Village of Darien*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Village of Darien and the Walworth County Metropolitan Sewerage District, dated December 2005.

During 2006, the Village of Darien placed into operation a new well, treatment facilities, and an elevated storage facility. The new well is finished in the deep sandstone aquifer and its treatment system is designed for a capacity of 1,000 gallons per minute.

Village of East Troy Municipal Water Utility

Plans for the Village of East Troy Water Utility system were documented in the following reports:

1. A report entitled *Wellhead Protection Plan for the Village of East Troy, Municipal Wells No. 5, No. 6, & No. 8,* prepared by Crispell-Snyder, Inc, dated October, 2004.

2. A report entitled *Sanitary Sewer Service Area for the Village of East Troy and Environs*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Village of East Troy, dated December 2000.

A review of available information for the Village of East Troy Municipal Water Utility water system indicates that the Utility is taking steps to protect water resources within its service area. The Village developed a well and wellhead protection plan for its three high-capacity wells in 2004, which prescribes steps to be taken by the Village of East Troy to promote water conservation through public education and measures needed to ensure water quantity and quality within the service area. Other information provided by the Village indicates that, as of 2006, the Village was undertaking a well siting project for the addition of a well with a capacity of about 1,000 gallons per minute near the limits of the Village in the vicinity of Lake Beulah. The siting of this well was controversial because of potential impacts on the groundwater discharges to surface waters, including Lake Beulah. The well development was the subject of legal action and negotiations involving the Village, the Lake Beulah Lake Management District, and the Lake Beulah Protective and Improvements Association. As of mid-2008, some legal action was pending and monitoring of groundwater levels was ongoing. Discussion continued between the parties involved regarding well pumping protocols. The Village is also developing the facilities needed to establish a higher pressure zone and booster pumping station to serve areas of urban development located south of IH 43.

Fontana Municipal Water Utility

Plans for the Fontana Municipal Water Utility system were documented in the following reports:

1. A report entitled *Report on Water Utility, Village of Fontana-on-Geneva Lake,* prepared by Strand Associates, Inc., dated November 1992.

2. A report entitled *Report on Village of Fontana-on-Geneva Lake Well Head Protection Plan for Well No. 4,* prepared by Strand Associates, Inc., dated July 1999.

3. A draft report entitled *Wellhead Protection Plan, Wells #1, #2, #3, and #4; Village of Fontana-on-Geneva Lake, Wisconsin,* prepared by the Village of Fontana, dated December 2004.

4. A report entitled *Elevated Tank Observation Report,* prepared by Strand Associates, Inc., dated November 2004.

5. A report entitled *Sanitary Sewer Service Area for the Villages of Fontana and Walworth and Environs*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Village of Fontana and the Fontana-Walworth Water Pollution Control Commission, dated June 1995.

A review of the available information for the Fontana Municipal Water Utility water system indicates that the utility was taking steps to protect water resources within its service area, although no system changes were currently anticipated. The Village has a wellhead protection ordinance for one of its four high-capacity wells, and in 2004, Fontana drafted a wellhead protection plan that extends the ordinance to the other three wells. This draft also indicates steps to be taken to promote water conservation through public education and to ensure quality with the identification of potential contaminant sources. Water supply facility management has been focused on maintenance of the existing facilities.

Village of Genoa City Municipal Water Utility

Plans for the Village of Genoa City Municipal Water Utility system were documented in the following reports:

1. A report entitled *Sanitary Sewer Service Area for the Village of Genoa City*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Village of Genoa City, dated May 1996.

2. A report entitled *Amendment to the Regional Water Quality Management Plan—2000; Village of Genoa City,* prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Village of Genoa City, dated June 1999.

No specific plans for expansion and modification are known to be proposed for the Village of Genoa City Municipal Water Utility water system.

Sharon Waterworks and Sewer System
Plans for the Sharon Waterworks and Sewer System were documented in the following report:

1. An undated document entitled *Village of Sharon Water and Wastewater Emergency Response Plan*, prepared by the Sharon Waterworks.

A review of the available information for the Village of Sharon Waterworks water system indicates that the Utility has developed an emergency response plan which identifies measures to be taken in the event of a disaster. No system expansion or modifications are currently anticipated.

Walworth Municipal Water and Sewer Utility
Plans for the Village of Walworth Municipal Water and Sewer Utility system were documented in the following reports:

1. A report entitled *Sanitary Sewer Service Area for the Villages of Fontana and Walworth and Environs*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Village of Walworth and the Fontana-Walworth Water Pollution Control Commission, dated June 1995.

2. A report entitled *Amendment to the Regional Water Quality Management Plan—2000; Village of Walworth*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Village of Walworth, and the Fontana-Walworth Water Pollution Control Commission, dated June 2001.

A review of the available information on the Walworth Municipal Water and Sewer Utility water system indicates that, as of 2005, two additional wells were being constructed near the southern Village limits. The Walworth water system is connected to the neighboring Village of Fontana-on-Geneva Lake water system for emergency purposes.

Williams Bay Municipal Water Utility
Plans for the Village of Williams Bay Municipal Water and Sewer Utility system were documented in the following reports:

1. A report entitled *Sanitary Sewer Service Area for the Walworth County Metropolitan Sewerage District*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Cities of Delavan and Elkhorn; the Village of Williams Bay; the Towns of Darien, Delavan, Geneva, Lafayette, Linn, Sugar Creek, and Walworth; the Delavan Lake Sanitary District; the Geneva National Sanitary District; the Town of Walworth Utility District No. 1; and the Walworth County Metropolitan Sewerage District, dated November 1991.

2. A report entitled *Amendment to the Regional Water Quality Management Plan, Walworth County Metropolitan Sewerage District—Williams Bay-Geneva National-Lake Como Sanitary Sewer Service Area*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with Walworth County, the Village of Williams Bay, and the Walworth County Metropolitan Sewerage District, dated September 2004.

A review of the available information for the Williams Bay Municipal Water Utility water system indicates that a new, 500,000 gallon capacity elevated storage tank is planned to be constructed and placed into operation in 2006. The storage tank is to be located near the northern Village limits.

Pell Lake Sanitary District No. 1
Plans for the Pell Lake Sanitary District No. 1 system were documented in the following reports:

1. A report entitled *Sanitary Sewer Service Area for the Pell Lake Sanitary District No. 1*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Pell Lake Sanitary District No. 1, dated June 1996.

2. A report entitled *Amendment to the Regional Water Quality Management Plan, Pell Lake Sanitary District No. 1*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Pell Lake Sanitary District No. 1, dated September 2003.

No specific plans for expansion and modifications are known to be proposed for the Pell Lake Sanitary District No. 1 water system. The entire system was installed in 1997.

Lake Como Sanitary District No. 1
Plans for the Lake Como Sanitary District No. 1 system were documented in the following report:

1. A report entitled *Amendment to the Regional Water Quality Management Plan, Walworth County Metropolitan Sewerage District—Williams Bay-Lake Geneva National-Lake Como Sanitary Sewer Service Area*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with Walworth County, the Village of Williams Bay, and the Walworth County Metropolitan Sewerage District, dated September 2004.

A review of the available information on the Lake Como Sanitary District No. 1 water system indicates that a wellhead protection plan was adopted in 1999, and in 2003, the utility adopted an emergency management plan. As of 2006, no system changes were anticipated.

Country Estates Sanitary District
Plans for the Country Estates Sanitary District system were documented in the following report:

1. A report entitled *Sanitary Sewer Service Area for the Town of Lyons Sanitary District No. 2*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Town of Lyons Sanitary District No. 2 and the Country Estates Sanitary District, dated August 1993.

A review of the available information on the Country Estates Sanitary District water system indicates that, as of 2006, no system expansion or modifications were anticipated. The Sanitary District water system has in the past experienced radium levels which exceeded the maximum contaminant level. Currently, the water from both of the District's wells is treated with zeolite softening which results in compliant water.

Existing Residential and Other-than-Municipal Community Systems
In 2005, there were 22 existing privately owned water, self-supplied, systems operating in Walworth County which provide water supply services to primarily residential land uses, such as subdivisions, apartment or condominium developments, and mobile home parks; such systems are generally designated by the WDNR as "other-than-municipal community systems." These systems served a year 2005 resident population of about 3,800 persons, or about 4 percent of the Walworth County year 2005 resident population. Of the 22 systems, nine were high-capacity and 13 were low-capacity systems. All of these systems utilized groundwater as a source of supply through 20 low-capacity and nine high-capacity wells. The location of these systems are shown on Map 42. Selected characteristics of each system are presented in Table D-1 in Appendix D.

Existing Industrial Water Supply Systems
In 2005, there were 13 existing privately owned, self-supplied, water systems operating in Walworth County which provide water for industrial land uses. Of these, eight are high-capacity systems and five are low-capacity

systems. These systems all utilize groundwater as a source of supply through 12 low-capacity wells and 14 high-capacity wells. The locations of these systems are shown on Map 43. Selected characteristics of each system are presented in Table D-2 in Appendix D.

Existing Commercial Water Supply Systems

In 2005, there were 96 existing privately owned, self-supplied, water systems operating in Walworth County which provide water for commercial land uses. Of these, five are high-capacity systems and 91 are low-capacity systems. These systems all utilize groundwater as a source of supply through 103 low-capacity wells and 10 high-capacity wells. The locations of these systems are shown on Map 43. Selected characteristics of each system are presented in Table D-3 in Appendix D.

Existing Institutional and Recreational Water Supply Systems

In 2005, there were 69 existing privately owned, self-supplied, water systems operating in Walworth County which provided water for institutional and recreational land uses. Of these, 25 are high-capacity systems and 44 are low-capacity systems. These systems all utilized groundwater as a source of supply through 123 low-capacity wells, six high-capacity wells, and six wells with an unknown capacity. The locations of these systems are shown on Map 43. Selected characteristics of each system are presented in Table D-4 in Appendix D.

Existing Agricultural Water Supply Systems

In 2005, there were 16 existing privately owned, self-supplied, water systems operating in Walworth County which provided water for irrigation and other purposes for agricultural land uses. All 16 systems are high-capacity systems and all utilized groundwater as a source of supply through 28 high-capacity wells. The locations of these systems are shown on Map 43. Selected characteristics of each system are presented in Table D-5 in Appendix D.

Existing Irrigation Water Supply Systems

In 2005, there were 10 existing privately owned, self-supplied, water systems operating in Walworth County which provided irrigation water for land uses other than agricultural uses, such as golf courses. All 10 systems are high-capacity systems and all utilized groundwater as a source of supply through 20 high-capacity wells. The locations of these systems are shown on Map 43. Selected characteristics of each system are presented in Table D-6 in Appendix D.

Existing Self-Supplied Residential Water Systems

As of the year 2005, there were about 36,000 persons, or about 37 percent of the total resident year 2005 population of Walworth County, served by private domestic wells. As shown on Map 42, numerous areas having urban development densities exist outside of the municipal water utility service areas within Walworth County were classified as having urban-density development, and were served by private wells. Assuming an average use of 65 gallons per capita per day, these private domestic wells would withdraw about 2.3 million gallons per day from the shallow groundwater aquifer. It is estimated that 16 percent of the households served by private domestic wells were served by public sanitary sewer systems. Thus, the water withdrawn from the groundwater system for about 16 percent of the private domestic wells, or about 0.4 million gallons per day, was discharged to the surface water system as treated sanitary sewage. The majority—approximately 90 percent—of the remaining 84 percent of the water withdrawn by private wells, or about 1.7 million gallons per day, was returned to the groundwater aquifer via onsite sewage disposal systems.

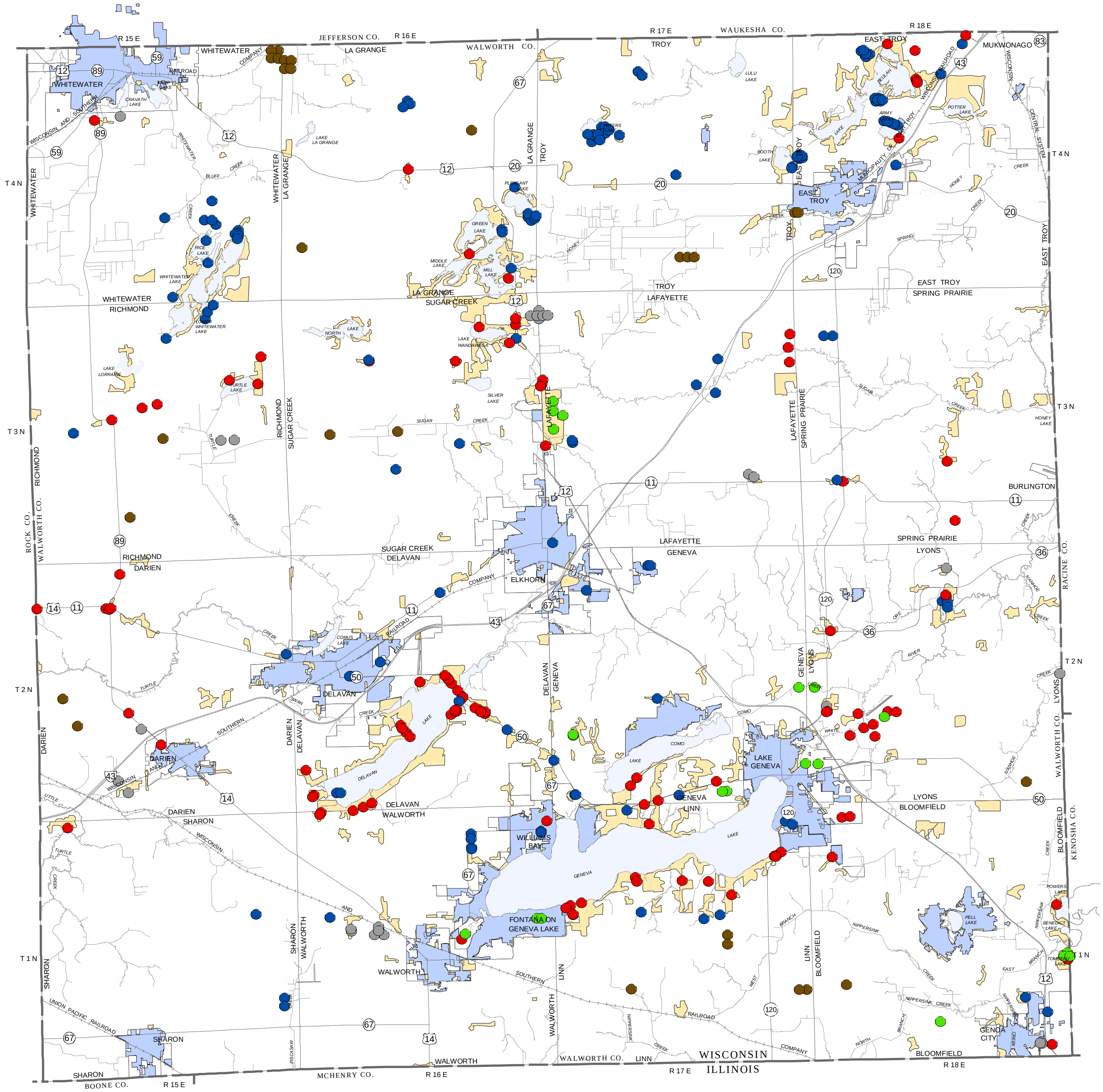
INVENTORY FINDINGS—WASHINGTON COUNTY

Existing Municipal Water Supply Systems

In 2005, seven municipal water supply utility systems provided water to about 22 square miles of service area, or about 5 percent of the area of Washington County. These systems served a 2005 population of about 73,400 persons, or about 58 percent of the residential population in Washington County. All of the water supply systems in Washington County rely on groundwater as the source of supply. The City of West Bend Water Utility is the largest supplier of treated groundwater in Washington County, pumping an average of about 3.0 mgd. The Village

Map 43

SELF-SUPPLIED INDUSTRIAL, COMMERCIAL, INSTITUTIONAL AND RECREATIONAL, AGRICULTURAL, AND IRRIGATION WATER SUPPLY SYSTEMS IN WALWORTH COUNTY: 2005



LEGEND

SELF-SUPPLIED WATER SYSTEM WELLS

- INDUSTRIAL
- COMMERCIAL
- INSTITUTIONAL AND RECREATIONAL
- IRRIGATION
- AGRICULTURAL

AREA SERVED BY PUBLIC WATER UTILITY USING GROUNDWATER

EXTENT OF URBAN DEVELOPMENT NOT SERVED BY PUBLIC OR PRIVATE WATER SUPPLY SYSTEMS: INCLUDES URBAN DEVELOPMENT AS IDENTIFIED IN THE REGIONAL PLANNING COMMISSION HISTORIC URBAN GROWTH RING ANALYSIS

GRAPHIC SCALE

0 1 2 3 4 Miles

0 5,000 10,000 15,000 20,000 Feet

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

of Jackson Water Utility provides water service to the Washington County Fair Park and St. Joseph's Community Hospital, both located north of the Village in the Town of Polk. The existing service areas of these systems are shown on Map 44 and selected characteristics of each system are presented in Table 44.

In 2005, the total storage capacity for the seven municipal water systems operating in Washington County was approximately 10 million gallons, divided among the 28 storage facilities, as listed in Table 44. As the largest water provider, the City of West Bend Water Utility maintained eight elevated tanks and standpipes and three reservoirs, with a total storage capacity of about 4.6 million gallons. Based on Wisconsin Public Service Commission annual reports for the year 2005, approximately 8.2 million gallons per day of water were pumped for use in the seven municipal systems concerned. As shown in Table 45, the water use totaled about 6.7 mgd for residential, commercial, industrial, institutional, or other urban uses, with the remaining 1.5 mgd of total pumpage being used for purposes, such as water production and system maintenance, or being unaccounted-for water. Overall, about 3.8 mgd, or about 57 percent of total municipal water used, was for single- and two-family housing units residential purposes; about 1.6 mgd, or about 24 percent, for commercial, multi-family residential, institutional, and miscellaneous uses; and about 1.0 mgd, or about 15 percent, was for industrial uses. The remaining approximately 0.3 mgd, or about 4 percent, was used for other municipal purposes. Based upon the population served and reported water use, residential water consumption within the seven water supply systems was approximately 67 gallons per person per day in 2005. When accounting for all municipal water uses, the average water consumption was about 92 gallons per person per day. In 2005, the amount of water which was unaccounted-for ranged from 5 to 25 percent, with an average of 13 percent of the water pumped for the utilities in Washington County. This unaccounted-for water was not included in the computed per capita consumption rates. It should be noted that the residential water use reported by the water utilities excludes that associated with the use of water by multiple-unit dwelling units with a single meter serving three or more units. Those uses are included with commercial water uses. Thus, the calculation of the water uses on a per capita and per acre basis for the residential and commercial categories were made by adjusting the population and acreage considered under these categories to reflect this reporting requirement.

The total water used in the seven municipal systems in 2005 was about the same as used in 2004 and about 5 percent higher than in 2000. The change between 2005 and 2000 represents an increase in residential use similar to the population growth between those years which was partially offset by a reduction in industrial water uses.

Municipal Water Supply System Interconnection

In 2006, the only known water supply system interconnections which existed in Washington County are between the Village of Germantown Water Utility and the neighboring Village of Menomonee Falls Water Utility in three locations. These interconnections are for emergency purposes.

Municipal Water Supply Water Conservation Measures

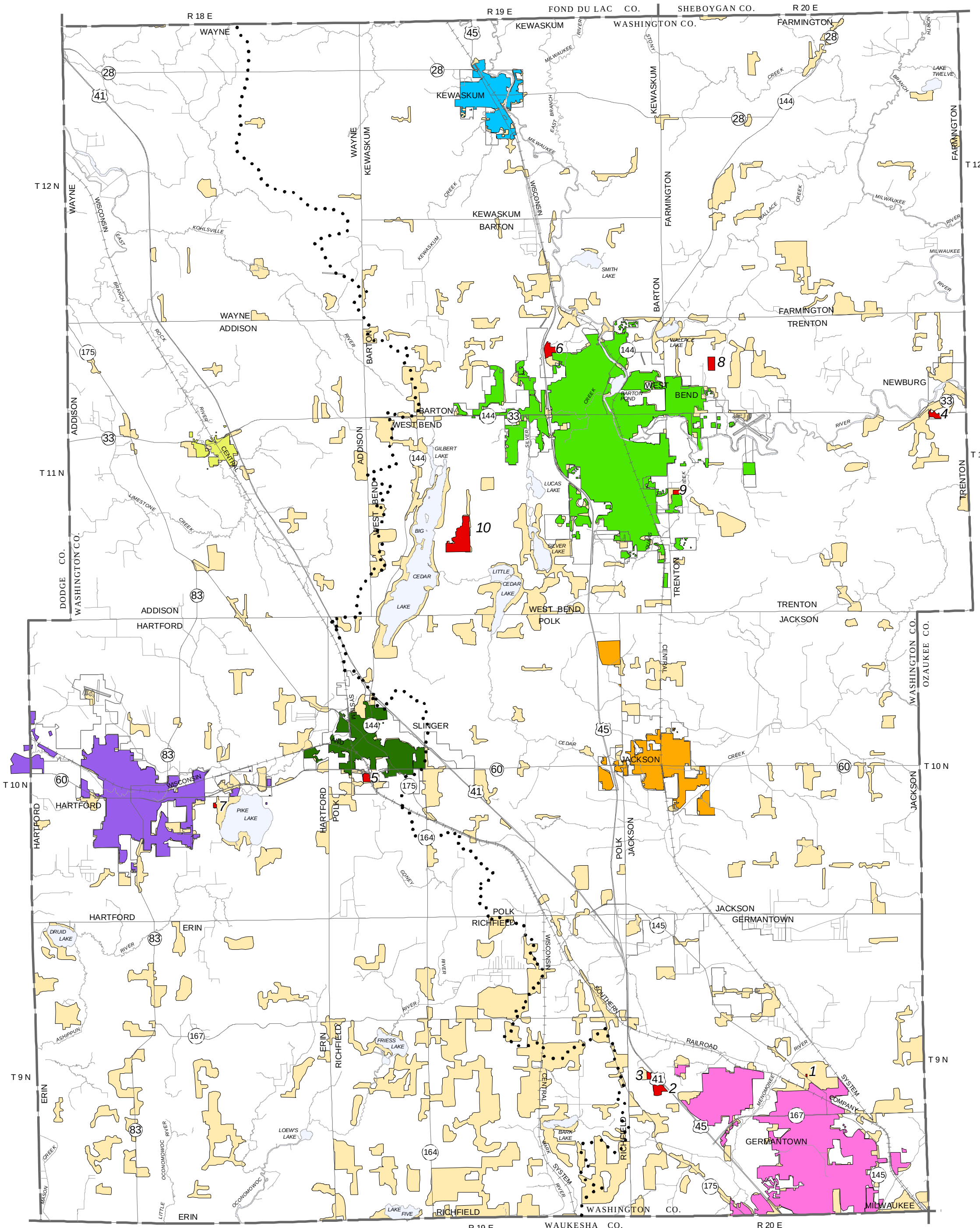
Water conservation measures reported to be in place or under development by the water utilities in Washington County include the ongoing development of water conservation policies and public information programs by the Village of Germantown, Village of Jackson, and the Allenton Sanitary District. These programs typically include lawn watering restrictions and notification of homeowners with unusually high water use as a warning of possible leakage. In addition, while not specifically reported, all of the utilities may be expected to be working to improve efficiency and minimize water losses in their systems. Such measures include meter testing for accuracy, leak detection programs, and repair of water main breaks and leaks. In addition, all of the water supply utilities within southeastern Wisconsin have water metering in place, have billing systems based upon usage, and are governed by the State plumbing code which limits flow rates and volumes for plumbing fixtures.

Proposed Municipal Water Supply System Modifications and Expansion Plans

The inventory revealed that, as of 2005, locally proposed water supply system modification and expansion plans existed for the Cities of Hartford and West Bend and the Village of Germantown. Other utilities have ongoing maintenance activities and planned urban service areas which have been documented in plans and related documents. Those plans are summarized in the subsequent paragraphs.

Map 44

MUNICIPAL AND OTHER-THAN-MUNICIPAL COMMUNITY WATER SUPPLY SYSTEMS IN WASHINGTON COUNTY: 2005



LEGEND

GROUNDWATER-SUPPLIED SYSTEMS AND SERVICE AREAS

- ALLENTON SANITARY DISTRICT
- CITY OF HARTFORD WATER UTILITIES
- CITY OF WEST BEND WATER UTILITY
- KEWASKUM WATER UTILITY
- SLINGER UTILITIES
- VILLAGE OF GERMANTOWN WATER UTILITY
- VILLAGE OF JACKSON WATER UTILITY
- SUBCONTINENTAL DIVIDE
- 23 AREA SERVED BY PRIVATE WATER SYSTEMS USING GROUNDWATER. IDENTIFICATION NUMBER CORRESPONDS WITH APPENDIX D
- EXTENT OF URBAN DEVELOPMENT NOT SERVED BY PUBLIC OR PRIVATE WATER SUPPLY SYSTEMS: INCLUDES URBAN DEVELOPMENT AS IDENTIFIED IN THE REGIONAL PLANNING COMMISSION HISTORIC URBAN GROWTH RING ANALYSIS

Water Supply Facilities	
Public Systems	7
Surface Water Treatment Plants	0
Surface Water Intakes	0
Wells	32
Storage Facilities	28
Private Systems	10
Number of Private System Wells	29

GRAPHIC SCALE

0 1 2 3 4 Miles

0 5,000 10,000 15,000 20,000 Feet

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

Table 44

SELECTED CHARACTERISTICS OF EXISTING MUNICIPAL WATER SUPPLY SYSTEMS WITHIN WASHINGTON COUNTY: 2005

Water Supply System	Class[a]	Estimated Area Served (square miles)	Estimated Population Served[b]	Source of Supply[c]	Number of Wells	Total Well Pumpage Capacity (mgd)	Well Aquifer[d]	Number of Lake Water Intakes	Treatment Processes[e]	Surface Treatment Plant Capacity (mgd)	Number of Storage Facilities	Total Storage Capacity (gallons x 1,000)	2005 Annual Average Pumpage (mgd)	2005 Maximum Daily Pumpage (mgd)	10-Year Maximum Daily Pumpage (mgd)	Spent Water Receiving System
City of Hartford Water Utilities	AB	3.4	12,800	G	6	4.80	SG, S[f]	- -	G, FL, SQ	- -	5	1,250[f]	1.60	2.99	- -	Rubicon River
City of West Bend Water Utility	AB	8.4	30,000	G	9	10.80	SAG'S	- -	H, P, FL, PA	- -	8	4,615	3.02	4.86	5.69	Milwaukee River
Village of Germantown Water Utility.......	AB	5.7	16,000	G	4	5.32	S, SD	- -	H, FL	- -	3	2,000	2.18	3.99	3.92	Lake Michigan
Village of Jackson Water Utility	C	1.6	5,900	G	4	3.53	SG, SD	- -	G	- -	2	700	0.61	1.13	- -	Cedar Creek
Village of Kewaskum Municipal Water Utility	C	1.0	3,800	G	4	2.26	SD	- -	FL	- -	6	925	0.34	0.65	1.20	Milwaukee River
Village of Slinger Utilities	C	1.4	4,100	G	3	1.45	SG, SD	- -	H, P, TA, F, OP	- -	3	610	0.35	0.43	0.98	Rubicon River
Allenton Sanitary District	D	0.3	800	G	2	1.12	S	- -	SH, P	- -	1	300	0.08	0.12	0.25	E. Branch Rock River
Total	- -	21.8	73,400	- -	32	29.28	- -	- -	- -	- -	28	10,400	8.18	14.17	- -	- -

NOTE: N/A indicates data not available.

[a]*The municipal water and combined water and sewer utilities are based upon the number of customers as follows: Class AB 4,000 or more customers; Class C from 1,000 to less than 4,000 customers; and Class D less than 1,000 customers.*

[b]*Population based upon Wisconsin Department of Natural Resources data base adjusted to 2004 Wisconsin Department of Administration Civil Division estimates and SEWRPC data, where appropriate.*

[c]*The following abbreviations are used:*

G = Groundwater
S = Surface Water (Lake Michigan)
SP = Surface Water Purchased (Lake Michigan)

[d]*The following abbreviations are used:*

SG = Sand and Gravel
SD = Silurian Dolomite
GP = Galena-Platteville Dolomite
S = Sandstone
M = Multiple Aquifers
SH = Shale

[e]*Code for treatment processes:*

CH = Pre-Sedimentation Chemical Addition
S = Sedimentation
C = Coagulation
F = Filtration
MC = Micro-Filtration
FL = Fluoridation
Z = Zeolite Softening
SA = Spray Aeration
SQ = Sequestration (Iron or Manganese Removal)
P = Polyphosphate Inhibitor (Corrosion Control)
I = Ion Exchange
G = Gaseous Chlorination
SH = Sodium Hypochlorite Chemical Addition
H = Hypochlorination
PA = Packed Tower Aeration
TA = Slat Tray Aeration
OP = Other Phosphates

[f]*As of June 2009, the City of Hartford completed development of a new sand and gravel aquifer well. The City no longer will use the one remaining deep sandstone aquifer well. In addition, the City initiated construction of a new 750,000 gallon elevated storage reservoir.*

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

Table 45

SUMMARY OF MUNICIPAL WATER USE IN WASHINGTON COUNTY: 2000, 2004, AND 2005

Year	Average Annual Water Uses										Percent Unaccounted-for Water[g]
	Residential Water Use[a]			Industrial Water Use		Commercial, Institutional, Multi-Family Residential, and Miscellaneous Water Use[a]		Other Municipal[e] Water Uses (gallons per day X 1,000)	Total Municipal Water Use[b]		
	Total[c] (gallons per day X 1,000)	Per Person[d] (gallons per capita per day)	Per Acre[d] (gallons per acre per day)	Total[c] (gallons per day X 1,000)	Per Acre (gallons per acre per day)	Total[c] (gallons per day X 1,000)	Per Acre (gallons per acre per day)		Total[c] (gallons per day X 1,000)	Per Person[f] (gallons per capita per day)	
2000	3,488	66	725	1,287	1,857	1,406	474	230	6,411	96	13
2004[h]	3,629	65	710	1,258	1,710	1,588	504	254	6,729	94	11
2005[i]	3,848	67	738	978	1,292	1,641	508	274	6,741	92	13

[a]*Residential category includes population associated with single-family and two-family housing units, plus some larger multi-family housing where individual water meters are used for each unit. Other multi-family units are included in the commercial water use category.*

[b]*Includes all water specifically accounted for.*

[c]*As reported in annual reports submitted to the Public Service Commission of Wisconsin.*

[d]*Reported residential water use excludes that associated with multiple-unit dwellings where a single meter serves three or more housing units. That water use is classified as commercial under the Public Service Commission of Wisconsin reporting system. The unit water uses presented on a per capita and per acre basis were calculated by adjusting the population and residential land area to be consistent with this reporting procedure.*

[e]*Includes uses for fire protection services, sales to public authorities, sales to irrigation customers and interdepartmental sales.*

[f]*Estimated based upon total residential population served.*

[g]*Water not specifically accounted for as a percent of total pumpage into distribution system.*

[h]*2004 population and land use was approximated by increasing the 2000 population and land use amounts by 6.2 percent.*

[i]*2005 population and land use was approximated by increasing the 2000 population and land use amounts by 8.7 percent.*

Source: Public Service Commission of Wisconsin and SEWRPC.

It should be noted that the sanitary sewer service area plans and related amendments listed for the utilities below were prepared under the regional water quality management planning program cooperatively being carried out by the WDNR and SEWRPC. These plans and amendments specifically address current and planned sanitary sewer service areas. However, these reports also serve as a surrogate for the identification of an urban services area for water supply, as well as sanitary sewer service.

City of Hartford Water Utility

Plans for the City of Hartford Water Utility system were documented in the following reports:

1. A report entitled *Sanitary Sewer Service Area for the City of Hartford and Environs*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the City of Hartford, dated September 2001.

2. A report entitled *Amendment to the Regional Water Quality Management Plan, City of Hartford*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the City of Hartford, dated December 2005.

A review of available information on the City of Hartford Water Utility water system indicates that the City of Hartford planned to construct a new well, Well No. 16, and pumping facility. The new well is to be constructed in the western part of the City in the vicinity of STH 60 in Dodge County. Construction of a new storage facility with a capacity of 750,000 gallons was also planned. During 2009, the City placed a new well, Well No. 16, in service. Also during 2009, the City began construction of the new 750,000-gallon storage facility. The City of Hartford Well No. 4, located in the downtown area, produces water which exceeds the radium maximum contaminant level. That well has been placed on standby and will only be used if emergency conditions, such as a major fire, warrant use.

City of West Bend Water Utility
Plans for the City of West Bend Water Utility system were documented in the following report:

1. A report entitled *Sanitary Sewer Service Area for the City of West Bend and Environs*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the City of West Bend, dated June 1998.

A review of the information available indicates that the City of West Bend was conducting well siting evaluations, with the intention of developing two new wells over the period 2006 through 2010. These new wells are needed to accommodate new development and to replace reduced well capacity due to declining water levels at some existing wells. In addition, the City continues to focus on maintenance of the existing water supply facilities. The age of the existing wells are all over 25 years. The City of West Bend also has enacted an emergency water use restriction ordinance.

Village of Germantown Water Utility
Plans for the Village of Germantown Water Utility system were documented in the following reports:

1. A report entitled *Water System Master Plan, Village of Germantown*, prepared by Earth Tech, Inc, dated November 2003.

2. A document on the results of a geophysical survey performed by Aquifer Science & Technology, dated October 2004.

3. A report entitled *Sanitary Sewer Service Area for the Village of Germantown*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Village of Germantown and the Milwaukee Metropolitan Sewerage District, dated July 1983.

4. A report entitled *Amendment to the Regional Water Quality Management Plan, Village of Germantown*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Village of Germantown and the Milwaukee Metropolitan Sewerage District, dated December 2003.

A review of the available information on the Germantown Water Utility water system indicated that the Utility had a comprehensive master plan that recommended immediate expansion of, and specified upgrades to, the water system in order to fulfill water demands imposed by development. The Village completed construction of a 1.0-million-gallon-capacity elevated tank in 2003 in order to satisfy projected storage needs. Information provided by the Village indicates that the Village is currently conducting well exploration studies for the addition of three new wells. Two of the wells are proposed to be located adjacent to each other, with one well being in the dolomite aquifer and one in the deep sandstone aquifer. The water from these two wells is proposed to be blended. The third well being considered is not expected to be needed for some time into the future. The Village is also nearing completion of a radium removal treatment facility using the hydrous manganese oxide (HMO) filtration process to treat water from Well No. 3, which has been out of service for the past three years pending resolution of the radium issue.

Village of Jackson Water Utility
Plans for the Village of Jackson Water Utility system were documented in the following reports:

1. A report entitled *Sanitary Sewer Service Area for the Village of Jackson and Environs,* prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Village of Jackson, dated September 1997.

2. A report entitled *Amendment to the Regional Water Quality Management Plan, Village of Jackson,* prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Village of Jackson, dated June 2004.

A review of the available information on the Village of Jackson Water Utility water system indicates that during 2006, the Village placed a new well, Well No. 5, into operation. The well is located in the vicinity of Northwest Passage and CTH P on the northwest side of the Village, and has a capacity of 1,080 gallons per minute. In addition, the Village acquired the well serving the former Seneca Foods (Northern Cranberry Company) industrial site. That well has been temporarily abandoned. It is planned to rehabilitate that well to serve as a municipal well in the future.

Village of Kewaskum Municipal Water Utility

Plans for the Village of Kewaskum Municipal Water Utility system were documented in the following reports:

1. A report entitled *Sanitary Sewer Service Area for the Village of Kewaskum*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Village of Kewaskum, dated March 1988.

2. A report entitled *Amendment to the Regional Water Quality Management Plan, Village of Kewaskum*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Village of Kewaskum, dated December 2005.

No specific plans for expansion or modifications are known to be proposed for the Village of Kewaskum Water Utility system.

Village of Slinger Utilities

Plans for the Village of Slinger Utilities system were documented in the following reports:

1. A report entitled *Sanitary Sewer Service Area for the Village of Slinger and Environs,* prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Village of Slinger, dated December 1998.

2. A report entitled *Amendment to the Regional Water Quality Management Plan, Village of Slinger*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Village of Slinger, dated September 2003.

The Village of Slinger has plans to conduct an evaluation of Well No. 6, and to upgrade and rehabilitate Well No. 3 and the pumping equipment at Well No. 3 and Well No. 4.

Allenton Sanitary District

Plans for the Allenton Sanitary District system were documented in the following report:

1. A report entitled *Sanitary Sewer Service Area for the Allenton Area*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Allenton Sanitary District and the Town of Addison, dated March 2004.

A review of the information provided by the Allenton Sanitary District indicates that the Utility was taking measures to protect water resources within its service area and is currently working on developing a wellhead protection program.

Existing Residential and Other-than-Municipal Community Systems

In 2005, there were 10 existing privately owned water, self-supplied, systems operating in Washington County which provide water supply services to primarily residential land uses, such as subdivisions, apartment or condominium developments, and mobile home parks. Such systems are generally designated by the WDNR as "other-than-municipal community systems." These systems served a resident population of about 1,400 persons, or about 1.5 percent of the Washington County residential population. Of the 10 systems, six were high-capacity and four were low-capacity systems. All of these 10 systems utilized groundwater as a source of supply through 26 low-capacity and three high-capacity wells. The location of these systems are shown on Map 44. Selected characteristics of each system are presented in Table D-1 in Appendix D.

Existing Industrial Water Supply Systems

In 2005, there were 17 existing privately owned, self-supplied, water systems operating in Washington County which provide water for industrial land uses. Of the 17 systems, nine were high-capacity and eight were low-capacity systems. These systems all utilize groundwater as a source of supply through 13 low-capacity wells and 10 high-capacity wells. The locations of these systems are shown on Map 45. Selected characteristics of each system are presented in Table D-2 in Appendix D.

Existing Commercial Water Supply Systems

In 2005, there were 123 existing privately owned, self-supplied, water systems operating in Washington County which provide water for commercial land uses. Of the 123 systems, two were high-capacity and 121 were low-capacity systems. These systems all utilized groundwater as a source of supply through 126 low-capacity wells. The locations of these systems are shown on Map 45. Selected characteristics of each system are presented in Table D-3 in Appendix D.

Existing Institutional and Recreational Water Supply Systems

In 2005, there were 80 existing privately owned, self-supplied, water systems operating in Washington County which provided water for institutional and recreational land uses. Of the 80 systems, 25 were high-capacity and 55 were low-capacity systems. These systems all utilized groundwater as a source of supply through 99 low-capacity wells and seven high-capacity wells. The locations of these systems are shown on Map 45. Selected characteristics of each system are presented in Table D-4 in Appendix D.

Existing Agricultural Water Supply Systems

In 2005, there were four existing privately owned, self-supplied, water systems operating in Washington County which provided water for irrigation and other purposes for agricultural land uses. All four systems are high-capacity systems and all utilized groundwater as a source of supply through four high-capacity wells. The locations of these systems are shown on Map 45. Selected characteristics of each system are presented in Table D-5 in Appendix D.

Existing Irrigation Water Supply Systems

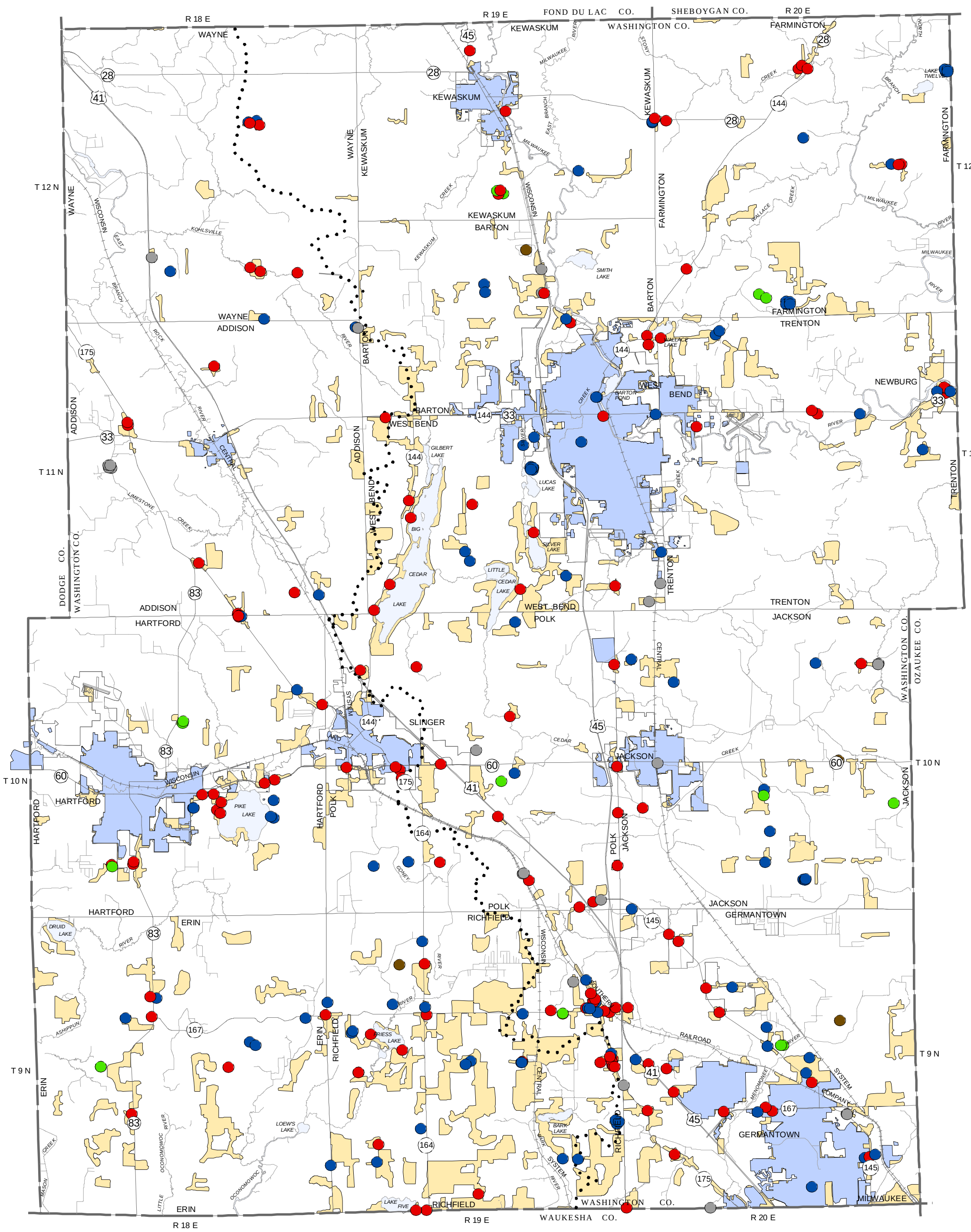
In 2005, there were 10 existing privately owned, self-supplied, water systems operating in Washington County which provided irrigation water for land uses other than agricultural uses, such as golf courses. All 10 systems are high-capacity systems and all utilized groundwater as a source of supply through 15 high-capacity wells. The locations of these systems are shown on Map 45. Selected characteristics of each system are presented in Table D-6 in Appendix D.

Existing Thermoelectric-Power-Generation Water Supply Systems

In 2005, there was one existing thermoelectric-power-generation facility operating in Washington County which used cooling water. This facility was a combustion turbine generating facility located in the Village of Germantown. The facility was constructed in 1978 and expanded in 2000. The facility utilizes groundwater obtained through a well with an approved pump capacity of 500 gallons per minute, or 720,000 gallons per day, and an approved well capacity of 100,000 gallons per day. This well was finished in the deep sandstone aquifer. The amount of water used varies annually depending upon the need for the intermittent operation of the load peaking facility. The water use for the only years reported, 1982 through 1989, averaged 220,000 gallons per year, or about 600 gallons per day. There are two primary water uses at the Germantown Power Plant: 1) water spray injection into the combustion turbines for nitrogen oxides control; and 2) an inlet air cooling system, used to enhance the combustion turbine generating capacity during warmer weather, cooling the intake air by passing it over coils containing recirculating cold water produced in an onsite refrigeration system.

Map 45

SELF-SUPPLIED INDUSTRIAL, COMMERCIAL, INSTITUTIONAL AND RECREATIONAL, AGRICULTURAL, AND IRRIGATION WATER SUPPLY SYSTEMS IN WASHINGTON COUNTY: 2005



LEGEND

SELF-SUPPLIED WATER SYSTEM WELLS

- INDUSTRIAL
- COMMERCIAL
- AGRICULTURAL
- IRRIGATION
- INSTITUTIONAL AND RECREATIONAL

AREA SERVED BY PUBLIC WATER UTILITY USING GROUNDWATER

EXTENT OF URBAN DEVELOPMENT NOT SERVED BY PUBLIC OR PRIVATE WATER SUPPLY SYSTEMS: INCLUDES URBAN DEVELOPMENT AS IDENTIFIED IN THE REGIONAL PLANNING COMMISSION HISTORIC URBAN GROWTH RING ANALYSIS

SUBCONTINENTAL DIVIDE

GRAPHIC SCALE
0 1 2 3 4 Miles
0 5,000 10,000 15,000 20,000 Feet

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

Existing Self-Supplied Residential Water Systems
As of the year 2005, there were about 51,000 persons, or about 41 percent of the total resident year 2005 population of Washington County, served by private domestic wells. As shown on Map 44. about 31.7 square miles of land area located outside of the municipal water utility service areas within Washington County were classified as having urban-density development, and were served by private wells. These were located primarily in the southern part of the County, including large portions of the Village of Richfield. Assuming an average use of 65 gallons per capita per day, these private domestic wells would withdraw about 3.3 million gallons per day from the shallow groundwater aquifer. It is estimated that 10 percent of the households served by private domestic wells were served by public sanitary sewer systems. Thus, the water withdrawn from the groundwater system for about 10 percent of the private domestic wells, or about 0.3 million gallons per day, was discharged to the surface water system as treated sanitary sewage. The majority—approximately 90 percent—of the remaining water withdrawn by private wells, or about 2.7 million gallons per day, was returned to the groundwater aquifer via onsite sewage disposal systems.

INVENTORY FINDINGS—WAUKESHA COUNTY

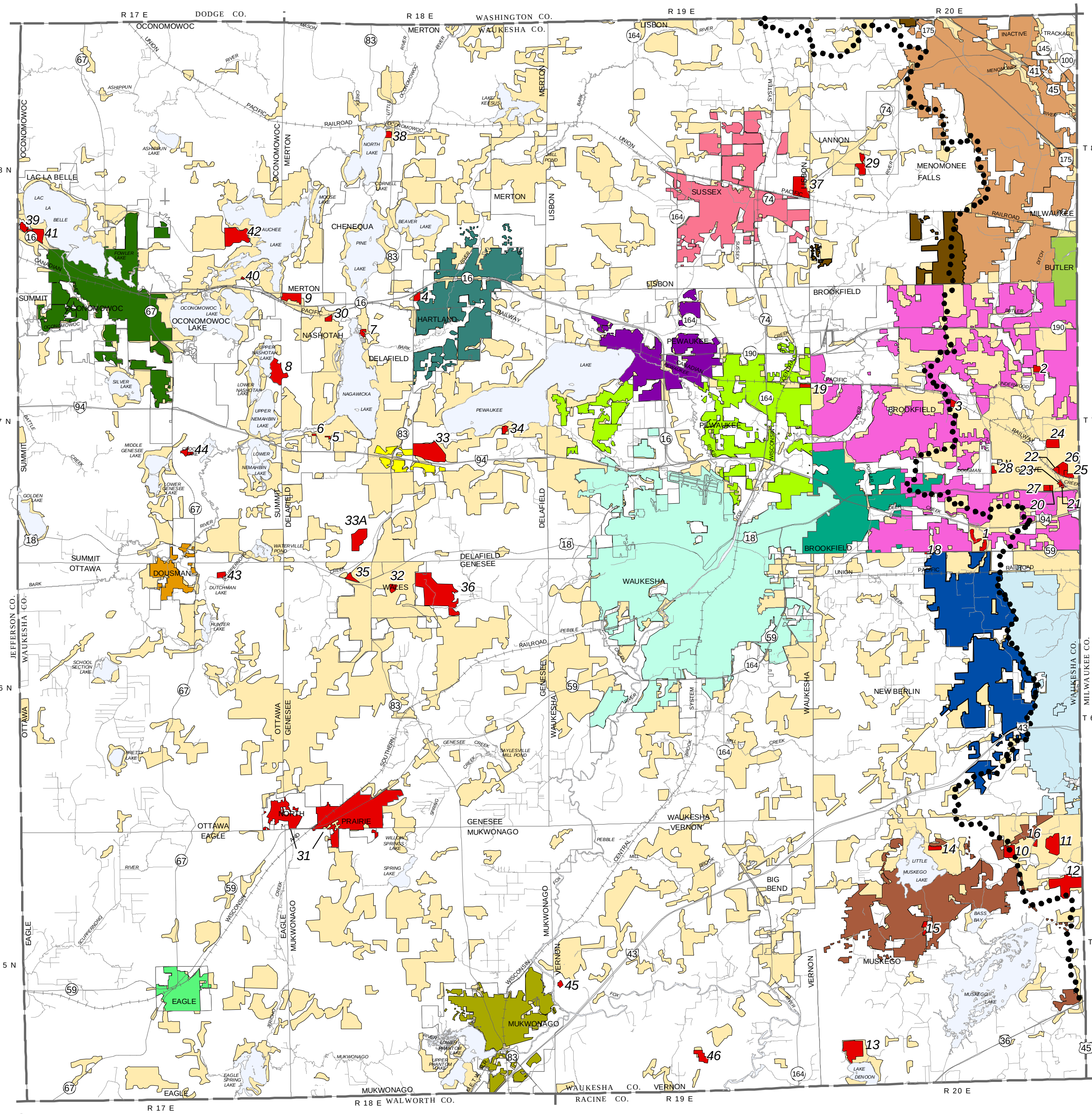
Existing Municipal Water Supply Systems
In 2005, 16 municipal water supply utility systems provided water to about 88 square miles of service area, or about 15 percent of the area of Waukesha County. These systems served a 2005 population of about 234,000 persons, or about 62 percent of the residential population in Waukesha County. Most of the water supply systems in Waukesha County rely on groundwater as the source of supply. The exceptions included the Village of Butler Public Water Utility, portions of the City of New Berlin Water Utility, and portions of the Village of Menomonee Falls Water Utility. These utilities purchased treated Lake Michigan surface water from the Milwaukee system, the spent water being returned to the Lake Michigan Basin via the Metropolitan Milwaukee Sewerage District sewerage system. The existing service areas of these systems are shown on Map 46 and selected characteristics of each system are presented in Table 46.

In addition to the 16 municipal water supply systems, there are two additional public water service supply systems; the Prairie Village Water Trust and the Ethan Allen School. The Prairie Village Water Trust, located in the Village of North Prairie, serves about 1,600 residents, or approximately 85 percent of the 2005 residential population within the Village. This system is classified as "other-than-municipal community water systems" by the WDNR. Located in the Town of Delafield, the Ethan Allen School is an institution operated by the Wisconsin Department of Corrections that serves a population of about 750 transient residents. This system is classified as an "other-than-municipal community water system" by the WDNR. Neither of these two systems is required to provide annual reports to the Public Service Commission of Wisconsin, and, therefore, information about their usage is excluded from Table 46.

In 2005, the total storage capacity for the 16 municipal water systems operating in Waukesha County was approximately 45.8 million gallons, divided among the 83 elevated tanks, standpipes, and reservoirs, as listed in Table 46. As the largest water provider, the City of Waukesha Water Utility maintained six elevated tanks and standpipes and six reservoirs, with a total storage capacity of about 15.3 million gallons. Based on Wisconsin Public Service Commission annual reports for the year 2005, approximately 29.3 million gallons per day of water were pumped for use in the 16 municipal systems concerned. As shown in Table 47, the water use totaled about 25.6 mgd for residential, commercial, industrial, institutional, or other urban uses, with the remaining 3.7 mgd of total pumpage being used for purposes such as water production and system maintenance, or being unaccounted-for water. Overall, about 13.7 mgd, or about 54 percent of total municipal water used, was for single- and two-family housing units residential purposes; about 8.3 mgd, or about 33 percent, for commercial, multi-family residential, institutional, and miscellaneous uses; and about 2.9 mgd, or about 11 percent, was for industrial uses. The remaining 0.7 mgd, or about 3 percent, was used for other municipal purposes. Based upon the population served and reported water use, residential water consumption within the seven water supply systems was approximately 72 gallons per person per day in 2005. When accounting for all municipal water uses, the average water consumption was about 134 gallons per person per day. In 2005, the amount of water which was unaccounted-for

Map 46

MUNICIPAL AND OTHER-THAN-MUNICIPAL COMMUNITY WATER SUPPLY SYSTEMS IN WAUKESHA COUNTY: 2005



LEGEND

GROUNDWATER-SUPPLIED SYSTEMS AND SERVICE AREAS

- CITY OF BROOKFIELD MUNICIPAL WATER UTILITY
- DELAFIELD MUNICIPAL WATER UTILITY
- CITY OF MUSKEGO PUBLIC WATER UTILITY
- CITY OF NEW BERLIN WATER UTILITY
- CITY OF OCONOMOWOC UTILITIES
- CITY OF PEWAUKEE WATER UTILITY
- CITY OF WAUKESHA WATER UTILITY
- VILLAGE OF EAGLE MUNICIPAL WATER UTILITY
- DOUSMAN WATER UTILITY
- HARTLAND MUNICIPAL WATER UTILITY
- VILLAGE OF MENOMONEE FALLS WATER UTILITY
- MUKWONAGO MUNICIPAL WATER UTILITY
- VILLAGE OF PEWAUKEE WATER UTILITY
- SUSSEX VILLAGE WATER UTILITY
- BROOKFIELD SANITARY DISTRICT NO. 4

SURFACE WATER-SUPPLIED SYSTEMS AND SERVICE AREAS

- VILLAGE OF BUTLER PUBLIC WATER UTILITY
- VILLAGE OF MENOMONEE FALLS WATER UTILITY
- CITY OF NEW BERLIN WATER UTILITY
- SUBCONTINENTAL DIVIDE

- 23 AREA SERVED BY PRIVATE WATER SYSTEMS USING GROUNDWATER. IDENTIFICATION NUMBER CORRESPONDS WITH APPENDIX D
- EXTENT OF URBAN DEVELOPMENT NOT SERVED BY PUBLIC OR PRIVATE WATER SUPPLY SYSTEMS: INCLUDES URBAN DEVELOPMENT AS IDENTIFIED IN THE REGIONAL PLANNING COMMISSION HISTORIC URBAN GROWTH RING ANALYSIS

Water Supply Facilities	
Public Systems	16
Surface Water Treatment Plants	0
Surface Water Intakes	0
Wells	93
Storage Facilities	83
Private Systems	47
Number of Private System Wells	97

GRAPHIC SCALE

0 1 2 3 4 Miles

0 5,000 10,000 15,000 20,000 Feet

Source: Wisconsin Public Service Commission, water utilities, and SEWRPC.

Table 46

SELECTED CHARACTERISTICS OF EXISTING MUNICIPAL WATER SUPPLY SYSTEMS WITHIN WAUKESHA COUNTY: 2005

Water Supply System	Class[a]	Estimated Area Served (square miles)	Estimated Population Served[b]	Source of Supply[c]	Number of Wells	Total Well Pumpage Capacity (mgd)	Well Aquifer[d]	Number of Lake Water Intakes	Treatment Processes[e]	Surface Treatment Plant Capacity (mgd)	Number of Storage Facilities	Total Storage Capacity (gallons x 1,000)	2005 Annual Average Pumpage (mgd)	2005 Maximum Daily Pumpage (mgd)	10-Year Maximum Daily Pumpage (mgd)	Spent Water Receiving System
City of Brookfield Municipal Water Utility............	AB	13.4	27,100	G	22	16.01	SD, S	- -	H, P, SQ	- -	12	5,445	4.10	7.36	8.11	Fox River and Lake Michigan
City of Delafield Municipal Water Utility..............	D	0.3	400	G	1	0.72	S	- -	H	- -	2	627	0.14	0.58	- -	Bark River
City of Muskego Public Water Utility...................	C	4.7	10,000	G	9	5.51	SD, SG, S	- -	H, SQ	- -	3	1,072	0.91	2.53	2.10	Lake Michigan
City of New Berlin Water Utility...........................	AB	11.6	31,400	G, SP	7	7.24	SD, S, SH	- -	G, SQ, P	- -	10	4,407	3.33	5.61	- -	Lake Michigan
City of Oconomowoc Utilities..............................	AB	4.3	13,600	G	6	9.60	GP, SG, S	- -	G, P, SQ, FL	- -	6	2,283	1.94	4.08	- -	Oconomowoc River
City of Pewaukee Water and Sewer Utility.........	AB	5.0	8,000	G	10	5.55	SD, SG, S	- -	H, P, SQ	- -	7	1,788	1.37	2.94	3.37	Fox River
City of Waukesha Water Utility...........................	AB	17.6	67,800	G	8	15.40[f]	S, SG	- -	H, SQ, FL	- -	12	15,272	7.76	12.87	12.87	Fox River
Village of Butler Public Water Utility...................	C	0.8	1,800	SP	- -	- -	- -	- -	H, FL	- -	1	300	0.34	0.52	- -	Lake Michigan
Village of Dousman Water Utility........................	C	0.5	1,800	G	2	0.94	GP, S	- -	H, SQ, FL	- -	1	300	0.21	0.48	0.44	Bark River
Village of Eagle Municipal Water Utility..............	C	0.8	1,800	G	3	1.77	SG, S	- -	H	- -	2	250	0.16	0.41	0.57	Groundwater via onsite sewage disposal system
Village of Hartland Municipal Water Utility..........	AB	3.6	8,400	G	4	6.87	GP, SG	- -	G, H, FL, PA	- -	4	1,350	1.09	2.36	2.36	Bark River
Village of Menomonee Falls Water Utility...........	AB	13.4	30,900	G, SP	2 active, plus 5 standby	3.12[g]	S, SD, SG	- -	G, P, F	- -	8	6,970	4.18	7.60	7.60	Lake Michigan and Sussex Creek
Village of Mukwonago Municipal Water Utility.....	AB	2.4	6,500	G	4	3.82	SG, S	- -	H, FL	- -	3	1,330	0.67	1.11	- -	Fox River
Village of Pewaukee Water Utility.......................	AB	2.4	9,000	G	4	3.64	SD, S	- -	H, SQ, FL	- -	5	1,700	0.91	1.66	1.66	Fox River
Village of Sussex Water Utility............................	AB	4.1	9,800	G	5	4.39	SD, S	- -	H, SQ	- -	4	2,000	1.27	2.61	3.02	Sussex Creek
Town of Brookfield Sanitary District No. 4..........	C	3.0	5,900	G	6	2.93	SD	- -	G	- -	3	690	0.95	1.57	1.70	Fox River
Total	- -	87.9	234,200	- -	93, plus 5 standby	87.51[g]	- -	- -	- -	- -	83	45,784	29.33	54.29	- -	- -

NOTE: N/A indicates data not available.

[a] *The municipal water and combined water and sewer utilities are based upon the number of customers as follows: Class AB 4,000 or more customers; Class C from 1,000 to less than 4,000 customers; and Class D less than 1,000 customers.*

[b] *Population based upon Wisconsin Department of Natural Resources data base adjusted to 2004 Wisconsin Department of Administration Civil Division estimates and SEWRPC data, where appropriate.*

[c] *The following abbreviations are used:*

G = Groundwater
S = Surface Water (Lake Michigan)
SP = Surface Water Purchased (Lake Michigan)

[d] *The following abbreviations are used:*

SG = Sand and Gravel
SD = Silurian Dolomite
GP = Galena-Platteville Dolomite
S = Sandstone
M = Multiple Aquifers
SH = Shale

[e] *Code for treatment processes:*

CH = Pre-Sedimentation Chemical Addition
S = Sedimentation
C = Coagulation
F = Filtration
MC = Micro-Filtration
FL = Fluoridation
Z = Zeolite Softening
SA = Spray Aeration
P = Polyphosphate Inhibitor
SQ = Sequestration (Iron or Manganese Removal)
I = Ion Exchange
G = Gaseous Chlorination
SH = Sodium Hypochlorite Chemical Addition
H = Hypochlorination
PA = Packed Tower Aeration
TA = Slat Tray Aeration

[f] *During 2009, the City of Waukesha developed a new shallow aquifer well with a capacity of about 1.0 million gallons per day.*

[g] *Well pumpage capacity is based upon the capacity of the active wells and excludes the standby well capacity.*

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

Table 47

SUMMARY OF MUNICIPAL WATER USE IN WAUKESHA COUNTY: 2000, 2004 AND 2005

	Average Annual Water Uses										
	Residential Water Use[a]			Industrial Water Use		Commercial, Institutional, Multi-Family Residential, and Miscellaneous Water Use[a]			Total Municipal Water Use[b]		
Year	Total[c] (gallons per day X 1,000)	Per Person[d] (gallons per capita per day)	Per Acre[d] (gallons per acre per day)	Total[c] (gallons per day X 1,000)	Per Acre (gallons per acre per day)	Total[c] (gallons per day X 1,000)	Per Acre (gallons per acre per day)	Other Municipal[e] Water Uses (gallons per day X 1,000)	Total[c] (gallons per day X 1,000)	Per Person[f] (gallons per capita per day)	Percent Unaccounted-for Water[g]
2000	11,404	64	507	3,720	1,248	7,308	653	661	23,093	106	10
2004[h]	12,306	66	516	2,710	862	7,802	658	696	23,514	102	10
2005[i]	13,729	72	565	2,890	904	8,320	689	698	25,637	109	8

[a]*Residential category includes population associated with single-family and two-family housing units, plus some larger multi-family housing where individual water meters are used for each unit. Other multi-family units are included in the commercial water use category.*

[b]*Includes all water specifically accounted for.*

[c]*As reported in annual reports submitted to the Public Service Commission of Wisconsin.*

[d]*Reported residential water use excludes that associated with multiple-unit dwellings where a single meter serves three or more housing units. That water use is classified as commercial under the Public Service Commission of Wisconsin reporting system. The unit water uses presented on a per capita and per acre basis were calculated by adjusting the population and residential land area to be consistent with this reporting procedure.*

[e]*Includes uses for fire protection services, sales to public authorities, sales to irrigation customers and interdepartmental sales.*

[f]*Estimated based upon total residential population served.*

[g]*Water not specifically accounted for as a percent of total pumpage.*

[h]*2004 population and land use was approximated by increasing the 2000 population and land use amounts by 3.6 percent.*

[i]*2005 population and land use was approximated by increasing the 2000 population and land use amounts by 4.6 percent.*

Source: Public Service Commission of Wisconsin and SEWRPC.

ranged from 5 to 15 percent, with an average of 8 percent of the water pumped. Thus, unaccounted-for water was not included in the computed per capita consumption rates. It should be noted that the residential water use reported by the water utilities excludes that associated with the use of water by multiple-unit dwelling units with a single meter serving three or more units. Those uses are included with commercial water uses. Thus, the calculation of the water uses on a per capita and per acre basis for the residential and commercial categories were made by adjusting the population and acreage considered under these categories to reflect this reporting requirement.

The water used in the 16 municipal systems in Waukesha County during 2005 was about 9 percent higher than was used in 2004, and about 11 percent higher than was used during 2000. Residential water use and commercial water use increased by about 20 and 14 percent between 2000 and 2005, respectively. However, industrial water use was reduced by about 22 percent over the same period.

Municipal Water Supply System Interconnection and Intermunicipal Service Provisions

Numerous water supply system interconnections exist between water utility systems in Waukesha County. Some of these interconnections are used only for emergency purposes; however, three systems are either fully or partially supplied with water by Milwaukee Water Works, and therefore, these interconnections are used for intermunicipal service provision. The three systems include the Village of Butler Public Water Utility which is fully supplied by Milwaukee Water Works, and the Village of Menomonee Falls Water Utility and the City of New Berlin Water Utility which are partially supplied by Milwaukee Water Works. The Village of Menomonee Falls Water Utility and the City of New Berlin Water Utility systems both straddle the subcontinental divide. The portions of the utility service areas lying east of the divide, as well as small portions of the Menomonee Falls service area lying west of the divide are supplied by purchased Lake Michigan water. The small portions of the

Village of Menomonee Falls water service area lying west of the subcontinental divide and served with purchased water are all connected to the MMSD sewerage system. Thus, the spent water is returned to Lake Michigan following treatment. The remaining water service areas to the west of the divide rely on groundwater supplies.

Numerous reciprocal emergency interconnections exist between adjacent water utility systems in Waukesha County. The City of Brookfield Municipal Water Utility shares one interconnection each with the City of Pewaukee Water and Sewer Utility and the Village of Menomonee Falls Water Utility and the Town of Brookfield Sanitary District No. 4. The City of Pewaukee shares one interconnection each with the City of Brookfield, the City of Waukesha Water Utility, the Village of Pewaukee, and the Town of Brookfield Sanitary District No. 4. The Village of Menomonee Falls Water Utility shares three interconnections with the Village of Germantown Water Utility in Washington County, and one interconnection with the City of Brookfield. These interconnections are in place.

Municipal Water Supply Water Conservation Measures

Water conservation measures reported to be in place or under development by the water utilities in Waukesha County include the ongoing development and implementation of water conservation policies and public information programs by the Cities of Brookfield, New Berlin, Pewaukee, and Waukesha; the Villages of Dousman, Eagle, Pewaukee, Sussex; and the Town of Brookfield Sanitary District No. 4. These efforts typically include lawn watering restrictions and notification of homeowners with unusually large water use, as a warning of possible leakage, and related public educational efforts. In 2006, the City of Waukesha Water Utility adopted a water conservation and protection plan.[30] The plan includes a stated preliminary goal of reducing the per capita water use by 20 percent, and reducing the peak water demand by 1.0 million gallons per day by the year 2020. The Utility has begun to implement some elements of the plan, including, among others, conducting public educational efforts, adopting and implementing a lawn sprinkling restriction ordinance, and conducting building fixture replacement demonstration projects. In addition, while not specifically reported, all of the utilities are continually working to improve efficiency and minimize water losses in their systems. In addition, all communities are governed by the State plumbing code which limits flow rates and volumes for plumbing fixtures.

During 2006, Waukesha County and the City of Waukesha organized a Water Conservation Coalition to prepare and help implement a water conservation education program. The initially identified mission of the Coalition was to develop an awareness of groundwater use-related issues, and of demand side conservation measures through areawide collaborative efforts. The target audience envisioned include, county and municipal officials, businesses leaders, and the general public. The initially identified components of the public awareness program included:

1. Develop and deliver educational materials and programs that enable individuals to safeguard their own drinking water (primarily private, nonregulated supplies);

2. Encourage municipalities and water users to develop and adopt water conservation plans, which include systemwide demand reduction goals;

3. Develop and deliver a demand side conservation awareness strategy to assist municipalities and water users in achieving systemwide demand reduction goals or in achieving demand side reduction measures identified in the regional water supply plan;

4. Develop outcome assessments for each of the educational initiatives; and

5. Encourage land development patterns that lead to a sustainable water supply.

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[30]*Waukesha Water Utility*, Water Conservation and Protection Plan, *dated March 2006.*

Proposed Municipal Water Supply System Modifications and Expansion Plans

The inventory revealed that, as of 2005, locally proposed water supply system modification and expansion plans existed for the City of Brookfield, City of Muskego, City of Pewaukee, and City of New Berlin systems; the Village of Dousman, the Village of Hartland, the Village of Menomonee Falls, the Village of Pewaukee, and the Village of Sussex systems. Other utilities had ongoing maintenance activities and planned urban service areas documented in plans. Those plans are summarized in the subsequent paragraphs.

It should be noted that the sanitary sewer service area plans and related amendments listed for the utilities below were prepared under the regional water quality management planning program cooperatively being carried out by the WDNR and SEWRPC. These plans and amendments specifically address current and planned sanitary sewer service areas. However, these reports do, as appropriate, address the need to coordinate water and sewer service to respect the rules and regulations relating to the diversion of Lake Michigan as a water supply source. These plans also serve as a surrogate for the identification of an urban services area for water supply, as well as sanitary sewer service.

City of Brookfield Municipal Water Utility

Plans for the City of Brookfield Municipal Water Utility system were documented in the following reports:

1. A report entitled *Wellhead Protection Plan, Well No. 28*, prepared by Ruekert & Mielke, Inc., dated March 1997.

2. A report entitled *Well 30 Wellhead Protection Plan*, prepared by Ruekert & Mielke, Inc., dated July 2002.

3. A report entitled *Results of Geologic Reconnaissance*, prepared by Aquifer Science & Technology, a division of Ruekert & Mielke, Inc., dated November 2002.

4. A report entitled *Sandstone Aquifer Model Report*, prepared by Bonestroo, Rosene, Anderlik and Associates, Inc., dated February 1998.

5. A report entitled *Report on Water Supply Facilities with Milwaukee Lake Water Option*, prepared by Ruekert & Mielke, Inc., dated May 2001.

6. A report entitled *Sanitary Sewer Service Area for the City and Town of Brookfield and the Village of Elm Grove*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the City of Brookfield, the Village of Elm Grove, the Town of Brookfield, the Town of Brookfield Sanitary District No. 4, and the Milwaukee Metropolitan Sewerage District, dated November 1991.

7. A report entitled *Amendment to the Regional Water Quality Management Plan, City of Brookfield*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the City of Brookfield, and the Milwaukee Metropolitan Sewerage District, dated June 1998.

A review of the available information indicates that the City of Brookfield Municipal Water Utility was taking measures to protect water quality and ensure quantity and availability within its service area. As of 2005, several residential areas within the City of Brookfield still relied on private wells, and the City Municipal Water Utility was engaged in continuing efforts to expand public water supply service to its residents in a coordinated manner. As part of its efforts to develop a plan for existing and proposed wells, the City of Brookfield Utility has developed a wellhead protection program, to ensure water quality as the City is projected to develop new shallow aquifer wells, which tend to be more susceptible to surface contamination than deep aquifer wells. The Utility in 2005 was conducting geophysical surveys to determine potential locations for additional wells within the service area. The Utility had assessed the radium issue affecting the quality of some of the wells which are finished in the deep sandstone aquifer; and has projected a tentative schedule for the addition of four to five new shallow aquifer wells as may be necessary. One of the new wells was installed in 2002 at a site located near the Brookfield Academy north of River Road.

During 2006, the City enhanced the capacity of an existing shallow aquifer well located in the vicinity of Capitol Drive and Mountain Drive. Water from that well is proposed to be used for blending with water from a nearby existing deep sandstone aquifer well. The City Utility is also in the process of constructing a treatment facility to remove radium from water provided by Well No. 15 and Well No. 16 located near the Brookfield Square complex. The treatment process to be used is an ion-selective adsorbent technology, in this case being provided by the firm Water Remediation Technology (WRT).

Delafield Municipal Water Utility

Plans for the Delafield Municipal Water Utility system were documented in the following reports:

1. A report entitled *Sanitary Sewer Service Area for the City of Delafield and the Village of Nashotah and Environs,* prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the City of Delafield, Village of Nashotah, and the Delafield-Hartland Water Pollution Control Commission, dated November 1992.

2. A report entitled *Amendment to the Regional Water Quality Management Plan - 2000, City of Delafield*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the City of Delafield, Village of Nashotah, and the Delafield-Hartland Water Pollution Control Commission, dated December 1996.

A review of the available information indicates that the Utility is proposing the construction of a new well to be located along Vettleson Road in the southwest quadrant of STH 83 and STH 16. The well is proposed to serve new development in the vicinity and would be connected with a transmission main to the Utility’s water system at IH 94 and STH 83. The water from the new well would be blended with water from an existing Golf Road well which currently serves the IH 94 and STH 83 service area in order to meet the radium level maximum contaminant level requirements.

City of Muskego Public Water Utility

Plans for the City of Muskego Public Water Utility system were documented in the following reports:

1. A report entitled *Sanitary Sewer Service Area for the City of Muskego,* prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the City of Muskego, and the Milwaukee Metropolitan Sewerage District, dated December 1997.

2. A report entitled *Amendment to the Regional Water Quality Management Plan, City of Muskego,* prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the City of Muskego, and the Milwaukee Metropolitan Sewerage District, dated June 2006.

A review of the available information indicates that, as of 2006, the City of Muskego is in the process of completing a water facility plan. Also as of 2006, one high-capacity well is currently undergoing construction, and plans were being made to develop two additional wells, an elevated storage tank, and one surface storage facility. The well construction and modifications carried out by the City permitted Well No. 5, which was the source of excessive radium levels to be taken out of service.

Planning proposals for system expansion include the anticipated conversion of one “other-than-municipal community system” by mid-2006, the Lake Lore/Tudor Oaks water trust system. It is anticipated that this private residential system will be connected to the City of Muskego system and that the two associated private system wells will be abandoned.

City of New Berlin Water Utility

Plans for the City of New Berlin Utility water system were documented in the following reports:

1. A report entitled *Sanitary Sewer Service Area for the City of New Berlin,* prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the City of New Berlin, City of Brookfield, and the Milwaukee Metropolitan Sewerage District, dated November 1987.

2. A report entitled *Amendment to the Regional Water Quality Management Plan, City of New Berlin,* prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the City of New Berlin, and the Milwaukee Metropolitan Sewerage District, dated June 2005.

The City of New Berlin Water Utility system historically relied exclusively on groundwater as its supply source. In 2005, the utility began purchasing treated surface water from Milwaukee Water Works. The subcontinental divide passes through the City of New Berlin, creating two distinct and separated water supply systems; portions east of the divide which utilize treated surface water purchased from the City of Milwaukee, and portions west of the divide which rely on groundwater. The groundwater supplied by some of the City of New Berlin Water Utility wells exceed the allowable radium maximum contaminant levels. The City is currently evaluating alternative means for resolving this issue. The options which are being considered include obtaining Lake Michigan surface water to serve the remainder of the City water service area, all of which is currently provided with sanitary sewer service by connection to the Milwaukee Metropolitan Sewerage District sewerage system. Thus, the spent water would be conveyed to Lake Michigan following treatment. Other options being considered are treatment of water from some of the wells, and modification or abandonment of certain wells.

City of Oconomowoc Utilities

Plans for the City of Oconomowoc Utilities water system were documented in the following reports:

1. A report entitled *Sanitary Sewer Service Area for the City of Oconomowoc and Environs,* prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the City of Oconomowoc, dated September 1999.

2. A report entitled *Amendment to the Regional Water Quality Management Plan, City of Oconomowoc*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the City of Oconomowoc, dated September 2005.

No specific plans for expansion or modification are known to be proposed for the City of Oconomowoc Utilities water system.

City of Pewaukee Water Utility

Plans for the City of Pewaukee Water Utility system were documented in the following reports:

1. A report entitled *East and West Side Water System Facilities Study 2000 Update, City of Pewaukee,* prepared by Ruekert & Mielke, Inc., dated May 2000.

2. A report entitled *Sanitary Sewer Service Area for the Town of Pewaukee Sanitary District No. 3, Lake Pewaukee Sanitary District, and the Village of Pewaukee,* prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the City of Pewaukee and the City of Brookfield, dated June 1985.

3. A report entitled *Amendment to the Regional Water Quality Management Plan, City of Pewaukee,* prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the City of Pewaukee and the City of Brookfield, dated December 2005.

A review of the available information indicates that, in 2000, the City of Pewaukee completed a plan to identify the improvements necessary to meet projected population growth and water demand within the City of Pewaukee. Based on growth projections to the year 2020, recommended improvements cited in the plan include the addition of nine new wells and five storage facilities, each with a 200,000 gallon capacity, expansion of the service area, the interconnection of two separate systems, continued wellhead protection planning efforts, and methods for resolving the problem of radium contamination. The City is also proposing to construct a treatment system to remove radium from the water pumped from its Green Road well. The treatment process to be used is an ion-selective adsorbent technology, in this case being provided by the firm Water Remediation Technology (WRT).

City of Waukesha Water Utility

Plans for the City of Waukesha Water Utility system were documented in the following reports:

1. A report entitled *Final Draft Water System Master Plan, City of Waukesha,* prepared by Earth Tech, Inc., dated May 2006.

2. A report entitled *Waukesha Water Supply, Lake Michigan Option,* prepared by the Waukesha Water Utility, City of Waukesha, Wisconsin, dated August 2003.

3. A report entitled *Report on Future Water Supply,* prepared by CH2M Hill, dated March 2002.

4. A report entitled *Water Conservation and Protection Plan; Waukesha Water Utility,* prepared by GeoSyntec Consultants, dated February 2006.

5. A report entitled *Sanitary Sewer Service Area for the City of Waukesha and Environs,* prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the City of Waukesha, dated March 1999.

6. A report entitled *Amendment to the Regional Water Quality Management Plan, City of Waukesha*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the City of Waukesha, dated September 2005.

A review of available information indicates that the Utility is planning short-term and long-term improvements to the system, in order to resolve radium contamination problems and declining well water levels associated with the current supply source. The City of Waukesha is under a consent order from the WDNR to be in compliance with MCLs for radium by December 8, 2006. As an interim solution to meet the radionuclide MCLs, the WDNR has agreed to allow the City of Waukesha to rely on a flow weighted average which would allow noncompliant wells to be operated in conjunction with compliant wells, provided the average combined radionuclide concentration within the system does not exceed the regulatory standard. This solution is considered to be short term, however, and must ultimately be replaced with a final solution.

Prior to 2006, the Waukesha Water Utility added two new shallow aquifer wells to its system and has plans to construct additional wells.[31] Water from these shallow wells is currently being blended with water from the noncompliant wells to reduce radionuclide concentration. A facility to treat water from Well No. 3 was placed into operation in 2006. The facility uses a hydrous manganese oxide (HMO) filtration treatment process to reduce radium contamination. In order to resolve other radium exceedence issues, the City of Waukesha Water Utility is considering additional shallow aquifer blending wells and treatment facility development in the short term. In the long term, the City is considering alternative sources of supply, including the development of additional wells, and purchasing Lake Michigan surface water. The Utility plans to minimize its water supply needs by implementation of its water conservation plan.

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[31]*During 2009, the City completed development of one new shallow aquifer well with a maximum capacity of 1.0 million gallons per day located on the south side of the City.*

Village of Butler Public Water Utility
Plans for the Village of Butler Public Water Utility system were documented in the following report:

1. A report entitled *Sanitary Sewer Service Area for the Village of Butler,* prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Village of Butler, dated February 1984.

No specific plans for expansion and modification are known to be proposed for the Village of Butler Public Water Utility water system. Located east of the subcontinental divide, the Village of Butler Public Water Utility is the only system within Waukesha County that relies in its entirety upon purchased surface water provided by Milwaukee Water Works.

Dousman Water Utility
Plans for the Dousman Water Utility system were documented in the following reports:

1. A report entitled *Comprehensive Water System Study,* prepared by Ruekert & Mielke, Inc., dated May 2005.

2. A report entitled *Sanitary Sewer Service Area for the Village of Dousman and Environs,* prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Village of Dousman, dated March 2000.

3. A report entitled *Amendment to the Regional Water Quality Management Plan, Village of Dousman,* prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Village of Dousman, dated December 2005.

A review of the available information indicates that the Utility recently conducted a comprehensive water utility analysis to identify potential water system needs and deficiencies in response to projected population growth and development. In order to meet projected growth demands, the study recommended the addition of two new wells, improvements to the existing wells, and additional storage capacity. Due to concerns regarding source reliability and capacity, the plan recommends that the Village begin planning for at least one new well and one new 500,000 gallon capacity storage facility to ensure current system and growth needs.

Village of Eagle Water Utility
Review of available information on the Village of Eagle Water Utility water system indicates no major infrastructure changes are currently anticipated. Two new shallow aquifer wells were constructed and placed into operation in 2003. In 2005, the Utility tested for lead contamination in 10 homes, and discovered that five of the 10 samples tested contained amounts exceeding the MCL. The source of the lead was presumed to be primarily from dissolution of plumbing system materials. During 2007, the Utility began to add phosphates to the water to resolve the lead contamination problem.

Hartland Municipal Water Utility
Plans for the Hartland Municipal Water Utility system were documented in the following reports:

1. A report entitled *Sanitary Sewer and Water System Planning Study; Village of Hartland,* prepared by Ruekert & Mielke, Inc., dated August 1993.

2. A report entitled *Wellhead Protection Plan for the Village of Hartland Municipal Well Field,* prepared by Ruekert & Mielke, Inc., dated October 1999.

3. A letter report regarding the North Side Water Study Update, prepared by Ruekert & Mielke, Inc., dated November 2001.

4. A letter report regarding Future Well 6 Sand and Gravel Test Boring Results, prepared by Ruekert & Mielke, Inc., dated July 2002.

5. A report entitled *Sanitary Sewer Service Area for the Village of Hartland,* prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Village of Hartland and the Delafield-Hartland Water Pollution Control Commission, dated April 1985.

6. A report entitled *Amendment to the Regional Water Quality Management Plan, Village of Hartland,* prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Village of Hartland and the Delafield-Hartland Water Pollution Control Commission, dated March 2002.

A review of the available information indicates that the Utility, in 1993, conducted a joint sewer and water study in order to determine and evaluate the impacts of projected growth on both infrastructure systems. This study provided the basis for further planning and system evaluation, and a determination was made that an additional well was required to meet increasing demand, system improvements were required, including the addition of booster pumping facilities be made to enhance pressure in higher elevation areas. As recommended in the 1993 study, a third elevated storage tank was constructed in 1995. The 1993 study also recommended that future well planning should consider well placement in the shallow aquifer more cost-effective and efficient. However, because the shallow aquifer is more susceptible to contamination than the deep aquifer, the study recommended careful well siting and development of well head protection areas. One of the older Utility wells, constructed in 1973, was finished in the shallow sand and gravel aquifer and was found to be contaminated with trichloroethylene (TCE). This well was still active in 2006, and a stripping tower treatment facility was added to bring the TCE levels to below the level of detection. The Village of Hartland completed construction of Well No. 6 in 2006 with a capacity of about 1,000 gallons per minute.

The Village of Hartland Water Utility provides water service to Arrowhead High School, and the Swallow Grade School in the Town of Merton north of the Village, and the Wee Know School and one residence in the Town of Delafield just west of the Village.

Village of Menomonee Falls Water Utility

Plans for the Village of Menomonee Falls Water Utility system were documented in the following reports:

1. A report entitled *Southwest Area Water Study Report; Village of Menomonee Falls,* prepared by Ruekert & Mielke, Inc., dated March 2005.

2. A report entitled *Sanitary Sewer Service Areas for the Villages of Lannon and Menomonee Falls,* prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Village of Menomonee Falls, the Village of Lannon, and the Milwaukee Metropolitan Sewerage District, dated June 1993.

3. A report entitled *Amendment to the Regional Water Quality Management Plan, Village of Menomonee Falls,* prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Village of Menomonee Falls, and the Milwaukee Metropolitan Sewerage District, dated December 2005.

The Village of Menomonee Falls Water Utility system historically relied exclusively on groundwater as its supply source. In 1999, the Utility began purchasing treated surface water from the Milwaukee Water Works to serve the majority of its service area. The subcontinental divide traverses the Village, creating two distinct and separated water supply systems: the larger portion located east of the divide and a few small areas located west of the divide. The portion of the service area east of the divide utilizes treated surface water purchased from the City of Milwaukee, the spent water being returned to Lake Michigan via the MMSD sewerage system; the two portions of service area west of the divide currently rely on groundwater. Most of the current service area and development lies east of the subcontinental divide, and in 2005, roughly 92 percent of the total water pumpage was purchased surface water; the remaining 8 percent was groundwater serving the two areas west of the divide.

A review of the available information indicates that current and projected development within the Village of Menomonee Falls will require the addition of wells and storage facilities based on projected growth both in and around the areas currently served by groundwater, and in and around the area served by surface water. Recommendations set forth in the 2005 southwest area water study include the development of a well siting program, procurement of land for an additional elevated tank, construction of a specified booster station to ensure adequate water pressure, and construction of water system interconnections with the Village of Sussex. The study recommends that the Village of Menomonee Falls construct a storage facility and secure up to four new well sites. Concerns about radium levels in the water provided by Well No. 9, which is finished in the deep sandstone aquifer and exceeded the maximum contaminant level, have been resolved by blending the water from Well No. 9 with water from Well No. 8, a shallow aquifer well.

Mukwonago Municipal Water Utility

Plans for the Mukwonago Municipal Water Utility system were documented in the following reports:

1. A report entitled *Sanitary Sewer Service Area for the Village of Mukwonago,* prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Village of Mukwonago, dated November 1990.

2. A report entitled *Amendment to the Regional Water Quality Management Plan, Village of Mukwonago,* prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Village of Mukwonago, dated March 2006.

A review of the available information indicates that the Village has recently constructed two new wells in the northeast portion of the Village. These wells have provided additional needed capacity and have been used to replace well water which exceeded the radium maximum contamination levels. The Village is also considering development of a new well in the southwest area of the Village. Preliminary well testing has been conducted.

Village of Pewaukee Water Utility

Plans for the Village of Pewaukee Water Utility system were documented in the following reports:

1. A report entitled *Village of Pewaukee Hydraulic Water Model,* prepared by Bonestroo, Rosene, Andelik, & Associates, dated January 2003.

2. A report entitled *Sanitary Sewer Service Area for the Town of Pewaukee Sanitary District No. 3, Lake Pewaukee Sanitary District, and the Village of Pewaukee,* prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the City of Brookfield, City of Pewaukee, Village of Pewaukee, Town of Pewaukee Sanitary District No. 3, and the Lake Pewaukee Sanitary District, dated June 1985.

3. A report entitled *Amendment to the Regional Water Quality Management Plan, Village of Pewaukee,* prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the City of Brookfield, City of Pewaukee, and the Village of Pewaukee, dated March 2004.

A review of the available information indicates that the Utility has conducted modeling analyses to identify potential flow and pressure problems within its distribution system. A well construction project to provide water from the shallower sand and gravel aquifer for blending with water from Well No. 4 was under construction in 2005. The blending of water from the new well and Well No. 4 will resolve the identified radium contamination problem. The Village is planning to abandon Well No. 5, which has limited production capacity and place a lining within a portion of Well No. 3.

Sussex Village Water Utility
Plans for the Sussex Water Utility system were documented in the following reports:

1. A report entitled *Sanitary Sewer Service Area for the Village of Sussex,* prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Village of Sussex, dated September 1994.

2. A report entitled *Amendment to the Regional Water Quality Management Plan, Village of Sussex and Environs,* prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Village of Sussex, dated March 2006.

A review of available information indicates that two new wells and one new reservoir were being constructed in 2006 in order to address current and projected population growth, and to lower the overall radium levels in order to bring the system into compliance with the radium maximum contamination level standard.

Town of Brookfield Sanitary District No. 4
Plans for the Town of Brookfield Sanitary District No. 4 system were documented in the following report:

1. A report entitled *Sanitary Sewer Service Area for the City and Town of Brookfield and the Village of Elm Grove,* prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the City of Brookfield and the Town of Brookfield Sanitary District No. 4, dated November 1991.

No specific plans for expansion or modification are known to be proposed for the Town of Brookfield Sanitary District No. 4 water system.

Village of Lannon
During 2006, the Village of Lannon officials were evaluating the possibility of developing a municipal water supply system to serve the Village. The system cost was estimated to be $3.0 million. The source of supply would be groundwater wells. The proposal calls for the system to serve new development in the Village, with existing development having the option of connecting to the system. A portion of the water system would be comprised of existing water mains constructed under Main Street in about 1996. These mains were never used due to a local decision to not complete the source of supply and distribution system needed for an operating system. The proposed system would also provide for an uninterrupted source of water for fire-fighting along Main Street. The Village is considering a cooperative project with the Village of Menomonee Falls.

Village of Elm Grove
During 2006, Village of Elm Grove officials were evaluating the possibility of developing a municipal water supply system to serve the central business district of the Village and other properties in the southeastern portion of the Village. The source of supply would be Lake Michigan water purchased water through the City of Wauwatosa, which obtains water on a wholesale basis from the City of Milwaukee Water Works. As initially proposed, the system would serve five condominium complexes, six apartment buildings, 14 single-family residences, and about 70 nonresidential buildings. As of 2008, the Village was also considering as an alternative the connection of the proposed water system to the City of Brookfield water system as a source of supply.

Existing Residential and Other-than-Municipal Community Systems
In 2005, there were 47 existing privately owned water, self-supplied, systems operating in Waukesha County which provide water supply services to primarily residential land uses, such as subdivisions, apartment or condominium developments, and mobile home parks; such systems are generally designated by the WDNR as “other-than-municipal community systems.” These systems served a population of about 11,000 persons, or about 3 percent of the Waukesha County population. Of the 47 systems, 39 were high-capacity and eight were low-capacity systems. All of these 47 systems utilized groundwater as a source of supply through 49 low-capacity

wells, 25 high-capacity wells, and 23 wells of unknown capacity. The existing service areas of these systems are shown on Map 46. Selected characteristics of each system are presented in Table D-1 in Appendix D.

In addition to the aforementioned residential systems, the Prairie Village Water Trust is also designated as an "other-than-municipal community systems." This system differs from the typical "other-than-municipal community systems" within southeastern Wisconsin. It serves nearly the entire Village of North Prairie population of 2,000, maintains infrastructure throughout nearly the entire geographic boundary of the municipality, and serves other land uses in addition to residential uses. The system includes three high-capacity wells. Based upon the population served, it is estimated that, using an estimate of 65 gallons per person per day, the annual residential water use within the Prairie Village Water Trust approximates 130,000 gallons per day. The Prairie Village Water Trust system is a privately held trust, and therefore not currently required to report information to the Wisconsin Public Service Commission.

Existing Industrial Water Supply Systems

In 2005, there were 26 existing privately owned, self-supplied, water systems operating in Waukesha County which provide water for industrial land uses. Of the 26 systems, 20 were high-capacity and six were low-capacity systems. These systems all utilize groundwater as a source of supply through 37 low-capacity wells, 20 high-capacity wells, and two wells of unknown capacity. The locations of these systems are shown on Map 47. Selected characteristics of each system are presented in Table D-2 in Appendix D.

Existing Commercial Water Supply Systems

In 2005, there were 283 existing privately owned, self-supplied, water systems operating in Waukesha County which provide water for commercial land uses. Of the 283 systems, 13 were high-capacity and 270 were low-capacity systems. These systems all utilized groundwater as a source of supply through 292 low-capacity wells and 11 high-capacity wells. The locations of these systems are shown on Map 47. Selected characteristics of each system are presented in Table D-3 in Appendix D.

Existing Institutional and Recreational Water Supply Systems

In 2005, there were 216 existing privately owned, self-supplied, water systems operating in Waukesha County which provided water for institutional and recreational land uses. Of the 216 systems, 77 were high-capacity and 139 were low-capacity systems. These systems all utilized groundwater as a source of supply through 264 low-capacity wells, 22 high-capacity wells, and 35 wells of unknown capacity. The locations of these systems are shown on Map 47. Selected characteristics of each system are presented in Table D-4 in Appendix D.

Existing Agricultural Water Supply Systems

In 2005, there were 12 existing privately owned, self-supplied, water systems operating in Waukesha County which provided water for irrigation and other purposes for agricultural land uses. All 12 systems are high-capacity systems and all utilized groundwater as a source of supply through eight low-capacity and 29 high-capacity wells. The locations of these systems are shown on Map 47. Selected characteristics of each system are presented in Table D-5 in Appendix D.

Existing Irrigation Water Supply Systems

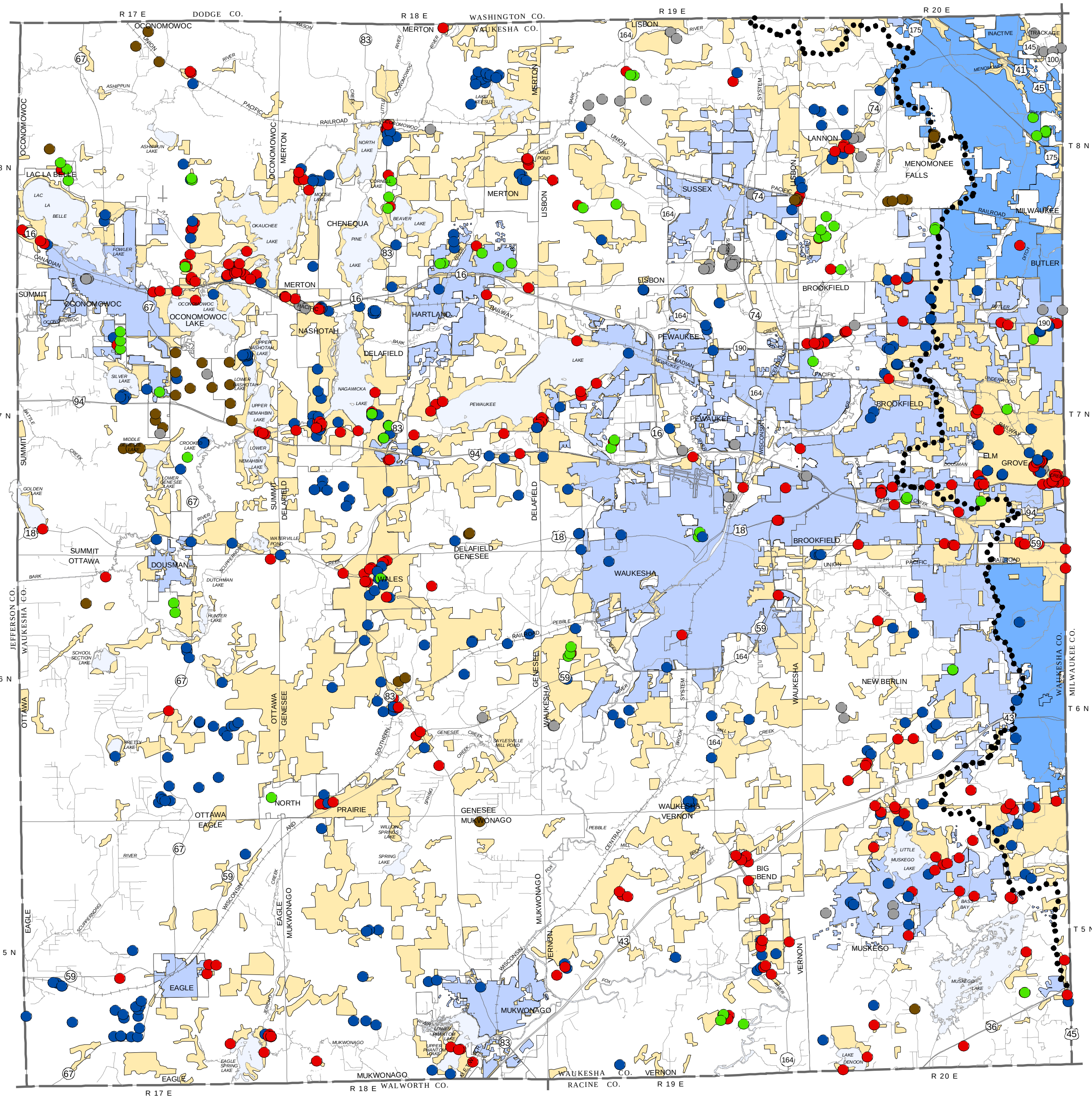
In 2005, there were 33 existing privately owned, self-supplied, water systems operating in Waukesha County which provided irrigation water for land uses other than agricultural uses, such as golf courses. All 33 systems are high-capacity systems and all utilized groundwater as a source of supply through 20 low-capacity wells, 37 high-capacity wells, and six wells of unknown capacity. The locations of these systems are shown on Map 47. Selected characteristics of each system are presented in Table D-6 in Appendix D.

Existing Self-Supplied Residential Water Systems

As of the year 2005, there were about 131,000 persons, or about 35 percent of the total year 2005 resident population of Waukesha County, served by private domestic wells. As shown on Map 46, numerous areas located outside of the municipal water utility service areas of the County were classified as having urban-density

Map 47

SELF-SUPPLIED INDUSTRIAL, COMMERCIAL, INSTITUTIONAL AND RECREATIONAL, AGRICULTURAL, AND IRRIGATION WATER SUPPLY SYSTEMS IN WAUKESHA COUNTY: 2005



LEGEND

SELF-SUPPLIED WATER SYSTEM WELLS

INDUSTRIAL

COMMERCIAL

INSTITUTIONAL AND RECREATIONAL

IRRIGATION

AGRICULTURAL

AREA SERVED BY PUBLIC WATER UTILITY USING SURFACE WATER

AREA SERVED BY PUBLIC WATER UTILITY USING GROUNDWATER

EXTENT OF URBAN DEVELOPMENT NOT SERVED BY PUBLIC OR PRIVATE WATER SUPPLY SYSTEMS: INCLUDES URBAN DEVELOPMENT AS IDENTIFIED IN THE REGIONAL PLANNING COMMISSION HISTORIC URBAN GROWTH RING ANALYSIS

SUBCONTINENTAL DIVIDE

GRAPHIC SCALE

0 1 2 3 4 Miles

0 5,000 10,000 15,000 20,000 Feet

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

development, and were served by private wells. Assuming an average use of 65 gallons per capita per day, these private domestic wells would withdraw about 8.5 million gallons per day from the shallow groundwater aquifer. It is estimated that 30 percent of the households served by private domestic wells are also served by public sanitary sewer systems. Thus, the water withdrawn from the groundwater system for about 30 percent of the private domestic wells, or about 2.6 million gallons per day, was discharged to the surface water system as treated sanitary sewage. The majority—approximately 90 percent—of the remaining 70 percent of the water withdrawn by private wells, or about 5.3 million gallons per day, was returned to the groundwater aquifer via onsite sewage disposal systems.

INVENTORY FINDINGS—SUBREGIONAL PLANS

Cities of Brookfield and Mequon and Villages of Bayside, Germantown, Menomonee Falls, River Hills, and Thiensville Sources of Supply Study

Over the period 1972 through 1975, a study[32] was conducted by the Cities of Brookfield and Mequon and Villages of Bayside, Germantown, Menomonee Falls, River Hills, and Thiensville to evaluate alternative potential sources of water supply. The study was precipitated primarily by the declines in groundwater aquifer levels affecting municipal and some residential wells. The study placed emphasis on fire protection needs. Cost factors considered included public infrastructure capital and operation and maintenance costs, as well as private costs for fire insurance and water softening. Three alternative plans were developed and evaluated as follows:

- Plan No. 1, Well Water Supply—Under this alternative plan, the communities concerned would continue to rely on groundwater as the source of supply;
- Plan No. 2, Purchase of Water from the City of Milwaukee—Under this alternative plan, water would be purchased on a wholesale basis from the City of Milwaukee by the communities involved, who would form a water commission or district to own, operate, and administer the system; and
- Plan No. 3, Independent Lake Michigan Water Supply—Under this alternative plan, the communities concerned would form a commission or district and construct, operate, and administer an independent Lake Michigan water supply system.

For each alternative plan, system-level information was developed on required storage facilities; wells, including cooperative well development; Lake Michigan treatment plants and intakes, transmission and booster pumping stations; and system interconnections.

The total capital and operation cost estimates developed for the three alternative plans are as follows:

Alternative	Initial Capital Cost (1980 dollars)	Annual Operation and Maintenance Cost (1980 dollars)
Plan No. 1–Well Water Supply	$36,114,000	$629,000
Plan No. 2–Purchase of Water from the City of Milwaukee	$22,334,000	$ 85,000
Plan No. 3–Independent Lake Michigan Water Supply	$93,268,000	$433,000

The estimated annual payments and water rates to the communities involved under the three alternative plans were estimated to be as follows:

[32]*Consoer, Townsend & Associates,* Engineering Report on Sources of Water Supply for Mequon, Brookfield, Bayside, River Hills, Thiensville, Menomonee Falls, and Germantown, Wisconsin, *March 1976.*

Alternative	Minimum Annual Payment for 1980 and 1990	Average Cost of Water per Thousand Gallons
Plan No. 1–Well Water Supply	$3,010,000 - $ 6,669,000	$0.82
Plan No. 2–Purchase of Water from the City of Milwaukee	$2,937,000 - $ 6,506,000	$0.80
Plan No. 3–Independent Lake Michigan Water Supply	$6,241,000 - $13,826,000	$1.70

The report recommended that the communities involved form a water commission district. Based upon an evaluation of the three alternative plans, the report recommended pursuing a Lake Michigan water source. The decision on which Lake Michigan source should be pursued was left to the communities. However, it was recommended that initial steps be taken to obtain Lake Michigan water by wholesale purchase from the City of Milwaukee. The recommendation was made based upon the costs involved, concerns about the long-term viability of the groundwater supplies, and private water softening costs.

SUMMARY

One of the elements of the regional water supply planning program consisted of an inventory of existing public and private water supply systems within the seven-county Southeastern Wisconsin Region. Such an inventory was needed in order to determine the capacities of these systems to meet present water supply needs and the capabilities of these systems to be expanded and upgraded to meet probable future needs. The inventory also collated data on water use and on both groundwater and surface water sources of supply. Locally prepared water supply engineering reports and plans were identified. In addition, areas of existing urban development not currently served by public water supply facilities were identified.

History of Water Supply System Development in Southeastern Wisconsin

Many of the existing public water supply systems within the Region were initially constructed in the latter part of the 19th Century in response to rapid population growth and attendant public health problems. The City of Milwaukee developed the first municipal water supply system within the Region. Design of the system was initiated in 1868, and operation began in 1874 with the development of the North Point pumping station. Other cities located on the Lake Michigan shore soon followed with system development. The Cities of Racine and Kenosha created water supply systems that began operations in 1886 and 1894, respectively. Except for the City of South Milwaukee, these early systems provided raw Lake Michigan water to consumers. South Milwaukee constructed the first water treatment plant on the western Great Lakes as part of the construction of its water supply system in 1893. The City of Milwaukee began treating water in the Kilbourn reservoir with hypochlorite in 1910, and the next year, a semi-permanent treatment system was installed at the North Point Tower. Waterborne diseases, such as cholera, were endemic in the City until the Linnwood Avenue treatment plant was placed into operation by the City in 1939. The City of Cudahy, the last Lake Michigan shore community to do so, initiated treatment of its water supply in 1963.

Unlike the Lake Michigan shore communities, interior communities within southeastern Wisconsin developed more slowly during the latter half of the 19th Century. Some of the earliest inland water supply systems utilizing groundwater as the source of supply included those for the City of Burlington in Racine County, the City of Hartford in Washington County, the Cities of Delavan, Elkhorn, and Lake Geneva in Walworth County, the Cities of Oconomowoc and Waukesha in Waukesha County, and the City of Cedarburg in Ozaukee County, all of which began operation between 1885 and 1901. Innovations in well pumping technology and equipment also encouraged municipal system development throughout the Region. Over the past century, as municipalities and water demand grew, changes also occurred in the delivery of municipal water service. Numerous public water utilities, primarily in Milwaukee County, which began as groundwater providers, converted to purchasing Lake Michigan surface water from other sources, such as the Milwaukee Water Works. Although municipal water supply systems continued to emerge and expand throughout the 20th Century, numerous industries and households in southeastern Wisconsin continued to rely on private wells and the use of private wells expanded greatly.

A regional aquifer simulation model for southeastern Wisconsin developed by the Regional Planning Commission in cooperation with the U.S. Geological Survey, the Wisconsin Geological and Natural History Survey, the Wisconsin Department of Natural Resources, the University of Wisconsin-Milwaukee, and a number of the water utilities in the Region was used to determine the performance of the aquifers underlying the Region. This model accounts for the effects of changes in pumping both within the Region and within adjacent counties, including counties in northeastern Illinois. Groundwater extraction began within the Region in the 1860s. Withdrawals from shallow and deep wells gradually changed the natural groundwater flow system between 1864 and 2000. In 1950, deep aquifer pumping centered on Milwaukee, with appreciable shallow aquifer pumping along the Rock River in central Rock County. By 2000, the deep aquifer pumping center had moved to central and eastern Waukesha County, with appreciable shallow aquifer pumping in Rock County, Washington and Ozaukee Counties. Total aquifer pumping within the Region increased from a negligible level in 1864, to about 37 million gallons per day (mgd) in 1950, and to about 113 mgd in 2000.

Water Supply Sources

Water resources, consisting of the surface waters in the lakes and streams of the Region, and of the groundwater aquifers underlying the Region, together with associated wetlands and floodlands, form important elements of the natural resource base of the Southeastern Wisconsin Region. Lake Michigan is a major source of water for municipal and industrial users in the most intensely developed areas of the Region lying east of the subcontinental divide. The underlying groundwater aquifers constitute a major source of supply for domestic, municipal, and other water users in areas of the Region lying west of the subcontinental divide, as well as for some areas of the Region lying east of the subcontinental divide, primarily in Ozaukee and Washington Counties. Understanding the interaction of the surface water and groundwater resources of the Region is essential to sound water supply system planning. The surface and groundwater of the Region are interrelated components of, in effect, a single hydrologic system. The groundwater resources of the Region are hydraulically connected to the surface water resources inasmuch as the former provide the base flow of streams, and the water levels of wetlands and inland lakes. The development and use of groundwater supply sources—such as wells for municipal or irrigation purposes—will have impacts on the surface water system. Thus, the analyses of existing conditions, and the evaluation of alternative and recommended plans developed under the regional water supply system planning program recognize the existence of such impacts.

The groundwater aquifers of southeastern Wisconsin extend to depths in excess of 1,500 feet in the eastern parts of the Region. The aquifer systems underlying southeastern Wisconsin can be divided into two types: the shallow unconfined water table aquifers, and the deep semi-confined or confined aquifers. Water-table conditions generally prevail in the sand and gravel deposits and Silurian dolomite aquifer above the Maquoketa Formation and in the Galena-Platteville aquifer west of the Maquoketa Formation. These aquifers are interconnected and are commonly referred to collectively as the “shallow aquifer.” These shallow aquifers provide water for most private domestic wells and some municipal wells within the Region. In the deep sandstone aquifer beneath the Maquoketa Formation, the water was historically under artesian pressure. Deep high-capacity wells in the eastern part of the Region extract millions of gallons of water per day from the sandstone aquifer, creating a decline in water pressure within this aquifer that extends throughout most of the Region, except into the western part of Walworth County. Heavy pumping of the high-capacity wells has caused the gradual, steady decline in the artesian pressure and a reversal of the predevelopment, upward flow of groundwater. Recharge to the aquifers underlying the Region is derived almost entirely from precipitation. Much of the groundwater in the shallow aquifer originates from precipitation that has fallen and infiltrated within a radius of about 20 or more miles from where it is found in the aquifer. The deeper sandstone aquifer is recharged by downward leakage of water through the Maquoketa Formation from the overlying aquifers or by infiltration of precipitation in and beyond the western reaches of the Region where the sandstone aquifer is not overlain by the Maquoketa Formation and is unconfined.

The chemical composition of groundwater largely depends on the composition and physical properties of the soil and rock formations it has been in contact with, the residence time of the water, and the antecedent water quality. The chemical composition of groundwater in the Region is primarily a result of its movement through, and the interaction with, Pleistocene unconsolidated materials and Paleozoic rock formations. The latter contain large amounts of dolomite—$CaMg(CO_3)_2$—that is dissolved by water passing through the rock formations. The current quality of groundwater in both the shallow and deep aquifers underlying the Region is generally good and suitable for most uses, although localized water quality problems occur in some areas. The exception to this is the concentration of radium exceeding drinking water standards which occurs in portions of the deep sandstone aquifer underlying the Region.

Nearly all of the surface water supply in the Region is from Lake Michigan, with some use of other surface waters for limited purposes. These include a few instances of water use from the Milwaukee River for intermittent recharge of the groundwater associated with building foundation maintenance, for cooling of buildings located primarily in the central business district of Milwaukee, and for thermoelectric-power-generation purposes. In addition, other surface waters are intermittently used for such purposes as irrigation of agricultural lands or golf courses and for ski-hill snowmaking.

Lake Michigan provides a high-quality source of supply for public water supply systems. The water taken from offshore deep water intakes is amenable to treatment by conventional methods, such as chemical addition, flocculation, sedimentation, filtration, and disinfection. Finished water utilizing these processes typically meets, and generally exceeds, Federal and State drinking water quality requirements. Some of the utilities have installed tertiary-level treatment units, such as microfiltration and ozonation in order to safeguard against contamination by microorganisms, such as *Cryptosporidium* and *Giardia*.

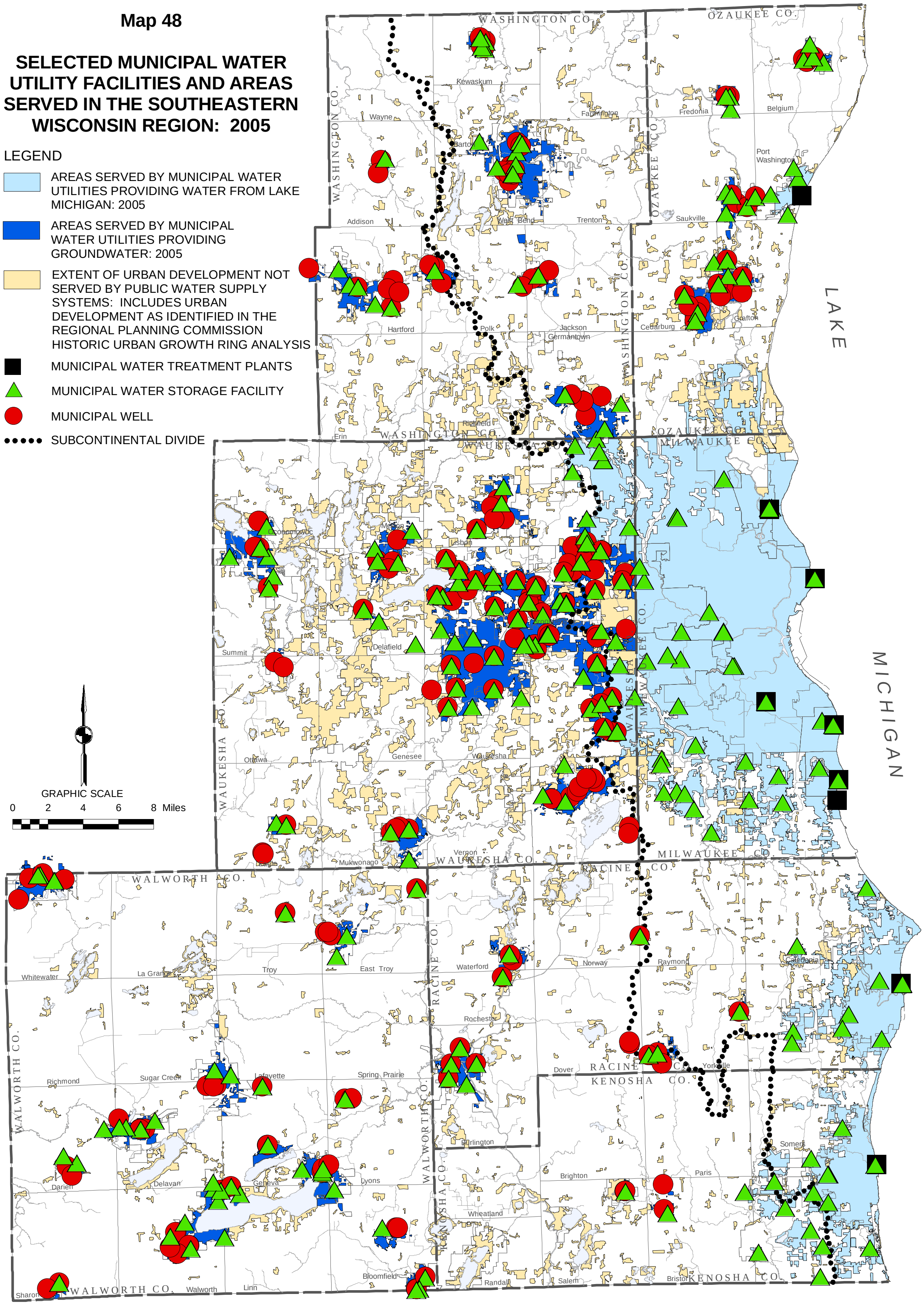
Existing Municipal Water Supply Systems

In 2005, 78 municipal water supply utility systems provided water to about 404 square miles of service area, or about 15 percent of the area of the Southeastern Wisconsin Region. These systems served a population of about 1.60 million persons, or about 81 percent of the 2005 residential population in the Region. Forty-eight of the water supply systems rely on groundwater as a source of supply. Twenty-eight of the water supply systems rely on Lake Michigan as the source of supply which is provided by nine water treatment plants, with 16 intakes. Two of the systems use both groundwater and surface water in different portions of their service area. The existing service areas and selected facilities of municipal water utilities serving the Region are shown on Map 48 and selected characteristics of the systems are presented in Table 48. The inventory information assembled under the planning effort is intended to provide the basis for an evaluation of the capabilities of the existing systems to meet current and probable future water supply needs. That findings of that evaluation are provided in Chapter VII.

In 2005, the total storage capacity for the 78 municipal water systems operating in the Region was approximately 295 million gallons, divided among the 257 storage facilities, as listed in Table 48. Based on Wisconsin Public Service Commission annual reports for the year 2005, approximately 257 million gallons per day of water were pumped for use in the 78 municipal systems concerned. As shown in Table 49, the water use totaled about 193 mgd for residential, commercial, industrial, institutional, or other urban uses, with the remaining 64 mgd of total pumpage being used for purposes such as water production and system maintenance, or being unaccounted-for water. Overall, about 90 mgd, or about 47 percent of total municipal water used, was for single- and two-family housing units residential purposes; about 51 mgd, or about 26 percent, for commercial and multi-family residential, and institutional uses; and about 40 mgd, or about 21 percent, was for industrial uses. The remaining about 12 mgd, or about 6 percent, was used for other municipal purposes. Based upon the population served and reported water use, residential water consumption within the 78 water supply systems was approximately 70 gallons per person per day in 2005. When accounting for all municipal water uses, the average water consumption was about 120 gallons per person per day. In 2005, the amount of water which was unaccounted-for by County ranged from 8 to 13 percent, with an average of 11 percent of the water pumped for the utilities. Thus, unaccounted-for water was not included in the computed per capita consumption rates. It should be noted that the residential water use reported by the water utilities excludes that associated with the use of water by multiple-unit dwelling units with a single meter serving three or more units. Those uses are included with commercial water uses. Thus, the calculation of the water uses on a per capita and per acre basis for the residential and commercial categories were made by adjusting the population and acreage considered under these categories to reflect this reporting requirement.

Map 48

SELECTED MUNICIPAL WATER UTILITY FACILITIES AND AREAS SERVED IN THE SOUTHEASTERN WISCONSIN REGION: 2005



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

Table 48

SELECTED CHARACTERISTICS OF EXISTING MUNICIPAL WATER SUPPLY SYSTEMS WITHIN THE SOUTHEASTERN WISCONSIN REGION: 2005

County	Number of Utilities	Estimated Area Served (square miles)	Estimated Population Served[a]	Source of Supply[b]	Number of Wells	Total Well Pumpage Capacity (mgd)	Number of Surface Water Treatment Plants	Number of Lake Water Intakes	Surface Treatment Plant Capacity (mgd)	Number of Storage Facilities	Total Storage Capacity (gallons x 1,000)	2005 Annual Average Pumpage (mgd)	2005 Maximum Daily Pumpage (mgd)
Kenosha	6	34.2	116,800	G, S, SP	4	2.09	1	2, plus 1 emergency	42	17	31,760	17.60	27.99
Milwaukee..........	14	181.5	920,800	S, SP	- -	- -	6	8	432	45	167,092	157.44	248.38
Ozaukee	7	17.7	49,200	G, SP, S	20	17.63	1	2	4	23	6,311	6.74	11.85
Racine	12	38.3	146,900	G, S, SP	12	14.18	1	3	60	23	20,554	29.68	44.23
Walworth...........	16	22.6	59,140	G	44	42.03	- -	- -	- -	38	13,547	8.42	17.15
Washington........	7	21.8	73,400	G	32	29.28	- -	- -	- -	28	10,400	8.18	14.17
Waukesha..........	16	87.9	234,200	G, SP	93, plus 5 standby	87.51	- -	- -	- -	83	45,784	29.33	54.29
Total	78	404.0	1,600,440	- -	205	192.72	9	15, plus 1 emergency	538	257	295,448	257.39	418.06

[a] *Population based upon Wisconsin Department of Natural Resources data base adjusted to 2005 Wisconsin Department of Administration Civil Division estimates and SEWRPC data, where appropriate.*

[b] *The following abbreviations are used:*

G = Groundwater
S = Surface Water (Lake Michigan)
SP = Surface Water Purchased (Lake Michigan)

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

Table 49

SUMMARY OF MUNICIPAL WATER USE IN THE SOUTHEASTERN WISCONSIN REGION: 2000, 2004, AND 2005

	Average Annual Water Uses										
	Residential Water Use[a]			Industrial Water Use		Commercial, Institutional, and Multi-Family Residential[a]			Total Municipal Water Use[b]		
Year	Total[c] (gallons per day X 1,000)	Per Person[d] (gallons per capita per day)	Per Acre[d] (gallons per acre per day)	Total[c] (gallons per day X 1,000)	Per Acre (gallons per acre per day)	Total[c] (gallons per day X 1,000)	Per Acre (gallons per acre per day)	Other Municipal[e] Water Uses (gallons per day X 1,000)	Total[c] (gallons per day X 1,000)	Per Person[f] (gallons per capita per day)	Percent Unaccounted-for Water[g]
2000	85,390	68	910	50,890	4,010	53,595	1,054	10,078	199,953	125	10
2004[h]	85,026	66	873	39,759	3,049	49,959	959	10,866	185,610	116	12
2005[i]	89,903	70	916	39,731	3,003	51,056	964	11,874	192,564	120	11

[a]*Residential category includes population associated with single-family and two-family housing units, plus some larger multi-family housing where individual water meters are used for each unit. Other multi-family units are included in the commercial water use category.*

[b]*Includes all water specifically accounted for.*

[c]*As reported in annual reports submitted to the Public Service Commission of Wisconsin.*

[d]*Reported residential water use excludes that associated with multiple-unit dwellings where a single meter serves three or more housing units. That water use is classified as commercial under the Public Service Commission of Wisconsin reporting system. The unit water uses presented on a per capita and per acre basis were calculated by adjusting the population and residential land area to be consistent with this reporting procedure.*

[e]*Includes uses for fire protection services, sales to public authorities, sales to irrigation customers and interdepartmental sales.*

[f]*Estimated based upon total residential population served.*

[g]*Water not specifically accounted for as a percent of total pumpage.*

[h]*2004 land use was approximated by increasing the 2000 land use amounts by the increase in population from 2000 to 2004 for the individual communities served.*

[i]*2005 land use was approximated by increasing the 2000 land use amounts by the increase in population from 2000 to 2005 for the individual communities served.*

Source: Public Service Commission of Wisconsin and SEWRPC.

The total water used in the 78 municipal utility systems in 2005 was about 4 percent less than used in 2000 and about 4 percent more than used in 2004. The decrease between 2000 and 2005 was due largely to a decrease of about 22 percent in industrial water use. The increase from 2004 to 2005 was due largely to an increase in residential water use of 6 percent. In this regard, it should be noted that 2005 was a relatively dry year during the growing season.

In addition to the description of the existing municipal water supply systems, this chapter documents the currently known water conservation measures being carried out by the utilities operating within the Region, and the locally prepared engineering studies and plans for future water utility system expansion and upgrading. With regard to water conservation measures, many of the utilities are working to improve efficiency and minimize water losses in their systems. Such measures include meter testing for accuracy, leak detection programs, and repair of water main breaks and leaks. In addition, nearly all of the water supply utilities within southeastern Wisconsin have water metering in place and have billing systems based upon usage. In addition, the utilities and the areas served are governed by the State plumbing code which limits flow rates and volumes for plumbing fixtures.

Self-Supplied Private Water Supply Systems

In 2005, there were 170 existing privately owned water, self-supplied, systems operating in the Southeastern Wisconsin Region which provided water supply services to primarily residential land uses, such as subdivisions, apartment or condominium developments, and mobile home parks, and to some institutional uses. Such systems are generally categorized by the Wisconsin Department of Natural Resources as “other-than-municipal community systems.” These systems serve a residential population of about 31,000 persons, or about 1.6 percent of the 2005 Region resident population. These systems are served by 320 wells and appurtenant equipment. Selected characteristics of each system are presented in Table D-1 in Appendix D.

In 2005, there were 106 existing privately owned, self-supplied, water systems operating in the Region which provided water for industrial land uses. These systems all utilize groundwater as a source of supply through 184 wells and appurtenant equipment. Selected characteristics of each system are presented in Table D-2 in Appendix D.

In 2005, there were 940 existing privately owned, self-supplied, water systems operating in the Region which provided water for commercial land uses. These systems all utilized groundwater as a source of supply through 1,023 wells and appurtenant equipment. Selected characteristics of each system are presented in Table D-3 in Appendix D.

In 2005, there were 593 existing privately owned, self-supplied, water systems operating in the Region which provided water for institutional and recreational land uses. These systems all utilized groundwater as a source of supply through 862 wells and appurtenant equipment. Selected characteristics of each system are presented in Table D-4 in Appendix D.

In 2005, there were 54 existing privately owned, self-supplied, water systems operating in the Region which provided water for irrigation and other purposes for agricultural land uses. These systems all use groundwater as a source of supply through 111 wells and appurtenant equipment. Selected characteristics of each system are presented in Table D-5 in Appendix D.

In 2005, there were 84 existing privately owned, self-supplied, water systems operating in the Region which provided irrigation water for land uses other than agricultural uses, such as golf courses. All of these systems utilize groundwater as a source of supply through 149 wells and appurtenant equipment. Selected characteristics of each system are presented in Table D-6 in Appendix D.

In 2005, there were seven existing privately owned, self-supplied, water systems operating in the Region which provided cooling water for thermoelectric-power-generation facilities. These facilities include the Pleasant Prairie Power Plant, a coal-based generating facility, and the Paris Generating Station, a combustion turbine generating facility, both in Kenosha County; the coal-based Valley Power Plant and the Oak Creek Power Plant, both in Milwaukee County; the Port Washington Power Plant, a facility being converted, in 2006, from coal to an intermediate-load, natural gas thermoelectric-power-generating facility in Ozaukee County; and the Germantown combustion turbine gas-fired, intermittent-use facility in Washington County. These facilities were reported to use about two billion gallons of water per day in 2000. Most of that water was utilized by the Valley, Oak Creek, and Port Washington power plants, all of which utilized Lake Michigan water for once-through cooling systems. These systems typically return over 99 percent of the cooling water used back to the Lake. The Pleasant Prairie Power Plant is located about five miles from the Lake Michigan shore and uses a cooling tower system. The amount of water utilized is reported to be about 11 million gallons per day, the majority which is make-up water for cooling the towers. The two small peaking combustion turbine power plants in the Village of Germantown and the Town of Paris use limited amounts of well water for cooling and air quality control on an intermittent-use basis. In addition to these six systems, the Milwaukee County Power Plant located on the Milwaukee County Grounds in the City of Wauwatosa is a co-generation facility which uses purchased surface water.

Existing Self-Supplied Residential Water Systems

As of the year 2005, there were about 346,000 persons, or about 18 percent of the total year 2005 resident population of the Region, served by private domestic wells. Assuming an average use of 65 gallons per capita per day,[33] the private domestic well within the Region would withdraw about 22.5 million gallons per day from the shallow groundwater aquifer. It is estimated that 37 percent of the households served by private domestic wells were served by public sanitary sewer systems. Thus, the water withdrawn from the groundwater system for about 37 percent of the private domestic wells, or about 8.3 million gallons per day, was discharged to the surface water system as treated sanitary sewage. The majority—approximately 90 percent—of the remaining 63 percent of the water withdrawn by private wells, or about 12.7 million gallons per day, was returned to the groundwater aquifer via onsite sewage disposal systems.

[33]*The value of 65 gallons per capita per day was selected to represent average water use in residential areas served by private wells. This value is somewhat lower than the regional average of 67 to 70 gallons per capita per day for residential use in areas served by municipal systems. The lower value was selected because residential water use in areas served by private wells may be expected to be somewhat lower than in areas served by municipal systems because of concerns with onsite well capacity and with performance of onsite sewage disposal systems. In addition, outdoor water use demands may be expected to be lower in areas served by private wells than areas served by public water supply systems.*

Chapter IV

ANTICIPATED GROWTH AND CHANGE AFFECTING WATER SUPPLY IN THE REGION

INTRODUCTION

In any planning effort, forecasts are required of future conditions which may affect either the design of the plans, or the implementation of the plans, over time. Future demands for water supply are determined primarily by the size and spatial distribution of the future population and economic activity levels in the Region, and by the level of water use and water conservation expected to be associated with those population and economic activity levels and their spatial distribution in the form of a land use pattern. In the preparation of the regional water supply plan, therefore, future population and employment levels and attendant land use needs and patterns had to be forecast. These forecasts could then be converted to future demands for water use within the Region. These water demands, in turn, provided a basis for the preparation of water supply plans. The adopted design year 2035 regional land use plan[1] served as a basis for the needed population and employment forecasts and land use pattern required for the preparation of the regional water supply plan. However, it was recognized that the regional water supply planning program might identify a need to refine or revise the design year 2035 land use plan owing to water supply considerations which were not known during development of the regional land use plan. The regional water supply plan, thus, includes recommendations for appropriate amendments to the regional land use plan. This iterative process has served well in the past for development of integrated regional land use and water resources plans.

BASIS OF POPULATION, ECONOMIC ACTIVITY, AND LAND USE FORECASTS

As already noted, the forecasts of the levels and spatial distribution of future population and economic activity presented in this chapter are based upon forecasts prepared for, and used in the preparation of other regional plan elements, including areawide land use and transportation system plans. This use of forecasts prepared for comprehensive, areawide planning purposes helps to assure consistency between the regional water supply plan and other long-range, areawide plan elements. For water supply planning purposes, the population forecasts were expressed in terms of resident individuals and households, while the economic activity forecasts were expressed in terms of employment. The spatial distributions concerned were expressed in terms of land use patterns.

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[1]*The regional land use plan as prepared and adopted by the Regional Planning Commission, is set forth in SEWRPC Planning Report No. 48,* A Regional Land Use Plan for Southeastern Wisconsin: 2035*, June 2006.*

The population and economic activity forecasts for the regional land use plan program were developed using an alternative futures approach. This approach projected a range of future population, household, and employment levels—high, intermediate, and low—for the Region, recognizing the uncertainty that surrounds any effort to forecast future socioeconomic conditions. The intermediate projections were considered the most likely to be achieved and constituted the forecasts used as a basis for the preparation of the regional water supply plan, as well as other regional plan elements, including land use and transportation system plans. The high and low projections are intended to provide an indication of the range of population, household, and employment levels which could conceivably be achieved under significantly higher and lower, but nevertheless plausible, development scenarios for the Region. While the intermediate projections were used as the forecasts for the preparation of the regional water supply plan, consideration may be given to the range of future conditions in local, utility-specific, water supply facility planning, and such planning may still be considered to be consistent with the regional plan framework.

PLANNED 2035 MUNICIPAL WATER SUPPLY SERVICE AREAS

Regional Land Use Plan Urban Service Areas

The initial basis for establishing planned municipal water supply service areas within the Region were the public sanitary sewer and water supply service areas proposed in the design year 2035 regional land use plan. That plan envisions that most new urban development within the Region will be served by municipal sanitary sewer and water supply facilities, and includes delineations of those areas of the Region within which such facilities are to be provided. With respect to utility service areas, the delineations contained in the adopted regional land use plan are generalized systems-level delineations that are intended to be refined and detailed in subregional and local land use and utility planning efforts. The areas proposed for municipal water supply service as identified in the regional land use plan are shown on Map 49.

Municipal Water Supply Service Area Reevaluation

Under the regional water supply planning program, the areas proposed in the regional land use plan to be served by municipal sanitary sewer and water supply facilities were reevaluated and refined. The reevaluation and refinement considered land use development type and density, the relationship to existing water supply service areas, shallow groundwater aquifer characteristics, the historical local position toward water supply service, and known local plans.

The refined water supply service areas as used in the water supply planning effort are shown on Map 50. These areas are largely comprised of the existing service areas of the 78 water utilities that provided municipal water supply services within the Region and proposed expansions of those areas as of 2005. In addition, the expanded Village of North Prairie water system, currently categorized as a water trust, is presented as a municipal system, since it has characteristics similar to a municipal water utility. The planned municipal water supply service areas also include 34 new service areas, as highlighted on Map 50.

In the service area reevaluation and refinement process, existing municipal utility water service areas were accepted, as were service areas represented by expansions to full service within municipal boundaries, or by expansion of existing contract service areas. Thirty-four potential new water service areas were identified. These potential new service areas are shown on Map 50 and listed in Table 50.

Information pertinent to water supply planning was developed for each of the 34 potential new water supply service areas. This information is summarized in Table 50. That information includes data on the predominant land use, existing housing units and densities, distance to the nearest existing municipal water supply service area, aquifer characteristics, and conclusions regarding the probable type of water supply service area.

Based upon the characteristics of the 34 potential water supply service areas, 23 of the areas are recommended to become municipal water service areas, while 11 are recommended to continue to rely on private water supply systems. The areas recommended to continue to rely on private individual water supply systems generally consist

Map 49

PROPOSED PUBLIC SANITARY SEWER AND WATER SUPPLY SERVICE AREAS IN THE REGION: 2035 RECOMMENDED LAND USE PLAN

LEGEND

AREA TO BE PROVIDED WITH PUBLIC SANITARY SEWER AND WATER SUPPLY SERVICE

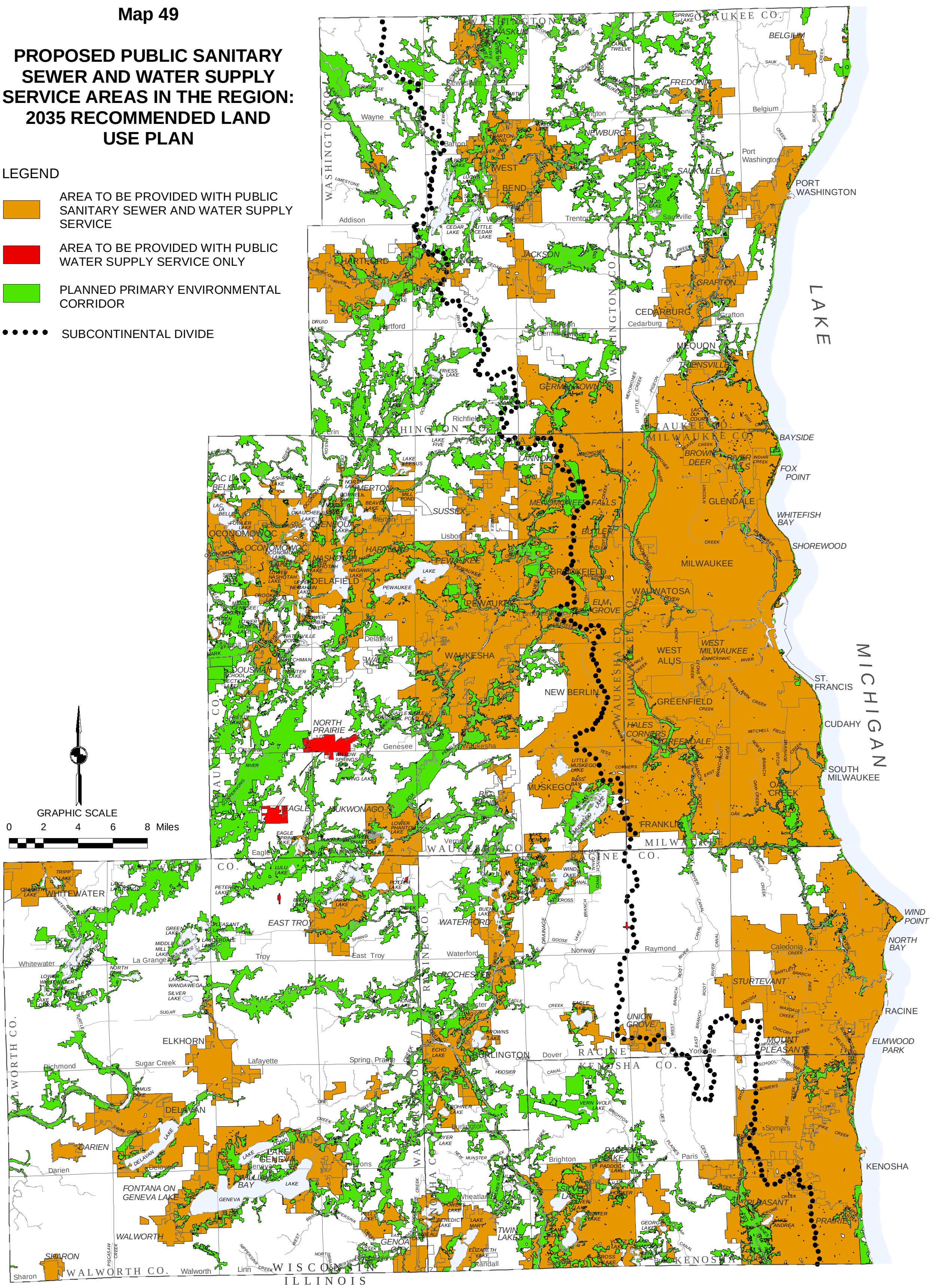
AREA TO BE PROVIDED WITH PUBLIC WATER SUPPLY SERVICE ONLY

PLANNED PRIMARY ENVIRONMENTAL CORRIDOR

SUBCONTINENTAL DIVIDE

GRAPHIC SCALE

0 2 4 6 8 Miles



Source: SEWRPC.

Map 50

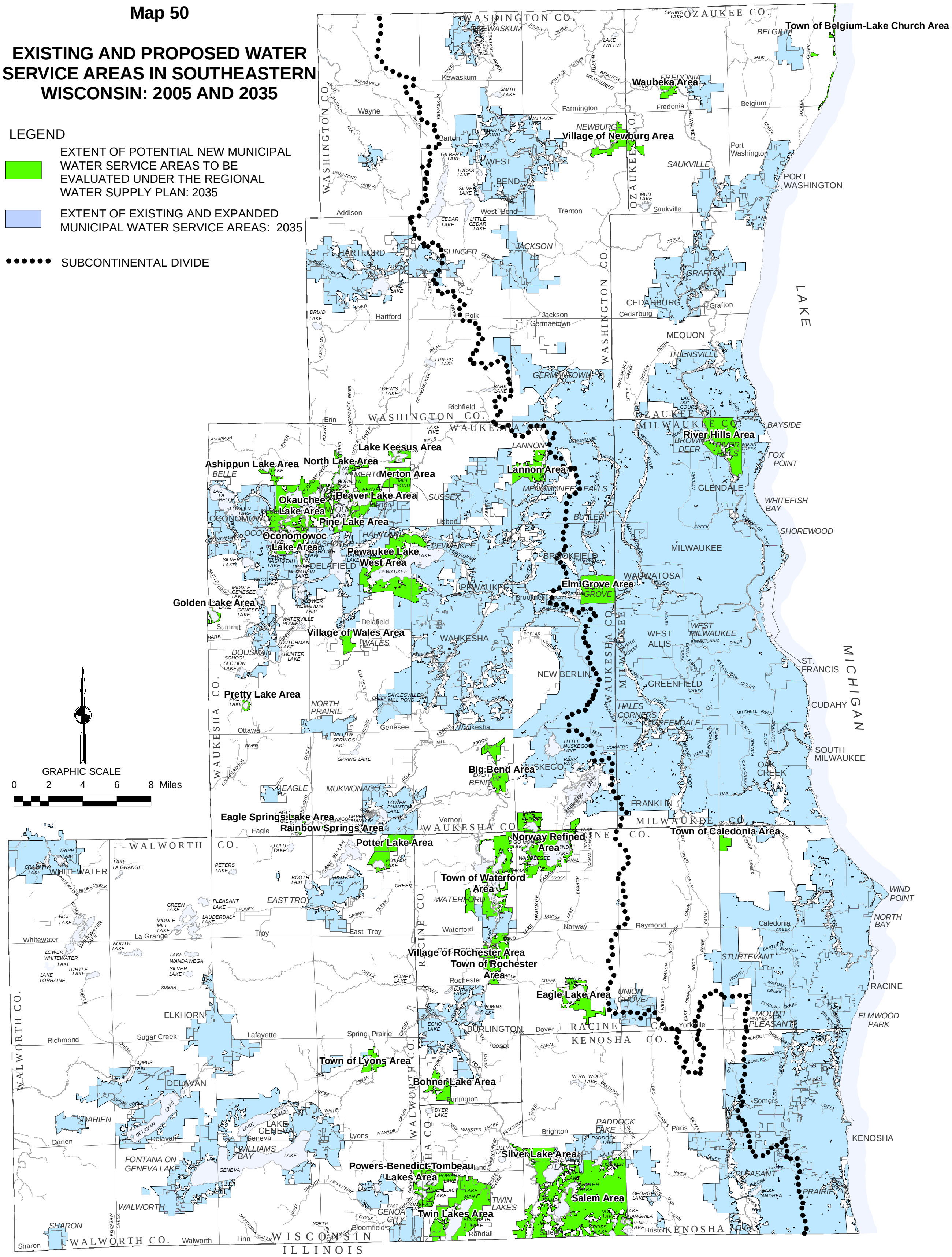
EXISTING AND PROPOSED WATER SERVICE AREAS IN SOUTHEASTERN WISCONSIN: 2005 AND 2035

LEGEND

- EXTENT OF POTENTIAL NEW MUNICIPAL WATER SERVICE AREAS TO BE EVALUATED UNDER THE REGIONAL WATER SUPPLY PLAN: 2035
- EXTENT OF EXISTING AND EXPANDED MUNICIPAL WATER SERVICE AREAS: 2035
- SUBCONTINENTAL DIVIDE

GRAPHIC SCALE

0 2 4 6 8 Miles



Source: SEWRPC.

Table 50

SELECTED CHARACTERISTICS OF POTENTIAL NEW MUNICIPAL WATER SUPPLY SERVICE AREAS IN THE SOUTHEASTERN WISCONSIN REGION: 2000

Potential Water Service Area	Predominant Land Use	Residential Land Use Data: Total Housing Units	Residential Land Use Data: Residential Acreage	Existing Density: Housing Units per Net Residential Acre	Existing Density: Approximate Housing Units per Gross Residential Acre	Distance to Nearest Existing Water Service Area Miles[a]	Shallow Aquifer Private Well Suitability[b]	Comments	Conclusion Regarding Type of Water Supply Service Area
Kenosha County									
Town of Salem	Residential	3,889	1,946	2.0	1.5	<0.5	High	Local initiative for part of area underway	Municipal water service area
Village of Silver Lake	Residential	1,217	390	3.1	2.3	0.5	High	- -	Municipal water service area
Village of Twin Lakes	Residential	2,905	1,062	2.7	2.0	0.5	High	Mixed-use community	Municipal water service area
Powers-Benedict-Tombeau Lakes	Residential	989	543	1.8	1.4	0.8	High	Lake-oriented development	Municipal water service area
Milwaukee County									
Village of River Hills	Residential	567	1,354	0.4	0.3	<0.5	High	- -	Private water systems[c]
Ozaukee County									
Town of Belgium-Lake Church	Residential	319	325	1.0	0.8	1.7	Medium	Shallow bedrock in vicinity	Private water systems[d]
Town of Fredonia-Waubeka Area	Residential	183	150	1.2	0.9	0.5	Medium	- -	Municipal water service area
Racine County									
Town of Burlington-Bohner Lake	Residential	911	456	2.0	1.5	0.6	Medium	Lake-oriented development. Previous local initiative for public water was not supported	Municipal water service area
Town of Caledonia-Northwest	Residential	50	37	1.3	1.0	0.5	High	Undeveloped nonresidential land	Municipal water service area
Town of Dover-Eagle Lake	Residential	735	285	2.6	2.0	0.4	High	Lake-oriented development	Municipal water service area
Town of Norway	Residential	2,420	1,177	2.1	1.6	0.5	Medium	Lake-oriented development	Municipal water service area
Town of Rochester	Residential	275	165	1.7	1.3	<0.5	High	- -	Municipal water service area
Town of Waterford	Residential	1,797	978	1.8	1.4	<0.5	High	Lake-oriented development	Municipal water service area
Village of Rochester	Residential	453	156	2.9	2.2	0.1	High	Mixed-use community	Municipal water service area
Walworth County									
Town of East Troy-Potter Lake	Residential	518	357	1.5	1.0	<0.5	Medium	Lake-oriented development	Municipal water service area
Town of Lyons	Residential	323	163	2.0	1.5	1.2	Medium	Municipal water service area	Municipal water service area
Washington County									
Village of Newburg	Residential	557	364	1.5	1.1	1.5	Medium	- -	Municipal water service area
Waukesha County									
Town of Eagle-Eagle Springs Lake	Residential	237	166	1.4	1.1	1.2	Medium	Lake-oriented development	Municipal water service area
Town and Village of Merton	Residential	596	556	1.1	0.8	0.5	High	- -	Private water systems[c]
Town of Merton-Beaver Lake	Residential	646	738	0.9	0.7	<0.5	High	Lake-oriented development	Private water systems[d]

Table 50 (continued)

Potential Water Service Area	Predominant Land Use	Residential Land Use Data				Distance to Nearest Existing Water Service Area Miles[a]	Shallow Aquifer Private Well Suitability[b]	Comments	Conclusion Regarding Type of Water Supply Service Area
				Existing Density					
		Total Housing Units	Residential Acreage	Housing Units per Net Residential Acre	Approximate Housing Units per Gross Residential Acre				
Waukesha County (continued)									
Town of Merton-Lake Keesus	Residential	365	320	1.1	0.9	2.3	Medium	60 percent of lots are less than 1.0 acre	Private water systems[d]
Town of Merton-North Lake	Residential	296	233	1.3	1.0	2.1	Medium	Lake-oriented development	Private water systems[d]
Town of Mukwonago-Rainbow Springs	Residential	1	1	0.8	0.6	2.2	High	Development density limitations due to wetlands and environmental corridors	Private water systems[e]
Town of Oconomowoc-Ashippun Lake	Residential	125	108	1.2	0.9	<0.5	High	Lake-oriented development	Private water systems[d]
Town of Ottawa-Pretty Lake	Residential	126	100	1.3	1.0	1.3	Medium	Lake-oriented development	Municipal water service area
Town of Summit-Golden Lake	Residential	104	63	1.7	1.3	1.8	High	Lake-oriented development	Municipal water service area
Village of Big Bend	Residential	636	442	1.4	1.1	0.6	Medium	Many lots less than 0.5 acre	Municipal water service area
Village of Elm Grove	Residential	2,155	1,204	1.8	1.4	<0.5	High	Local initiative for public water to serve portion of area is underway	Municipal water service area
Village of Lannon	Residential	535	298	1.8	1.4	<0.5	Medium	Local initiative for public water underway	Municipal water service area
Village of Wales	Residential	299	158	1.9	1.4	<0.5	High	Mixed-use community	Municipal water service area
Oconomowoc Lake	Residential	188	259	0.7	0.5	<0.5	High	Lake-oriented development	Private water systems[d]
Okauchee Lake	Residential	2,550	1,680	1.5	1.0	<0.5	Medium	Lake-oriented development	Municipal water service area
Pewaukee Lake West	Residential	1,871	1,596	1.2	0.9	<0.5	High	Lake-oriented development	Private water systems[d]
Pine Lake	Residential	287	427	0.7	0.5	<0.5	High	Lake-oriented development	Private water systems[d]

[a]*Distance was measured to the nearest planned 2035 boundary of existing municipal water utility service areas.*

[b]*High:*
- *Sand and gravel deposits with expected aquifer well yield of over 15 gallons per minute*
- *No known quality problems*

Medium:
- *Sand and gravel aquifer depth and capacity limited*
- *No known quality problems*

Or
- *Sand and gravel deposits with expected aquifer well yield of over 15 gallons per minute*
- *Limited known quality problems*

Low:
- *Known significant quality problems*

[c]*Conclusion based upon very low-density development and adequate aquifer capacity.*

[d]*Conclusion based upon relatively low-density trends in similar lake-oriented developments and adequate aquifer capacity.*

[e]*Conclusion based upon natural resources of the area and limited development potential.*

Source: SEWRPC.

of areas of inland lake and Lake Michigan lake-oriented residential development, and together with some other areas of residential development with a gross density of less than 1.0 dwelling unit per acre. The latter equates to a density of less than approximately 640 dwelling units per square mile—or approximately 1,600 persons per square mile. Typically, all of these areas were located in parts of the Region where the sand and gravel aquifer yield is considered suitable to support private systems, and no major groundwater quality issues were known to exist. Such areas are considered in the regional land use plan as areas with the potential, over the long-term, for the provision of municipal sanitary sewer service, but not for municipal water supply service.

Contaminated Groundwater Area Considerations

As reported in Chapter III, the Wisconsin Department of Natural Resources (WDNR) has established 35 areas within the Region where special well casing requirements apply because of the presence of, or potential for, groundwater contamination. Of those 35 areas, 20 areas were either included in proposed service areas, or were not considered for inclusion within such service areas due to the nature of the groundwater contamination, or the distance of the area from the planned water supply service areas. However, 15 of the 35 special well casing areas were considered for inclusion in the proposed water supply service areas. In addition, there are two other areas for which special well casing requirements are being developed by the Wisconsin Department of Natural Resources and which are also considered for inclusion in the proposed public water supply service areas. Accordingly, 17 special well casing areas were considered for inclusion in the proposed water supply service areas. These 17 areas are listed in Table 51 and are shown on Map 51. More-detailed maps of each of the 17 areas are included in Appendix E.

The recommendations for each of the 17 groundwater contamination areas considered with regard to municipal water service are summarized in Table 51. Following review of the existing development, developable land, and extent of the groundwater contamination areas, all or portions of 12 of the 17 groundwater contamination areas were added to the planned municipal water supply service areas. As summarized in Table 51, in the case of some areas, only the existing development and adjacent infill areas were added to the municipal water supply service areas. In other cases, the entire area was added. In the case of five of the areas, there was no significant development within the portion of the area of concern that was not included in a water supply service area. Given that these areas are located beyond the urban services set forth in the regional land use plan, no changes were proposed to the water supply service areas in these five instances.

FORECAST EMPLOYMENT, POPULATION, AND HOUSEHOLD LEVELS

The Regional Planning Commission prepared a range of projected design year 2035 employment, population, and household levels—high, intermediate, and low—for the Region. The intermediate projections were considered the most likely to be achieved for the Region overall, and, in this sense, constitute the Commission forecast levels. Accordingly, the intermediate projection was selected for use as the basis for the preparation of the design year 2035 regional land use plan, and also for the regional water supply plan. The high and low projections are intended to provide an indication of the range of population, household, and employment levels which could conceivably be achieved under significantly higher and lower, but nevertheless plausible, growth scenarios for the Region.

Commission county-level projections envision that the historic trend in the decentralization of population, households, and employment relative to Milwaukee County within the Region would continue, but at a significantly moderated rate. The intermediate population projection for Milwaukee County envisions that the recent decreases in population experienced by the County—a 0.6 percent loss during the 1980s and a 2 percent loss during the 1990s—would be replaced by modest growth of 1.5 percent between 2000 and 2010, and growth of about 7 percent over the entire 35-year forecast period from 2000 to 2035. The projections envision growth in households within Milwaukee County at rates higher than occurred during the 1980s and 1990s. These projections for Milwaukee County assume substantial development in the remaining undeveloped areas of the County; and assume further that the City of Milwaukee and other municipalities in the County will continue to be proactive and successful in efforts to maintain, renew, and revitalize as appropriate their existing developed areas.

Table 51

ANALYSIS OF SPECIAL WELL CASING AREAS CONSIDERED FOR ADDITION TO MUNICIPAL WATER SUPPLY SERVICE AREAS

Identification Number on Map 51	WDNR Identification Number	Location[a]	Contaminant Found	Casing Recommendation	Comments	Water Service Area Recommendation
Washington County						
1	40	Town of Barton Section 27 SE 1/4	VOC	60 feet into bedrock	Area includes existing industrial development	Add to water supply service area
2	41a and b	Town of Barton, Town of West Bend Sections 3, 4, 9, 10, 15, and 16	VOC, vinyl chloride	To base of Maquoketa shale	Portion of well casing area is in service area. Includes existing residential development and environmentally sensitive areas	Add existing residential development and adjacent potential infill development areas to water supply service area
3	47	Town of Polk Section 20 SE 1/4	VOC	210 feet	Aesthetically poor groundwater quality. Local resident complaints	Add to water supply service area
4	46a, b, and c	Town of Jackson Sections 21, 27, and 28	Bacteria, nitrate, gasoline	220 feet	Includes a high school, otherwise mostly rural	Extend water supply service area east to include high school site. Do not include most of the rural lands in service area
5	45	Town of Richfield Sections 12 and 13	Gasoline, VOC	100 feet into bedrock	Includes existing mixed-use development	Include older “village area” along STH 175 in new or expanded water supply service area
6	42a and b	Village and Town of Germantown Sections 9 and 10	Gasoline, bacteria, nitrate	80-100 feet	Includes existing mixed-use development. Contamination from onsite sewage disposal system and spills	Add to water supply service area
7	43	Village of Germantown Section 32	Gasoline	150 feet	Most of area of concern is in service area, small portion is not	Add to water supply service area
8	44/55	Village of Germantown Section 31	Gasoline	220 feet	Includes existing residential development and intervening developable lands	Add to water supply service area
Ozaukee County						
9	27	City and Town of Cedarburg Section 21	VOC	Special sampling	Most of area of concern is in service area, small portion is not	Include only existing development in water supply service area
10	28	Village and Town of Grafton Section 25	VOC	Special sampling	Aesthetically poor water quality; portion of well casing area is in service area; most of area not included is not developable at urban-density	Maintain initial water supply service area boundary
11	- -	Village of Thiensville Section 15	Aesthetics, VOC	140-160 feet	No significant development in area. Some of area is undevelopable at urban-density	Maintain initial water supply service area boundary

Table 51 (continued)

Identification Number on Map 51	WDNR Identification Number	Location[a]	Contaminant Found	Casing Recommendation	Comments	Water Service Area Recommendation
			Waukesha County			
12	53a and b, 54/44	Town of Lisbon and Village of Sussex Sections 22, 24, 25, 26, 28, 33, 34, 35, and 36	Bacteria, turbidity, gasoline	100-200 feet or special approval	Portion of well casing area is in service area; shallow bedrock	Include existing residential development and adjacent potential infill development areas in water supply service area
13	52a and b	Town of Genesee Sections 23, 24, 25, 26, and 35	Bacteria	200 feet	Includes existing residential development and one large industry	Include existing development as new or expanded area in water supply service area
14	67a and b	City of Muskego Sections 17, 18, 19, and 20	VOC, leachate	Special sampling and site-specific casing requirements	Portion of well casing area is in service area; no significant development in area not included in service area	Maintain initial service area boundary
			Walworth County			
15	39	Town of East Troy Sections 15, 21, and 22	Leachate	To top of bedrock	Portion of well casing area is in service area; no significant development in area. Some of area is undevelopable at urban-density	Maintain initial water supply service area boundary
16	- -	Town of Lyons	Bacteria, nitrates	Under development	Nearly all of the “Village of Lyons” area is included as a new service area	Include all of the “Village of Lyons” in water supply service area
17	- -	City of Lake Geneva and Town of Lyons	Salt	Under development	No significant development in area. Some of area is undevelopable at urban-density	Maintain initial water supply service area boundary

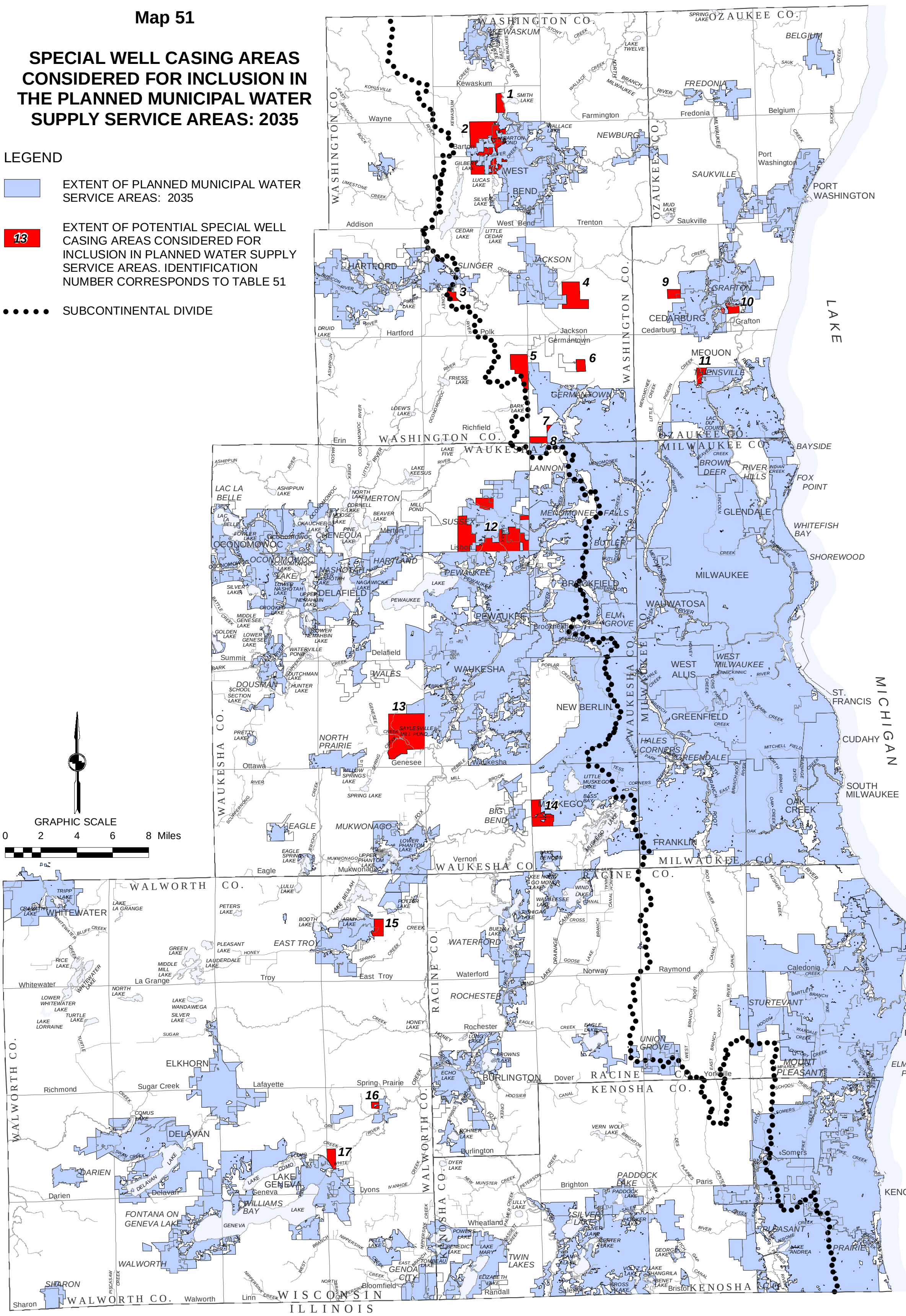
NOTE: VOC = Volatile Organic Compound.

[a] *The location descriptions for the well casing areas, in some cases, vary from the location descriptions provided in Table 31 in Chapter III due to refinements made by the Wisconsin Department of Natural Resources staff and due to the partial inclusion of the areas noted in Chapter III within the initially delineated planned water supply service areas.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Map 51

SPECIAL WELL CASING AREAS CONSIDERED FOR INCLUSION IN THE PLANNED MUNICIPAL WATER SUPPLY SERVICE AREAS: 2035



Source: SEWRPC.

The Commission projections also envision the continuation of an “Illinois influence” on future population and household levels in Kenosha and Walworth Counties. One facet of this “influence” involves persons from northeastern Illinois seeking residences in Wisconsin. Available data indicate a significant net movement of individuals from residences in northeastern Illinois to residences in Kenosha and Walworth Counties during the 1990s. Commission projections anticipate a continuation of this trend.

Forecast Employment Levels

Future employment levels in the Region may be expected to be strongly influenced by the strength of the regional economy relative to the rest of the State and Nation. The Commission’s most recent economic study found no reasons to conclude that the regional economy is likely to significantly increase or decrease in strength relative to the State or Nation over the course of the projection period. While there are some indications that the regional economy has diminished marginally relative to economies of the State and Nation over the past several decades—as evidenced, for example, by a gradual decline in the Region’s share of total State and national employment—a material change in the relative competitiveness of the regional economy is not expected.

The regional employment projections by industry group, presented in Table 52, were developed based upon a consideration of past industry trends, available indicators of future trends nationally and in the State and Region, and relative industry and sector strength in the Region as compared to State and national industries and sectors. Projections by State agencies and other recently published projections were also consulted. The projected employment levels take into account the employment declines of the 2001 recession and use 2003 data estimates as the last historical data points. Commission population projections indicate that a leveling-off in the regional labor force may be expected, particularly toward the middle of the projection period, as much of the baby-boom generation—those born from 1946 through 1964—reaches retirement age. This leveling-off in the labor force may be expected to moderate the number of jobs able to be accommodated in the Region. The sectoral changes—particularly, the shift from a goods producing economy to a services providing economy—that have occurred in the Region in recent decades are projected to continue.

Commission employment projections for the year 2035 are presented on a county basis in Table 53 and are shown graphically in Figure 23. The intermediate projection envisions a total employment level of 1.37 million jobs within the Region in 2035, an increase of 145,000 jobs, or about 12 percent, over the 2000 level of 1.22 million jobs.

Forecast Population Levels

As shown in Table 54, the total resident population of the Region increased from about 1.76 million persons in 1970 to about 1.93 million persons in 2000, an increase of about 175,000 persons, or about 10 percent, over the 30-year period. As also presented in Table 54, and shown graphically in Figure 24, the population of the Region is expected to increase from the year 2000 level of 1.93 million persons to about 2.28 million persons by the plan design year 2035, an increase of about 345,000 persons, or about 18 percent, over the 35-year period.

As anticipated population growth occurs within the Region, population changes within municipal water service areas are also expected to occur. As summarized in Table 55, the population of the areas proposed to be served by municipal water supply systems within the Region is expected to increase from the year 2000 level of about 1.56 million persons to about 2.10 million persons in 2035, an increase of about 536,000 persons, or about 34 percent. While the resident population within the Region is projected to increase by about 18 percent, a decline in the total number of people that reside in areas planned to be served by private water supply systems is anticipated, from approximately 370,000 people in the year 2000 to about 179,000 people in the year 2035. This anticipated decline in the population residing in areas planned to be served by private water systems is primarily due to the anticipated expansion of existing municipal water service areas into areas currently served by private systems, and to the development of new municipal water supply service areas throughout the Region. Table 55 summarizes the data on forecast population changes within existing and anticipated year 2035 municipal water supply service areas for each county and for the Region as a whole.

Table 52

PROJECTED EMPLOYMENT BY INDUSTRY GROUP IN THE SOUTHEASTERN WISCONSIN REGION: 2000-2035

Industry	2000 Employment		Projected 2035 Employment	
	Number of Jobs	Percent of Total	Number of Jobs	Percent of Total
Manufacturing				
Printing and Publishing	24,500	2.0	24,700	1.8
Fabricated Metal Products	25,600	2.1	11,600	0.9
Industrial Machinery and Equipment	48,000	3.9	24,900	1.8
Electrical and Other Electrical Equipment	27,000	2.2	15,300	1.1
All Other Manufacturing	99,200	8.1	83,900	6.1
Subtotal	224,300	18.3	160,400	11.7
Construction	53,800	4.4	57,100	4.2
Retail Trade	193,700	15.8	205,400	15.0
Wholesale Trade	64,400	5.3	64,400	4.7
Transportation, Communication, and Utilities	54,800	4.5	51,100	3.7
Services				
Business Services	102,800	8.4	164,600	12.0
Health Services	97,700	8.0	132,000	9.7
Social Services	34,300	2.8	62,100	4.5
All Other Services	171,200	14.0	231,300	16.9
Subtotal	406,000	33.2	590,000	43.1
Finance, Insurance, and Real Estate	93,700	7.7	103,600	7.6
Government and Government Enterprises[a]	114,400	9.3	115,300	8.4
Agriculture	6,000	0.5	4,800	0.4
Other[b]	11,700	1.0	16,200	1.2
Total	1,222,800	100.0	1,368,300	100.0

[a]*Includes all nonmilitary government agencies and enterprises, regardless of SIC code.*

[b]*Includes agricultural services, forestry, commercial fishing, mining, and unclassified jobs.*

Source: U.S. Bureau of Economic Analysis and SEWRPC.

Forecast Household Levels

Accompanying the changes in the size of the resident population of the Region are changes in the number and size of households. As shown in Table 56, and shown graphically in Figure 25, the number of households in the Region is projected to increase from about 749,000 in 2000 to about 925,700 in 2035, an increase of about 176,700, or about 24 percent, over the 35-year period. As also shown in Table 56, the average household size in the Region is expected to decrease from the 2000 level of 2.52 persons per household to 2.39 persons per household by the plan design year 2035, a decline of 0.13 persons per household, or about 5.2 percent, over the 35-year period.

As presented in Table 57, the number of households within the area proposed to be served by municipal water supply systems in the Region is expected to increase from the year 2000 level of about 610,000 to about 855,000 households in 2035, an increase of about 245,000 households, or about 40 percent. Although the number of households within the Region is projected to increase by 24 percent, the number of households located in areas served by private water systems is forecast to decrease from about 139,000 households in the year 2000 to about

Table 53

ACTUAL AND PROJECTED EMPLOYMENT IN THE SOUTHEASTERN WISCONSIN REGION BY COUNTY: 2000-2035

County	Year 2000		Year 2035		2000-2035 Increment	
	Total Employment	Percent of Region	Total Employment	Percent of Region	Total Employment	Percent of Year 2000 Employment
Kenosha	68,700	5.6	88,500	6.5	19,800	28.8
Milwaukee	624,600	51.1	628,900	45.9	4,300	0.7
Ozaukee	50,800	4.2	62,300	4.5	11,500	22.6
Racine	94,400	7.7	106,600	7.8	12,200	12.9
Walworth	51,800	4.2	69,400	5.1	17,600	34.0
Washington	61,700	5.0	78,900	5.8	17,200	27.9
Waukesha	270,800	22.2	333,700	24.4	62,900	23.2
Region	1,222,800	100.0	1,368,300	100.0	145,500	11.9

Source: U.S. Bureau of Economic Analysis and SEWRPC.

70,000 households in the year 2035, a reduction of about 69,000 households, or about 49 percent. This anticipated decline in the number of households located in areas served by private water supply systems is primarily due to the anticipated expansion of existing municipal water service areas to include areas of private service, and to the development of new municipal water service areas throughout the Region. This conversion of private water supply service to municipal service for areas of existing development is envisioned to occur only if a local need arises which would dictate such conversion, and then only if there is a local initiative to implement the change. Absent such a local need and initiative, the areas involved would continue to rely on individual private wells.

The projections envision a significant increase in the number of households in each county in the Region between 2000 and 2035. In each county, the relative increase in households is expected to exceed the relative increase in population, as household sizes continue to decline in each county.

PLANNED LAND USE

The design year 2035 land use plan, as already noted, serves as the basis for the preparation of the regional water supply plan. The regional land use plan was designed to accommodate the regional employment, population, and household forecasts previously described. The plan seeks to encourage infill development and redevelopment in existing urban centers, and new urban development adjacent to and outward from existing urban centers in areas which can be readily served by sanitary sewerage, and water supply and mass transit facilities; to preserve the environmental corridors[2] of the Region in essentially natural open uses; and to preserve the best remaining agricultural areas of the Region in agricultural uses. For purposes of the regional land use plan, “urban land” was

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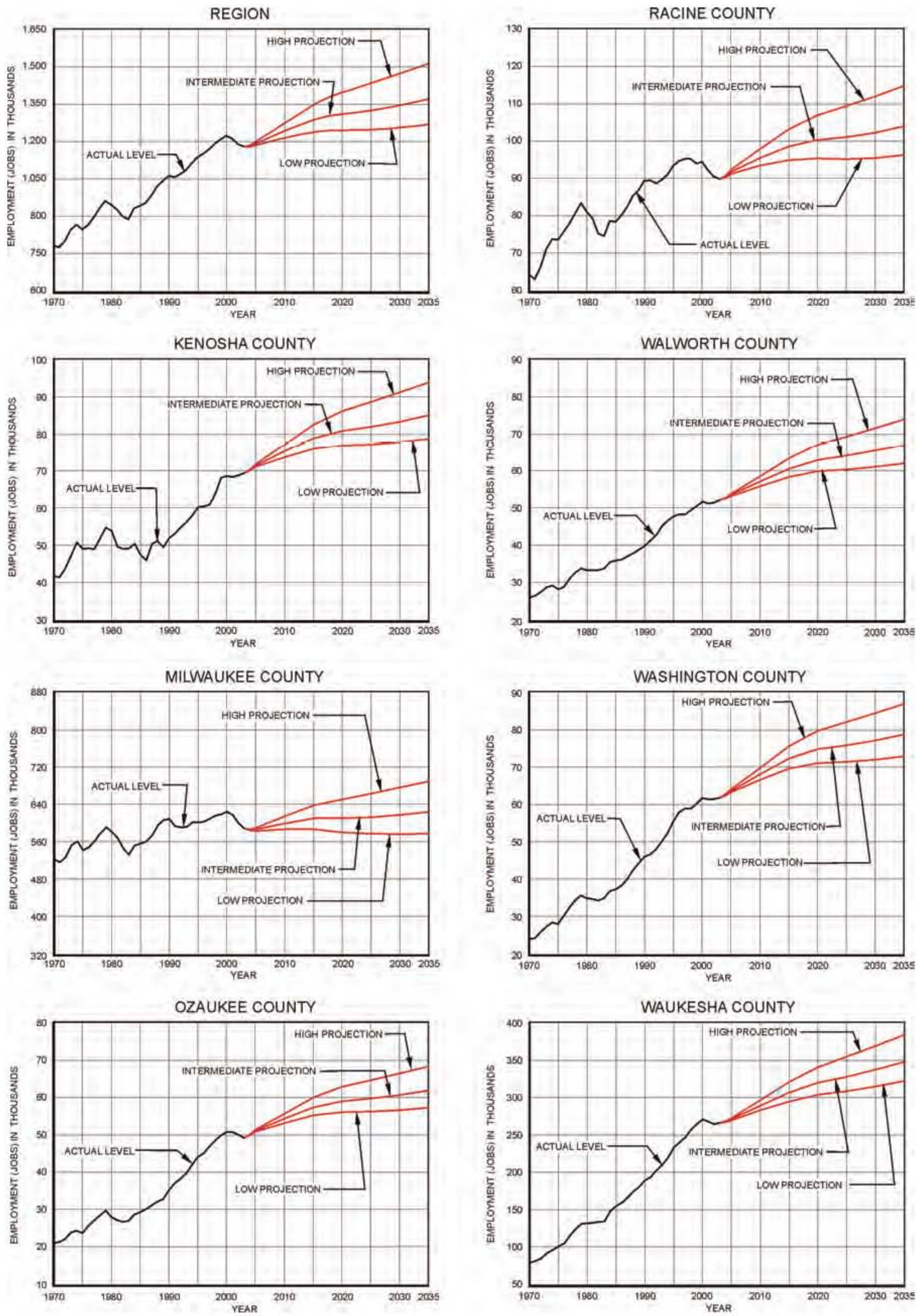
[2]*Environmental corridors are elongated areas in the landscape encompassing concentrations of the best remaining elements of the natural resource base, including the best remaining wetlands, woodlands, and wildlife habitat areas; surface water and associated shorelands and floodplains; and related features, such as existing park and open space sites, scenic views, and natural area sites.*

Figure 23

ACTUAL AND PROJECTED REGIONAL AND COUNTY EMPLOYMENT LEVELS: 1970-2035



Source: U.S. Bureau of Economic Analysis; Wisconsin Department of Workforce Development; and SEWRPC.

Table 54

ACTUAL AND PROJECTED POPULATION CHANGES IN THE SOUTHEASTERN WISCONSIN REGION: 1970, 2000, AND 2035

County	1970 Population	2000 Population	1970-2000 Increment		2035 Projected Population	2000-2035 Increment	
			Number	Percent		Number	Percent
Kenosha	117,900	149,600	31,700	26.9	210,100	60,500	40.4
Milwaukee	1,054,200	940,200	-114,000	-10.8	1,007,100	66,900	7.1
Ozaukee	54,500	82,300	27,800	51.0	101,100	18,800	22.8
Racine	170,800	188,800	18,000	10.5	213,600	24,800	13.1
Walworth	63,400	92,000	28,600	45.1	140,000	48,000	52.2
Washington	63,800	117,500	53,700	84.2	157,300	39,800	33.9
Waukesha	231,300	360,800	129,500	56.0	446,800	86,000	23.8
Region	1,755,900	1,931,200	175,300	10.0	2,276,000	344,800	17.9

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

defined as an area devoted to high-, medium-, and low-density residential use,[3] as well as to commercial, industrial, governmental and institutional, recreational, and transportation, communication, and utility use. Under the regional land use plan, the combined area in these urban use categories would increase from about 732 square miles in 2000 to about 825 square miles in 2035, an increase of about 93 square miles, or about 13 percent. Also under the 2035 regional land use plan, the area in urban use would account for about 31 percent of the total area of the Region, compared to about 27 percent in 2000. Table 58 summarizes the existing year 2000 land use and the projected 2035 land use based on land use type.

Under the year 2035 regional land use plan, urban development would, as already noted, occur within delineated urban service areas—areas that are intended to accommodate urban development provided with basic urban services and facilities, including public sanitary sewer service and typically also including public water supply service.[4] To the extent practicable, new urban land uses would be accommodated within existing urban service areas as infill development and through redevelopment as appropriate, thus maintaining and enhancing the viability of existing urban areas; maximizing the use of existing public infrastructure and services; and moderating the amount of open land converted to urban use. Additional urban development required to meet projected needs of the growing Region would be accommodated on lands proximate to existing urban service areas where basic urban services and facilities can be readily provided, resulting in the orderly expansion of existing urban service areas.

Map 52 depicts the land use pattern for the Region in the year 2035 as envisioned under the 2035 regional land use plan. This map shows urban areas in the Region as envisioned under the plan; sub-urban areas, which are neither truly urban nor rural in character; environmental corridors recommended for preservation in essentially

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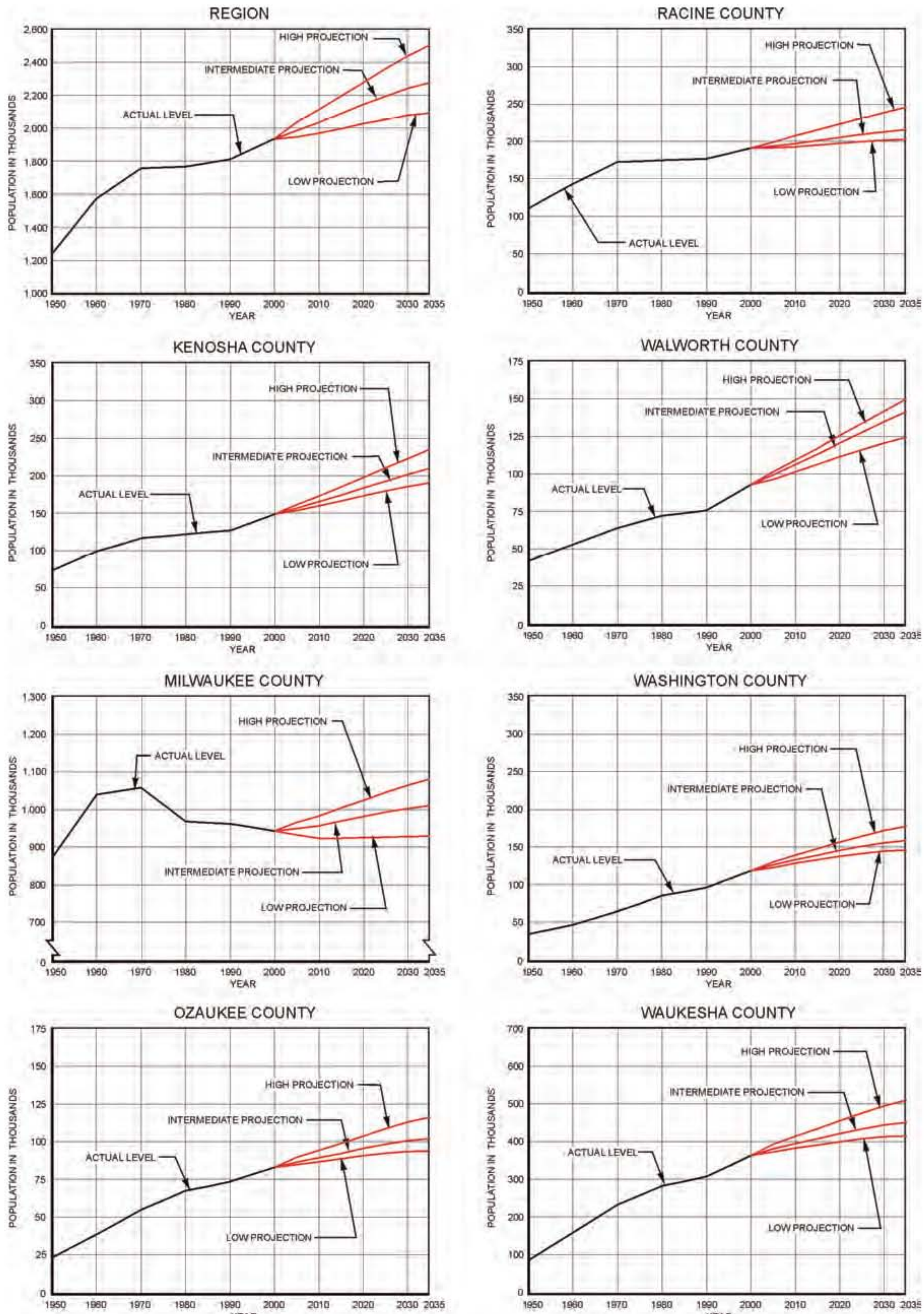
[3]*Residential densities are defined as follows: high-density—at least 7.0 dwelling units per net residential acre; medium-density—2.3 to 6.9 dwelling units per net residential acre; and low-density—0.7 to 2.2 dwelling units per net residential acre.*

[4]*Under the regional land use plan, urban development beyond planned urban service areas would be limited to low-density residential development in areas already committed to such use, along with highway-oriented business uses, utility uses, and recreational uses that may, of necessity, have to be located beyond planned urban service areas.*

Figure 24

ACTUAL AND PROJECTED REGIONAL AND COUNTY POPULATION LEVELS: 1950-2035



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

Table 55

ACTUAL AND PROJECTED POPULATION CHANGES IN MUNICIPAL AND PRIVATE WATER SUPPLY SERVICE AREAS WITHIN THE SOUTHEASTERN WISCONSIN REGION: 2000 AND 2035

County	Municipal Water Service Area				Private Water Service Area			
	2000 Population	2035 Projected Population	2000-2035 Increment Number	2000-2035 Increment Percent	2000 Population	2035 Projected Population	2000-2035 Increment Number	2000-2035 Increment Percent
Kenosha	111,000	199,900	88,900	80.1	38,600	10,200	-28,400	-73.6
Milwaukee..........	917,300	1,004,200	86,900	9.5	22,900	2,900	-20,000	-87.3
Ozaukee	45,400	86,800	41,400	91.2	36,900	14,300	-22,600	-61.2
Racine	146,400	196,200	49,800	34.0	42,400	17,400	-25,000	-59.0
Walworth............	56,200[a]	112,100[a]	55,900	99.5	35,800	27,900	-7,900	-22.1
Washington........	66,800	113,000	46,200	69.2	50,700	44,300	-6,400	-12.6
Waukesha..........	218,400	385,000	166,600	76.3	142,400	61,800	-80,600	-56.6
Region	1,561,500	2,097,200	535,700	34.3	369,700	178,800	-190,900	-51.6

[a]*Does not include about 2,600 persons in Jefferson County.*

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

Table 56

ACTUAL AND PROJECTED HOUSEHOLDS AND HOUSEHOLD SIZES IN THE SOUTHEASTERN WISCONSIN REGION BY COUNTY: 2000-2035

County	Year 2000			Year 2035			Year 2000-2035 Projected Change		
	Total Households	Percent of Region	Average Household Size[a]	Total Households	Percent of Region	Average Household Size	Households	Percent of Region	Percent Change Average Household Size
Kenosha	56,100	7.5	2.60	82,900	8.9	2.46	26,800	47.8	-5.4
Milwaukee.........	377,700	50.4	2.43	427,500	46.2	2.29	49,800	13.2	-5.8
Ozaukee	30,900	4.1	2.61	40,000	4.3	2.45	9,100	29.4	-6.1
Racine	70,800	9.5	2.59	84,000	9.1	2.46	13,200	18.6	-5.0
Walworth...........	34,500	4.6	2.57	54,400	5.9	2.47	19,900	57.7	-3.9
Washington.......	43,800	5.8	2.65	62,800	6.8	2.45	19,000	43.4	-7.5
Waukesha.........	135,200	18.1	2.63	174,100	18.8	2.50	38,900	28.8	-4.9
Region	749,000	100.0	2.52	925,700	100.0	2.39	176,700	23.6	-5.2

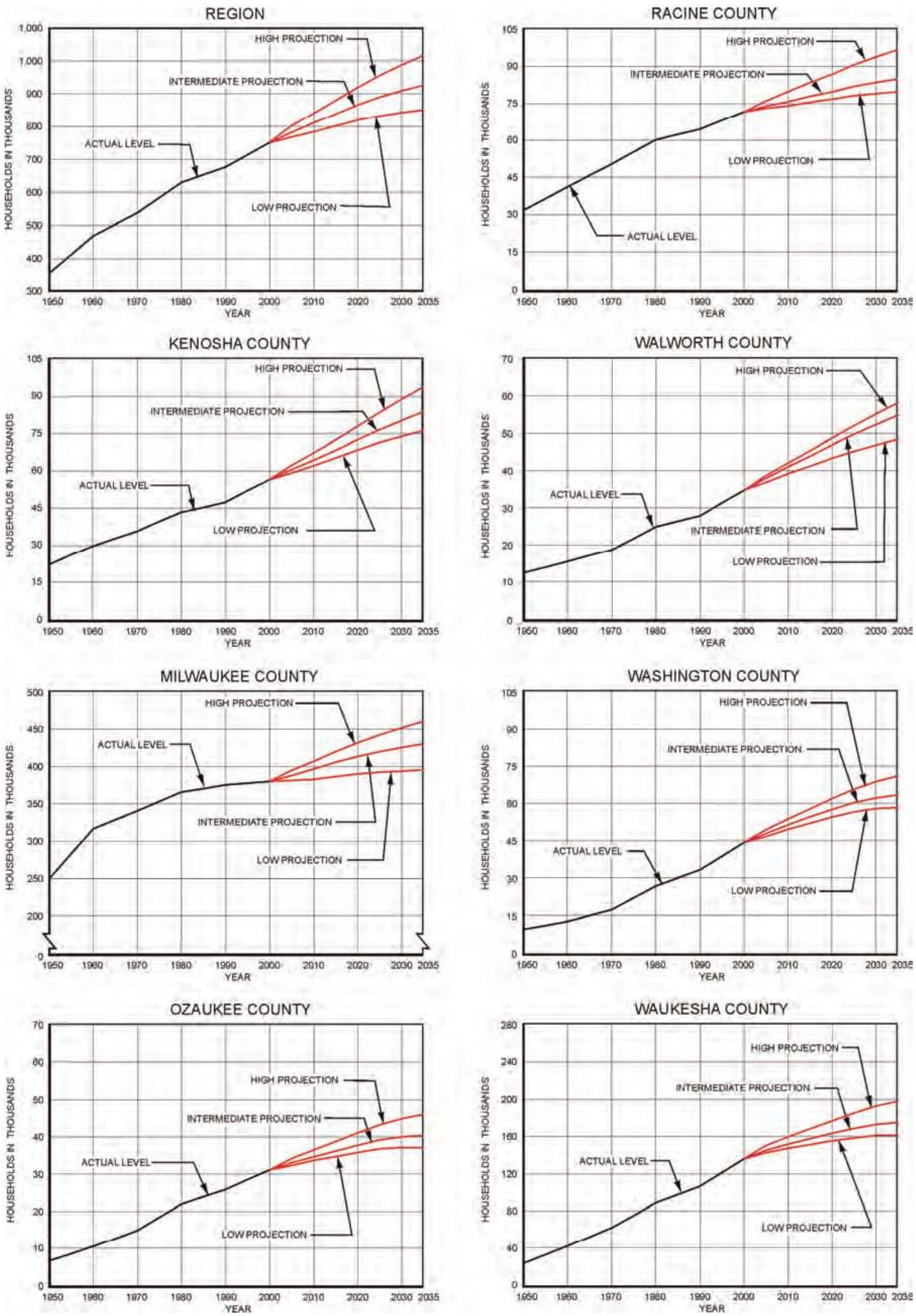
[a]*It should be noted that household size is based upon the population residing in households, and excludes the population residing in group quarters, such as college dormitories, nursing homes, and prisons. The proportion of the total population residing in group quarters within the planning area by county ranges from 1.1 to 3.7 percent, and in 2000 was 2.4 percent for the planning area as a whole.*

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

natural open uses; and rural areas consisting of prime agricultural land, other agricultural land, rural-density residential land, and other open lands. The urban land use pattern shown on Map 52 generally reflects the sanitary sewer service areas as adopted by the local municipalities, the Regional Planning Commission, and the Wisconsin Department of Natural Resources as of December 2005. In this respect, it should be recognized that many municipalities within the Region have established sanitary sewer service areas that would accommodate the high-growth—rather than the intermediate-growth—projections of population, households, and employment. This approach provides some flexibility at both the regional and local levels to accommodate the urban land market in determining the spatial distribution of new urban development. As a result of this approach, however, some of the urban areas shown on Map 52 will probably not be fully developed by 2035.

Figure 25

ACTUAL AND PROJECTED REGIONAL AND COUNTY HOUSEHOLD LEVELS: 1950-2035



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

Table 57

ACTUAL AND PROJECTED HOUSEHOLD CHANGES IN MUNICIPAL WATER AND PRIVATE WATER SUPPLY SERVICE AREAS IN THE SOUTHEASTERN WISCONSIN REGION: 2000 AND 2035

County	Municipal Service Area				Private Water			
	Year 2000 Households	Year 2035 Projected Households	2000-2035 Increment		Year 2000 Households	Year 2035 Projected Households	2000-2035 Increment	
			Number	Percent			Number	Percent
Kenosha	41,600	78,900	37,300	89.7	14,500	4,000	-10,500	-72.4
Milwaukee	368,700	426,300	57,600	15.6	9,100	1,200	-7,900	-86.8
Ozaukee	17,000	34,300	17,300	101.8	13,800	5,700	-8,100	-58.7
Racine	54,900	77,200	22,300	40.6	15,900	6,800	-9,100	-57.2
Walworth	21,100	43,600	22,500	106.6	13,400	10,800	-2,600	-19.4
Washington	24,900	45,100	20,200	81.1	18,900	17,700	-1,200	-6.3
Waukesha	81,900	149,900	68,000	83.0	53,400	24,200	-29,200	-54.7
Region	610,100	855,300	245,200	40.2	139,000	70,400	-68,600	-49.4

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

As already noted, under the design year 2035 regional land use plan, most new urban development would be served with municipal sanitary sewer and water supply facilities. In addition, municipal sanitary sewer and water supply service would be extended to certain existing urban areas currently lacking these facilities. In this regard, the design year 2035 regional land use plan envisions that certain existing urban development served by onsite sewage treatment and disposal and water supply facilities and located within planned urban service areas would eventually be connected to municipal sanitary sewer and water supply systems.

Under the regional land use plan, development beyond planned sanitary sewer and water service areas would be discouraged in primary environmental corridors and other environmentally sensitive areas, and on prime farmland. The regional land use plan recommends that any development of nonprime farmland be limited to rural residential development using conservation subdivision design at a density of no more than one unit per five acres. Low-density and sub-urban density development in rural areas of one unit per three-quarter acre to one unit per five acres would be discouraged, and limited to that development already committed through approved subdivision plats and certified surveys.[5]

WATER DEMAND FORECAST PROCEDURES

The development of water supply systems requires the long term investment of large amounts of capital. The facilities concerned have relatively long physical, as well as economic, lives. Therefore, water supply systems and facilities must be planned and designed to meet future, as well as existing, needs. Accordingly, forecasts of the probable future demand for water must be prepared as a basis for sizing future water supply, storage, transmission and distribution facilities. The preparation of water demand forecasts typically includes consideration of historic trends in water use, projection of water demands associated with planned future land use patterns, and assumptions regarding the impacts on demand of probable future regulations, programs, policies, and other influencing factors, including water conservation programs.

[5] *In addition to the low- and sub-urban-density residential development outside planned sanitary sewer and water supply service areas indicated above, some residential development served by onsite sewage treatment and disposal systems and private wells may be expected within planned urban service areas, prior to the time that centralized utility services become available. The amount of such "premature" development will depend upon the demand for housing in such areas and community response to that demand, including the timing of utility extensions.*

Table 58

EXISTING AND PROPOSED LAND USE IN THE SOUTHEASTERN WISCONSIN REGION: 2000 AND 2035

Land Use Category	Existing 2000		Planned Increment 2000-2035		Planned 2035	
	Square Miles	Percent of Total	Square Miles	Percent Change	Square Miles	Percent of Total
Urban						
Residential						
High-Density[a]	46.0	1.7	3.8	8.3	49.8	1.9
Medium-Density[b]	109.0	4.1	52.8	48.4	161.8	6.0
Low-Density[c]	178.0	6.6	12.0	6.7	190.0	7.1
Subtotal	333.0	12.4	68.6	20.6	401.6	15.0
Commercial	30.3	1.1	12.8	42.2	43.1	1.6
Industrial	32.9	1.2	5.3	16.1	38.2	1.4
Transportation, Communication, and Utilities	200.9	7.5	19.5	9.7	220.4	8.2
Governmental and Institutional[d]	33.7	1.2	2.2	6.5	35.9	1.3
Recreational[e]	50.4	1.9	7.7	15.3	58.1	2.2
Unused Urban	50.9	1.9	-23.4	-46.0	27.5	1.0
Subtotal	732.1	27.2	92.7	12.7	824.8	30.7
Nonurban						
Sub-Urban-Density Residential[f]	29.1	1.1	9.0	30.9	38.1	1.4
Rural-Density Residential[g]	- -	- -	5.9	- -	5.9	0.2
Agricultural	1,259.4	46.8	-103.9	-8.2	1,155.5	43.0
Other Open Land[h]	669.3	24.9	-3.7	-0.6	665.6	24.7
Subtotal	1,957.8	72.8	-92.7	-4.7	1,865.1	69.3
Total	2,689.9	100.0	- -	- -	2,689.9	100.0

NOTE: Offstreet parking area is included with the associated land use.

[a] *7.0 or more dwelling units per net residential acre.*

[b] *2.3-6.9 dwelling units per net residential acre.*

[c] *0.7-2.2 dwelling units per net residential acre.*

[d] *Increment consists primarily of increase of public sites.*

[e] *Includes only that land that is intensively used for recreational purposes. Increment consists primarily of increase of public sites.*

[f] *0.2-0.6 dwelling unit per net residential acre.*

[g] *No more than 0.2 dwelling unit per acre. Only the planned incremental rural residential area is indicated on this table; the area associated with existing (2000) rural residential development is included in the urban and sub-urban residential land categories. The planned incremental rural residential area assumes that there would be one acre of developed homesite area per dwelling, the remainder of the required area being retained in attendant open space use.*

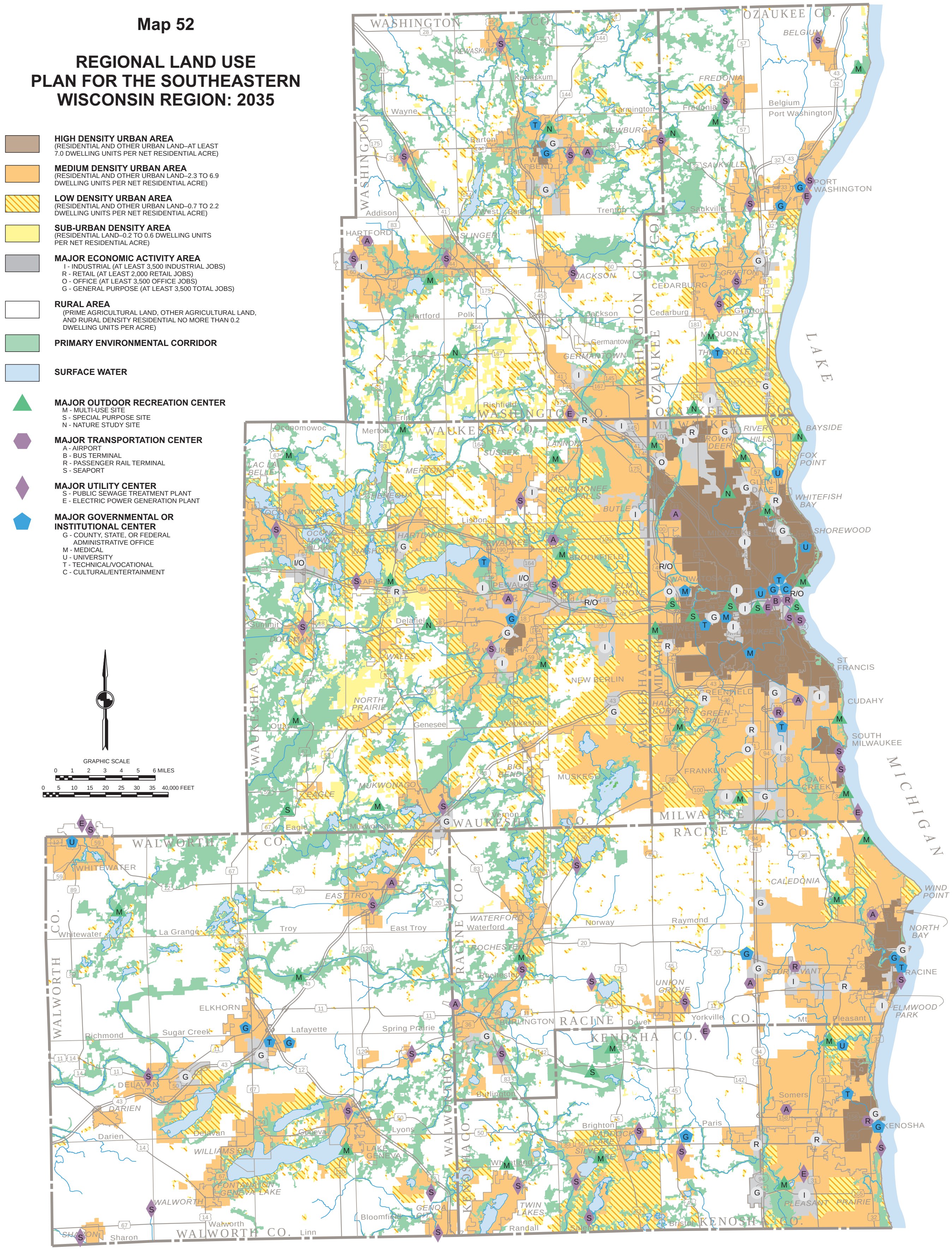
[h] *Includes woodlands, water, wetlands, landfill sites, quarries, and unused rural lands.*

Source: SEWRPC.

Forecasting future water demand can be accomplished in a number of ways, including development and application of per capita unit water demand factors, extrapolation of historic trends, or water demand modeling. The use of unit water demand factors for the various user categories is an effective method in areas like southeastern Wisconsin where good data bases on existing and historic water uses, on existing and historic land use patterns, and sound comprehensive land use planning are in place. That technique was, therefore, selected for use in the regional water supply planning program for southeastern Wisconsin. The process to be followed involves the

Map 52

REGIONAL LAND USE PLAN FOR THE SOUTHEASTERN WISCONSIN REGION: 2035



Source: SEWRPC.

preparation of alternative projections of future socioeconomic and land use conditions and the selection of a forecast from among the alternative projections of those conditions, followed by conversion of those projections to water demand by application of unit demand factors. The water demand projections and forecasts involve consideration of potential future resident population, household, and employment levels, as well as of future land use development patterns in the planning area. As previously noted, these socioeconomic and land use projections and forecasts have been developed under the regional planning program to the plan design year of 2035.[6] These socioeconomic and land use forecasts were then converted to water demands utilizing the unit water demand coefficients set forth in this chapter.

In order to assess the variations in demands between municipal water systems due to differences in system age, service area demographics, and land use development patterns, a review of water use for the years 2000, 2004, and 2005 by utility was performed. Water use data are reported on an annual basis to the Wisconsin Public Service Commission (PSC) by each regulated utility based upon metered usage. Other public utilities, such as unregulated water trusts, report water pumpage in accordance with State requirements, but may or may not meter actual usage. Water use data were calculated for the year 2000, the base year for the regional water supply planning program. Population, household, and land use data were available for that base year. In addition, the water use data were reviewed for the last two years for which the data were available, as of mid-2006, those years being 2004 and 2005. These two years presented a range of precipitation conditions, with 2004 having higher than average precipitation, and 2005 having lower than average precipitation, especially during the growing seasons, placing the year 2000 data in a range. Thus, existing demands were determined using recorded data for the base year—2000—and checked against available data for the two other years to identify possibly anomalous situations.

Once existing demand and pumpage patterns are established, unit demand factors were calculated and applied to expected future socioeconomic and land use conditions to obtain forecasts of future demand. Assumptions concerning potential reductions in demand due to conservation were then made and applied as the design and analyses of alternative plans dictated. The unit demand factors used were developed under the state-of-the-art water supply practices report prepared under the planning program,[7] and were as follows:

- Residential land use, average daily demand—70 gallons per capita per day;
- Commercial and Institutional land use, average daily demand—800 gallons per acre per day;
- Industrial land use, average daily demand—1,500 gallons per acre per day; and
- Miscellaneous municipal use, average daily demand—100 gallons per acre of urban service area per day.

The year 2035 average daily water use demand was initially calculated by using the year 2000 demand and the incremental demand between 2000 and 2035 as estimated using the abovenoted factors. That demand was then reduced by from 4 to 10 percent to reflect the expected implementation of water conservation measures. The percent reduction was used and applied on a utility-specific basis to reflect the source of supply and existing infrastructure, as summarized in Table 59, which was developed and documented in the state-of-the-art water supply practices report. It should be noted that the expected reductions in water use are anticipated as the result of implementing additional water conservation measures over and above those currently in place. All of the water

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[6]*SEWRPC Planning Report No. 48,* A Regional Land Use Plan for Southeastern Wisconsin: 2035*, June 2006; SEWRPC Technical Report No. 10, 4th Edition,* The Economy of Southeastern Wisconsin*, July 2004; and SEWRPC Technical Report No. 11, 4th Edition,* The Population of Southeastern Wisconsin*, July 2004.*

[7]*SEWRPC Technical Report No. 43,* State-of-the-Art of Water Supply Practices*, July 2007.*

Table 59

ASSUMED EFFECTIVENESS OF WATER CONSERVATION PROGRAM LEVELS FOR USE IN ALTERNATIVE PLAN DEVELOPMENT AND ANALYSIS

Water Utility Category	Future Water Conservation Assumption Over and Above the Current Level[a]		Comments
	Average Day Demand Reduction (percent)	Maximum Day Demand Reduction (percent)	
• Lake Michigan Supply with Return of Spent Water • Adequate Water Supply Infrastructure in Place for 10 or More Years	4	6	• Assuming a current level of water conservation effectiveness of 4 percent,[b] these values would equate to total reduction levels of 8 and 10 percent • Cost of water conservation program may be offset by savings in operational cost • Cost savings associated with infrastructure avoidance is not a major consideration
• Lake Michigan Supply with Return of Spent Water • Some Water Supply Infrastructure Needs Expected During the Next 10 Years	4	10	• Assuming a current level of 4 percent,[b] these values would equate to total reduction levels of 8 and 14 percent • Cost of water conservation program may exceed savings in operating costs • Cost savings associated with infrastructure avoidance is an important consideration
• Groundwater Supply • Adequate Water Supply Infrastructure for 10 or More Years • No Major Aquifer Quality or Quantity Issues	6	12	• Assuming a current level of 4 percent,[b] these values would equate to total reduction levels of 10 to 16 percent • Cost of water conservation program is expected to exceed savings in operating costs • Cost savings associated with infrastructure avoidance is not a major consideration
• Groundwater Supply • Major Infrastructure Needs Expected During the Next 10 Years • No Major Aquifer Quantity or Quality Problems	8	16	• Assuming a current level of water conservation effectiveness of 4 percent,[b] these values would equate to total reduction levels of 12 to 20 percent • Cost of the water conservation program will likely exceed the associated reduction in operational costs • Cost savings associated with infrastructure avoidance is an important consideration
• Groundwater Supply • Major Infrastructure Needs Expected During the Next 10 Years • Aquifer Quantity or Quality Problems	10	18	• Assuming a current level of water conservation effectiveness of 4 percent,[b] these values would equate to total reduction levels of 14 to 22 percent • Cost of the water conservation program will likely exceed the associated reduction in operational costs • Cost savings associated with infrastructure avoidance is an important consideration • Aquifer considerations may be the driving factor

[a] *Initial assumptions which may be revised following development and evaluation of alternative water supply plans, if demonstrated as needed by cost, environmental impacts, planned revisions to supply sources, or other factors related to the plan objectives.*

[b] *This level of water conservation is assumed to currently be carried out by the water utilities' water supply efficiency programs. Such programs may include metering, meter testing for accuracy, leak detection and repair, and repair or replacement of water mains with identified problems.*

Source: SEWRPC.

utilities operating within the Region currently practice water conservation, primarily in the form of water supply efficiency programs. Such programs may include metering, meter testing for accuracy, leak detection and repair, and repair or replacement of water mains with identified problems. As noted in Table 59, these ongoing programs were assumed to have reduced otherwise current water use by 4 percent.

The initial water conservation levels selected are intended to be related to comprehensive water conservation programs, including both a supply side water supply system efficiency element and demand side water conservation measures. The selected levels are also intended to represent an increase in water conservation effectiveness over and above the current levels which are the result of a number of water efficiency and water conservation measures already in place at most municipal utilities in the Region. Thus, the selected levels are not as high as would be the case in an area where no water conservation measures are in place. These initial water conservation level assumptions were reviewed and revised following the development and evaluation of the alternative plans if cost, environmental impact, planned revisions to the supply sources, or other factors relating to the achievement of plan objectives so dictated. Such revisions in water conservation levels were then incorporated into the recommended regional water supply plan.

Average daily demand includes only those components which can be accounted for by metered billings and treatment plant records. Average daily pumpage is the total amount of water which is pumped to the distribution system and water used in production, and is reported by the utilities in the Public Service Commission annual reports. For purposes of the regional water supply planning program, average daily pumpage was calculated for 2035 by using the year 2000 ratio of average daily pumpage to average daily demand, except where anomalies appeared to be involved. In such cases, other data from other years were considered. Maximum daily pumpage for the year 2035 was estimated using the three-year average—2000, 2001, and 2002—of the ratio of maximum daily pumpage to average daily pumpage. This three-year average was used rather than the year 2000 ratio alone, since the year 2000 had a high amount of precipitation during the growing season. The 2035 maximum daily pumpage was reduced by from 2 to 8 percent to account for the effects of water conservation measures over and above the effects of such measures on average daily demand, as shown in Table 59.

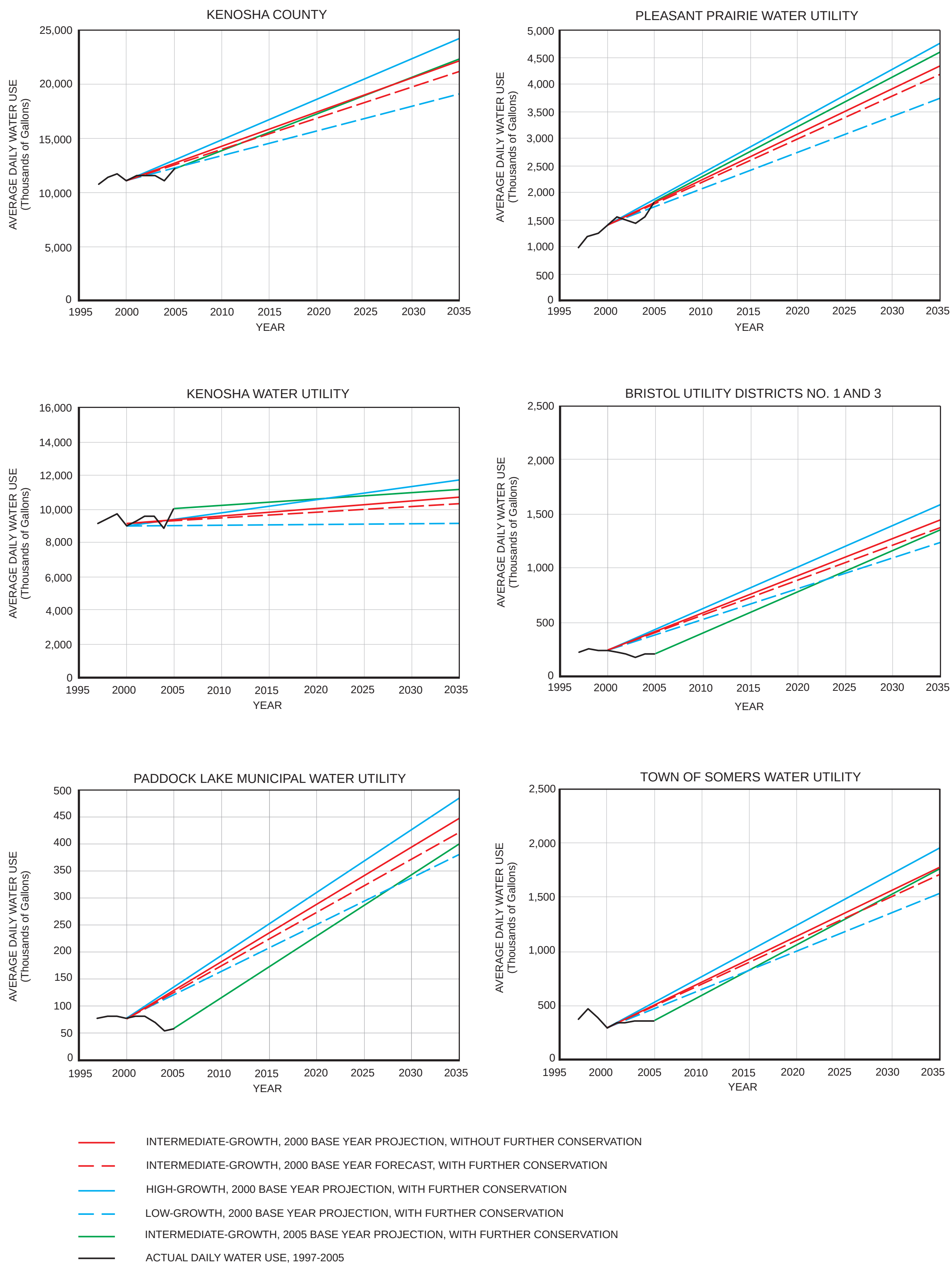
The reduction in forecast maximum day water pumpage due to water conservation measures is intended to reflect the demand reduction due to the implementation of water conservation programs during periods of peak demand, including outdoor water use restrictions. This calculation is not intended to compromise fire-fighting capabilities. Fire-fighting capacity is typically established by pressure and flow requirements within the water supply distribution system. These requirements are typically designed to be met over and above the maximum day pumpage and are provided by system storage and pumping stations. As local utility water supply systems are developed, care should be taken to ensure that fire-fighting capability is not compromised by the assumptions on water conservation program effectiveness.

Additional detail in the calculation of water use demand and related pumpage for each municipal water utility are included in Appendix F.

The plan design year 2035 water use forecasts herein presented were developed based upon the intermediate-growth forecasts of land use and socioeconomic conditions set forth in the regional land use plan, year 2000 water use levels, and with an assumed application of further water conservation measures. Alternative water use projections were also developed to illustrate a potential range of future water use conditions. One of the alternative projections was based upon the intermediate-growth land use and socioeconomic data for the plan design year 2035, year 2005 water use levels, and an assumed further application of water conservation. In addition to this projection, two additional projections of water use were made, one based upon the high-growth and one based on the low-growth land use and socioeconomic projections set forth in the regional land use plan, year 2000 water use levels, and an assumed further application of water conservation. Finally, a projection was made based upon the intermediate-growth forecasts of land use and socioeconomic conditions set forth in the regional land use plan, year 2000 water use levels, and no further application of water conservation measures. These alternative projections, together with the forecasts, are shown graphically by county and municipality in Figures 26 through 32.

Figure 26

ACTUAL, PROJECTED, AND FORECAST AVERAGE DAILY WATER USE: KENOSHA COUNTY



Source: Public Service Commission and SEWRPC.

Figure 27

ACTUAL, PROJECTED, AND FORECAST AVERAGE DAILY WATER USE: MILWAUKEE COUNTY

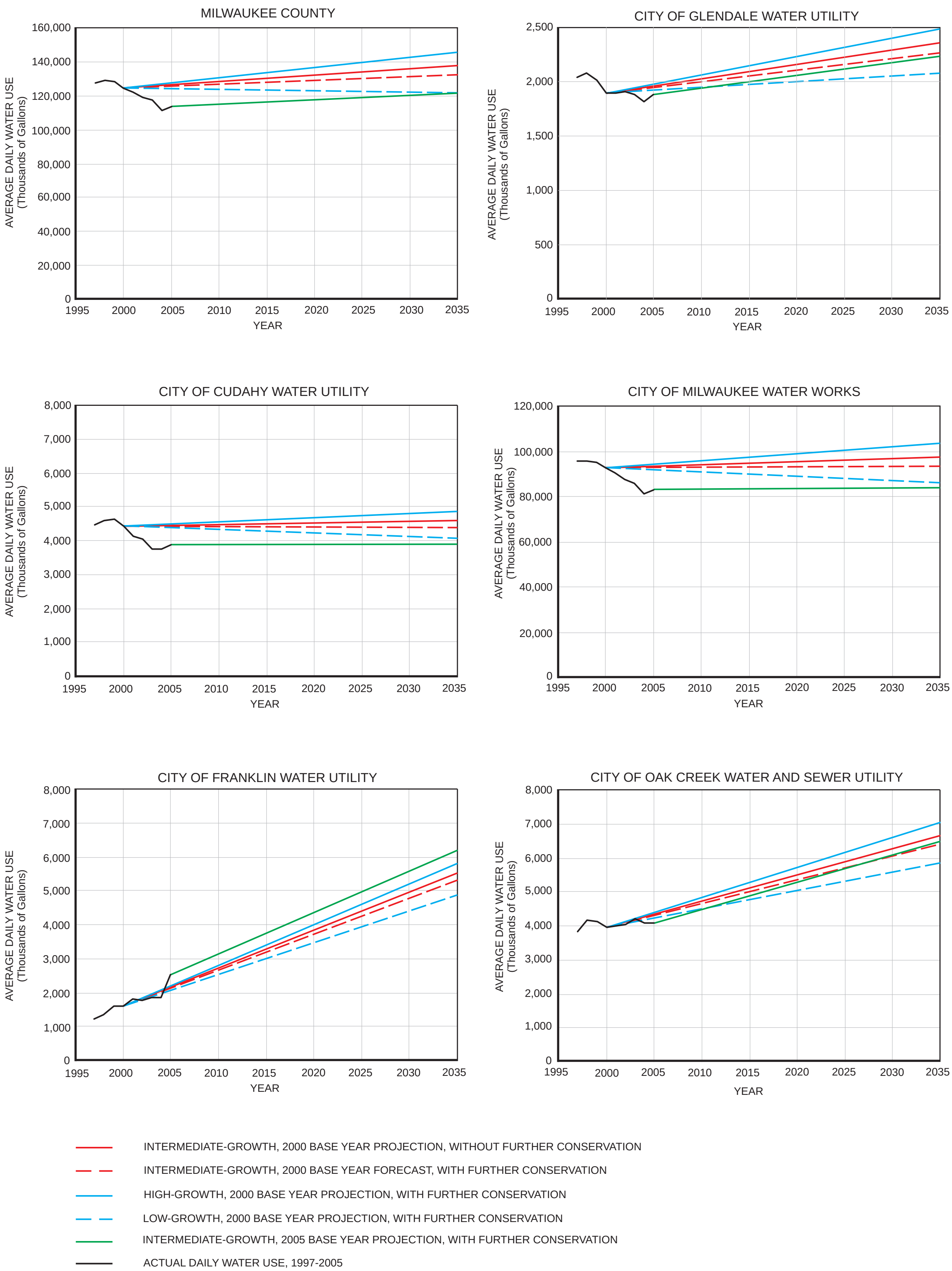
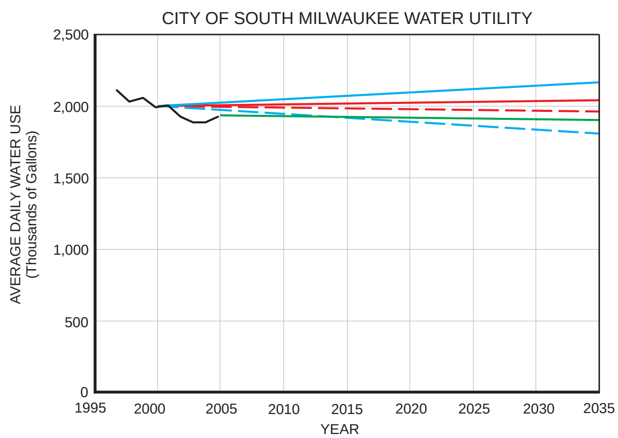
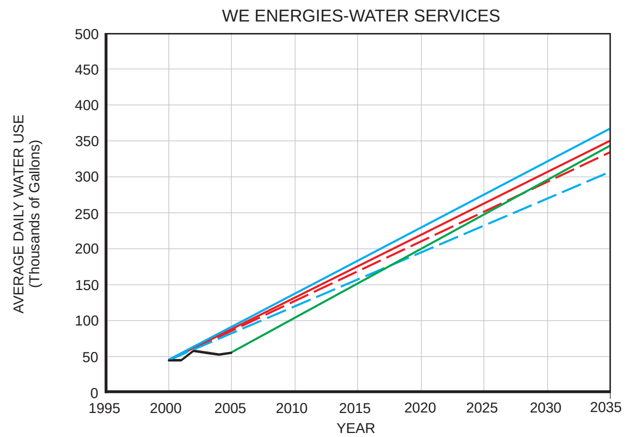
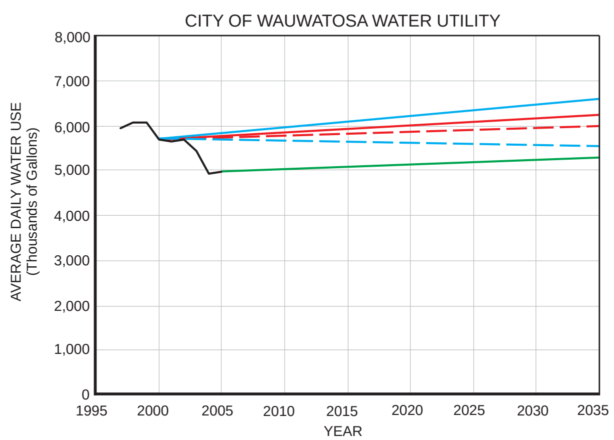
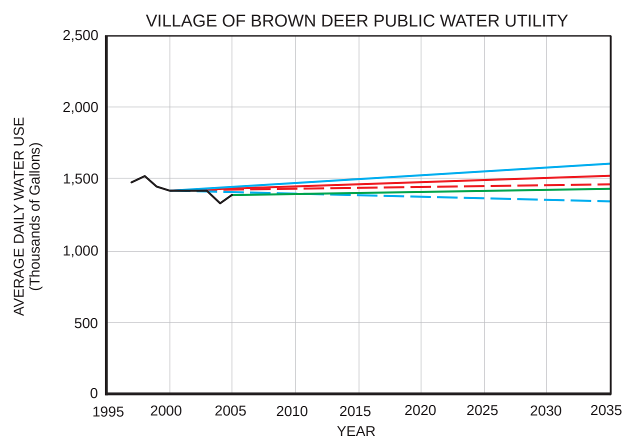


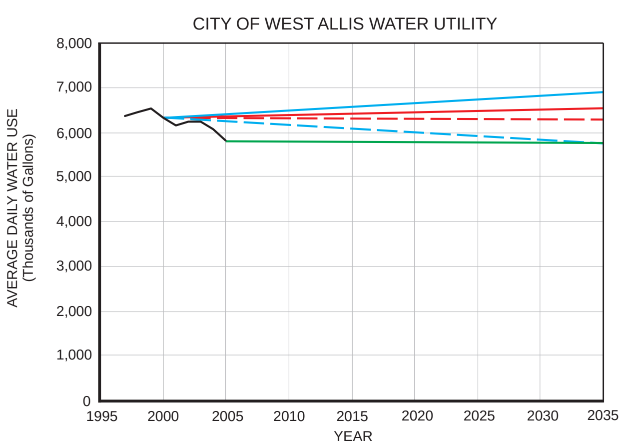
Figure 27 (continued)

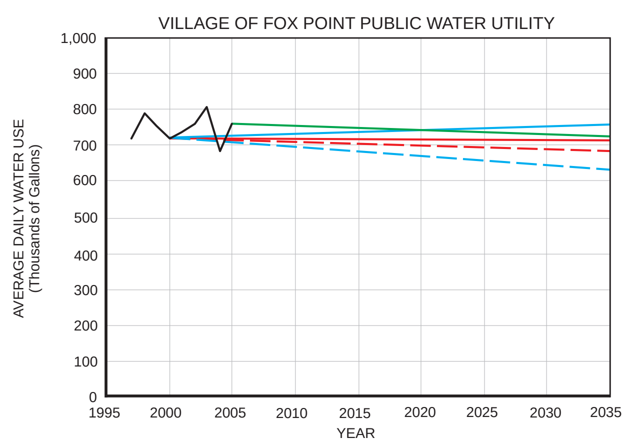












INTERMEDIATE-GROWTH, 2000 BASE YEAR PROJECTION, WITHOUT FURTHER CONSERVATION

INTERMEDIATE-GROWTH, 2000 BASE YEAR FORECAST, WITH FURTHER CONSERVATION

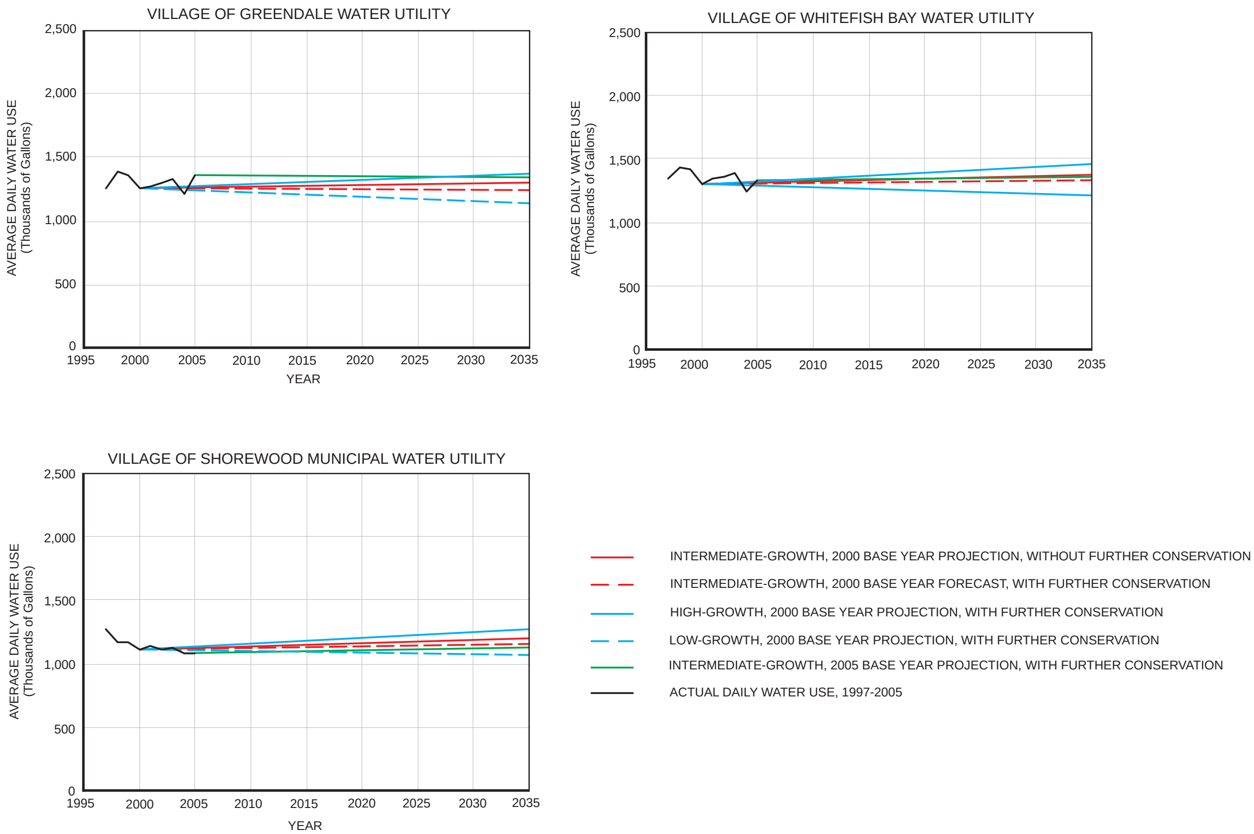
HIGH-GROWTH, 2000 BASE YEAR PROJECTION, WITH FURTHER CONSERVATION

LOW-GROWTH, 2000 BASE YEAR PROJECTION, WITH FURTHER CONSERVATION

INTERMEDIATE-GROWTH, 2005 BASE YEAR PROJECTION, WITH FURTHER CONSERVATION

ACTUAL DAILY WATER USE, 1997-2005

Figure 27 (continued)



Source: Public Service Commission and SEWRPC.

In general, it was concluded that the forecasts were reasonable for use in the design of alternative and recommended water supply plans for the Region. In some cases, these forecasts are at variance with the projections made using the year 2005 water use levels, as they do not reflect the changes in water use which actually occurred between 2000 and 2005. In these cases, that difference reflects a reduction in water use typically due to reductions in industrial water use within the service area of the utilities concerned. Such reductions were experienced by some of the water utilities in Milwaukee County, and, to a lesser extent, in some of the water utilities in Racine County, and in some utilities serving small areas of the Region. The regional land use plan and the regional water supply plan, however, are intended to be normative plans which meet regional development objectives that envision the maintenance of vibrant industrial and commercial environments within the larger central cities of the Region. It was, therefore, considered prudent to plan for what may be regarded as somewhat optimistic water use demand in those central city areas in order to be able to accommodate an envisioned increase in industrial and commercial development and associated water use. In nearly all of the cases concerned, the differences between the forecast based upon the intermediate-growth land use and socioeconomic data and the year 2000 water use levels, and the alternative projections based upon the intermediate-growth land use and socioeconomic data and year 2005 water use levels are less than 12 percent. These differences were further considered on a utility-specific basis and, in some cases, adjustments were made in the initial forecast levels as plan design proceeded.

Data are also presented in this chapter on the self-supplied water systems within the Region. The data presented include the location and selected information on residential, other-than-municipal community systems and self-supplied industrial, commercial, institutional, recreational, agricultural, other irrigation, and water supply

Figure 28

ACTUAL, PROJECTED, AND FORECAST AVERAGE DAILY WATER USE: OZAUKEE COUNTY

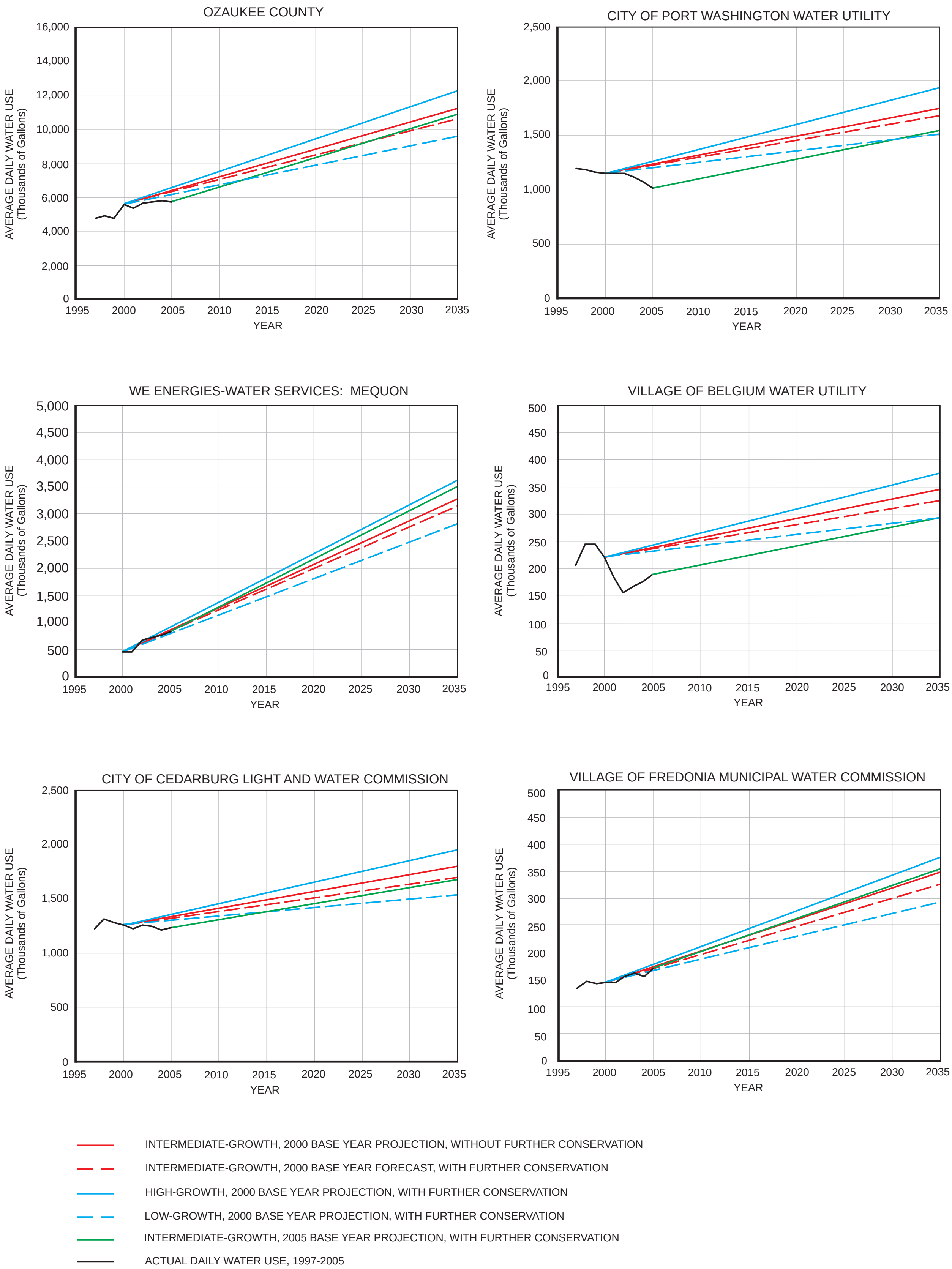
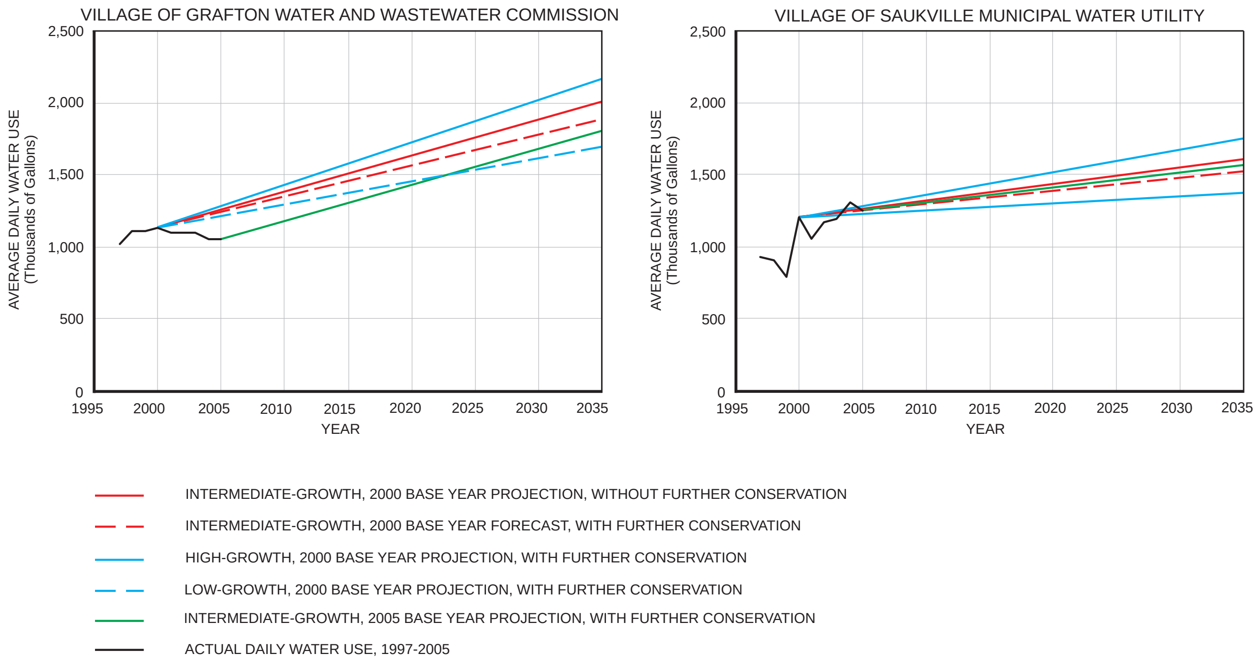


Figure 28 (continued)



Source: Public Service Commission and SEWRPC.

thermoelectric-power generation water supply systems. Data are also presented on private domestic wells within the Region. The data presented are based upon a review of the existing 2005 self-supplied system inventory documented in Chapter III. Assumptions were made that most systems, excepting systems for large water users, such as irrigation, located within the planned 2035 municipal water supply service areas, would be connected to the municipal system concerned. The data were obtained from the Wisconsin Department of Natural Resources data base, and it was recognized that some of the data on the self-supplied systems lacks currency. The data for the residential other-than-municipal community water supply systems are kept relatively current. However, no periodic reporting is required for most of the self-supplied industrial, commercial, institutional, recreational, agricultural, and other irrigation self-supplied wells. As such, some of the self-supplied systems reported may no longer be in service, and there may be a limited number of new wells in service which are not included in the data base. In cases where these situations were known to the Commission staff, based upon Commission planning inventories, the data reported were adjusted accordingly. The data on estimated pumpage are limited—typically including normal and maximum approved daily pumpage. For groundwater modeling purposes further investigations were made under the regional water supply planning program to develop estimates of self-supplied water system pumpage. As of 2007, the WDNR was in the process of updating the data base concerned.

The data presented in this chapter report only on existing self-supplied water supply systems which may be expected to remain in operation through the year 2035. No attempt was made to specifically identify new self-supplied water systems which may be developed over the plan design period. However, for purposes of the groundwater modeling analyses used to define future conditions and develop alternative and recommended plans, as documented in Chapters VIII and IX, an allowance for such new systems was made. That allowance was made by adjusting the per capita water use for self-supplied residential private wells from 65 gallons per day to 100 gallons per day, and applying that allowance over the model cells based upon expected existing and new private well development locations. The adjustment is intended to provide an allowance for new nonresidential development using low-capacity wells, such as commercial establishments. Should new large-scale unplanned self-supplied water systems be proposed in the future, such systems would have to be considered on a case-by-case basis.

Figure 29

ACTUAL, PROJECTED, AND FORECAST AVERAGE DAILY WATER USE: RACINE COUNTY

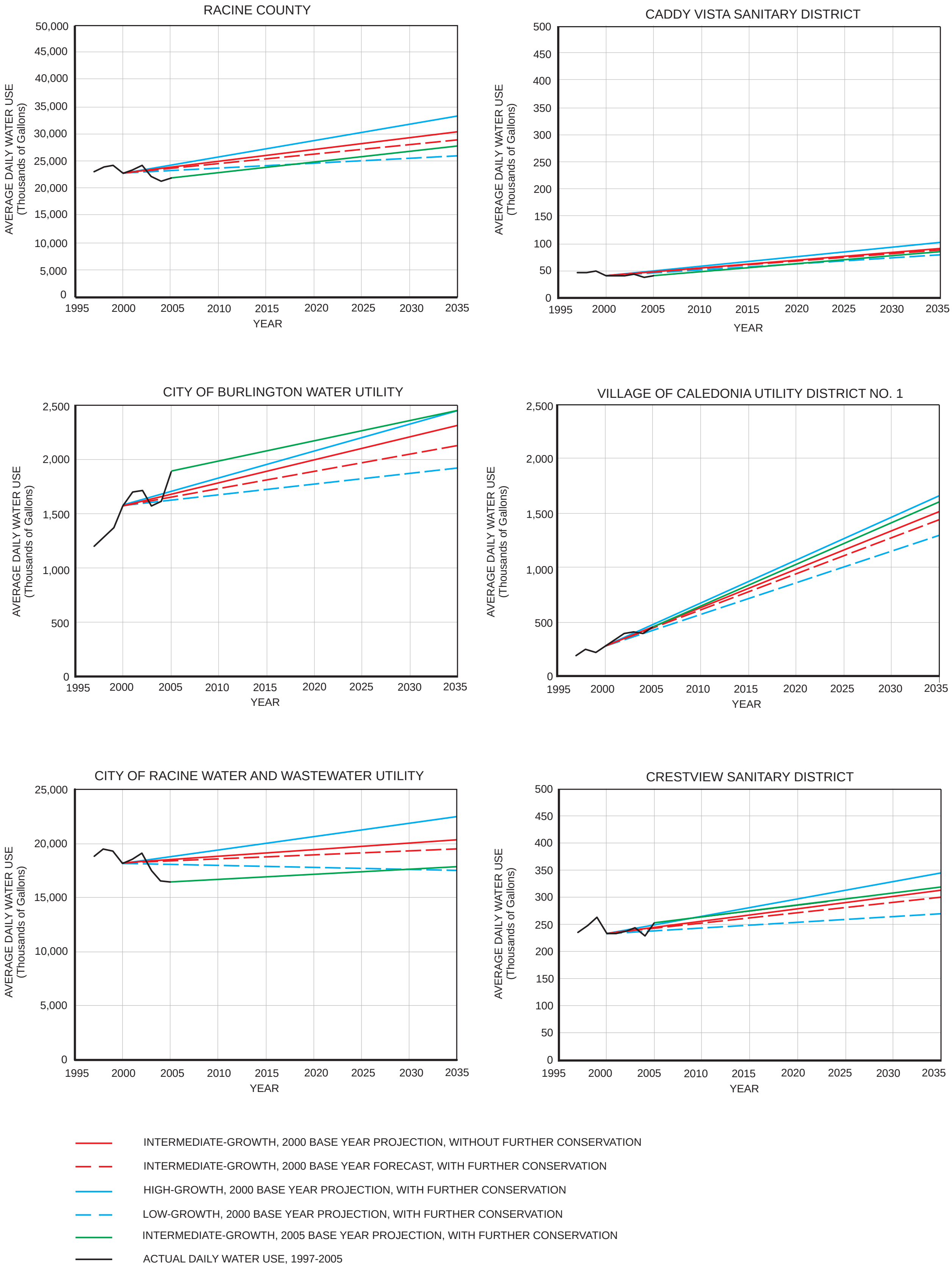


Figure 29 (continued)

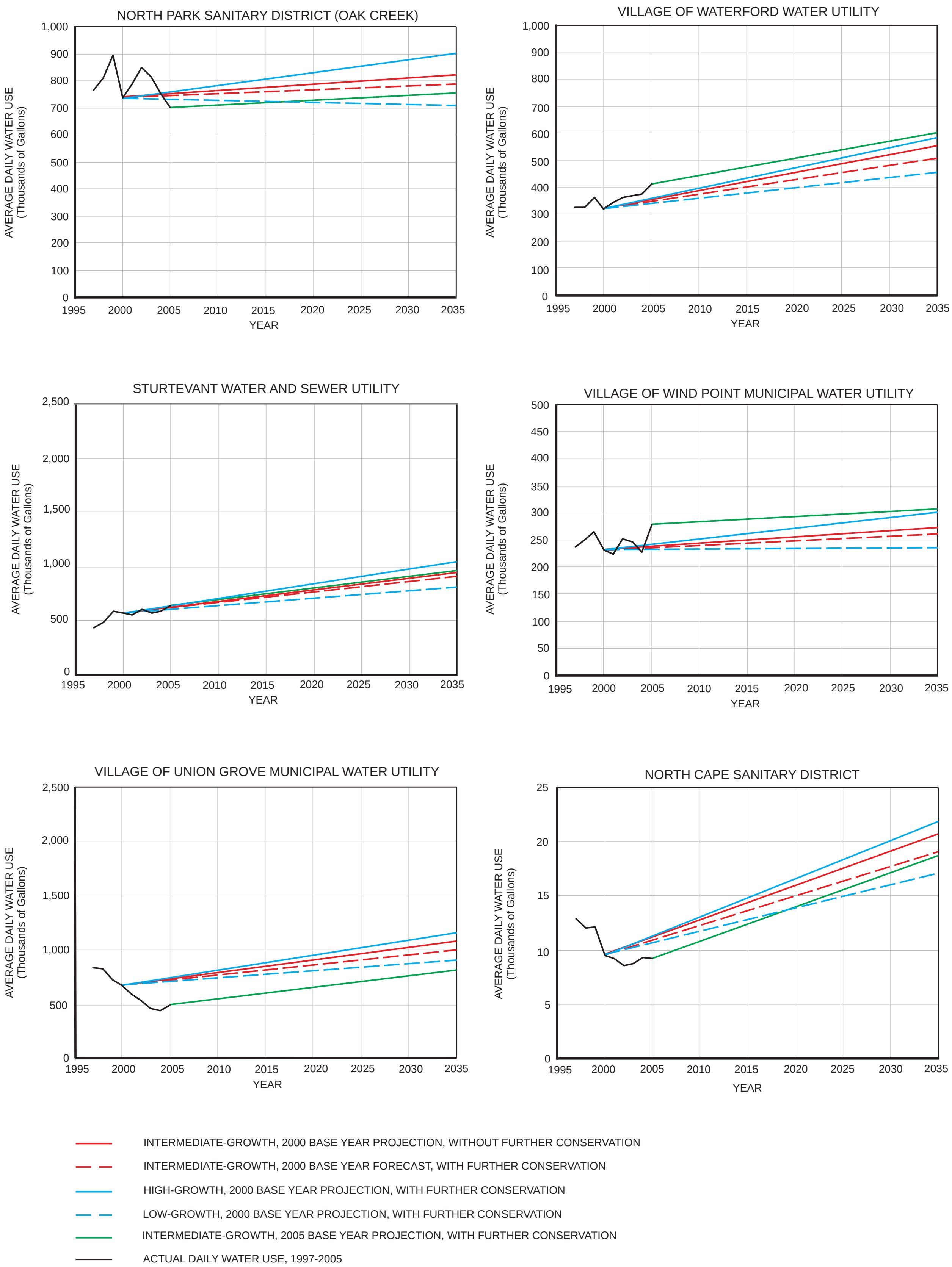
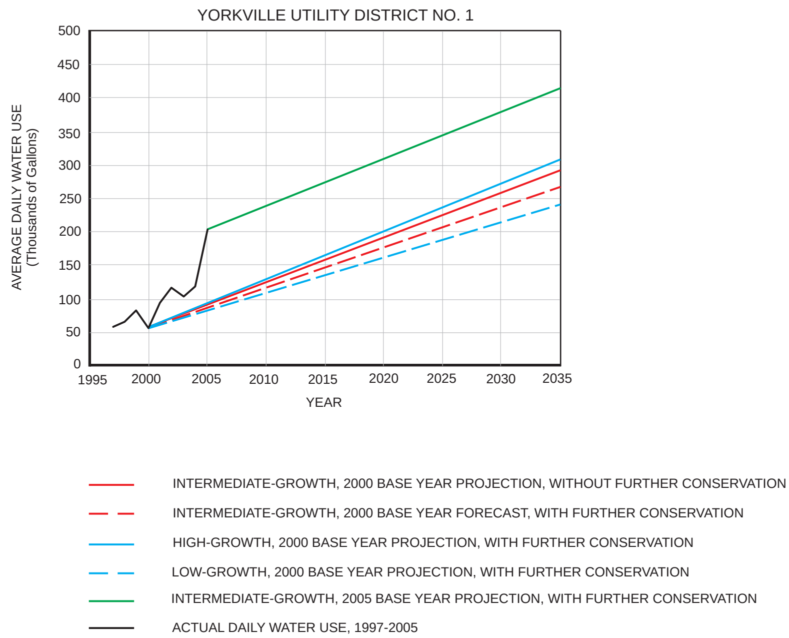


Figure 29 (continued)



Source: Public Service Commission and SEWRPC.

FORECAST OF WATER USE—KENOSHA COUNTY

Municipal Water Supply Systems

In 2000, there were six municipal water supply utility systems operating in Kenosha County, as shown on Map 53. By the year 2035, each of these municipal utility water service areas in Kenosha County is projected to experience an increase in service area and water demand. In addition to the six existing municipal water utilities in Kenosha County, four additional municipal water supply systems may be developed by 2035 to serve the Villages of Silver Lake and Twin Lakes, a portion of the Town of Salem, and the Powers-Benedict-Tombeau Lakes area in the Towns of Randall and Wheatland and partially in the Town of Bloomfield in Walworth County. As presented in Table 60, the year 2000 total resident population served by municipal water utilities in Kenosha County was about 111,000, or about 74 percent of the 149,600 total population of the County. By 2035, the total population projected to be served by municipal water utilities is expected to increase by about 88,900 to just under 200,000 residents, or about 95 percent of the 2035 population of 210,100.

The area served by municipal water supply systems within Kenosha County is expected to increase by about 265 percent between 2000 and 2035, from about 29.8 square miles in 2000 to about 108.7 square miles in 2035. As noted in Chapter III, about 34.2 square miles were served by municipal water supply systems in 2005. Thus, the expected increase in area served between 2005 and 2035 is about 74.5 square miles, or an increase of about 218 percent. About 34 percent of the increase in water supply service area is due to the potential development of the four new utilities noted above the projected service areas of which include areas that are currently largely developed. A significant portion of the increase in area served is also due to the expansion of existing municipal water service areas into developed areas currently served by self-supplied water systems. Table 60 sets forth the forecast changes in population and service area for the 10 existing and proposed municipal water service areas in Kenosha County for the plan design year 2035.

Figure 30

ACTUAL, PROJECTED, AND FORECAST AVERAGE DAILY WATER USE: WALWORTH COUNTY

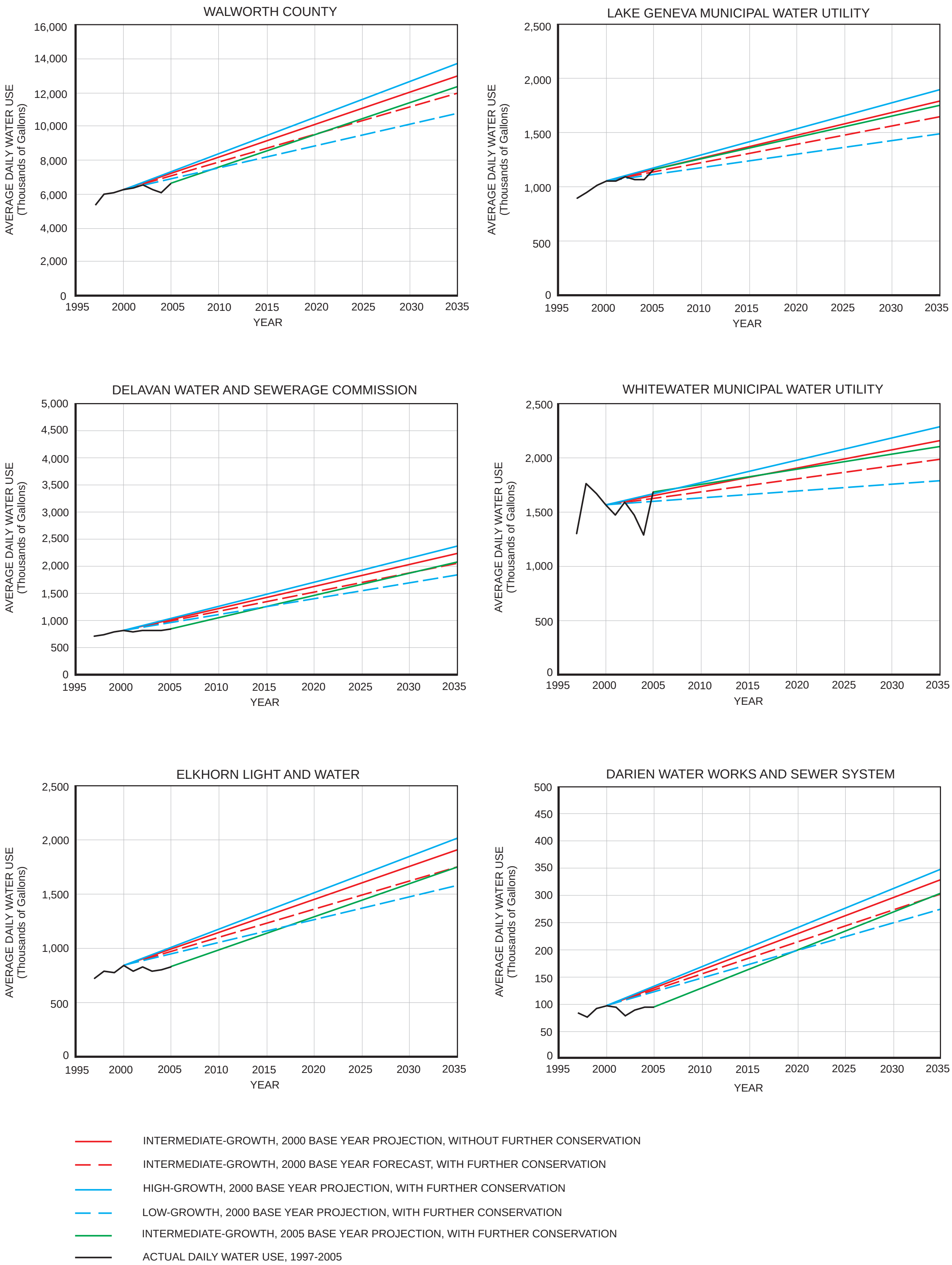
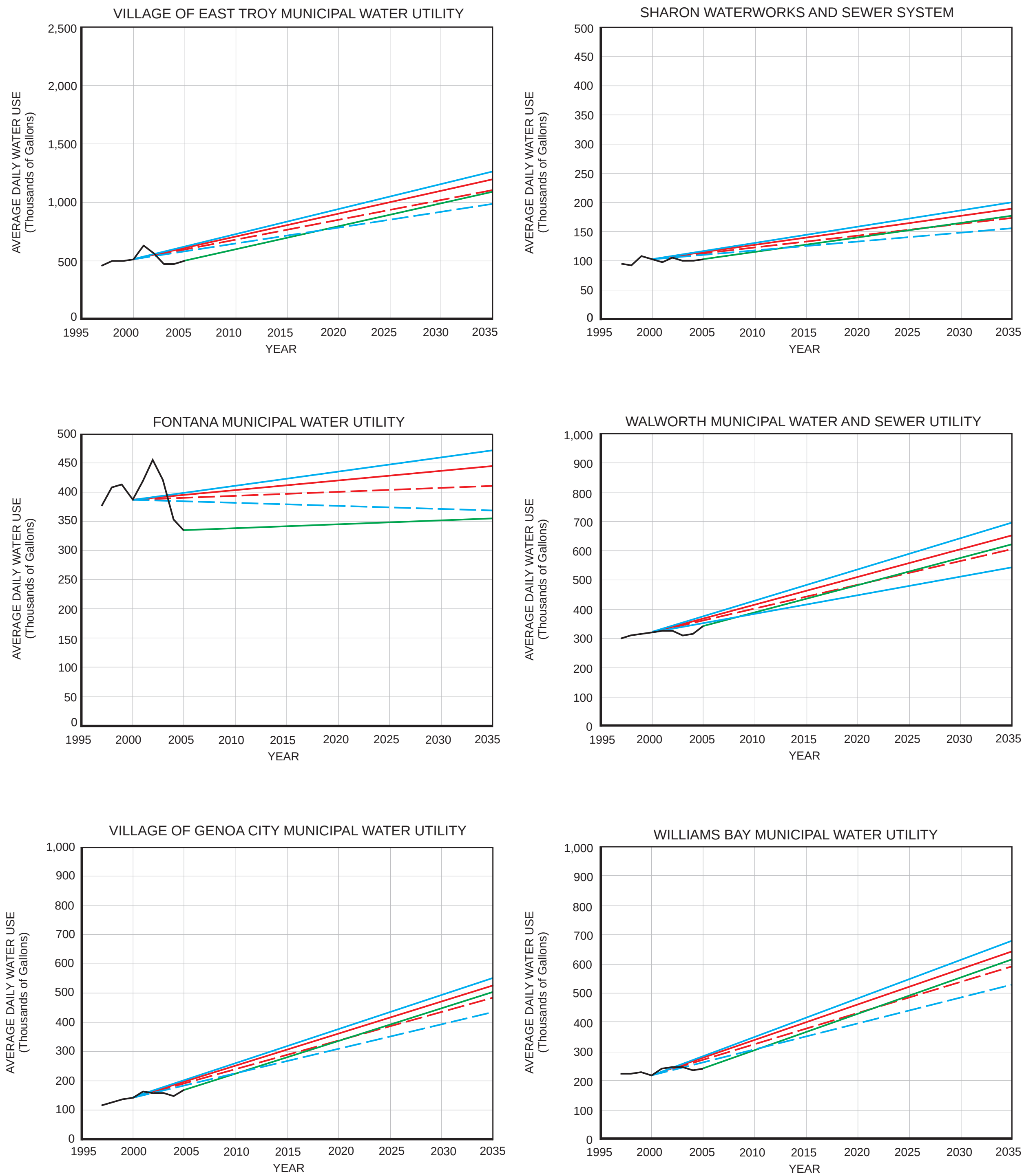


Figure 30 (continued)



INTERMEDIATE-GROWTH, 2000 BASE YEAR PROJECTION, WITHOUT FURTHER CONSERVATION

INTERMEDIATE-GROWTH, 2000 BASE YEAR FORECAST, WITH FURTHER CONSERVATION

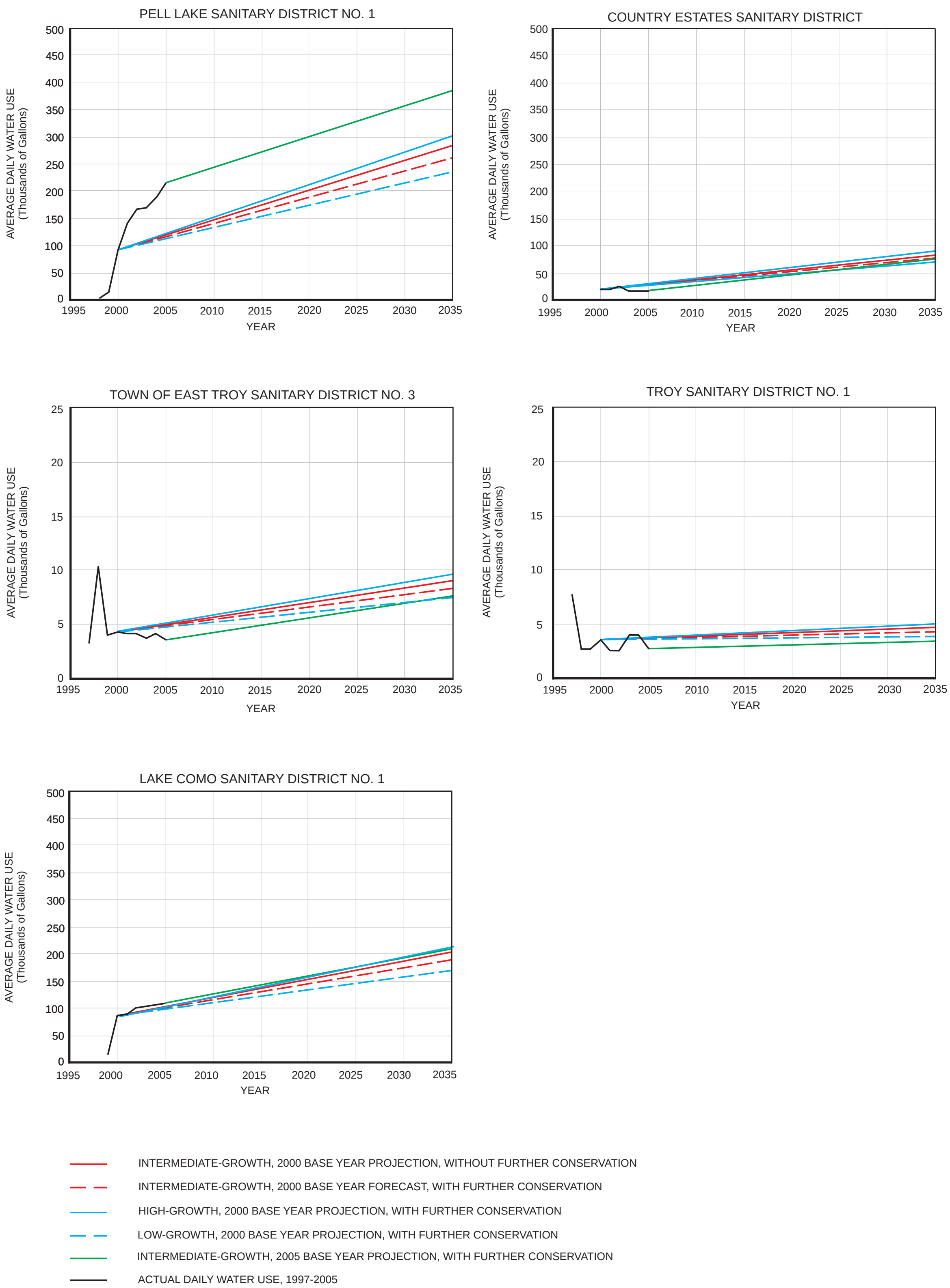
HIGH-GROWTH, 2000 BASE YEAR PROJECTION, WITH FURTHER CONSERVATION

LOW-GROWTH, 2000 BASE YEAR PROJECTION, WITH FURTHER CONSERVATION

INTERMEDIATE-GROWTH, 2005 BASE YEAR PROJECTION, WITH FURTHER CONSERVATION

ACTUAL DAILY WATER USE, 1997-2005

Figure 30 (continued)



Source: Public Service Commission and SEWRPC.

Figure 31

ACTUAL, PROJECTED, AND FORECAST AVERAGE DAILY WATER USE: WASHINGTON COUNTY

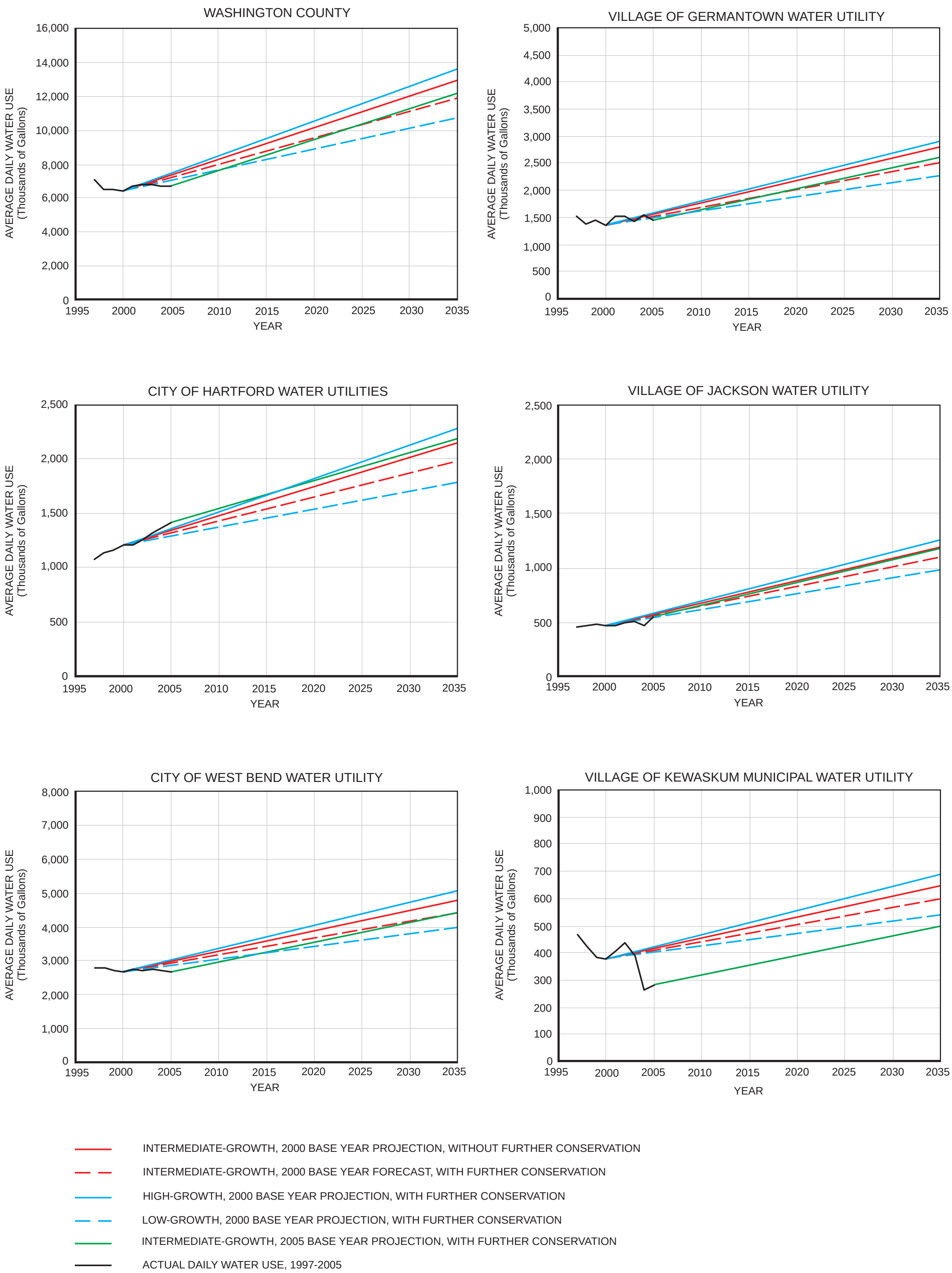
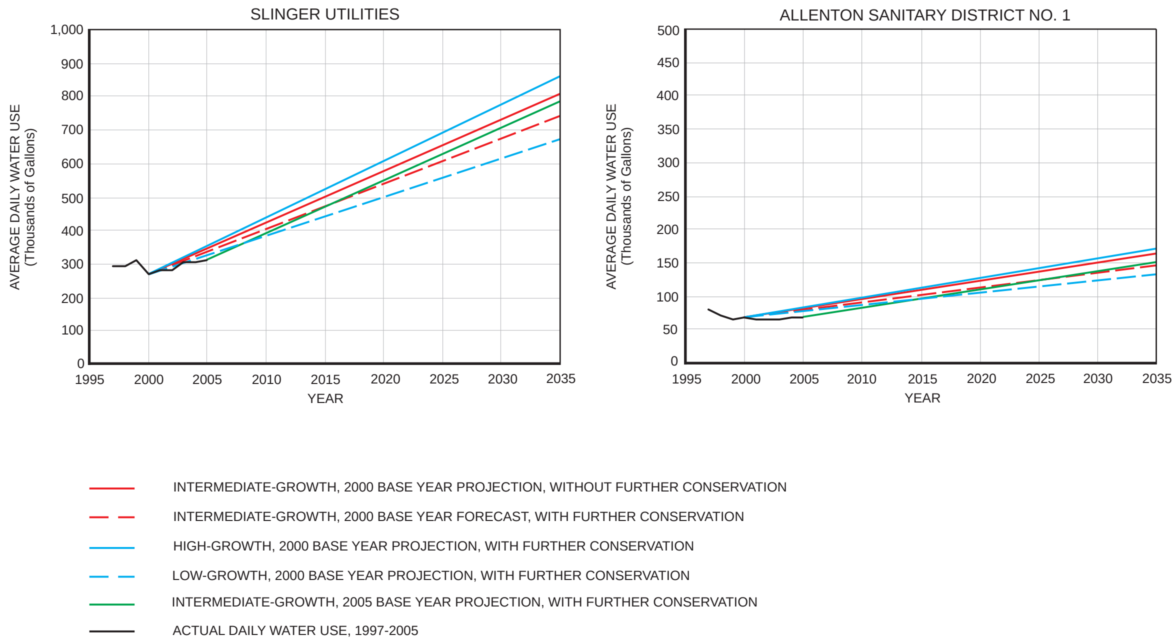


Figure 31 (continued)



Source: Public Service Commission and SEWRPC.

Based upon the anticipated changes in population and land use within each of the municipal water service areas, estimates were made of the probable future water use demands and pumpages for each utility, as summarized in Table 61. More detailed information on the development of the forecast water uses and pumpage is included in Table F-1 of Appendix F. The total water use demand on an average daily basis for the 10 municipal water utilities in Kenosha County is estimated to increase from about 11.0 mgd in 2000, to about 21.1 mgd in 2035. The corresponding pumpage is estimated to increase from about 14.9 mgd to about 27.8 mgd on an average daily basis; and from about 22.2 mgd to about 42.6 mgd on a maximum day basis. These pumpage estimates include water use demand based upon water sales, water used for production and system maintenance, and unaccounted-for water. These estimates of water use and pumpage serve as the basis for the design of the water supply systems envisioned under alternative plan conditions.

Figure 26 illustrates the forecast water use between the years 2000 and 2035 and the actual use between 1997 and 2005 for each municipal water supply system within Kenosha County and for the total municipal water use within the County. As already noted, the forecasts of 2035 water uses were developed based upon the intermediate-growth forecasts of land use and socioeconomic conditions set forth in the regional land use plan, year 2000 water use levels, and assumed further application of water conservation measures. As previously noted, alternative water use projections were prepared. These projections, together with the forecasts, are shown graphically in Figure 26. Review of Figure 26 indicates that the relationship of the forecast to actual municipal water use appears to be reasonable when considered at the County level. In the cases of the Village of Paddock Lake and Town of Bristol Utility Districts, and the Town of Somers Water Utility, the actual water use appears to be lagging the projected use between 2000 and 2005. This would be expected, given that these water supply systems are proposed to be expanded substantially over the planning period and that such expansion has been limited over the period 1997 to 2005. For all three of these utilities, the differences between the 2005 projected water use based upon the intermediate-growth scenario and the actual 2005 water use are 5 percent or less. Given this small difference, it was determined that the initial water use forecasts should be utilized for these utilities.

Figure 32

ACTUAL, PROJECTED, AND FORECAST AVERAGE DAILY WATER USE: WAUKESHA COUNTY

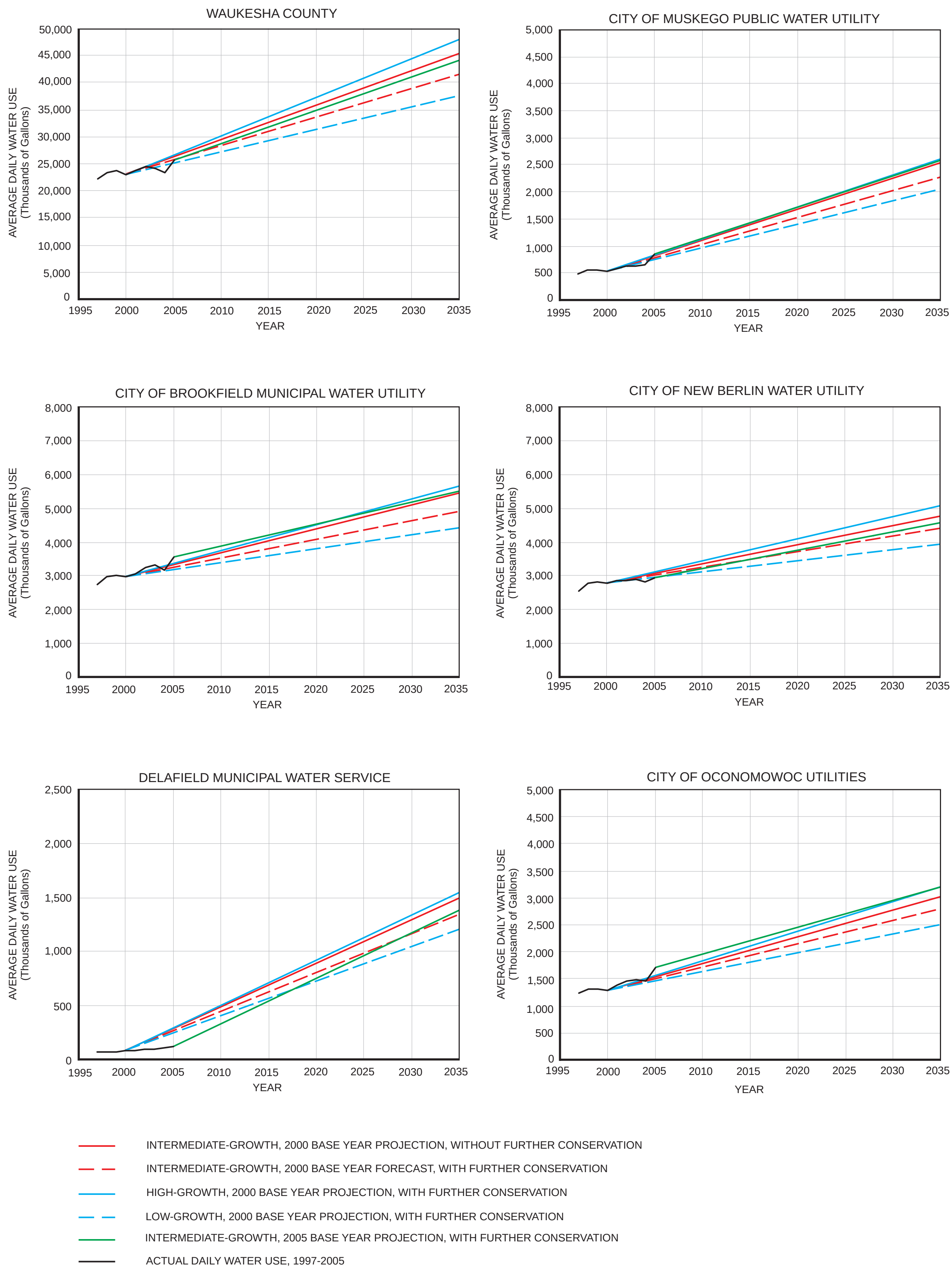


Figure 32 (continued)

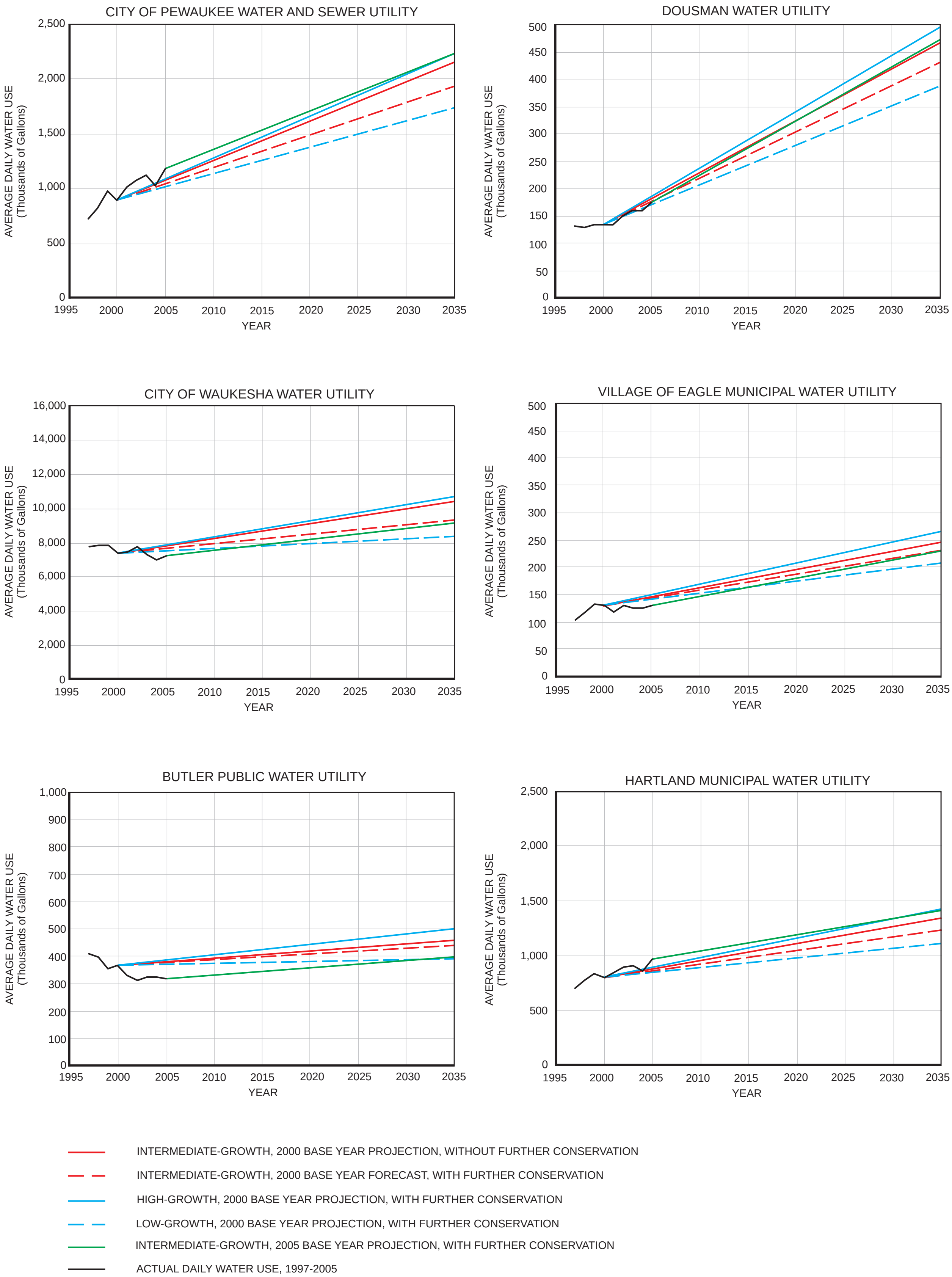
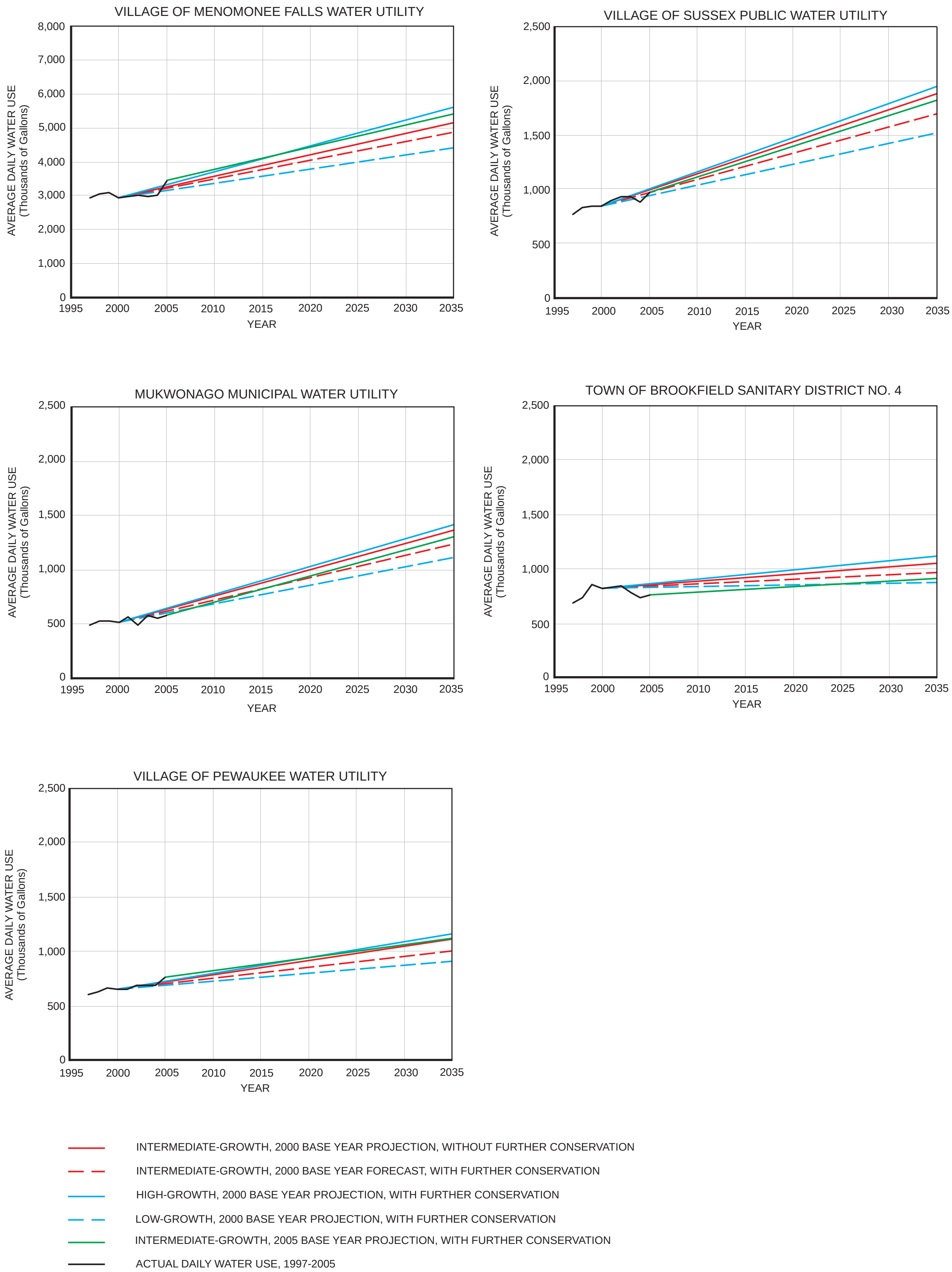


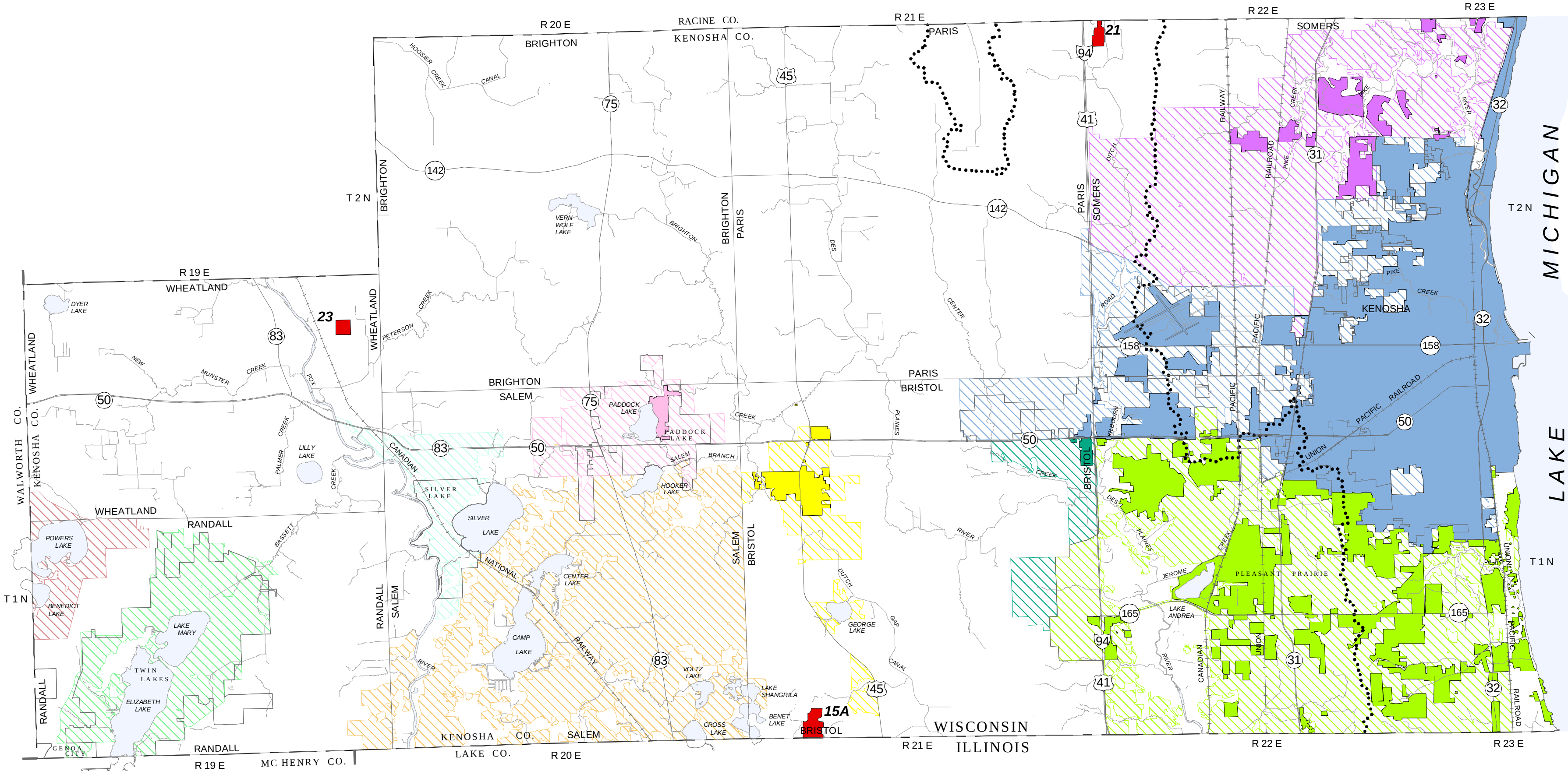
Figure 32 (continued)



Source: Public Service Commission and SEWRPC.

Map 53

EXISTING 2005 AND AREAS PROJECTED TO BE SERVED BY MUNICIPAL AND OTHER-THAN-MUNICIPAL COMMUNITY WATER SUPPLY SYSTEMS IN KENOSHA COUNTY: 2035



LEGEND

SURFACE WATER-SUPPLIED SYSTEMS AND SERVICE AREAS IN 2005

2005 2035

KENOSHA WATER UTILITY

PLEASANT PRAIRIE WATER UTILITY

TOWN OF SOMERS WATER UTILITY

TOWN OF BRISTOL UTILITY DISTRICT 3

SUBCONTINENTAL DIVIDE

GROUNDWATER-SUPPLIED SYSTEMS AND SERVICE AREAS IN 2005 -FUTURE RECOMMENDED SOURCES OF SUPPLY ARE NOT YET ESTABLISHED

2005 2035

PADDOCK LAKE MUNICIPAL WATER UTILITY

TOWN OF BRISTOL UTILITY DISTRICT 1

NEW WATER SUPPLY SYSTEMS AND SERVICE AREAS-FUTURE RECOMMENDED SOURCES OF SUPPLY ARE NOT YET ESTABLISHED

2035

POWERS-BENEDICT-TOMBEAU LAKES AREA

TOWN OF SALEM

VILLAGE OF SILVER LAKE

VILLAGE OF TWIN LAKES

23 AREA SERVED BY OTHER THAN MUNICIPAL, COMMUNITY WATER SYSTEMS USING GROUNDWATER. IDENTIFICATION NUMBER CORRESPONDS WITH APPENDIX G

GRAPHIC SCALE

0 1 2 3 4 Miles

0 5,000 10,000 15,000 20,000 Feet

Source: Water utilities and SEWRPC.

Table 60

MUNICIPAL WATER SUPPLY SERVICE AREA AND POPULATION FOR KENOSHA COUNTY: 2000-2035

Utility	Population				Area Served			
	2000 Population	2000-2035 Increment		2035 Population	2000 Area Served (square miles)	2000-2035 Increment		2035 Area Served (square miles)
		Population	Percent			Area (square miles)	Percent	
City of Kenosha Water Utility	98,700	11,200	11.3	109,900	21.3	10.4	48.8	31.7
Village of Paddock Lake Water Utility	1,000	4,000	400.0	5,000	0.2	2.9	145.0	3.1
Village of Pleasant Prairie Water Utility	7,900	22,650	286.7	30,550	6.0	20.0	333.3	26.0
Town of Bristol Utility District No. 1	1,100	3,800	345.5	4,900	0.7	2.3	328.6	3.0
Town of Bristol Utility District No. 3	200	0	0.0	200	0.1	1.8	1,800.0	1.9
Town of Somers Water Utility	2,100	13,250	631.0	15,350	1.5	14.8	986.7	16.3
Powers-Benedict-Tombeau Lakes Area[a] New Utility	- -	1,800	- -	1,800	- -	1.5	- -	1.5
Village of Silver Lake New Utility	- -	4,900	- -	4,900	- -	2.4	- -	2.4
Village of Twin Lakes New Utility	- -	9,400	- -	9,400	- -	6.1	- -	6.1
Town of Salem New Utility	- -	17,900	- -	17,900	- -	16.7	- -	16.7
Total	111,000	88,900	80.1	199,900	29.8	78.9	264.8	108.7

[a]*Limited to the portion of proposed Powers-Benedict-Tombeau Lakes service area within Kenosha County.*

Source: SEWRPC.

Table 61

MUNICIPAL WATER SUPPLY DEMAND AND PUMPAGE FOR KENOSHA COUNTY: 2000-2035

Utility	Year 2000			Year 2035		
	Average Water Use Demand (gallons per day X 1,000)[a]	Average Daily Pumpage (gallons per day X 1,000)[a]	Maximum Daily Pumpage (gallons per day X 1,000)[a]	Average Water Use Demand[b] (gallons per day X 1,000)	Average Daily Pumpage[b] (gallons per day X 1,000)	Maximum Daily Pumpage[b] (gallons per day X 1,000)
City of Kenosha Water Utility[c]	9,071	12,460	19,188[c]	10,228	14,050	21,186
Village of Paddock Lake Water Utility	57	72	181	421	535	1,458
Village of Pleasant Prairie Water Utility	1,382	1,703	1,822	4,142	5,104	6,947
Town of Bristol Utility District No. 1	193	226	346	573	672	1,239
Town of Bristol Utility District No. 3	13	15	26	815	940	1,814
Town of Somers Water Utility	295	371	608	1,697	2,135	3,428
Powers-Benedict-Tombeau Lakes Area	- -	- -	- -	261	352	527
Village of Silver Lake	- -	- -	- -	483	652	976
Village of Twin Lakes	- -	- -	- -	828	1,117	1,673
Town of Salem	- -	- -	- -	1,654	2,233	3,344
Total	11,011	14,847	22,171	21,102	27,790	42,592

[a]*Data based upon year 2000 Wisconsin Public Service Commission report data for water sales with the exception of Paddock Lake Water Utility and Town of Bristol Utility District Nos. 1 and 3 for which data were based upon year 2005 reports.*

[b]*See Appendix F for additional detail.*

[c]*City of Kenosha Water Utility data include estimates for the Utility's retail service area.*

Source: SEWRPC.

The data set forth in Tables 60 and 61 were developed on an individual water utility basis. The Kenosha Water Utility provides water to multiple utilities, including the Village of Pleasant Prairie Water Utility, the Town of Bristol Utility District No. 1, and the Town of Somers Water Utility. Data on the population and area served, as well as water use and pumpage for the entire Kenosha utility service area are provided in Table 62.

Residential Other-than-Municipal Community Systems

In 2035, it is expected that three of the privately owned, self-supplied, water systems operating in Kenosha County which provide water supply services primarily to enclaves of residential land uses housing about 1,000 residents, will remain in service. These systems serve mobile home parks located beyond the municipal water supply service areas. The other self-supplied systems which existed in 2005 are expected to be incorporated into expanded municipal systems. No new systems are currently known to be planned. The remaining three systems utilize groundwater provided by eight low-capacity wells as a source of supply. The location of these systems is shown on Map 53. Selected characteristics of these systems are presented in Table G-1 of Appendix G.

Industrial Water Supply Systems

In 2035, five privately owned, self-supplied, water systems may be expected to be in operation in Kenosha County which provide water for industrial land uses. Of these, one system is currently classified as a low-capacity system, while four are classified as high-capacity systems. These systems currently all utilize groundwater as a source of supply through three low-capacity and five high-capacity wells. The locations of these systems are shown on Map 54. Selected characteristics of each system are presented in Table G-2 of Appendix G.

Commercial Water Supply Systems

In 2035, 20 privately owned, self-supplied, water systems may be expected to be in operation in Kenosha County which provide water for commercial land uses. Of these, three are currently classified as high-capacity and 17 as low-capacity systems. These systems all currently utilize groundwater as a source of supply through two high-capacity wells and 20 low-capacity wells. The locations of these systems are shown on Map 54. Selected characteristics of each system are presented in Table G-3 of Appendix G.

Institutional and Recreational Water Supply Systems

In 2035, 19 privately owned, self-supplied, water systems may be expected to be in operation in Kenosha County which provide water for institutional and recreational land uses. Of these, six are currently classified as high-capacity s and 13 as low-capacity well systems. These systems all currently utilize groundwater as a source of supply through 32 low-capacity wells, and four high-capacity wells. The locations of these systems are shown on Map 54. Selected characteristics of each system are presented in Table G-4 of Appendix G.

Agricultural Water Supply Systems

In 2035, four privately owned, self-supplied, water systems may be expected to be in operation in Kenosha County which provide water for irrigation and other purposes for agricultural land uses. All four systems are currently categorized as high-capacity and all utilize groundwater as a source of supply through eight high-capacity wells. The locations of these systems are shown on Map 54. Selected characteristics of each system are presented in Table G-5 of Appendix G.

Irrigation Water Supply Systems

In 2035, seven privately owned, self-supplied, water systems may be expected to be in operation in Kenosha County which provide irrigation water for land uses other than agricultural uses, such as golf courses. All seven systems are currently categorized as high-capacity systems and all utilize groundwater as a source of supply through 15 high-capacity wells. The locations of these systems are shown on Map 54. Selected characteristics of each system are presented in Table G-6 of Appendix G.

Thermoelectric-Power-Generation Water Supply Systems

In 2035, two existing privately owned, self-supplied, water systems may be expected to be in operation in Kenosha County which provide cooling water for thermoelectric-power-generation facilities. These facilities

Table 62

WATER SUPPLY SERVICE AREA, POPULATION, WATER DEMAND AND PUMPAGE FOR MUNICIPAL UTILITIES PROVIDING WATER TO MULTIPLE SYSTEMS IN KENOSHA COUNTY: 2000-2035

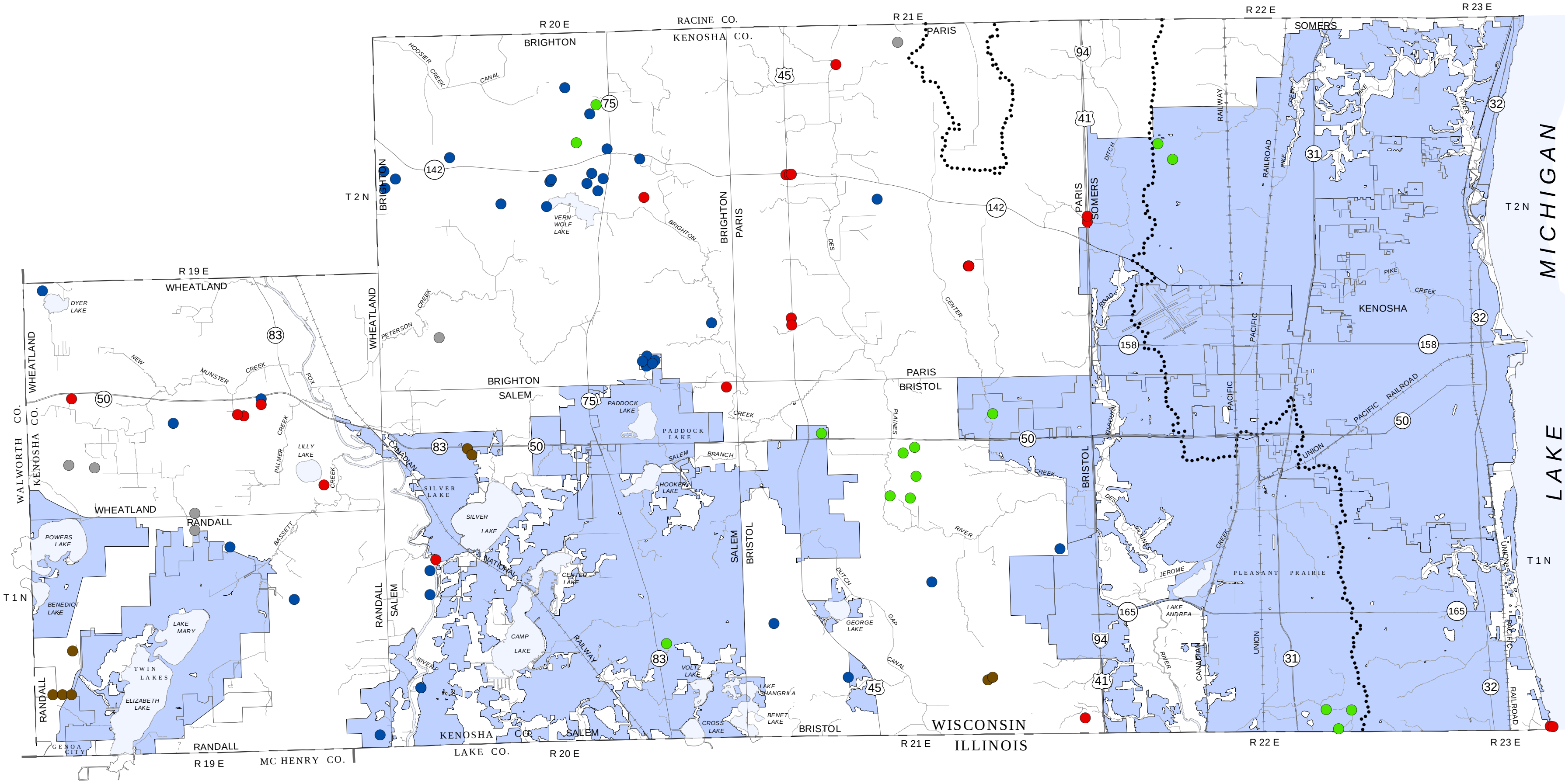
Utility	2000 Population	2035 Population	2000 Area Served (square miles)	2035 Area Served (square miles)	Water Demand					
					Year 2000			Year 2035		
					Average Water Use Demand (gallons per day X 1,000)	Average Daily Pumpage (gallons per day X 1,000)	Maximum Daily Pumpage (gallons per day X 1,000)	Average Water Use Demand (gallons per day X 1,000)	Average Daily Pumpage[b] (gallons per day X 1,000)	Maximum Daily Pumpage (gallons per day X 1,000)
Kenosha Water Utility Service Area[a].....	108,900	156,000	28.9	75.9	10,761	14,549	21,644	16,882	22,229	33,375

[a] *Includes City of Kenosha Water Utility, Village of Pleasant Prairie Water Utility, Town of Bristol Utility District No. 3, and Town of Somers Water Utility.*

Source: SEWRPC.

Map 54

PROJECTED SELF-SUPPLIED INDUSTRIAL, COMMERCIAL, INSTITUTIONAL AND RECREATIONAL, AGRICULTURAL, AND IRRIGATION WATER SUPPLY SYSTEMS IN KENOSHA COUNTY: 2035



LEGEND

SELF-SUPPLIED WATER SYSTEM WELLS

- INDUSTRIAL
- COMMERCIAL
- INSTITUTIONAL AND RECREATIONAL
- IRRIGATION
- AGRICULTURAL

AREA PROPOSED TO BE SERVED BY PUBLIC WATER UTILITY

SUBCONTINENTAL DIVIDE

NOTE: The self-supplied water systems shown on this map include wells defined as Non-Community Transient and Non-Transient, and all Non-Community High-Capacity wells expected to remain through the plan design year 2035. The well locations shown on this map are approximate. More specific information on the number and location of self-supplied water systems is available from the Wisconsin Department of Natural Resources.

GRAPHIC SCALE

0 1 2 3 4 Miles

0 5,000 10,000 15,000 20,000 Feet

Source: Wisconsin Department of Natural Resources and SEWRPC.

consist of the Pleasant Prairie Power Plant, a coal-based generating facility located in the Village of Pleasant Prairie, and the Paris Generating Station, a combustion turbine generating facility in the Town of Paris. Currently, the Pleasant Prairie Power Plant uses about 11 million gallons of water per day obtained from Lake Michigan, the majority of this water being used as make-up water for evaporation losses in the plant cooling tower system. Nearly 75 percent of the water used at this facility is evaporated to the atmosphere. The Paris Generating Station facility uses groundwater obtained through one well finished in the deep sandstone aquifer which has a maximum capacity of 600 gallons per minute. The amount of water used varies annually depending upon the need for the intermittent operation of the peaking facility; the water use estimated at the time of permitting was 36,000 gallons per day. At the Paris Generating Station the water is used primarily for: 1) water spray injection into the combustion turbines for control of nitrogen oxides; and 2) an inlet air cooling system, used to enhance the combustion turbine generating capacity during warmer weather, which system cools the intake air by passing it over coils containing recirculating cold water produced in an onsite refrigeration system.

Self-Supplied Residential Water Systems

In 2035, about 9,200 persons, or about 4 percent of the total resident year 2035 population of Kenosha County, may be expected to be served by private domestic wells. As shown on Map 53, areas totaling about 170 square miles may be expected to exist outside of the planned 2035 municipal water utility service areas within Kenosha County. Assuming an average use of 65 gallons per capita per day, these private domestic wells would withdraw about 0.60 million gallons per day from the shallow groundwater aquifer. The households served by private domestic wells may also be expected to be served by onsite sewage treatment and disposal systems. Thus, the majority—approximately 90 percent—of the water withdrawn by private wells, or about 0.54 million gallons per day, may be expected to be returned to the groundwater aquifer via onsite sewage disposal systems.

FORECAST OF WATER USE—MILWAUKEE COUNTY

Municipal Water Supply Systems

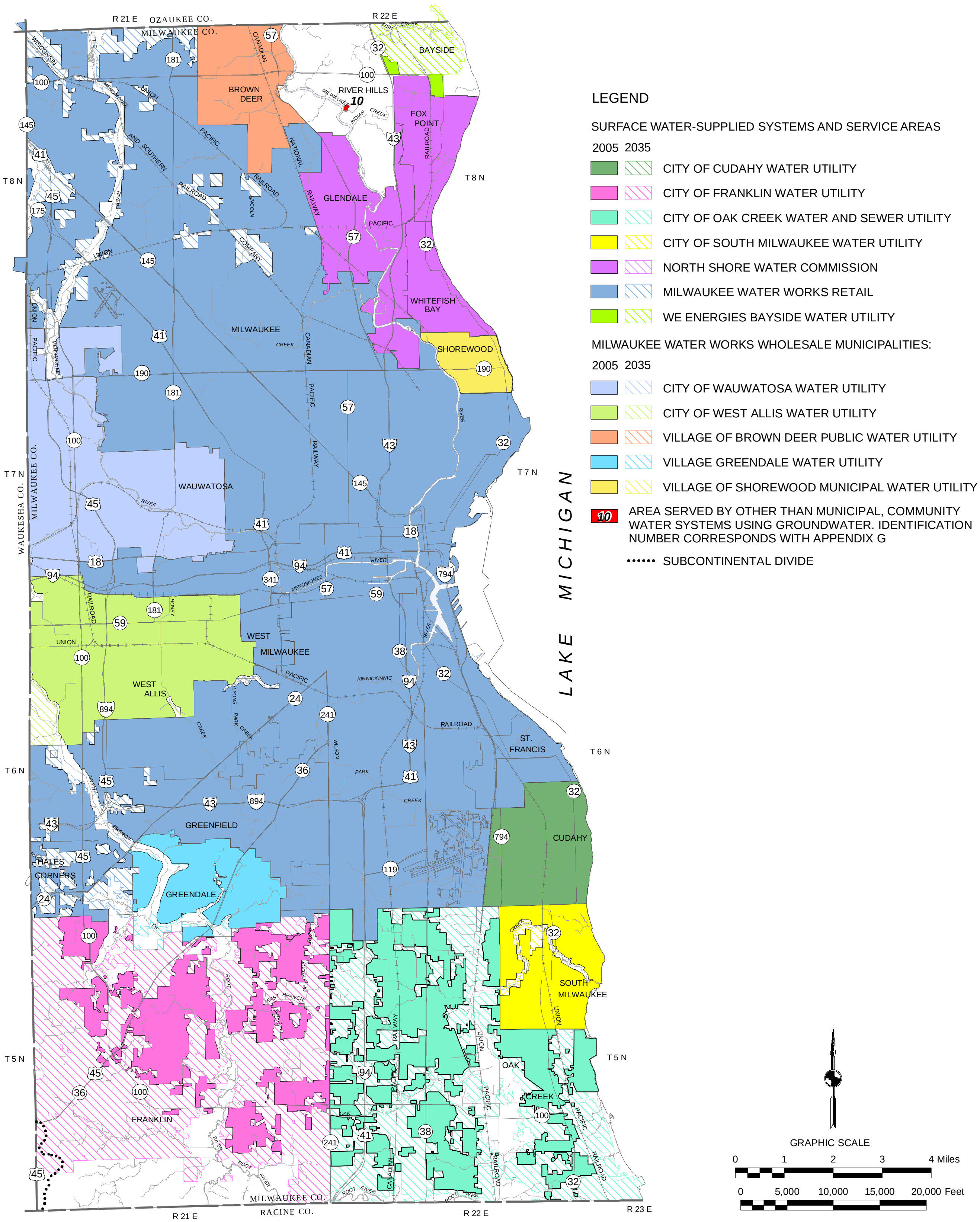
In 2000, there were 14 municipal water supply utility systems operating in Milwaukee County, as shown on Map 55. By the year 2035, each of these municipal utility water service areas in Milwaukee County is projected to either experience an increase in service area and water demand, or to have a water demand similar to that currently being experienced. As presented in Table 63, the year 2000 total resident population served by municipal water utilities in Milwaukee County was about 917,000, or about 97 percent of the 940,200 total population of the County. In 2035, the total population projected to be served by municipal water utilities is expected to increase to just over one million residents, or over 99 percent of the 2035 population of 1,007,100.

The area served by municipal water supply systems within Milwaukee County is expected to increase by about 22 percent between 2000 and 2035, from about 179 square miles in 2000 to about 219 square miles in 2035. About 80 percent of the increase in water supply service area is due to the expected expansion of the municipal water service areas in the Cities of Franklin and Oak Creek. Table 63 sets forth the forecast changes in population and service area expected for the 14 municipal water service areas in Milwaukee County for the plan design year 2035.

Based upon the anticipated changes in population and land use within each of the municipal water service areas, estimates were made of the probable future water use demands and pumpage for each utility, as summarized in Table 64. More detailed information on the development of the forecast water uses and pumpage is included in Table F-2 of Appendix F. The total water use demand on an average daily basis for the 14 municipal water utilities in Milwaukee County is estimated to increase from about 125 mgd in 2000, to about 132 mgd in 2035. The corresponding pumpage is estimated to increase from about 139 mgd to about 147 mgd on an average daily basis; and from about 204 mgd to about 222 mgd on a maximum day basis. These pumpage estimates include water use demand based upon water sales, water used for production and system maintenance, and unaccounted-for water. These estimates of water use and pumpage serve as the basis for the design of the water supply systems envisioned under alternative plan conditions, as set forth in Chapter VIII of this report.

Map 55

EXISTING 2005 AND AREAS PROJECTED TO BE SERVED BY MUNICIPAL AND OTHER-THAN-MUNICIPAL COMMUNITY WATER SUPPLY SYSTEMS IN MILWAUKEE COUNTY: 2035



Source: Water utilities and SEWRPC.

Table 63

MUNICIPAL WATER SUPPLY SERVICE AREA AND POPULATION FOR MILWAUKEE COUNTY: 2000-2035

Utility	Population				Area Served			
	2000 Population	2000-2035 Increment		2035 Population	2000 Area Served (square miles)	2000-2035 Increment		2035 Area Served (square miles)
		Population	Percent			Area (square miles)	Percent	
City of Cudahy Water Utility............	18,450	400	2.2	18,850	4.7	0.0	0.0	4.7
City of Franklin Water Utility	16,900	33,250	196.7	50,150	8.2	19.4	236.6	27.6
City of Glendale Water Utility..........	13,350	4,000	30.0	17,350	5.8	0.0	0.0	5.8
City of Milwaukee Water Works.......	650,750	13,800	2.1	664,550	105.4	5.4	5.1	110.8
City of Oak Creek Water and Sewer Utility.........................	26,000	24,850	95.6	50,850	11.8	13.0	110.2	24.8
City of South Milwaukee Water Utility	21,250	600	2.8	21,850	4.2	0.0	0.0	4.2
City of Wauwatosa Water Utility	47,300	3,450	7.3	50,750	12.8	0.0	0.0	12.8
City of West Allis Water Utility	61,250	3,400	5.6	64,650	10.6	0.7	6.6	11.3
We Energies-Water Services	550	3,650	663.6	4,200	0.3	1.5	500.0	1.8
Village of Brown Deer Public Water Utility.......................	12,200	-400	-3.3	11,800	4.4	0.0	0.0	4.4
Village of Fox Point Water Utility	7,000	-900	-12.9	6,100	2.8	0.0	0.0	2.8
Village of Greendale Water Utility....	14,400	-900	-6.2	13,500	4.3	0.3	7.0	4.6
Village of Shorewood Municipal Water Utility	13,750	1,100	8.0	14,850	1.6	0.0	0.0	1.6
Village of Whitefish Bay Water Utility	14,150	600	4.2	14,750	2.2	0.0	0.0	2.2
Total	917,300	86,900	9.6	1,004,200	179.1	40.3	22.5	219.4

Source: SEWRPC.

Figure 27 illustrates the forecast water use between the years 2000 and 2035 and, where applicable, the actual use between 1997 and 2005 for each municipal water supply system within Milwaukee County and for the total municipal water use within the County. As already noted, the forecasts of 2035 water uses were developed based upon the intermediate-growth forecasts of land use and socioeconomic conditions set forth in the regional land use plan, year 2000 water use levels, and assumed further application of water conservation measures. As previously described, alternative water use projections were prepared. These projections, together with the forecasts, are shown graphically in Figure 27. Review of Figure 27 indicates that the actual water uses are lagging the forecast water uses for several of the water utilities, including the City of Cudahy Water Utility, the Milwaukee Water Works, the City of South Milwaukee Water Utility, the City of Wauwatosa Water Utility, and the City of West Allis Water Utility. As already noted, the primary reason the variations appear to be reductions in industrial water use over the period 2000 through 2005, which were not offset by small increases in residential water use. In the case of the City of Milwaukee Water Works and the City of West Allis Water Utility, there were also small reductions in commercial water use over the period 2000 through 2005. Some of this reduction for the City of Milwaukee Water Works was offset by the addition of wholesale water customers located outside of Milwaukee County. Based upon review of the alternative future condition forecasts and projections shown in Figure 27, a case could be made for selected communities to use a 2035 water use forecast based upon the intermediate-growth future condition scenario applied to the 2005 water use as a base, rather than to the 2000 water use. This would result in forecasts of water use that would be 4 to 12 percent lower than the forecasts initially indicated. In this respect, it should be noted that the industrial portion of water use in Milwaukee County has declined from about 27 percent to 20 percent of the total water use over the period from 2000 through 2005. A further significant reduction in the industrial portion of the water use is probably unlikely to occur. In addition, as

Table 64

MUNICIPAL WATER SUPPLY DEMAND AND PUMPAGE FOR MILWAUKEE COUNTY: 2000-2035

Utility	Year 2000			Year 2035		
	Average Water Use Demand (gallons per day X 1,000)[a]	Average Daily Pumpage (gallons per day X 1,000)[a]	Maximum Daily Pumpage (gallons per day X 1,000)[a]	Average Water Use Demand[b] (gallons per day X 1,000)	Average Daily Pumpage[b] (gallons per day X 1,000)	Maximum Daily Pumpage[b] (gallons per day X 1,000)
City of Cudahy Water Utility............	4,416	4,800	6,565	4,394	4,777	6,010
City of Franklin Water Utility	1,618	1,797	4,686	5,294	5,947	12,795
City of Glendale Water Utility..........	2,013	2,092	3,860	2,262	2,350	4,725
City of Milwaukee Water Works[c].....	92,916	103,023	147,014	93,561	103,738	145,074
City of Oak Creek Water and Sewer Utility[d].......................	3,969	4,755	9,510	6,382	7,646	14,973
City of South Milwaukee Water Utility	2,003	2,666	3,635	1,963	2,613	4,251
City of Wauwatosa Water Utility	5,699	6,243	8,148	5,984	6,556	10,997
City of West Allis Water Utility	6,307	6,948	9,082	6,264	6,900	10,009
We Energies-Water Services	46	67	171	335	488	793
Village of Brown Deer Public Water Utility......................	1,417	1,545	2,561	1,463	1,595	2,979
Village of Fox Point Water Utility	753	764	1,680	686	697	1,117
Village of Greendale Water Utility....	1,265	1,338	2,550	1,247	1,319	3,527
Village of Shorewood Municipal Water Utility	1,116	1,253	2,080	1,156	1,298	2,110
Village of Whitefish Bay Water Utility	1,294	1,321	2,280	1,326	1,353	3,012
Total	124,832	138,612	203,822	132,317	147,277	222,372

[a] *Data based upon year 2000 Wisconsin Public Service Commission report data for water sales with the exception of City of Glendale Water Utility and Village of Fox Point Water Utility for which data were based upon year 1999 reports.*

[b] *See Appendix F for more detail.*

[c] *City of Milwaukee Water Works data include estimate for the Utility's retail service area.*

[d] *City of Oak Creek Water and Sewer Utility data include estimate for the Utility's retail service area.*

Source: SEWRPC.

already noted, the regional land use plan seeks to promote a vibrant industrial and commercial economy in the central cities of the Region where water use has declined. That plan envisions increased employment levels in Milwaukee County from 2005 to 2035. It was, therefore, considered desirable to plan for a water supply system which would be capable of supporting an increase in the industrial base within the areas where that base has eroded. Accordingly, it was determined that the initial water use forecasts were to be utilized for regional water supply plan planning purposes.

The data set forth in Tables 63 and 64 were developed on an individual water utility basis. The City of Milwaukee Water Works, City of Oak Creek Water and Sewer Utility, and the North Shore Water Commission provide water to multiple utilities. Data on the population and area served, as well as water use and pumpage for the entire service areas of each of these three water providers are provided in Table 65.

Residential and Other-than-Municipal Community Systems

In 2035, it is expected that there will be one remaining privately owned, self-supplied, water system operating in Milwaukee County which provides water supply services to primarily residential land uses. That remaining

Table 65

MUNICIPAL WATER SUPPLY SERVICE AREA, POPULATION, WATER DEMAND AND PUMPAGE FOR UTILITIES PROVIDING WATER TO MULTIPLE SYSTEMS IN MILWAUKEE COUNTY: 2000-2035

					Water Demand					
					Year 2000			Year 2035		
Utility	2000 Population	2035 Population	2000 Area Served (square miles)	2035 Area Served (square miles)	Average Water Use Demand (gallons per day X 1,000)[a]	Average Daily Pumpage[a] (gallons per day X 1,000)	Maximum Daily Pumpage[b] (gallons per day X 1,000)	Average Water Use Demand[b] (gallons per day X 1,000)	Average Daily Pumpage[b] (gallons per day X 1,000)	Maximum Daily Pumpage[b] (gallons per day X 1,000)
City of Milwaukee Water Works[a]	834,900	906,300	156.7	187.2	113,853	127,068	181,672	119,253	133,911	194,589
City of Oak Creek Water and Sewer Utility[b]	48,100	107,200	21.6	54.9	5,997	7,049	15,521	12,208	14,235	29,223
North Shore Water Commission[c]	35,050	42,400	10.8	10.8	4,106	4,244	7,991	4,609	4,888	9,647

[a] *Includes City of Milwaukee Water Works retail service area, Village of West Milwaukee, City of West Allis Water Utility, City of Wauwatosa Water Utility, Village of Brown Deer Water Utility, Village of Greendale Water Utility, Village of Shorewood Municipal Water Utility, a portion of the City of New Berlin Water Utility, the Village of Butler, a portion of the Village of Menomonee Falls, and a portion of the City of Mequon and Village of Thiensville provided by We Energies-Water Services.*

[b] *Includes the City of Oak Creek Water Utility retail service area, the City of Franklin Water Utility, the Caddy Vista Sanitary District, the Crestview Sanitary District, and a portion of the North Park Sanitary District No. 1.*

[c] *Includes the City of Glendale Water Utility, the Village of Fox Point Water Utility, the Village of Whitefish Bay Water Utility, and a portion of the Village of Bayside provided by the We Energies-Water Services.*

Source: SEWRPC.

self-supplied system provides service to a private residence and is classified as a high-capacity system with three wells.

Industrial Water Supply Systems

In 2035, five privately owned, self-supplied, water systems may be expected to be in operation in Milwaukee County which provide water for industrial land uses. Of these, two systems are currently classified as low-capacity systems, while three are classified as high-capacity systems. These systems currently all utilize groundwater as a source of supply through three low-capacity and three high-capacity wells. The locations of these systems are shown on Map 56. Selected characteristics of each system are presented in Table G-2 of Appendix G.

Commercial Water Supply Systems

In 2035, two privately owned, self-supplied, water systems may be expected to be in operation in Milwaukee County which provide water for commercial land uses. Both of these systems are classified as low-capacity systems. Both systems use groundwater as a source of supply through three low-capacity wells. The locations of these systems are shown on Map 56. Selected characteristics of these systems are presented in Table G-3 of Appendix G.

Institutional and Recreational Water Supply Systems

In 2035, 15 privately owned, self-supplied, water systems may be expected to be in operation in Milwaukee County which provide water for institutional and recreational land uses. Of these, six are currently classified as high-capacity systems, while nine are classified as low-capacity systems. These systems all currently utilize groundwater as a source of supply through 11 low-capacity wells, and eight high-capacity wells. The locations of these systems are shown on Map 56. Selected characteristics of each system are presented in Table G-4 of Appendix G.

Agricultural Water Supply Systems

In 2035, there are expected to be no privately owned, self-supplied, water systems operating in Milwaukee County which provide water for irrigation and other purposes for agricultural land uses. No such systems were in operation in Milwaukee County in 2005.

Irrigation Water Supply Systems

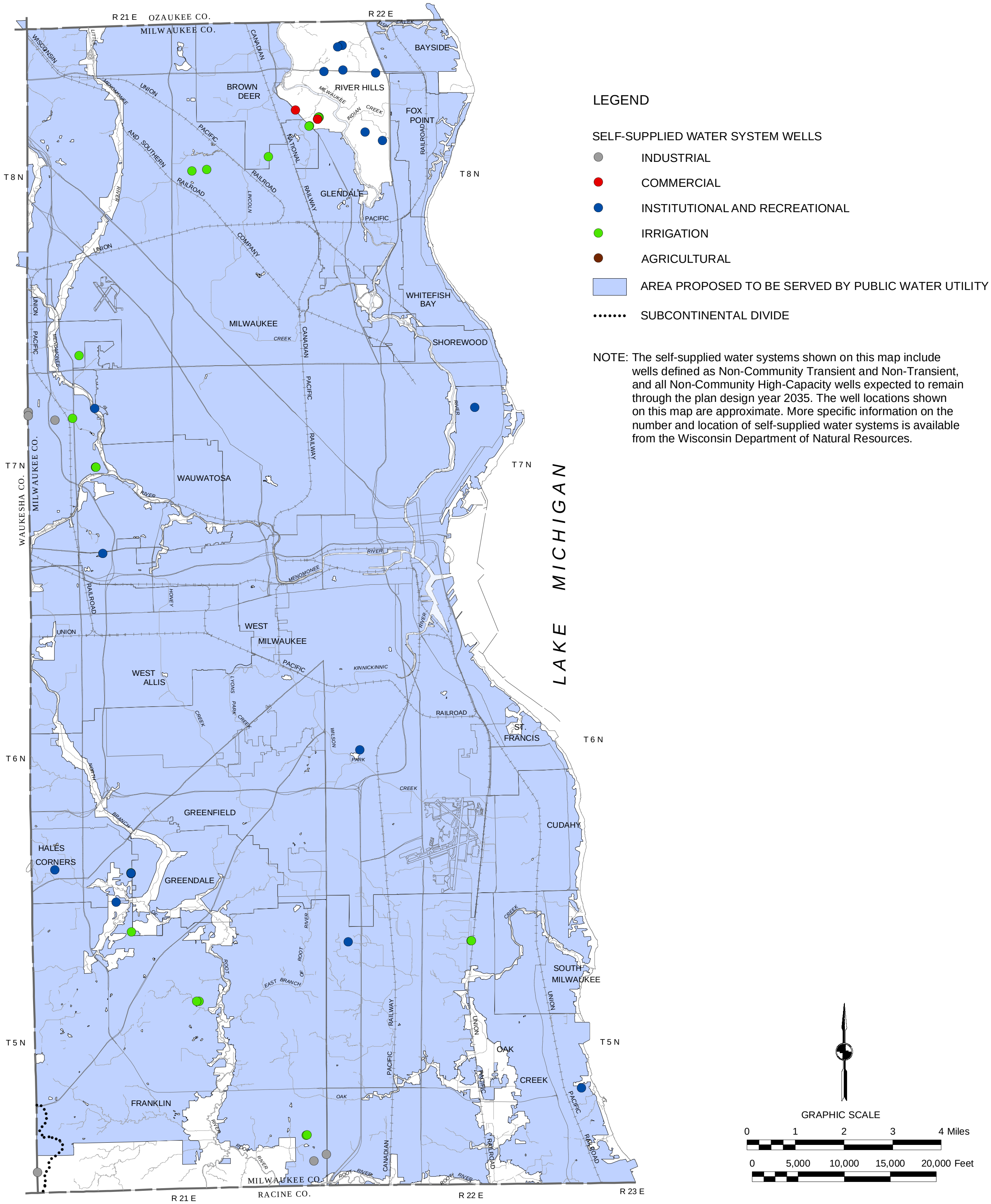
In 2035, 13 privately owned, self-supplied, water systems may be expected to be in operation in Milwaukee County which provide irrigation water for land uses other than agricultural uses, such as golf courses. All 13 systems are currently categorized as high-capacity systems and all utilize groundwater as a source of supply through 21 high-capacity wells. The locations of these systems are shown on Map 56. Selected characteristics of each system are presented in Table G-6 of Appendix G.

Thermoelectric-Power-Generation Water Supply Systems

In 2035, three existing privately owned, self-supplied, water systems may be expected to be in operation in Milwaukee County which provide cooling water for thermoelectric-power-generation facilities. These three facilities consist of the Valley Power Plant located in the City of Milwaukee, the Milwaukee County Power Plant located on the Milwaukee County grounds in the City of Wauwatosa, and the Oak Creek Power Plant. The Valley Power Plant is a co-generation facility, providing both electricity and steam for the City of Milwaukee's heating system. The Valley Power Plant circulates about 160 million gallons of water per day obtained from the Menomonee River and returned to the South Menomonee Canal. The Milwaukee County Power Plant is a co-generation facility, providing steam and chilled water and some electric power to the Milwaukee Regional Medical Center. The Milwaukee County Power Plant utilizes purchased surface water. Water use at the plant is relatively low due to its size and the use of closed loop cooling towers. The existing Oak Creek Power Plant draws cooling water from Lake Michigan and uses an open cycle cooling system which passes the water through heat exchangers and then returns the water to its source. The plant is authorized by WDNR permit to utilize 1.8 billion gallons per day of Lake water. The power plant is currently undergoing an expansion and is expected to

Map 56

PROJECTED SELF-SUPPLIED INDUSTRIAL, COMMERCIAL, INSTITUTIONAL AND RECREATIONAL, AGRICULTURAL, AND IRRIGATION WATER SUPPLY SYSTEMS IN MILWAUKEE COUNTY: 2035



Source: Wisconsin Department of Natural Resources and SEWRPC.

use up to 2.2 billion gallons per day upon completion of that expansion. Nearly all the water withdrawn is returned to the Lake with a very small percentage being used for various power plant components other than heat exchange, such as air pollutant emission reduction equipment.

Self-Supplied Residential Water Systems

In 2035, about 3,000 persons, or less than 0.3 percent of the total resident year 2035 population of Milwaukee County, may be expected to be served by private domestic wells. As shown on Map 55, areas totaling about 59 square miles may be expected to exist outside of the planned 2035 municipal water utility service areas within Milwaukee County. Assuming an average use of 65 gallons per capita per day, these private domestic wells would withdraw about 0.20 million gallons per day from the shallow groundwater aquifer. The households served by private domestic wells may also be expected to be served by onsite sewage treatment and disposal systems. Thus, the majority—approximately 90 percent—of the water withdrawn by private wells, or about 0.18 million gallons per day, would be expected to be returned to the groundwater aquifer via onsite sewage disposal systems.

FORECAST OF WATER USE—OZAUKEE COUNTY

Municipal Water Supply Systems

In 2000, there were seven municipal water supply utility systems operating in Ozaukee County, as shown on Map 57. By the year 2035, each of these municipal utility water service areas in Ozaukee County is projected to experience an increase in service area and water demand. In addition to the seven existing municipal water utilities in Ozaukee County, one additional municipal water supply system may be developed by 2035 to serve the Town of Fredonia-Waubeka Area. In addition, a small portion of the planned Village of Newburg service area is located within Ozaukee County. As presented in Table 66, the year 2000 total resident population served by municipal water utilities in Ozaukee County was about 45,400, or about 55 percent of the 82,300 total population of the County. In 2035, the total population projected to be served by municipal water utilities is expected to increase by about 41,400 to about 86,800 residents, or about 86 percent of the 2035 population of 101,100.

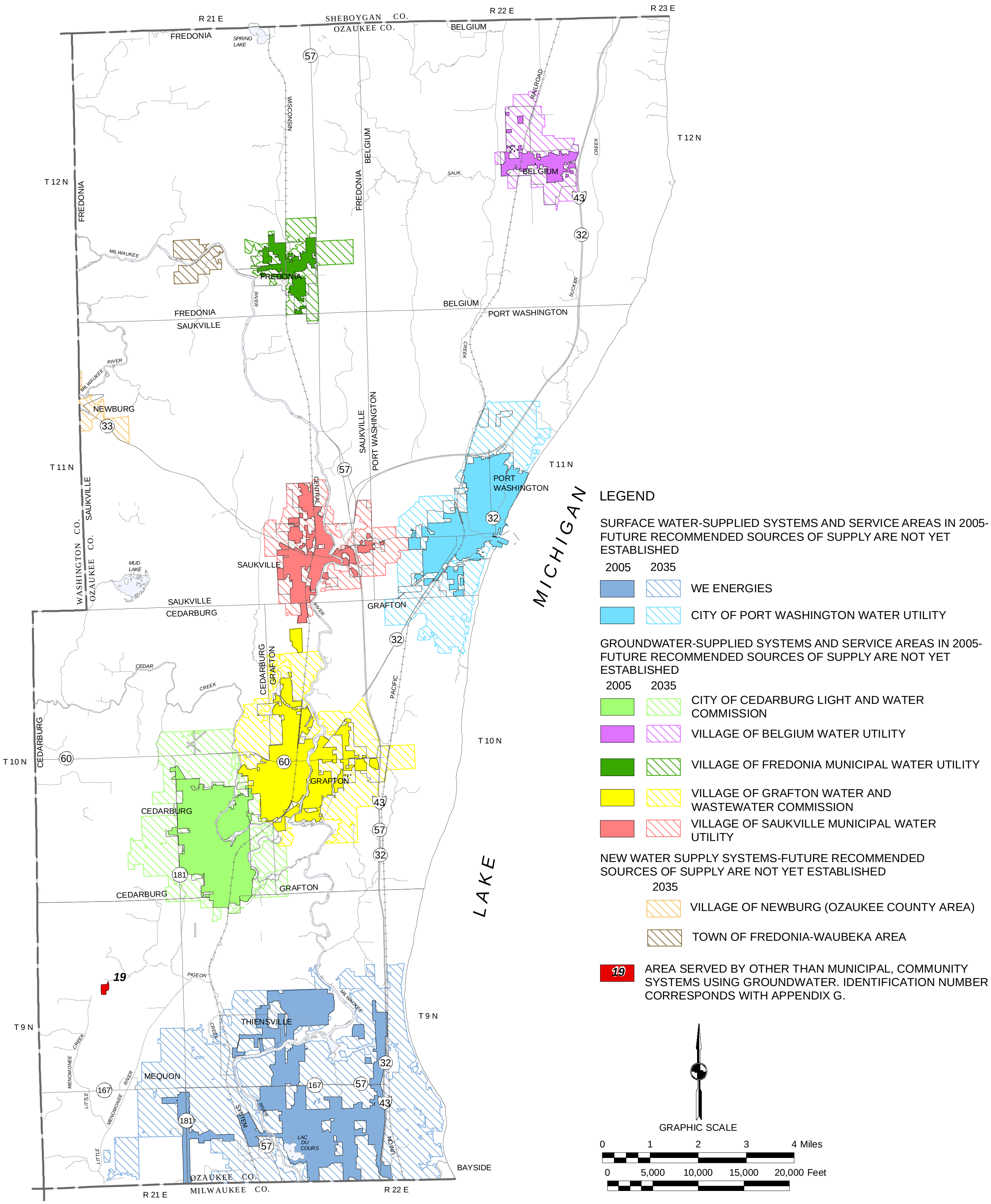
The area served by municipal water supply systems within Ozaukee County is expected to increase by about 198 percent between 2000 and 2035, from about 17.5 square miles in 2000 to about 52.1 square miles in 2035. Just over 50 percent of the increase in water supply service area is due to the anticipated expansion of We Energies-Water Services system serving major portions of the City of Mequon. Another significant portion of the increase in urban land served is due to expansion of existing municipal water service into developed areas currently served by self-supplied water systems. Table 66 sets forth forecast changes in population and service area expected for the nine existing and potential planned municipal water service areas in Ozaukee County for the plan design year 2035.

Based upon the anticipated changes in population and land use within each of the municipal water service areas, estimates were made of the probable future water use demands and pumpage for each utility, as summarized in Table 67. More detailed information on the development of the forecast water uses and pumpage is included in Table F-3 of Appendix F. The total water use demand on an average daily basis for the seven municipal water utilities in Ozaukee County is estimated to increase from about 5.6 mgd in 2000, to about 10.6 mgd in 2035. The corresponding pumpage is estimated to increase from about 6.5 mgd to about 13.2 mgd on an average daily basis; and from about 10.4 mgd to about 20.4 mgd on a maximum day basis. These pumpage estimates include water use demand based upon water sales, water used for production and system maintenance, and unaccounted-for water. These estimates of water use and pumpage serve as the basis for the design of the water supply systems envisioned under alternative plan conditions, as set forth in Chapter VIII of this report.

Figure 28 illustrates the forecast water use between the years 2000 and 2035 and, where applicable, the actual use between 1997 and 2005 for each municipal water supply system within Ozaukee County and for the total municipal water use within the County. As already noted, the forecasts of 2035 water uses were developed based upon the intermediate-growth forecasts of land use and socioeconomic conditions set forth in the regional land use plan, year 2000 water use levels, and assumed further application of water conservation measures. As

Map 57

EXISTING 2005 AND AREAS PROJECTED TO BE SERVED BY MUNICIPAL AND OTHER-THAN-MUNICIPAL COMMUNITY WATER SUPPLY SYSTEMS IN OZAUKEE COUNTY: 2035



Source: Water utilities and SEWRPC.

Table 66

MUNICIPAL WATER SUPPLY SERVICE AREA AND POPULATION FOR OZAUKEE COUNTY: 2000-2035

Utility	Population				Area Served			
	2000 Population	2000-2035 Increment		2035 Population	2000 Area Served (square miles)	2000-2035 Increment		2035 Area Served (square miles)
		Population	Percent			Area (square miles)	Percent	
City of Cedarburg Light & Water Commission	11,250	3,650	32.4	14,900	3.3	4.5	136.4	7.8
We Energies-Water Services[a]	5,300	23,500	443.4	28,800	5.2	14.2	273.1	19.4
City of Port Washington Water Utility	10,600	4,400	41.5	15,000	3.0	5.0	166.7	8.0
Village of Belgium Water Utility	1,700	600	35.3	2,300	0.6	1.8	300.0	2.4
Village of Fredonia Municipal Water Utility	1,900	1,100	57.9	3,000	0.7	0.6	85.7	1.3
Village of Grafton Water and Wastewater Commission	10,500	5,950	56.7	16,450	3.3	4.5	136.4	7.8
Village of Saukville Municipal Water Utility	4,150	1,500	36.1	5,650	1.4	2.9	207.1	4.3
Village of Newburg Area[b]	- -	250	- -	250	- -	0.5	- -	0.5
Town of Fredonia-Waubeka Area	- -	500	- -	500	- -	0.6	- -	0.6
Total	45,400	41,450	91.3	86,850	17.5	34.6	197.7	52.1

[a] *Provides service to portions of the City of Mequon and the Village of Thiensville.*

[b] *Limited to the portion of proposed Village of Newburg service area within Ozaukee County.*

Source: SEWRPC.

Table 67

MUNICIPAL WATER SUPPLY DEMAND AND PUMPAGE FOR OZAUKEE COUNTY: 2000-2035

Utility	Year 2000			Year 2035		
	Average Water Use Demand[a] (gallons per day X 1,000)	Average Daily Pumpage[a] (gallons per day X 1,000)	Maximum Daily Pumpage[a] (gallons per day X 1,000)	Average Water Use Demand[b] (gallons per day X 1,000)	Average Daily Pumpage[b] (gallons per day X 1,000)	Maximum Daily Pumpage[b] (gallons per day X 1,000)
City of Cedarburg Light & Water Commission	1,256	1,418	2,150	1,694	1,913	2,937
We Energies-Water Services[c]	464	672	1,727	3,140	4,547	6,352
City of Port Washington Water Utility	1,151	1,334	1,702	1,681	1,947	3,127
Village of Belgium Water Utility	221	267	605	325	393	1,107
Village of Fredonia Municipal Water Utility	144	171	398	326	388	825
Village of Grafton Water and Wastewater Commission	1,130	1,420	2,043	1,884	2,366	3,833
Village of Saukville Municipal Water Utility	1,207	1,261	1,737	1,513	1,580	2,071
Town of Fredonia-Waubeka Area	- -	- -	- -	65	76	104
Total	5,573	6,543	10,362	10,628	13,210	20,356

[a] *Data based upon year 2000 Wisconsin Public Service Commission report.*

[b] *See Appendix F for more detail.*

[c] *Provides service to portions of the City of Mequon and the Village of Thiensville.*

Source: SEWRPC.

previously described, alternative water use projections were also prepared. These projections, together with the forecasts, are shown graphically in Figure 28. Review of Figure 28 indicates that actual water use is lagging the forecast water use by a small amount for the County as a whole. This appears to be reasonable when considering that a large portion of the forecast increase in water use is attributable to existing urban land uses not yet incorporated into the municipal water service areas. Some variation may also be noted for certain water utilities. This is the case for the City of Port Washington Water Utility, the Village of Belgium Water Utility, and the Village of Grafton Water Utility. Where these variations occur, the primary reason may be attributed to reductions in industrial water use over the period 2000 to 2005 which were not offset by smaller increases in residential water use. For all three of these utilities, the projected water use under the forecast intermediate-growth land use and socioeconomic conditions and 2005 water use as a base, is lower than the initial forecast water uses developed using 2000 water use as a base by 10 percent or less. Given these small differences, it was determined that the initial water use forecasts were to be utilized for regional water supply planning purposes.

Residential Other-than-Municipal Community Systems
In 2035, it is expected that there will be one remaining privately owned, self-supplied, water system operating in Ozaukee County which provides water supply services to primarily residential land uses. That system serves an isolated enclave of residential land use located in the northwestern portion of the City of Mequon. The other self-supplied systems which existed in 2005 are expected to be connected to expanded municipal systems. The one remaining system utilizes groundwater provided by one high-capacity well as a source of supply. The location of this system is shown on Map 57. Selected characteristics of this system are presented in Table G-1 of Appendix G.

Industrial Water Supply Systems
In 2035, five privately owned, self-supplied, water systems may be expected to be operation in Ozaukee County which provide water for industrial land uses. All of these systems are currently classified as high-capacity systems. These systems all utilize groundwater as a source of supply through two low-capacity and seven high-capacity wells. The locations of these systems are shown on Map 58. Selected characteristics of each system are presented in Table G-2 of Appendix G.

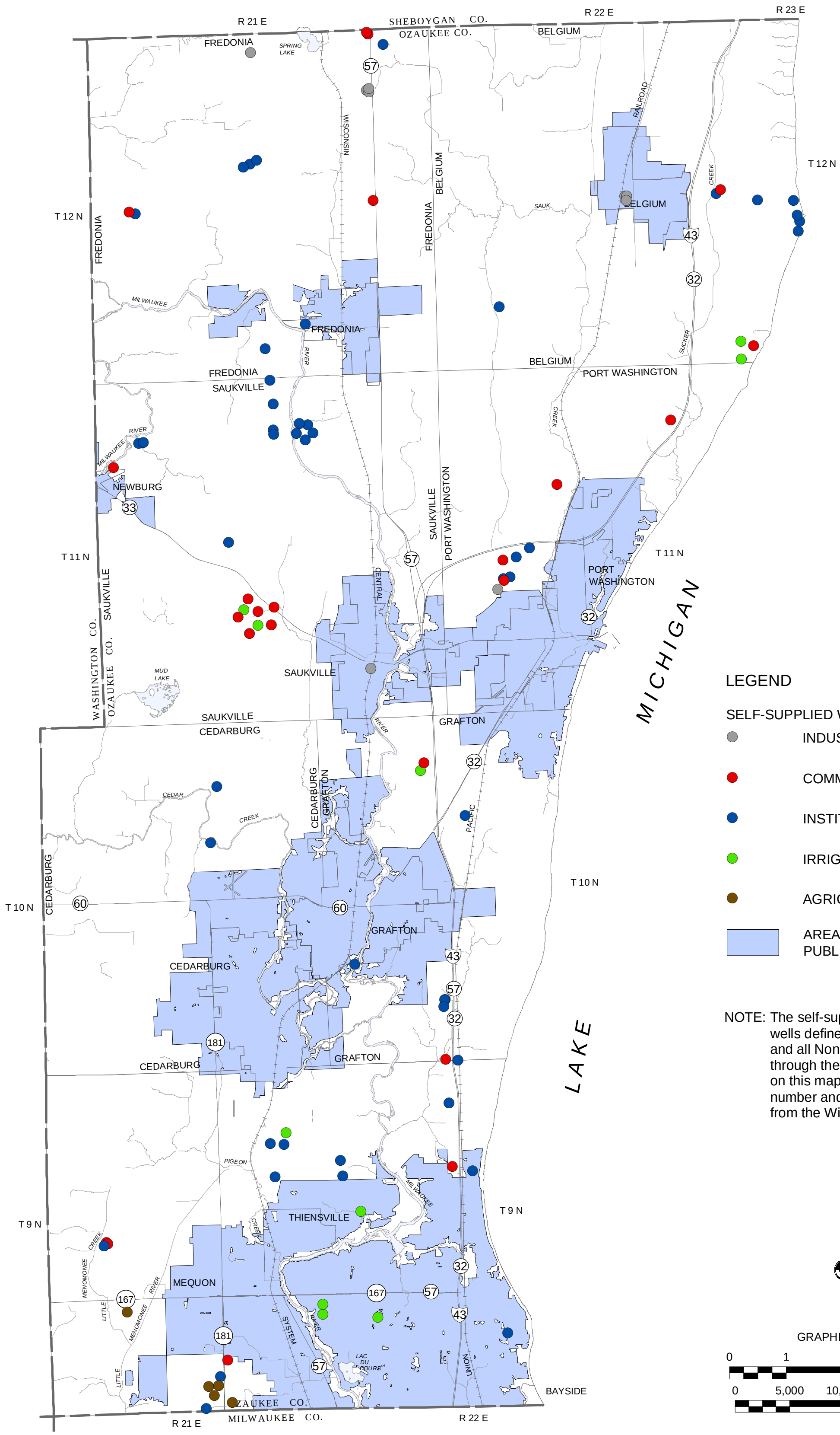
Commercial Water Supply Systems
In 2035, 19 privately owned, self-supplied, water systems may be expected to be operation in Ozaukee County which provide water for commercial land uses. Of these, one is currently classified as a high-capacity system and 18 are classified as low-capacity systems. These systems all utilize groundwater as a source of supply through 23 low-capacity wells. The locations of these systems are shown on Map 58. Selected characteristics of each system are presented in Table G-3 of Appendix G.

Institutional and Recreational Water Supply Systems
In 2035, 35 privately owned, self-supplied, water systems may be expected to be operation in Ozaukee County which provide water for institutional and recreational land uses. Of these, seven are currently classified as high-capacity systems and 28 are classified as low-capacity systems. These systems all currently utilize groundwater as a source of supply through 44 low-capacity wells, and five high-capacity wells. The locations of these systems are shown on Map 58. Selected characteristics of each system are presented in Table G-4 of Appendix G.

Agricultural Water Supply Systems
In 2035, three privately owned, self-supplied, water systems may be expected to be operation in Ozaukee County which provide water for irrigation and other purposes for agricultural land uses. All three systems are currently categorized as high-capacity and all utilize groundwater as a source of supply through five high-capacity wells. The locations of these systems are shown on Map 58. Selected characteristics of each system are presented in Table G-5 of Appendix G.

Map 58

PROJECTED SELF-SUPPLIED INDUSTRIAL, COMMERCIAL, INSTITUTIONAL AND RECREATIONAL, AGRICULTURAL, AND IRRIGATION WATER SUPPLY SYSTEMS IN OZAUKEE COUNTY: 2035

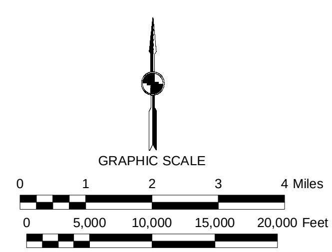


LEGEND

SELF-SUPPLIED WATER SYSTEM WELLS

- INDUSTRIAL
- COMMERCIAL
- INSTITUTIONAL AND RECREATIONAL
- IRRIGATION
- AGRICULTURAL
- AREA PROPOSED TO BE SERVED BY PUBLIC WATER UTILITY

NOTE: The self-supplied water systems shown on this map include wells defined as Non-Community Transient and Non-Transient, and all Non-Community High-Capacity wells expected to remain through the plan design year 2035. The well locations shown on this map are approximate. More specific information on the number and location of self-supplied water systems is available from the Wisconsin Department of Natural Resources.



Source: Wisconsin Department of Natural Resources and SEWRPC.

Irrigation Water Supply Systems
In 2035, seven privately owned, self-supplied, water systems may be expected to be operation in Ozaukee County which provide irrigation water for land uses other than agricultural uses, such as golf courses. All seven systems are currently categorized as high-capacity systems and all utilize groundwater as a source of supply through 10 high-capacity wells. The locations of these systems are shown on Map 58. Selected characteristics of each system are presented in Table G-6 of Appendix G.

Thermoelectric-Power-Generation Water Supply Systems
In 2035, the Port Washington Power Plant is expected to be the only privately owned, self-supplied system providing water for a thermoelectric-power-generation facility operating in Ozaukee County. During 2005, that system was being converted from a coal-fired power generation facility to an intermediate load, natural gas-fired, thermoelectric-power-generation facility. Based upon a Wisconsin Department of Natural Resources WPDES permit records, the average water withdrawal rate from Lake Michigan by the proposed facility for cooling water purposes is estimated to be 390 mgd. Of this total, approximately 353 mgd would be passed through the condensers and other heat exchange equipment. Another 24 mgd would be used to enhance the combustion turbine generating capacity during warmer weather by cooling the intake air by passing it over coils containing once-through circulating Lake water. The remaining 13 mgd would be used in auxiliary cooling systems and the water supply for the spray backwash system for the intake traveling water screens.

The existing water intake structure for the Port Washington power plant was designed with a capacity of 565,000 gpm, which is expected to be adequate for the proposed new plant configuration. Two new 150,000-gallon demineralized water storage tanks are proposed to be constructed to store water for use as steam-cycle makeup. The existing demineralizer plant, consisting of two trains, each with a capacity of 150 gpm, would be used to produce demineralized water for the new facility. The existing municipal water supply source would be used for potable uses, back-up fire protection, and for providing makeup to the demineralizer system.

Self-Supplied Residential Water Systems
In 2035, about 14,300 persons, or about 14 percent of the total resident year 2035 population of Ozaukee County, may be expected to be served by private domestic wells. As shown on Map 57, areas totaling about 183 square miles may be expected to exist outside of the planned 2035 municipal water utility service areas within Ozaukee County. Assuming an average use of 65 gallons per capita per day, these private domestic wells would withdraw about 0.93 million gallons per day from the shallow groundwater aquifer. The households served by private domestic wells may also be expected to be served by onsite sewage disposal systems. Thus, the majority—approximately 90 percent—of the water withdrawn by private wells, or about 0.84 million gallons per day, would be expected to be returned to the groundwater aquifer via onsite sewage disposal systems.

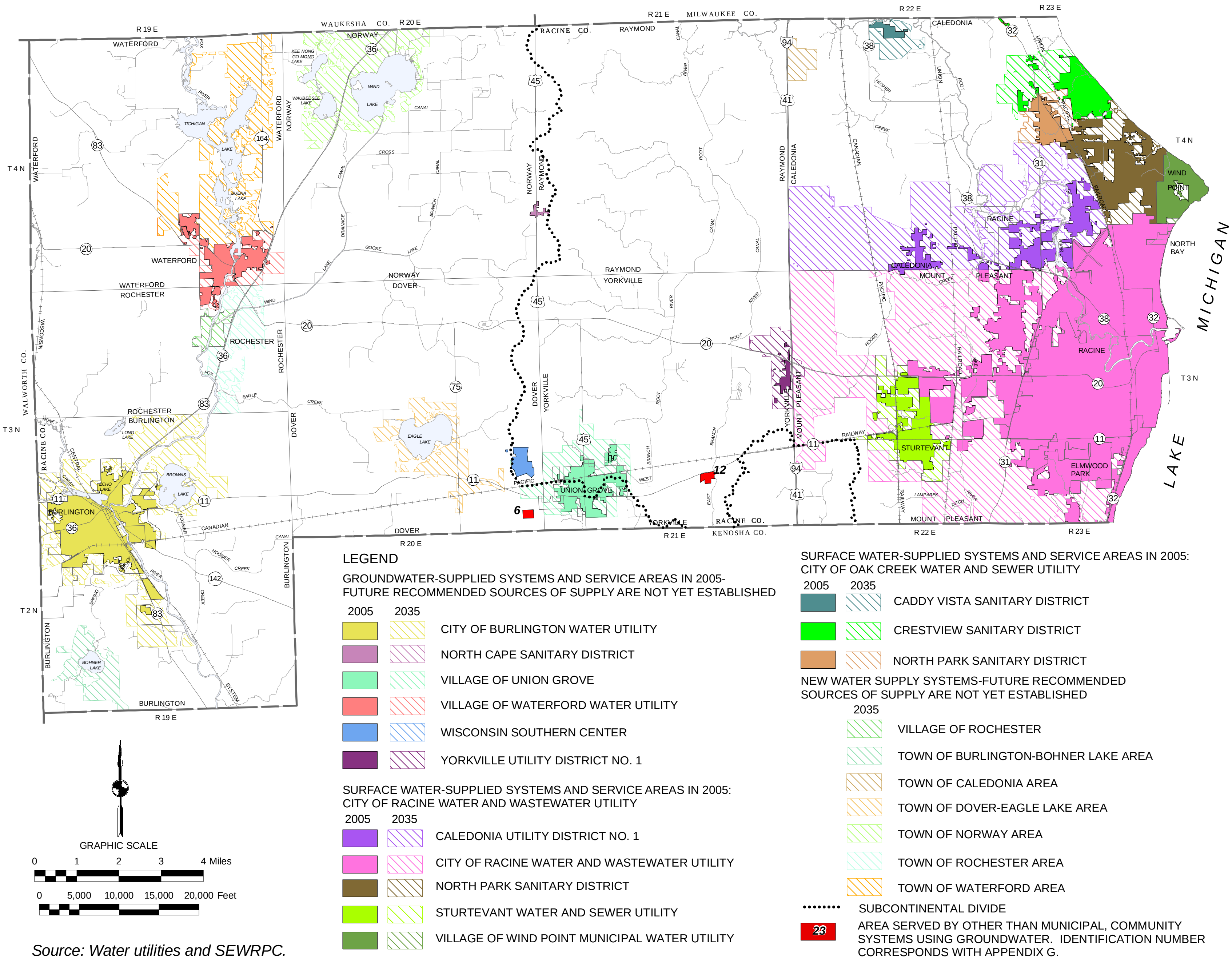
FORECAST OF WATER USE—RACINE COUNTY

Municipal Water Supply Systems
In 2000, there were 12[8] municipal water supply utility systems operating in Racine County, as shown on Map 59. By the year 2035, each of these municipal utility water service areas in Racine County is projected to experience an increase in service area and water demand. In addition to the 12 existing municipal water utilities in Racine County, seven additional municipal water supply systems may be developed by 2035 to serve areas which are currently largely developed in the Towns of Burlington, Dover, Norway, Rochester, and Waterford, and in the Village of Rochester, as well as an undeveloped area in the Town of Caledonia. As presented in Table 68, the year 2000 total resident population served by municipal water utilities in Racine County was about 146,400, or about

[8]*As of 2007, there has been consolidation of utilities within the Village of Caledonia, and the Village of Sturtevant Water Utility has been purchased by the City of Racine. Thus, as of 2007, there were nine municipal water supply utilities in existence within Racine County, potentially there may be 16 municipal water supply utilities in 2035.*

Map 59

EXISTING 2005 AND AREAS PROJECTED TO BE SERVED BY MUNICIPAL AND OTHER-THAN-MUNICIPAL COMMUNITY WATER SUPPLY SYSTEMS IN RACINE COUNTY: 2035



Source: Water utilities and SEWRPC.

Table 68

MUNICIPAL WATER SUPPLY SERVICE AREA AND POPULATION FOR RACINE COUNTY: 2000-2035

Utility	Population				Area Served			
	2000 Population	2000-2035 Increment: Population	2000-2035 Increment: Percent	2035 Population	2000 Area Served (square miles)	2000-2035 Increment: Area (square miles)	2000-2035 Increment: Percent	2035 Area Served (square miles)
City of Burlington Water Utility	9,950	5,350	53.7	15,300	3.5	5.6	160.0	9.1
City of Racine Water and Wastewater Utility	103,800	9,700	9.3	113,500	21.9	19.1	87.2	41.0
Caddy Vista Sanitary District[a]	800	450	56.2	1,250	0.2	0.6	300.0	0.8
Village of Caledonia Utility District No. 1[a]	3,550	8,250	232.4	11,800	2.0	11.3	565.0	13.3
Crestview Sanitary District[b]	3,800	450	11.8	4,250	1.3	1.4	107.7	2.7
North Park Sanitary District (Oak Creek)[b]	600	100	16.7	700	0.4	1.0	250.0	1.4
North Park Sanitary District (Racine)	8,300	900	10.8	9,200	3.0	1.0	33.3	4.0
Village of Sturtevant Water and Sewer Utility[c]	5,300	1,250	23.6	6,550	1.6	1.5	93.8	3.1
Village of Union Grove Municipal Water Utility	4,300	1,600	37.2	5,900	1.2	2.5	208.3	3.7
Village of Waterford Water Utility	4,050	1,350	33.3	5,400	1.2	1.3	108.3	2.5
Village of Wind Point Municipal Water Utility	1,850	500	27.0	2,350	1.1	0.0	0.0	1.1
North Cape Sanitary District	100	50	50.0	150	0.1	0.0	0.0	0.1
Yorkville Utility District No. 1	<50	350	700.0	400	0.1	1.2	1,200.0	1.3
Town of Burlington-Bohner Lake Area	- -	2,200	- -	2,200	- -	1.3	- -	1.3
Town of Dover-Eagle Lake Area	- -	2,000	- -	2,000	- -	2.0	- -	2.0
Northwest Caledonia Area	- -	200	- -	200	- -	0.5	- -	0.5
Town of Norway Area[d]	- -	5,800	- -	5,800	- -	3.8	- -	3.8
Village of Rochester Area[e]	- -	1,250	- -	1,250	- -	0.5	- -	0.5
Town of Rochester Area[e]	- -	1,300	- -	1,300	- -	1.7	- -	1.7
Town of Waterford Area	- -	6,700	- -	6,700	- -	4.5	- -	4.5
Total	146,400	49,750	34.0	196,200	37.6	60.8	161.7	98.4

[a] *As of 2006, the Caddy Vista Sanitary District and the Village of Caledonia Utility District No. 1 have been combined into the Caledonia West Utility District.*

[b] *As of 2007, the Crestview Sanitary District and the North Park Sanitary District have been combined into the Caledonia East Utility District.*

[c] *As of 2007, the Village of Sturtevant Water Utility was purchased by the City of Racine Water and Wastewater Utility and is served by the City Utility on a retail basis. The Village of Sturtevant continues to own and operate its sewer utility facilities.*

[d] *Limited to the portion of proposed Norway refined service area within Racine County.*

[e] *During December 2008, the Village and Town of Rochester were consolidated as the Village of Rochester. Thus, one new potential utility is now envisioned serving the former Village and Town of Rochester.*

Source: SEWRPC.

78 percent of the 188,800 total population of the County. In 2035, the total population projected to be served by municipal water utilities is expected to increase by about 49,800 to about 196,200 residents, or about 92 percent of the 2035 population of 213,600.

The area served by municipal water supply systems within Racine County is expected to increase by about 162 percent between 2000 and 2035, from about 37.6 square miles in 2000 to about 98.4 square miles in 2035.

About 24 percent of the increase in water service area is due to the potential development of the seven new utilities noted above which include areas that are largely developed. Another significant portion of the increase in urban area served is due to the expansion of existing municipal water service areas into developed areas currently served by self-supplied water systems. In total, the amount of urban land existing in 2000 included within the expanded or new municipal water service areas in Racine County totals about 27.2 square miles, or about 45 percent of the increased service area. The amount of newly developed urban land envisioned to be served by municipal water systems between 2000 and 2035 is about 33.6 square miles, an increase of about 52 percent over the 64.8 square miles of urban land existing in 2000 within the planned 2035 municipal water service area. Table 68 sets forth forecast changes in population and service area expected for the 20 existing and potential planned municipal water service areas in Racine County for the plan design year 2035.

Based upon the anticipated changes in population and land use within each of the municipal water service areas, estimates were made of the probable future water use demands and pumpage for each utility, as summarized in Table 69. More detailed information on the development of the forecast water uses and pumpage is included in Table F-4 of Appendix F. The total water use demand on an average daily basis for municipal water utilities in Racine County is estimated to increase from about 23.3 mgd in 2000, to about 29.0 mgd in 2035. The corresponding pumpage is estimated to increase from about 28.6 mgd to about 36.8 mgd on an average daily basis; and from about 45.4 mgd to about 57.4 mgd on a maximum day basis. These pumpage estimates include water use demand based upon water sales, water used for production and system maintenance, and unaccounted-for water. These estimates of water use and pumpage serve as the basis for the design of the water supply systems envisioned under alternative plan conditions, as set forth in Chapter VIII of this report.

Figure 29 illustrates the forecast water use between the years 2000 and 2035 and, where applicable, the actual use between 1997 and 2005 for each municipal water supply system within Racine County and for the total municipal water use within the County. As already noted, the forecasts of 2035 water uses have been developed considering the intermediate-growth forecasts of land use and socioeconomic conditions set forth in the regional land use plan, year 2000 water use levels, and assumed further application of water conservation measures. As previously described, alternative water use projections were also prepared. These projections, together with the forecasts, are shown graphically in Figure 29. Review of Figure 29 indicates that the actual water use is lagging the forecast water use somewhat for the County as a whole. This is primarily due to a similar lag in the City of Racine Water and Wastewater Utility and the Village of Union Grove Municipal Water Utility which experienced reductions in industrial water use which were not offset by small increases in residential and commercial water uses. The projected water use under the intermediate-growth scenario using 2005 as a base is 9 percent lower for the City of Racine Water and Wastewater Utility, and 18 percent lower for the Village of Union Grove Water Utility than the initial forecast water use. In the case of the City of Racine Water and Wastewater Utility, the trend in reduced total water use and industrial water use appears to have reversed in 2006 with increases in both categories from 2005 to 2006. In the case of the Village of Union Grove Municipal Water Utility, the trend in reduced total water use and industrial water use appears to have continued in 2006. However, the difference between the water use developed utilizing the intermediate-growth future scenario with 2000 and 2005 water use base levels is less than 200,000 gallons per day. That amount could be required by a single new major industrial user or group of users. In addition, as already noted, the regional land use plan seeks to promote a vibrant industrial and commercial economy in the central cities of the Region, and envisions that there will be an increase in employment levels in Racine County from 2005 and 2035. It was, therefore, considered desirable to plan for a water supply system which would be capable of supporting an increase in the industrial base of the City of Racine and of Racine County. Accordingly, it was determined that the initial water use forecasts were to be utilized for regional water supply planning purposes in a manner similar to the other utilities.

In the cases of the Village of Waterford Utility and the Town of Yorkville Utility District No. 1, the actual water use over the period 2000 to 2005, has exceeded the utility forecast levels. In the case of the Town of Yorkville Utility District No. 1, the 2006 water use was reported to be about 100,000 gallons per day, nearly the same as forecast. In the case of the Village of Waterford, the increase of actual use over the utility forecast level is due to increases in residential water use. This is due, in part, to new residential development which has been more rapid

Table 69

MUNICIPAL WATER SUPPLY DEMAND AND PUMPAGE FOR RACINE COUNTY: 2000-2035

Utility	Year 2000			Year 2035		
	Average Water Use Demand[a] (gallons per day X 1,000)	Average Daily Pumpage[a] (gallons per day X 1,000)	Maximum Daily Pumpage[a] (gallons per day X 1,000)	Average Water Use Demand[b] (gallons per day X 1,000)	Average Daily Pumpage[b] (gallons per day X 1,000)	Maximum Daily Pumpage[b] (gallons per day X 1,000)
City of Burlington Water Utility	1,576	1,884	2,892	2,129	2,545	4,508
City of Racine Water and Wastewater Utility[c]	18,513	22,763	35,510	19,470	23,940	36,568
Caddy Vista Sanitary District[d]	42	50	199	88	105	317
Caledonia Utility District No. 1[d]	276	613	698	1,444	3,208	4,366
Crestview Sanitary District[e]	233	270	836	300	348	835
North Park Sanitary District (Oak Creek)[e]	135	177	290	144	189	303
North Park Sanitary District (Racine)[e]	601	789	1,294	641	842	1,352
Village of Sturtevant Water and Sewer Utility[f]	580	595	1,103	906	930	1,493
Village of Union Grove Municipal Water Utility	678	716	1,359	1,000	1,056	1,841
Village of Waterford Water Utility	320	391	698	507	620	1,228
Village of Wind Point Municipal Water Utility	231	254	417	262	288	462
North Cape Sanitary District	10	11	15	19	21	26
Yorkville Utility District No. 1	57	71	115	267	332	530
Town of Burlington-Bohner Lake Area	- -	- -	- -	177	237	355
Town of Dover-Eagle Lake Area	- -	- -	- -	212	285	426
Northwest Caledonia Area	- -	- -	- -	71	95	143
Town of Norway Area	- -	- -	- -	553	741	1,110
Village of Rochester Area	- -	- -	- -	98	132	197
Town of Rochester Area	- -	- -	- -	118	158	237
Town of Waterford Area	- -	- -	- -	549	736	1,102
Total	23,252	28,584	45,426	28,955	36,808	57,399

[a] *Data based upon year 2000 Wisconsin Public Service Commission report.*

[b] *See Appendix F for more detail.*

[c] *Data presented are estimates for the City of Racine Water and Wastewater Utility retail service area.*

[d] *As of 2006, the Caddy Vista Sanitary District and the Village of Caledonia Utility District No. 1 have been combined into the Caledonia West Utility District.*

[e] *As of 2007, the Crestview Sanitary District and the North Park Sanitary District have been combined into the Caledonia East Utility District.*

[f] *As of 2007, the Village of Sturtevant Water Utility was purchased by the City of Racine Water and Wastewater Utility and is served by the City Utility on a retail basis. The Village of Sturtevant continues to own and operate its sewerage facilities.*

Source: SEWRPC.

during the period of 2000 through 2005 than forecast. The regional land use plan does not envision that this rate of development will be sustained in the Waterford area. Accordingly, the initial water use forecasts based upon the year 2000 water use as a base are being utilized for regional water supply planning purposes in a manner similar to the other utilities.

The data set forth in Tables 68 and 69 were developed on an individual water utility basis. The Racine Water and Wastewater Utility provides water to multiple utilities, including the Caledonia Utility District No. 1, the Village of Sturtevant Water and Sewer Utility, the Village of Wind Point Municipal Water Utility, and a portion of the North Park Sanitary District. Data on the population and area served, as well as water use and pumpage for the entire Racine utility service area are provided in Table 70.

Residential Other-than-Municipal Community Systems

In 2035, it is expected that two privately owned, self-supplied, water systems operating in Racine County which provide water supply services to primarily residential land uses, are expected to remain in operation. These systems serve mobile home parks located beyond the municipal water supply service areas. The other self-supplied systems which existed in 2005 are expected to be connected to expanded municipal systems. The remaining two systems utilize groundwater provided by five low-capacity wells as a source of supply. The location of these systems is shown on Map 59. Selected characteristics of these systems are presented in Table G-1 of Appendix G.

Industrial Water Supply Systems

In 2035, nine privately owned, self-supplied, water systems may be expected to be in operation in Racine County which provide water for industrial land uses. Of these, one system is currently classified as a low-capacity system and eight are classified ad high-capacity systems. These systems currently all utilize groundwater as a source of supply through 15 low-capacity and 11 high-capacity wells. The locations of these systems are shown on Map 60. Selected characteristics of each system are presented in Table G-2 of Appendix G.

Commercial Water Supply Systems

In 2035, 30 privately owned, self-supplied, water systems may be expected to be in operation in Racine County which provide water for commercial land uses. Of these, two are currently classified as high-capacity systems and 28 are classified as low-capacity systems. These systems all currently utilize groundwater as a source of supply through one high-capacity well and 41 low-capacity wells. The locations of these systems are shown on Map 60. Selected characteristics of each system are presented in Table G-3 of Appendix G.

Institutional and Recreational Water Supply Systems

In 2035, 24 privately owned, self-supplied, water systems are expected to be in operation in Racine County which provide water for institutional and recreational land uses. Of these, eight are currently classified as high-capacity systems and 16 are classified as low-capacity systems. These systems all currently utilize groundwater as a source of supply through 31 low-capacity wells, and one high-capacity well, and five wells of indeterminate capacity. The locations of these systems are shown on Map 60. Selected characteristics of each system are presented in Table G-4 of Appendix G.

Agricultural Water Supply Systems

In 2035, 15 privately owned, self-supplied, water systems are expected to be in operation in Racine County which provide water for irrigation and other purposes for agricultural land uses. All 15 systems are currently categorized as high-capacity and all utilize groundwater as a source of supply through three low-capacity wells and 26 high-capacity wells. The locations of these systems are shown on Map 60. Selected characteristics of each system are presented in Table G-5 of Appendix G.

Irrigation Water Supply Systems

In 2035, three privately owned, self-supplied, water systems are expected to be in operation in Racine County which provide irrigation water for land uses other than agricultural uses, such as golf courses. Two of these systems are categorized as high-capacity systems and one is classified as a low-capacity system. These systems all utilize groundwater as a source of supply through three low-capacity wells and one high-capacity well. The locations of these systems are shown on Map 60. Selected characteristics of each system are presented in Table G-6 of Appendix G.

Table 70

MUNICIPAL WATER SUPPLY SERVICE AREA, POPULATION, WATER DEMAND AND PUMPAGE FOR UTILITIES PROVIDING WATER TO MULTIPLE SYSTEMS IN RACINE COUNTY: 2000-2035

					Water Demand					
					Year 2000			Year 2035		
Utility	2000 Population	2035 Population	2000 Area Served (square miles)	2035 Area Served (square miles)	Average Water Use Demand (gallons per day X 1,000)[a]	Average Daily Pumpage (gallons per day X 1,000)[a]	Maximum Daily Pumpage (gallons per day X 1,000)[a]	Average Water Use Demand (gallons per day X 1,000)	Average Daily Pumpage (gallons per day X 1,000)	Maximum Daily Pumpage (gallons per day X 1,000)
City of Racine Water and Wastewater Utility Service Area[b]	122,800	143,400	29.6	62.5	20,201	25,014	39,022	22,723	29,208	44,241

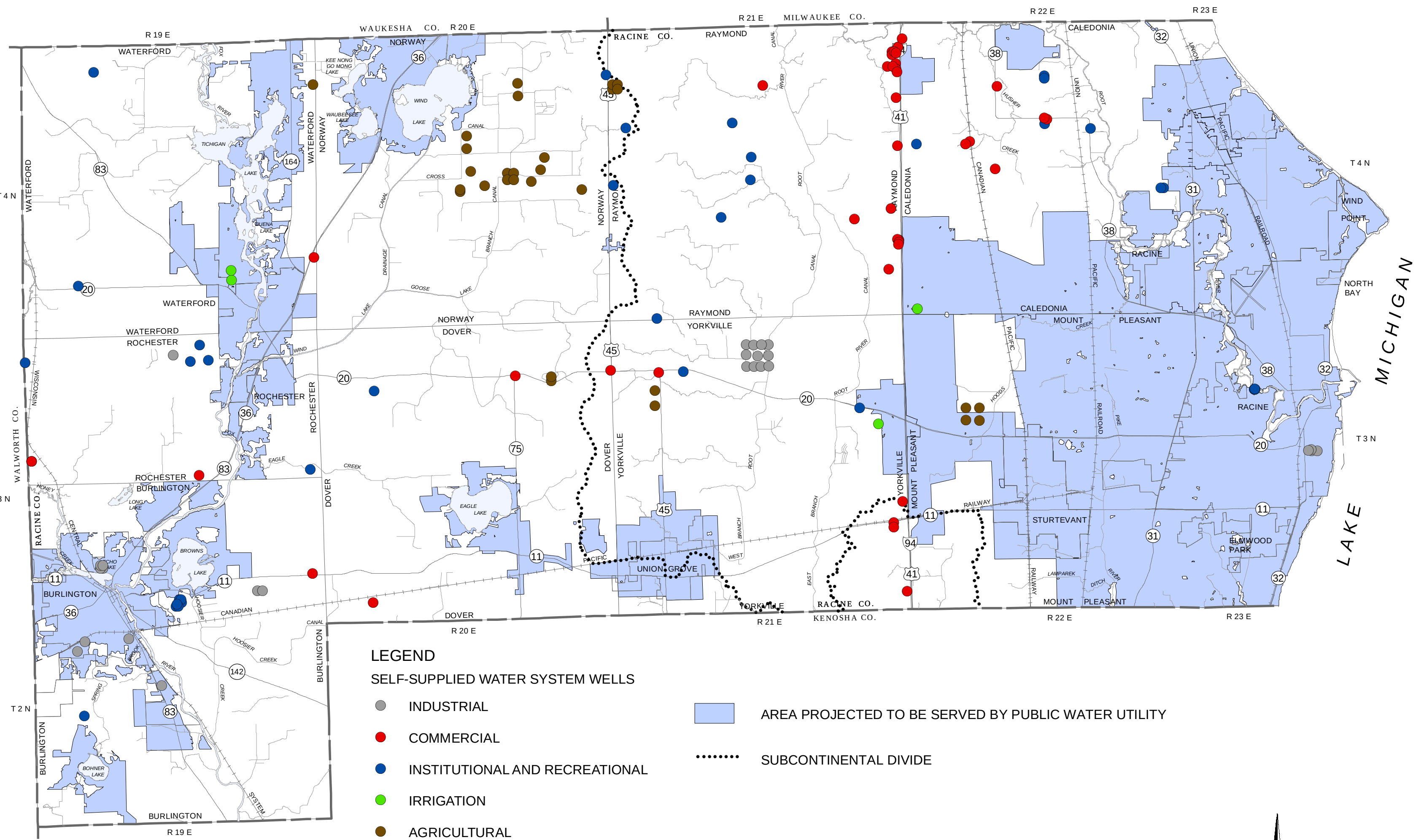
[a]*Data based upon year 2000 Wisconsin Public Service Commission report data for water sales.*

[b]*Includes the City of Racine Water and Wastewater Utility, the Village of Sturtevant Water and Sewer Utility, the Village of Wind Point Municipal Water Utility, the Village of Caledonia Utility District No. 1, and a portion of the North Park Sanitary District.*

Source: SEWRPC.

Map 60

PROJECTED SELF-SUPPLIED INDUSTRIAL, COMMERCIAL, INSTITUTIONAL AND RECREATIONAL, AGRICULTURAL, AND IRRIGATION WATER SUPPLY SYSTEMS IN RACINE COUNTY: 2035



LEGEND

SELF-SUPPLIED WATER SYSTEM WELLS

- INDUSTRIAL
- COMMERCIAL
- INSTITUTIONAL AND RECREATIONAL
- IRRIGATION
- AGRICULTURAL

AREA PROJECTED TO BE SERVED BY PUBLIC WATER UTILITY

SUBCONTINENTAL DIVIDE

NOTE: The self-supplied water systems shown on this map include wells defined as Non-Community Transient and Non-Transient, and all Non-Community High-Capacity wells expected to remain through the plan design year 2035. The well locations shown on this map are approximate. More specific information on the number and location of self-supplied water systems is available from the Wisconsin Department of Natural Resources.

GRAPHIC SCALE

0 1 2 3 4 Miles

0 5,000 10,000 15,000 20,000 Feet

Source: Wisconsin Department of Natural Resources and SEWRPC.

Self-Supplied Residential Water Systems
In 2035, about 16,700 persons, or about 8 percent of the total resident year 2035 population of Racine County, may be expected to be served by private domestic wells. As shown on Map 59, areas totaling about 242 square miles exist outside of the planned 2035 municipal water utility service areas within Racine County. Assuming an average use of 65 gallons per capita per day, these private domestic wells would withdraw about 1.09 million gallons per day from the shallow groundwater aquifer. The households served by private domestic wells may also be expected to be served by onsite sewage disposal systems. Thus, the majority—approximately 90 percent—of the water withdrawn by private wells, or about 0.98 million gallons per day, would be expected to be returned to the groundwater aquifer via onsite sewage disposal systems.

FORECAST OF WATER USE—WALWORTH COUNTY

Municipal Water Supply Systems
In 2000, there were 16 municipal water supply utility systems operating in Walworth County, as shown on Map 61. By the year 2035, all but one of these municipal utility water service areas in Walworth County is projected to experience an increase in service area and water demand. In addition to the 16 existing municipal water utilities in Walworth County, two additional municipal water supply systems may be developed by 2035 to serve the Town of Lyons and the Town of East Troy-Potter Lake Area. As presented in Table 71, the year 2000 total resident population served by municipal water utilities in Walworth County was about 56,200, or about 61 percent of the 92,000 total population of the County. In addition, about 2,600 persons residing in Jefferson County are served by the City of Whitewater municipal water utility system. By 2035, the total population projected to be served by municipal water utilities is expected to increase by about 55,900 to about 114,700 residents, including about 112,100 residents in Walworth County, or about 80 percent of the 2035 population of about 140,000.

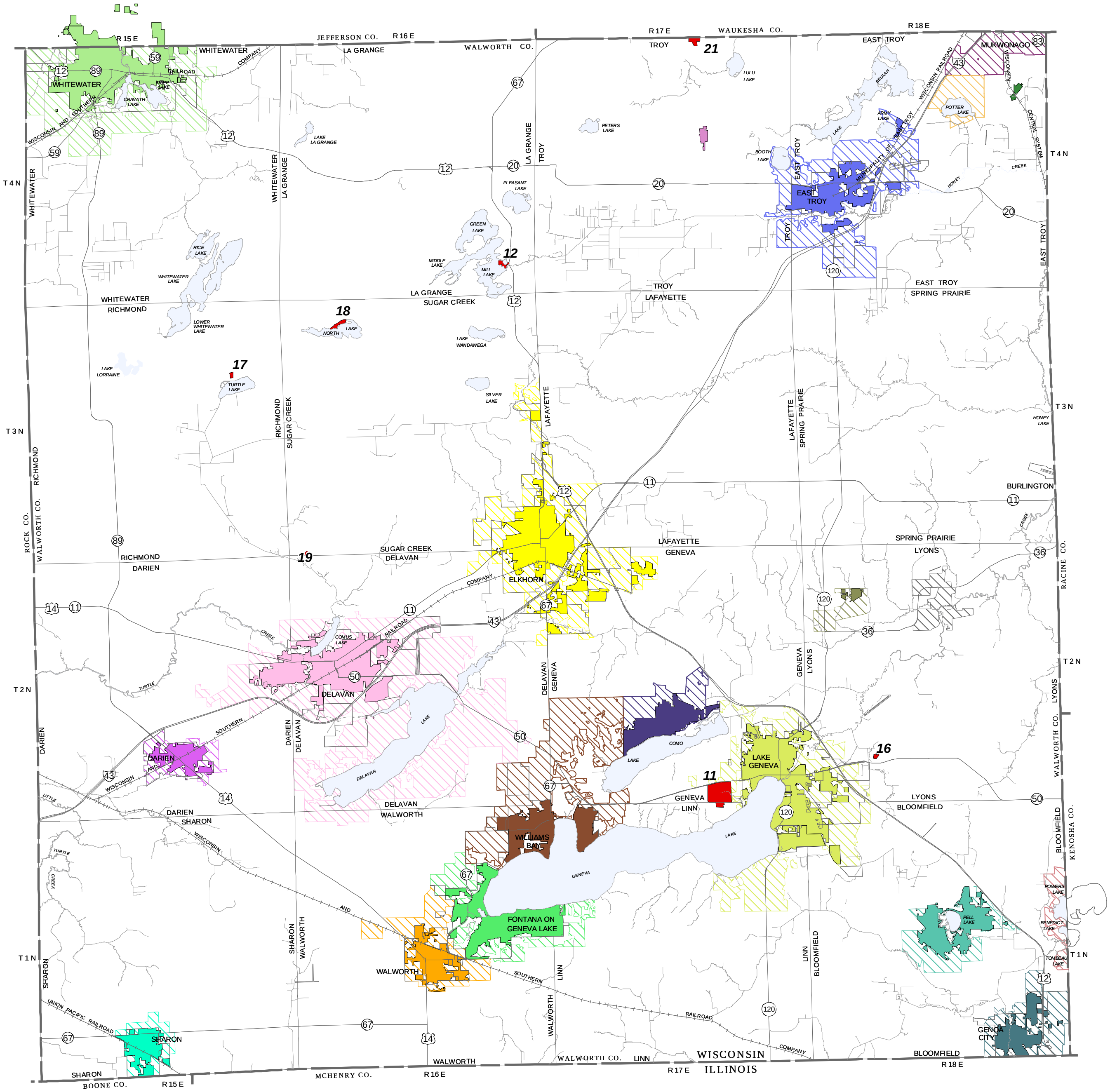
The area served by municipal water supply systems within Walworth County is expected to increase by about 250 percent between 2000 and 2035, from about 22.2 square miles in 2000 to about 77.6 square miles in 2035. The increase in area served is largely due to the expansion of the existing municipal water service areas associated with the major existing urban centers in the County. A significant portion of the expanded service area includes existing developed areas currently served by self-supplied water systems. Table 71 sets forth forecast changes in population and service area for the 18 existing and proposed municipal water service areas in Walworth County for the plan design year 2035.

Based upon the anticipated changes in population and land use within each of the municipal water service areas, estimates were made of the probable future water use demands and pumpages for each utility, as summarized in Table 72. More detailed information on the development of the forecast water uses and pumpage is included in Table F-5 of Appendix F. The total water use demand on an average daily basis for the 18 municipal water utilities in Walworth County is estimated to increase from about 6.3 mgd in 2000, to about 12.0 mgd in 2035. The corresponding pumpage is estimated to increase from about 8.1 mgd to about 15.5 mgd on an average daily basis; and from about 14.2 mgd to about 25.7 mgd on a maximum day basis. These pumpage estimates include water use demand based upon water sales, water used for production and system maintenance, and unaccounted-for water. These estimates of water use and pumpage serve as the basis for the design of the water supply systems envisioned under alternative plan conditions, as set forth in Chapter VIII of this report.

Figure 30 illustrates the forecast water use between the years 2000 and 2035 and, where applicable, the actual use between 1997 and 2005 for each municipal water supply system within Walworth County and for the total municipal water use within the County. As already noted, the forecasts of 2035 water uses have been developed considering the intermediate-growth forecasts of land use and socioeconomic conditions set forth in the regional land use plan, year 2000 water use levels, and assumed further application of water conservation measures. As previously noted, alternative water use projections were prepared. These projections, together with the forecasts, are shown graphically in Figure 30. Review of Figure 30 indicates that the actual water use lags the forecast water use by a small amount for the County as a whole. With one exception, the actual and forecast water uses are

Map 61

EXISTING 2005 AND AREAS PROJECTED TO BE SERVED BY MUNICIPAL AND OTHER-THAN-MUNICIPAL COMMUNITY WATER SUPPLY SYSTEMS IN WALWORTH COUNY: 2035



LEGEND

GROUNDWATER-SUPPLIED SYSTEMS AND SERVICE AREAS IN 2005

2005 2035

- COUNTRY ESTATES SANITARY DISTRICT
- DARIEN WATER WORKS AND SEWER SYSTEM
- DELAVAN WATER AND SEWERAGE COMMISSION
- ELKHORN LIGHT AND WATER
- FONTANA MUNICIPAL WATER UTILITY
- LAKE COMO SANITARY DISTRICT NO. 1
- LAKE GENEVA MUNICIPAL WATER UTILITY
- PELL LAKE SANITARY DISTRICT NO. 1
- SHARON WATERWORKS AND SEWER SYSTEM
- TOWN OF EAST TROY SANITARY DISTRICT NO. 3
- 23 AREA SERVED BY OTHER THAN MUNICIPAL, COMMUNITY WATER SYSTEMS USING GROUNDWATER. IDENTIFICATION NUMBER CORRESPONDS WITH APPENDIX G.

2005 2035

- TROY SANITARY DISTRICT NO. 1
- VILLAGE OF EAST TROY MUNICIPAL WATER UTILITY
- VILLAGE OF GENOA CITY MUNICIPAL WATER UTILITY
- WALWORTH MUNICIPAL WATER AND SEWER UTILITY
- WHITEWATER MUNICIPAL WATER UTILITY
- WILLIAMS BAY MUNICIPAL WATER UTILITY
- MUKWONAGO MUNICIPAL WATER UTILITY

NEW SYSTEMS

- TOWN OF LYONS AREA
- TOWN OF EAST TROY, POTTER LAKE AREA
- POWERS-BENEDICT-TOMBEAU LAKES AREA

GRAPHIC SCALE

0 1 2 3 4 Miles

0 5,000 10,000 15,000 20,000 Feet

Source: Water utilities and SEWRPC.

Table 71

MUNICIPAL WATER SUPPLY SERVICE AREA AND POPULATION FOR WALWORTH COUNTY: 2000-2035

Utility	Population				Area Served			
	2000 Population	2000-2035 Increment		2035 Population	2000 Area Served (square miles)	2000-2035 Increment		2035 Area Served (square miles)
		Population	Percent			Area (square miles)	Percent	
City of Delavan Water and Sewerage Commission	8,350	11,700	140.1	20,050	2.8	13.6	485.7	16.4
City of Elkhorn Light and Water Commission	7,650	7,300	95.4	14,950	2.8	6.4	228.6	9.2
City of Lake Geneva Municipal Water Utility	8,100	6,400	79.0	14,500	2.8	5.5	196.4	8.3
City of Whitewater Municipal Water Utility[a]	13,950	4,750	34.1	18,700	3.1	5.4	174.2	8.5
Village of Darien Water Works and Sewer System	1,650	1,150	69.7	2,800	0.7	0.8	114.3	1.5
Village of East Troy Municipal Water Utility	3,750	5,700	152.0	9,450	1.5	4.9	326.7	6.4
Village of Fontana Municipal Water Utility	1,850	300	16.2	2,150	2.0	1.8	90.0	3.8
Village of Genoa City Municipal Water Utility	1,900	2,400	126.3	4,300	0.7	1.9	271.4	2.6
Village of Sharon Waterworks and Sewer System	1,650	950	57.6	2,600	0.7	0.7	100.0	1.4
Village of Walworth Municipal Water and Sewer Utility	2,400	2,350	97.9	4,750	0.9	2.1	233.3	3.0
Village of Williams Bay Municipal Water Utility	2,550	3,400	133.3	5,950	1.5	5.2	346.7	6.7
Pell Lake Sanitary District No. 1	2,450	2,250	91.8	4,700	1.3	1.3	100.0	2.6
Town of East Troy Sanitary District No. 3	50	50	100.0	100	0.1	0.0	0.0	0.1
Lake Como Sanitary District No. 1	1,900	1,050	55.3	2,950	1.1	1.1	100.0	2.2
Country Estates Sanitary District	450	650	144.4	1,100	0.1	0.6	600.0	0.7
Town of Troy Sanitary District No. 1	150	0	0.0	150	0.1	<0.1	<100.0	0.2
Town of Lyons Area	- -	1,700	- -	1,700	- -	1.0	- -	1.0
Village of Mukwonago Municipal Water Utility[b]	- -	1,450	- -	1,450	- -	1.5	- -	1.5
Town of East Troy-Potter Lake Area	- -	1,200	- -	1,200	- -	0.9	- -	0.9
Powers-Benedict-Tombeau Lakes Area[c]	- -	1,150	- -	1,150	- -	0.6	- -	0.6
Total	58,800	55,900	95.1	114,700	22.2	55.4	249.5	77.6

[a] *Includes population and areas in both Jefferson and Walworth Counties.*

[b] *Limited to the portion of Mukwonago Municipal Water Utility within Walworth County.*

[c] *Limited to the portion of proposed Powers-Benedict-Tombeau Lakes area within Walworth County.*

Source: SEWRPC.

reasonably consistent with actual recent experience in Walworth County. That exception is the Pell Lake Sanitary District No. 1, where the actual water use exceeds the forecast water use from 2000 through 2005. A review of the 2006 water use indicates this trend has continued. There was a small reduction in water use from 2005 to 2006. However, the 2006 value is about 36 percent higher than the initial forecast water use for 2006. This is may be attributed to the fact that the Pell Lake water supply distribution system was still under construction through the

Table 72

MUNICIPAL WATER SUPPLY DEMAND AND PUMPAGE FOR WALWORTH COUNTY: 2000-2035

Utility	Year 2000			Year 2035		
	Average Water Use Demand[a] (gallons per day X 1,000)	Average Daily Pumpage[a] (gallons per day X 1,000)	Maximum Daily Pumpage[a] (gallons per day X 1,000)	Average Water Use Demand[b] (gallons per day X 1,000)	Average Daily Pumpage[b] (gallons per day X 1,000)	Maximum Daily Pumpage[b] (gallons per day X 1,000)
City of Delavan Water and Sewerage Commission	808	898	1,552	2,052	2,280	4,019
City of Elkhorn Light and Water Commission	838	1,208	1,714	1,754	2,528	3,324
City of Lake Geneva Municipal Water Utility	1,049	1,289	1,965	1,648	2,025	3,587
City of Whitewater Municipal Water Utility	1,567	1,888	3,276	1,987	2,394	3,979
Village of Darien Water Works and Sewer System	96	110	281	303	347	789
Village of East Troy Municipal Water Utility	510	569	904	1,101	1,229	2,030
Village of Fontana Municipal Water Utility	388	513	1,090	409	541	716
Village of Genoa City Municipal Water Utility	144	280	485	483	938	1,414
Village of Sharon Waterworks and Sewer System	102	132	727	173	224	682
Village of Walworth Municipal Water and Sewer Utility	320	489	655	603	921	1,253
Village of Williams Bay Municipal Water Utility	220	320	728	590	858	1,762
Pell Lake Sanitary District No. 1	190[c]	230[c]	400[c]	350	423	735
Town of East Troy Sanitary District No. 3	4	4	13	8	9	22
Lake Como Sanitary District No. 1	86	131	294	187	285	568
Country Estates Sanitary District	20	23	42	77	89	152
Town of Troy Sanitary District No. 1	4	4	40	4	5	16
Town of Lyons Area	- -	- -	- -	167	215	351
Town of East Troy-Potter Lake Area	- -	- -	- -	139	179	293
Total	6,346	8,088	14,166	12,035	15,490	25,692

[a]*Data based upon year 2000 Wisconsin Public Service Commission report.*

[b]*See Appendix F for more detail.*

[c]*2000 water use adjusted by 2005 values since the water distribution system was under construction in 2000.*

Source: Public Service Commission of Wisconsin and SEWRPC.

year 2002. Thus, the current 2005 through 2006 period water use is considered to be more representative of the water use associated with the existing system. Accordingly, the forecast water use as summarized in Table 72 was revised upward for use in plan design to reflect current water use and pumpage based upon 2005 water use data.

Residential Other-than-Municipal Community Systems

In 2035, it may be expected that seven of the privately owned, self-supplied, water systems operating in Walworth County which provide water supply services to primarily residential land uses, will remain in service. These systems serve residential development, such as mobile home parks and condominium complexes, located beyond the limits of the planned municipal water supply service areas. The other self-supplied systems which existed in

2005 are expected to be incorporated into expanded municipal systems. No new systems are currently known to be planned. The remaining seven systems utilize groundwater provided by one high-capacity and six low-capacity wells as a source of supply. The location of these systems is shown on Map 61. Selected characteristics of these systems are presented in Table G-1 of Appendix G.

Industrial Water Supply Systems

In 2035, 12 privately owned, self-supplied, water systems may be expected to be in operation in Walworth County which provide water for industrial land uses. Of these, four systems are currently classified as low-capacity systems and eight are classified as high-capacity systems. These systems currently all utilize groundwater as a source of supply through 10 low-capacity and 14 high-capacity wells, and one well of indeterminate capacity. The locations of these systems are shown on Map 62. Selected characteristics of each system are presented in Table G-2 of Appendix G.

Commercial Water Supply Systems

In 2035, 47 privately owned, self-supplied, water systems may be expected to be in operation in Walworth County which provide water for commercial land uses. Of these, two are currently classified as high-capacity systems and 45 are classified as low-capacity systems. These systems all currently utilize groundwater as a source of supply through six high-capacity wells and 48 low-capacity wells. The locations of these systems are shown on Map 62. Selected characteristics of each system are presented in Table G-3 of Appendix G.

Institutional and Recreational Water Supply Systems

In 2035, 46 privately owned, self-supplied, water systems may be expected to be in operation in Walworth County which provide water for institutional and recreational land uses. Of these, 15 are currently classified as high-capacity systems and 31 are classified as low-capacity systems. These systems all currently utilize groundwater as a source of supply through 97 low-capacity wells, and four high-capacity wells, and five wells of indeterminate capacity. The locations of these systems are shown on Map 62. Selected characteristics of each system are presented in Table G-4 of Appendix G.

Agricultural Water Supply Systems

In 2035, 16 privately owned, self-supplied, water systems may be expected to be in operation in Walworth County which provide water for irrigation and other purposes for agricultural land uses. All 16 systems are currently categorized as high-capacity systems and all utilize groundwater as a source of supply through six low-capacity wells and 22 high-capacity wells. The locations of these systems are shown on Map 62. Selected characteristics of each system are presented in Table G-5 of Appendix G.

Irrigation Water Supply Systems

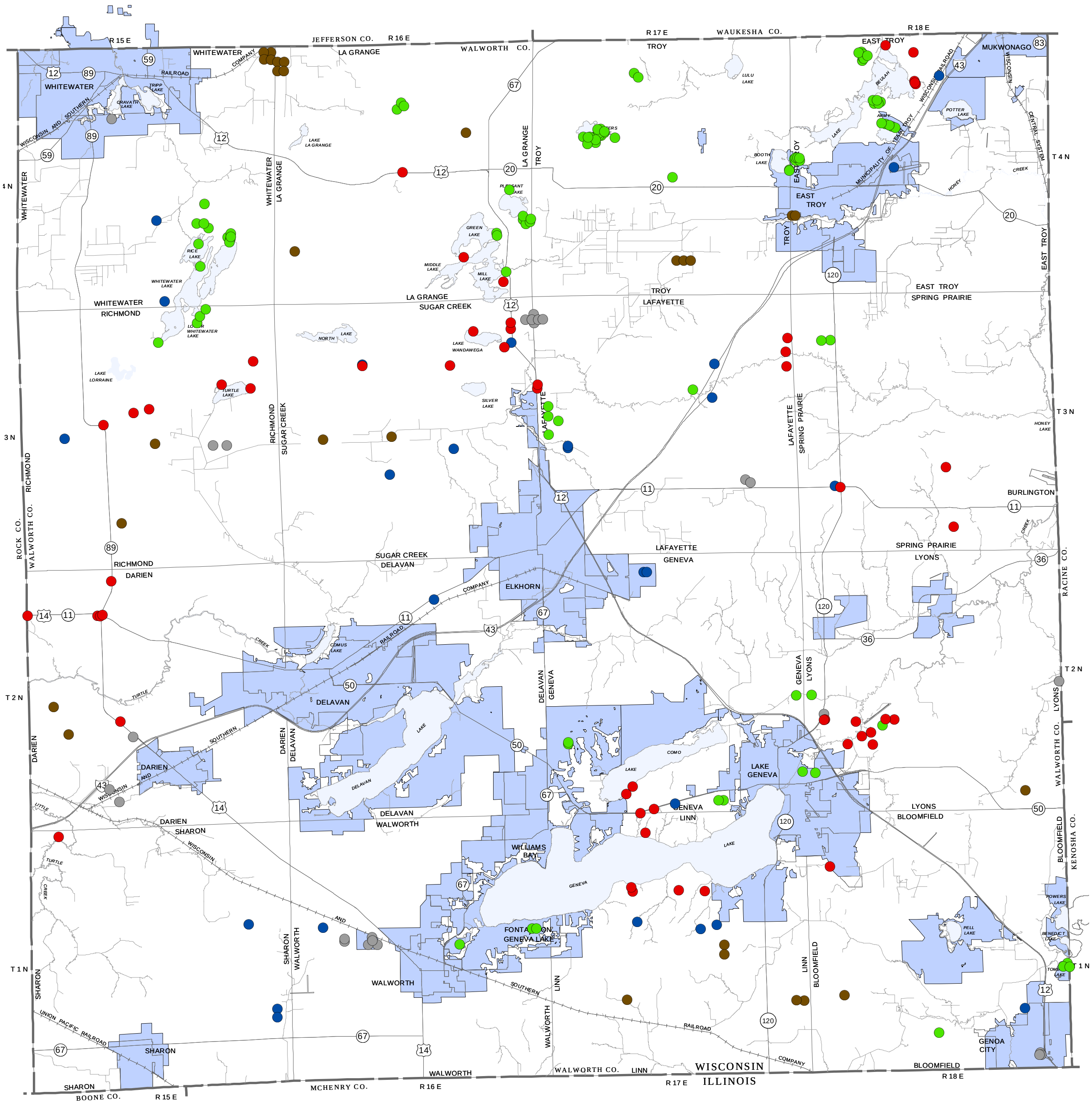
In 2035, 10 privately owned, self-supplied, water systems may be expected to be in operation in Walworth County which provide irrigation water for land uses other than agricultural uses, such as golf courses. All 10 systems are categorized as high-capacity systems and all utilize groundwater as a source of supply through six low-capacity and 13 high-capacity wells, and one well of indeterminate capacity. The locations of these systems are shown on Map 62. Selected characteristics of each system are presented in Table G-6 of Appendix G.

Self-Supplied Residential Water Systems

In 2035, about 25,000 persons, or about 18 percent of the total resident year 2035 population of Walworth County, may be expected to be served by private domestic wells. As shown on Map 61, areas totaling about 500 square miles may be expected to exist outside of the planned 2035 municipal water utility service areas within Walworth County. Assuming an average use of 65 gallons per capita per day, these private domestic wells would withdraw about 1.62 million gallons per day from the shallow groundwater aquifer. The households served by private domestic wells may also be expected to be served by onsite sewage treatment and disposal systems. Thus, the majority—approximately 90 percent—of the water withdrawn by private wells, or about 1.46 million gallons per day, would be expected to be returned to the groundwater aquifer via onsite sewage disposal systems.

Map 62

PROJECTED SELF-SUPPLIED INDUSTRIAL, COMMERCIAL, INSTITUTIONAL AND RECREATIONAL, AGRICULTURAL, AND IRRIGATION WATER SUPPLY SYSTEMS IN WALWORTH COUNTY: 2035



LEGEND

SELF-SUPPLIED WATER SYSTEM WELLS

- INDUSTRIAL
- COMMERCIAL
- INSTITUTIONAL AND RECREATIONAL
- IRRIGATION
- AGRICULTURAL

AREA PROPOSED TO BE SERVED BY PUBLIC WATER UTILITY

NOTE: The self-supplied water systems shown on this map include wells defined as Non-Community Transient and Non-Transient, and all Non-Community High-Capacity wells expected to remain through the plan design year 2035. The well locations shown on this map are approximate. More specific information on the number and location of self-supplied water systems is available from the Wisconsin Department of Natural Resources.

GRAPHIC SCALE

0 1 2 3 4 Miles

0 5,000 10,000 15,000 20,000 Feet

Source: Wisconsin Department of Natural Resources and SEWRPC.

FORECAST OF WATER USE—WASHINGTON COUNTY

Municipal Water Supply Systems

In 2000, there were seven municipal water supply utility systems operating in Washington County, as shown on Map 63. By the year 2035, each of these municipal utility water service areas in Washington County is projected to experience an increase in service area and water demand. In addition to the seven existing municipal water utilities in Washington County, one additional municipal water supply system may be developed by 2035 to serve the Village of Newburg service area. As presented in Table 73, the year 2000 total resident population served by municipal water utilities in Washington County was about 66,800, or about 57 percent of the 117,500 total population of the County. In 2035, the total population projected to be served by municipal water utilities is projected to increase by about 46,200 to about 113,000 residents, or about 72 percent of the 2035 population of 157,300.

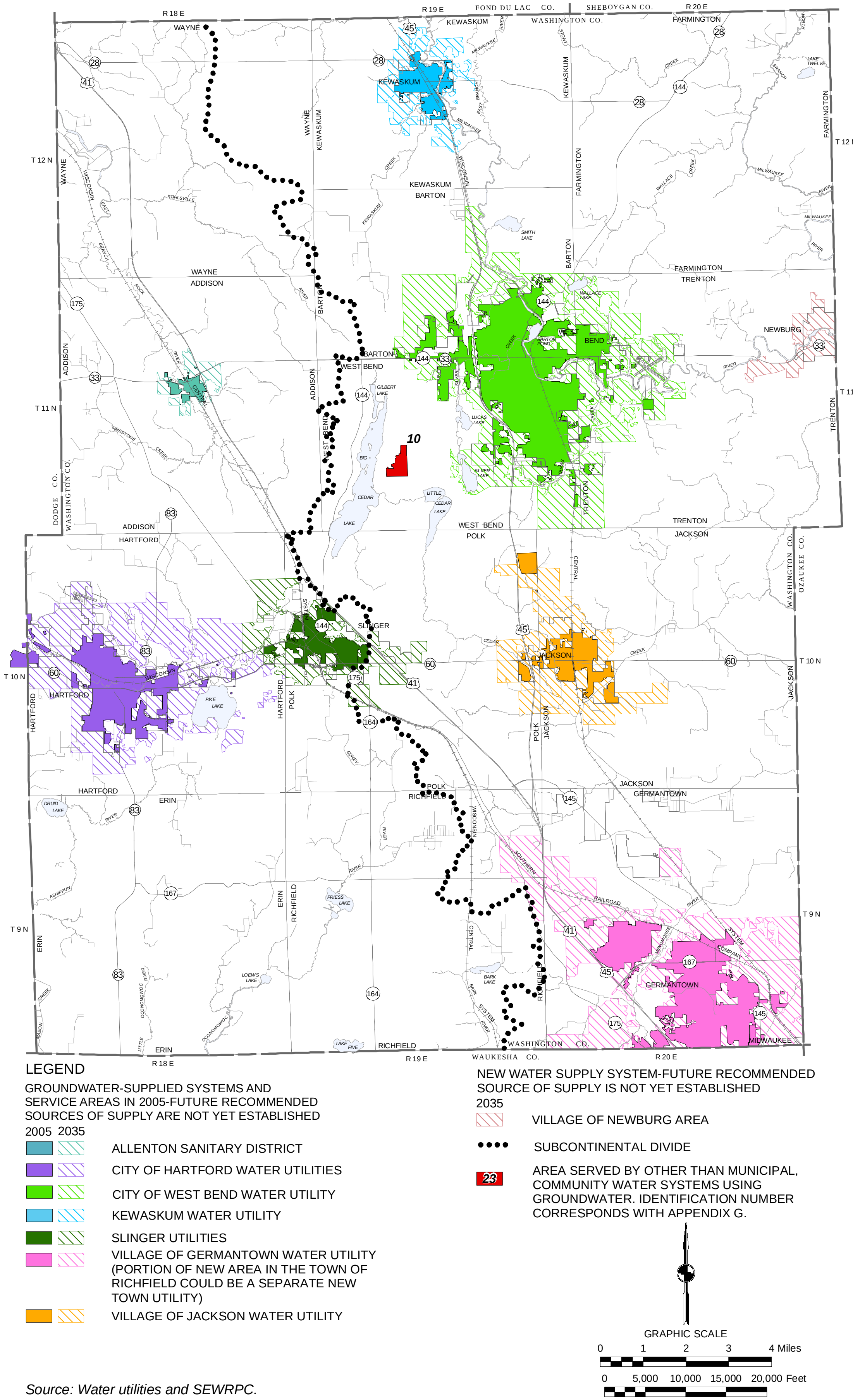
The area served by municipal water supply systems within Washington County is expected to increase by about 219 percent between 2000 and 2035, from about 21.4 square miles in 2000 to about 68.3 square miles in 2035. About 72 percent of the increase in water supply service area is due to the anticipated expansion of water service areas in the Cities of Hartford and West Bend and the Village of Germantown. A significant portion of the expanded service area is existing development currently served by self-supplied water systems. Table 73 provides forecast changes in population and urban area expected for the seven existing and the one potential new municipal water service areas in Washington County for the plan design year 2035.

Based upon the anticipated changes in population and land use within each of the municipal water service areas, estimates were made of the probable future water use demands and pumpages for each utility, as summarized in Table 74. More detailed information on the development of the forecast water uses and pumpage is included in Table F-6 of Appendix F. The total water use demand on an average daily basis for the eight municipal water utilities in Washington County is estimated to increase from about 6.4 mgd in 2000, to about 11.7 mgd in 2035. The corresponding pumpage is estimated to increase from about 7.6 mgd to about 13.8 mgd on an average daily basis; and from about 12.1 mgd to about 21.7 mgd on a maximum day basis. These pumpage estimates include water use demand based upon water sales, water used for production and system maintenance, and unaccounted-for water. These estimates of water use and pumpage serve as the basis for the design of the water supply systems envisioned under alternative plan conditions, as set forth in Chapter VIII of this report.

Figure 31 illustrates the forecast water use between the years 2000 and 2035 and, where applicable, the actual use between 1997 and 2005 for each municipal water supply system within Washington County and for the total municipal water use within the County. As already noted, the forecasts of 2035 water uses have been developed considering the intermediate-growth forecast of land use and socioeconomic conditions set forth in the regional land use plan, year 2000 water use levels, and assumed further application of water conservation measures. For comparison purposes, and, as previously noted, alternative water use projections were prepared. These projections, together with the forecasts, are shown graphically in Figure 31. Review of Figure 31 indicates that the relationship of the forecast to actual municipal water use appears to be reasonable when considered at the County level. Small differences existed between the forecast and actual water uses in 2004 and 2005. In the West Bend area, this difference appears to be largely due to reductions in industrial water use which were only partially offset by increases in residential and commercial water uses. This difference is not considered to be significant. In the case of the Village of Kewaskum, actual use from 2000 through 2003 matched the 2000 forecast water use; however, in 2004 and 2005, there was an abrupt drop in water use due to a reduction in industrial water use. This trend continued in 2006. Recently completed local facility planning for wastewater treatment plant upgrading and expansion identified proposed new areas for industrial and commercial development, which, if developed, would result in a reversal of the decline in the industrial water use. Accordingly, it was determined that the initial water use forecasts would be utilized for regional water supply planning purposes in a manner similar to the other water utilities.

Map 63

EXISTING 2005 AND AREAS PROJECTED TO BE SERVED BY MUNICIPAL AND OTHER-THAN-MUNICIPAL COMMUNITY WATER SUPPLY SYSTEMS IN WASHINGTON COUNTY: 2035



Source: Water utilities and SEWRPC.

Table 73

MUNICIPAL WATER SUPPLY SERVICE AREA AND POPULATION FOR WASHINGTON COUNTY: 2000-2035

Utility	Population				Area Served			
	2000 Population	2000-2035 Increment		2035 Population	2000 Area Served (square miles)	2000-2035 Increment		2035 Area Served (square miles)
		Population	Percent			Area (square miles)	Percent	
City of Hartford Water Utilities	10,850	7,300	67.3	18,150	3.4	8.7	255.9	12.1
City of West Bend Water Utility............	28,200	16,350	58.0	44,550	8.1	13.7	169.1	21.8
Village of Germantown Water Utility	15,050	8,400	55.8	23,450	5.7	11.2	196.5	16.9
Village of Jackson Water Utility	4,900	5,050	103.1	9,950	1.6	5.5	343.8	7.1
Village of Kewaskum Municipal Water Utility	3,350	2,150	64.2	5,500	1.0	2.1	210.0	3.1
Village of Slinger Utilities.....................	3,700	4,450	120.3	8,150	1.3	3.6	276.9	4.9
Allenton Sanitary District	750	800	106.7	1,550	0.3	0.7	233.3	1.0
Village of Newburg Area[a]....................	- -	1,700	- -	1,700	- -	1.4	- -	1.4
Total	66,800	46,200	69.2	113,000	21.4	46.9	219.2	68.3

[a]*Limited to the portion of the proposed Village of Newburg service area within Washington County.*

Source: SEWRPC.

Table 74

MUNICIPAL WATER SUPPLY DEMAND AND PUMPAGE FOR WASHINGTON COUNTY: 2000-2035

Utility	Year 2000			Year 2035		
	Average Water Use Demand (gallons per day X 1,000)[a]	Average Daily Pumpage (gallons per day X 1,000)[a]	Maximum Daily Pumpage (gallons per day X 1,000)[a]	Average Water Use Demand (gallons per day X 1,000)	Average Daily Pumpage (gallons per day X 1,000)	Maximum Daily Pumpage (gallons per day X 1,000)
City of Hartford Water Utilities	1,204	1,497	2,424	1,981	2,463	3,703
City of West Bend Water Utility............	2,665	2,908	4,070	4,405	4,807	6,470
Village of Germantown Water Utility	1,363	1,786	2,924	2,523	3,305	5,452
Village of Jackson Water Utility	467	494	986	1,097	1,161	2,096
Village of Kewaskum Municipal Water Utility	377	473	907	597	749	1,358
Village of Slinger Utilities.....................	283	327	604	742	857	1,598
Allenton Sanitary District	67	92	159	147	202	677
Village of Newburg Area......................	- -	- -	- -	189	223	345
Total	6,426	7,577	12,074	11,681	13,767	21,699

[a]*Data based upon year 2000 Wisconsin Public Service Commission report data for water sales, with the exception of Slinger Utilities and Allenton Sanitary District for which data were based upon year 2001 reports.*

Source: SEWRPC.

Residential Other-than-Municipal Community Systems

In 2035, it may be expected that one privately owned, self-supplied, water system will be operating in Washington County which provide water supply services primarily to a residential land use area, would remain in service. This system is classified as a high-capacity system using two wells as a source of supply.

Industrial Water Supply Systems

In 2035, 14 privately owned, self-supplied, water systems may be expected to remain in operation in Washington County which provide water for industrial land uses. Of these systems, eight are currently classified as high-capacity systems and six are classified as low-capacity systems. These systems currently all utilize groundwater as a source of supply through 11 low-capacity and eight high-capacity wells. The locations of these systems are shown on Map 64. Selected characteristics of each system are presented in Table G-2 of Appendix G.

Commercial Water Supply Systems

In 2035, 82 privately owned, self-supplied, water systems may be expected to be in operation in Washington County which provide water for commercial land uses. Of these, two are currently classified as high-capacity systems and 80 are classified as low-capacity systems. These systems all currently utilize groundwater as a source of supply through 85 low-capacity wells. The locations of these systems are shown on Map 64. Selected characteristics of each system are presented in Table G-3 of Appendix G.

Institutional and Recreational Water Supply Systems

In 2035, 64 privately owned, self-supplied, water systems may be expected to be in operation in Washington County which provide water for institutional and recreational land uses. Of these, 19 are currently classified as high-capacity systems and 45 are classified as low-capacity systems. These systems all currently utilize ground-water as a source of supply through 78 low-capacity wells, six high-capacity wells, and six wells with an indeterminate capacity. The locations of these systems are shown on Map 64. Selected characteristics of each system are presented in Table G-4 of Appendix G.

Agricultural Water Supply Systems

In 2035, four privately owned, self-supplied, water systems are expected to be in operation in Washington County which provide water for irrigation and other purposes for agricultural land uses. All four systems are currently categorized as high-capacity systems, and all utilize groundwater as a source of supply through four high-capacity wells. The locations of these systems are shown on Map 64. Selected characteristics of each system are presented in Table G-5 of Appendix G.

Irrigation Water Supply Systems

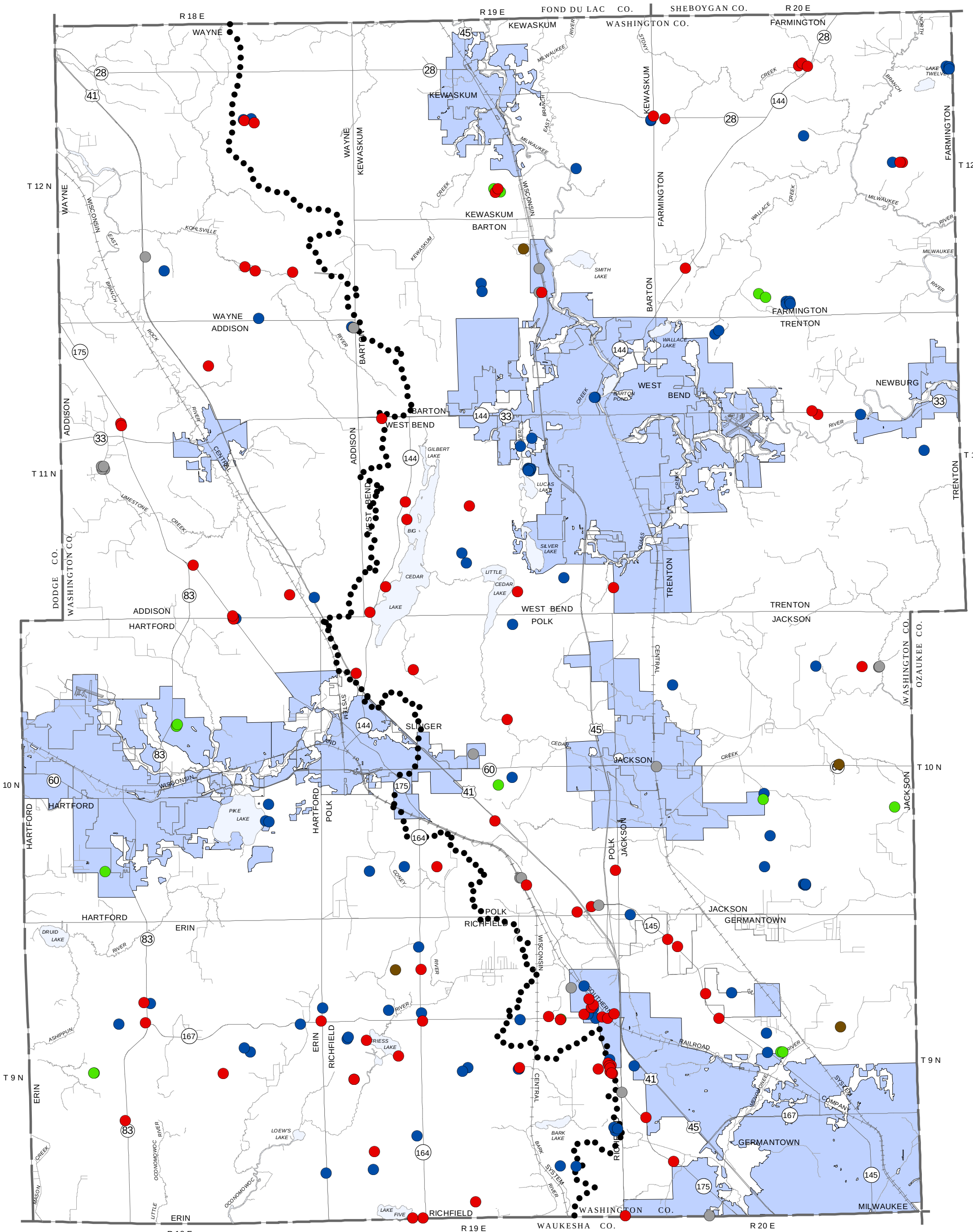
In 2035, 10 privately owned, self-supplied, water systems may be expected to be in operation in Washington County which provide irrigation water for land uses other than agricultural uses, such as golf courses. All 10 systems are currently categorized as high-capacity systems and all utilize groundwater as a source of supply through three low-capacity wells and 12 high-capacity wells. The locations of these systems are shown on Map 64. Selected characteristics of each system are presented in Table G-6 of Appendix G.

Thermoelectric-Power-Generation Water Supply Systems

In 2035, the We Energies Germantown Power Plant is expected to be the only privately owned, self-supplied system that may be expected to be in operation in Washington County providing water for thermoelectric-power-generation. This system serves a combustion turbine generating facility located in the Village of Germantown. The Germantown Power Plant was constructed in 1978 and expanded in 2000. The facility utilizes groundwater obtained through a well with an approved pump capacity of 500 gallons per minute, and an approved well capacity of 100,000 gallons per day. This well is finished in the deep sandstone aquifer. The amount of water used varies annually depending upon the need for the intermittent operation of the peaking facility. The water use for the only years reported, 1982 through 1989, averaged 220,000 gallons per year, or about 600 gallons per day. There are two primary water uses at the Germantown Power Plant: 1) water spray injection into the combustion turbines for control of nitrogen oxides; and 2) an inlet air cooling system, used to enhance the combustion turbine generating capacity during warmer weather, which cools the intake air by passing it over coils containing recirculating cold water produced in an onsite refrigeration system.

Map 64

PROJECTED SELF-SUPPLIED INDUSTRIAL, COMMERCIAL, INSTITUTIONAL AND RECREATIONAL, AGRICULTURAL, AND IRRIGATION WATER SUPPLY SYSTEMS IN WASHINGTON COUNTY: 2035



LEGEND

SELF-SUPPLIED WATER SYSTEM WELLS

- INDUSTRIAL
- COMMERCIAL
- AGRICULTURAL
- IRRIGATION
- INSTITUTIONAL AND RECREATIONAL

AREA PROPOSED TO BE SERVED BY PUBLIC WATER UTILITY

SUBCONTINENTAL DIVIDE

NOTE: The self-supplied water systems shown on this map include wells defined as Non-Community Transient and Non-Transient, and all Non-Community High-Capacity wells expected to remain through the plan design year 2035. The well locations shown on this map are approximate. More specific information on the number and location of self-supplied water systems is available from the Wisconsin Department of Natural Resources.

GRAPHIC SCALE

0 1 2 3 4 Miles

0 5,000 10,000 15,000 20,000 Feet

Source: Wisconsin Department of Natural Resources and SEWRPC.

Self-Supplied Residential Water Systems
In 2035, about 43,800 persons, or about 28 percent of the total resident year 2035 population of Washington County, may be expected to be served by private domestic wells. As shown on Map 63, areas totaling about 367 square miles may be expected to exist outside of the planned 2035 municipal water utility service areas within Washington County. Assuming an average use of 65 gallons per capita per day, these private domestic wells would withdraw about 2.85 million gallons per day from the shallow groundwater aquifer. The households served by private domestic wells may also be expected to be served by onsite sewage treatment and disposal systems. Thus, the majority—approximately 90 percent—of the water withdrawn by private wells, or about 2.56 million gallons per day, would be expected to be returned to the groundwater aquifer via onsite sewage disposal systems.

FORECAST OF WATER USE—WAUKESHA COUNTY

Municipal Water Supply Systems
In 2000, there were 16 municipal water supply utility systems operating in Waukesha County, as shown on Map 65. By the year 2035, each of these municipal utility water service areas in Waukesha County are projected to experience an increase in service area and water demand. In addition to the 16 existing municipal water utilities in Waukesha County, nine additional municipal water supply systems may be developed by 2035 to serve areas which are currently largely developed in the Villages of Big Bend, Elm Grove, Lannon, North Prairie, and Wales and in the Towns of Eagle, Oconomowoc, Ottawa, and Summit. As presented in Table 75, the year 2000 total resident population served by municipal water utilities in Waukesha County was about 218,400, or about 61 percent of the 360,800 total population of the County. In 2035, the total population planned to be served by municipal water utilities is projected to increase by about 166,600 to about 385,000 residents, or about 86 percent of the 2035 population of 446,800.

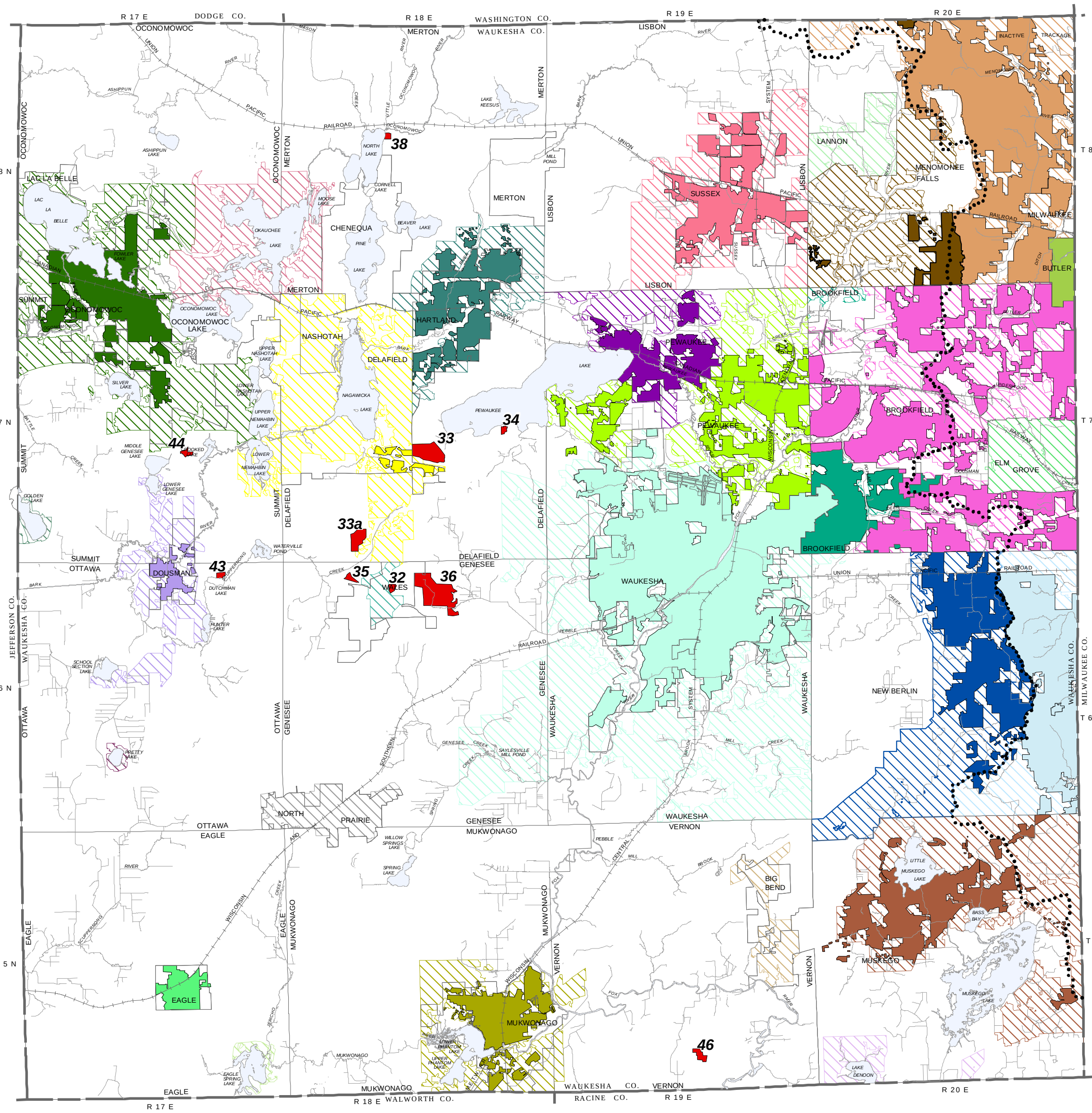
The area served by municipal water supply systems within Waukesha County is expected to increase by about 171 percent between 2000 and 2035, from about 82 square miles in 2000 to about 223 square miles in 2035. About 13 percent of the increase in water service area is due to the potential development of the eight new utilities noted above which include areas that are largely developed. A significant portion of the provided increase in area served is also attributable to the expansion of existing municipal water service areas into existing developed areas currently served by self-supplied water systems. Table 75 sets forth forecast changes in population and service area for the 26 existing and proposed municipal water service areas in Waukesha County for the plan design year 2035.

Based upon the anticipated changes in population and land use within each of the municipal water service areas, estimates were made of the probable future water use demands and pumpages for each utility, as summarized in Table 76. More detailed information on the development of the forecast water uses and pumpage is included in Table F-7 of Appendix F. The total water use demand on an average daily basis for the 25 existing and projected municipal water utilities in Waukesha County is estimated to increase from about 23.1 mgd in 2000, to about 41.8 mgd in 2035. The corresponding pumpage is estimated to increase from about 27.0 mgd to about 49.0 mgd on an average daily basis; and from about 38.9 mgd to about 80.6 mgd on a maximum day basis. These pumpage estimates include water use demand based upon water sales, water used for production and system maintenance, and unaccounted-for water. These estimates of water use and pumpage serve as the basis for the design of the municipal water supply systems envisioned under alternative plan conditions, as set forth in Chapter VIII of this report.

Figure 32 illustrates the forecast water use between the years 2000 and 2035 and, where applicable, the actual use between 1997 and 2005 for each municipal water supply system within Waukesha County and for the total municipal water use within the County. As already noted, the forecasts of 2035 water uses have been developed considering the intermediate-growth projection of land use and socioeconomic conditions set forth in the regional land use plan, year 2000 water use levels, and assumed further application of water conservation measures. As previously noted, alternative 2035 water use projections were prepared. These projections, together with the forecasts, are shown graphically in Figure 32. Review of Figure 32 indicates the comparison of the projected to

Map 65

EXISTING 2005 AND AREAS PROJECTED TO BE SERVED BY MUNICIPAL AND OTHER-THAN-MUNICIPAL COMMUNITY WATER SUPPLY SYSTEMS IN WAUKESHA COUNTY: 2035



LEGEND

GROUNDWATER-SUPPLIED SYSTEMS AND SERVICE AREAS IN 2005-FUTURE RECOMMENDED SOURCES OF SUPPLY ARE NOT YET ESTABLISHED

2005 2035

- CITY OF BROOKFIELD MUNICIPAL WATER UTILITY
- DELAFIELD MUNICIPAL WATER UTILITY
- CITY OF MUSKEGO PUBLIC WATER UTILITY
- CITY OF NEW BERLIN WATER UTILITY
- CITY OF OCONOMOWOC UTILITIES
- CITY OF PEWAUKEE WATER UTILITY
- CITY OF WAUKESHA WATER UTILITY (PORTION OF NEW AREA IN TOWN OF GENESEE COULD BE A NEW TOWN UTILITY DISTRICT)
- VILLAGE OF EAGLE MUNICIPAL WATER UTILITY
- DOUSMAN WATER UTILITY
- HARTLAND MUNICIPAL WATER UTILITY
- VILLAGE OF MENOMONEE FALLS WATER UTILITY
- MUKWONAGO MUNICIPAL WATER UTILITY
- PRAIRIE VILLAGE WATER TRUST
- VILLAGE OF PEWAUKEE WATER UTILITY
- SUSSEX WATER UTILITY
- BROOKFIELD SANITARY DISTRICT NO. 4

SURFACE WATER-SUPPLIED SYSTEMS AND SERVICE AREAS IN 2005-FUTURE RECOMMENDED SOURCES OF SUPPLY ARE NOT YET ESTABLISHED

2005 2035

- VILLAGE OF BUTLER PUBLIC WATER UTILITY
- VILLAGE OF MENOMONEE FALLS WATER UTILITY
- CITY OF NEW BERLIN WATER UTILITY

NEW WATER SUPPLY SYSTEMS AND SERVICE AREAS-FUTURE RECOMMENDED SOURCES OF SUPPLY ARE NOT YET ESTABLISHED

2035

- VILLAGE OF BIG BEND
- VILLAGE OF ELM GROVE
- VILLAGE OF LANNON AREA
- VILLAGE OF WALES AREA
- TOWN OF EAGLE-EAGLE SPRING LAKE AREA
- TOWN OF NORWAY-WIND LAKE AREA
- TOWN OF OCONOMOWOC-OKAUCHEE LAKE AREA
- TOWN OF OTTAWA-PRETTY LAKE AREA
- TOWN OF SUMMIT-GOLDEN LAKE AREA

SUBCONTINENTAL DIVIDE

23 AREA SERVED BY OTHER THAN MUNICIPAL, COMMUNITY SYSTEMS USING GROUNDWATER. IDENTIFICATION NUMBER CORRESPONDS WITH APPENDIX G.

GRAPHIC SCALE

0 1 2 3 4 Miles

0 5,000 10,000 15,000 20,000 Feet

Source: Water utilities and SEWRPC.

Table 75

MUNICIPAL WATER SUPPLY SERVICE AREA AND POPULATION FOR WAUKESHA COUNTY: 2000-2035

Utility	Population				Area Served			
	2000 Population	2000-2035 Increment		2035 Population	2000 Area Served (square miles)	2000-2035 Increment		2035 Area Served (square miles)
		Population	Percent			Area (square miles)	Percent	
City of Brookfield Municipal Water Utility	24,000	20,950	87.3	44,950	13.4	9.9	73.9	23.3
City of Delafield Municipal Water Utility	400	12,300	3,075.0	12,700	0.3	10.6	3,533.3	10.9
City of Muskego Public Water Utility	7,800	20,850	267.3	28,650	2.7	12.8	474.1	15.5
City of New Berlin Water Utility (east)	19,900	2,900	14.6	22,800	5.9	4.0	67.8	9.9
City of New Berlin Water Utility (central)	10,200	8,300	81.4	18,500	5.7	8.1	142.1	13.8
City of Oconomowoc Utilities	12,500	9,800	78.4	22,300	3.9	11.7	300.0	15.6
City of Pewaukee Water and Sewer Utility	6,850	8,150	119.0	15,000	4.4	7.1	161.4	11.5
City of Waukesha Water Utility	65,000	23,500	36.2	88,500	17.6	21.5	122.2	39.1
Village of Butler Public Water Utility	1,900	0	0.0	1,900	0.8	<0.1	12.5	0.9
Village of Dousman Water Utility	1,600	3,150	196.9	4,750	0.5	3.1	620.0	3.6
Village of Eagle Municipal Water Utility	1,700	200	11.8	1,900	0.8	<0.1	12.5	0.9
Village of Hartland Municipal Water Utility	7,900	3,650	46.2	11,550	3.1	4.0	129.0	7.1
Village of Menomonee Falls Water Utility (east)	28,050	4,650	16.6	32,700	11.6	5.4	46.6	17.0
Village of Menomonee Falls Water Utility (west)	1,550	6,650	429.0	8,200	0.5	7.6	152.0	8.1
Village of Mukwonago Municipal Water Utility	6,150	5,350	87.0	11,500	2.2	4.8	218.2	7.0
Village of Pewaukee Water Utility	8,150	3,450	42.3	11,600	2.3	3.1	134.8	5.4
Village of Sussex Water Utility	8,850	7,950	89.8	16,800	3.4	8.3	244.1	11.7
Town of Brookfield Sanitary District No. 4	5,900	200	3.4	6,100	3.0	0.4	13.3	3.4
Village of Big Bend	- -	2,200	- -	2,200	- -	1.9	- -	1.9
Village of Elm Grove	- -	6,650	- -	6,650	- -	3.3	- -	3.3
Village of Lannon	- -	1,700	- -	1,700	- -	2.1	- -	2.1
Village of North Prairie	- -	2,900	- -	2,900	- -	2.7	- -	2.7
Village of Wales	- -	1,600	- -	1,600	- -	0.7	- -	0.7
Town of Eagle-Eagle Spring Lake Area	- -	450	- -	450	- -	0.3	- -	0.3
Town of Norway-Wind Lake Area[a]	- -	1,350	- -	1,350	- -	1.3	- -	1.3
Town of Oconomowoc-Okauchee Lake Area	- -	7,250	- -	7,250	- -	5.3	- -	5.3
Town of Summit-Golden Lake Area	- -	200	- -	200	- -	0.2	- -	0.2
Town of Ottawa-Pretty Lake Area	- -	250	- -	250	- -	0.1	- -	0.1
Total	218,400	166,550	76.3	384,950	82.1	140.5	171.1	222.6

[a]*Limited to the portion of the proposed Town of Norway-Wind Lake service area within Waukesha County.*

Source: SEWRPC.

Table 76

MUNICIPAL WATER SUPPLY DEMAND AND PUMPAGE FOR WAUKESHA COUNTY: 2000-2035

Utility	Year 2000			Year 2035		
	Average Water Use Demand (gallons per day X 1,000)[a]	Average Daily Pumpage (gallons per day X 1,000)[a]	Maximum Daily Pumpage (gallons per day X 1,000)[a]	Average Water Use Demand[b] (gallons per day X 1,000)	Average Daily Pumpage[b] (gallons per day X 1,000)	Maximum Daily Pumpage[b] (gallons per day X 1,000)
City of Brookfield Municipal Water Utility	2,971	3,659	4,545	4,908	6,045	9,374
City of Delafield Municipal Water Utility	85	95	218	1,344	1,503	2,982
City of Muskego Public Water Utility	525	586	1,075	2,276	2,540	5,400
City of New Berlin Water Utility (east)	1,527	1,777	2,547	1,906	2,218	3,824
City of New Berlin Water Utility (central)	1,279	1,488	2,133	2,494	2,902	4,656
City of Oconomowoc Utilities	1,296	1,562	2,609	2,785	3,356	5,790
City of Pewaukee Water and Sewer Utility	889	1,150	1,793	1,938	2,507	4,935
City of Waukesha Water Utility	7,356	7,770	10,147	9,296	9,819	13,437
Village of Butler Public Water Utility	363	404	670	437	487	782
Village of Dousman Water Utility	133	148	234	430	479	811
Village of Eagle Municipal Water Utility	130	145	566	230	257	775
Village of Hartland Municipal Water Utility	801	923	1,472	1,237	1,426	2,617
Village of Menomonee Falls Water Utility (east)	2,779	3,565	5,293	4,095	5,253	8,935
Village of Menomonee Falls Water Utility (west)	140	180	267	787	1,011	1,604
Village of Mukwonago Municipal Water Utility	520	636	896	1,232	1,506	2,217
Village of Pewaukee Water Utility	655	849	1,220	1,003	1,300	1,977
Village of Sussex Water Utility	836	996	1,812	1,694	2,018	3,692
Town of Brookfield Sanitary District No. 4	819	1,029	1,392	970	1,219	1,689
Village of Big Bend	- -	- -	- -	438	512	807
Village of Elm Grove	- -	- -	- -	657	769	1,299
Village of Lannon	- -	- -	- -	321	375	591
Village of North Prairie	- -	- -	- -	361	422	665
Village of Wales	- -	- -	- -	205	240	378
Town of Eagle-Eagle Spring Lake Area	- -	- -	- -	36	42	67
Town of Oconomowoc-Okauchee Lake Area	- -	- -	- -	641	750	1,182
Town of Summit-Golden Lake Area	- -	- -	- -	14	17	26
Town of Ottawa-Pretty Lake Area	- -	- -	- -	20	24	38
Total	23,104	26,962	38,889	41,755	48,997	80,550

[a] *Data based upon year 2000 Wisconsin Public Service Commission report data for water sales, except for the City of New Berlin data which was based upon estimated year 2006 data provided by the City of New Berlin Water Utility.*

[b] *See Appendix F for more detail.*

Source: SEWRPC.

actual municipal water use appears to be consistent when considered at the County level. Some variation is noted for selected water utilities. A variance may be noted for the City of Delafield Municipal Water Utility where a relatively small, primarily commercial, area is currently served, and a much larger mixed-use area is projected to be served in 2035. Thus, the variation may be expected to exist in the early portion of the planning period until the water supply system is expanded. Small variations are also noted for the City of Waukesha Water Utility and Village of Butler Water Utility. These variations appear to be due to a reduction in industrial water use from 2000 to 2005 in the case of the City of Waukesha Water Utility, and a reduction in commercial water use from 2000 to 2005 in the case of the Village of Butler Water Utility. In both cases, the variance of the actual use to the forecast is considered to be short-term, and it was determined that the initial water use forecasts should be used for regional water supply planning purposes in a manner similar to the other water utilities.

Residential Other-than-Municipal Community Systems

In 2035, it may be expected that 10 of the privately owned, self-supplied, water systems operating in Waukesha County which provide water supply services primarily to residential land uses, would remain in service. These systems serve youth residential centers, condominiums, and residential developments located beyond the municipal water supply service areas. The other self-supplied systems which existed in 2005 are expected to be incorporated into expanded municipal systems. No new systems are currently known to be planned. The remaining 10 systems utilize groundwater provided by 10 low-capacity wells, four high-capacity wells, and four wells of indeterminate capacity as a source of supply. The location of these systems is shown on Map 65. Selected characteristics of these systems are presented in Table G-1 of Appendix G.

Industrial Water Supply Systems

In 2035, 13 privately owned, self-supplied, water systems may be expected to be in operation in Waukesha County which provide water for industrial land uses. Of these, two systems are currently classified as low-capacity systems while 11 are classified as high-capacity systems. These systems currently all utilize groundwater as a source of supply through 18 low-capacity and 15 high-capacity wells, and one well with unknown capacity. The locations of these systems are shown on Map 66. Selected characteristics of each system are presented in Table G-2 of Appendix G.

Commercial Water Supply Systems

In 2035, 58 privately owned, self-supplied, water systems may be expected to be in operation in Waukesha County which provide water for commercial land uses. Of these, five are currently classified as high-capacity systems and 53 are classified as low-capacity systems. These systems all currently utilize groundwater as a source of supply through 64 low-capacity wells and one high-capacity well. The locations of these systems are shown on Map 66. Selected characteristics of each system are presented in Table G-3 of Appendix G.

Institutional and Recreational Water Supply Systems

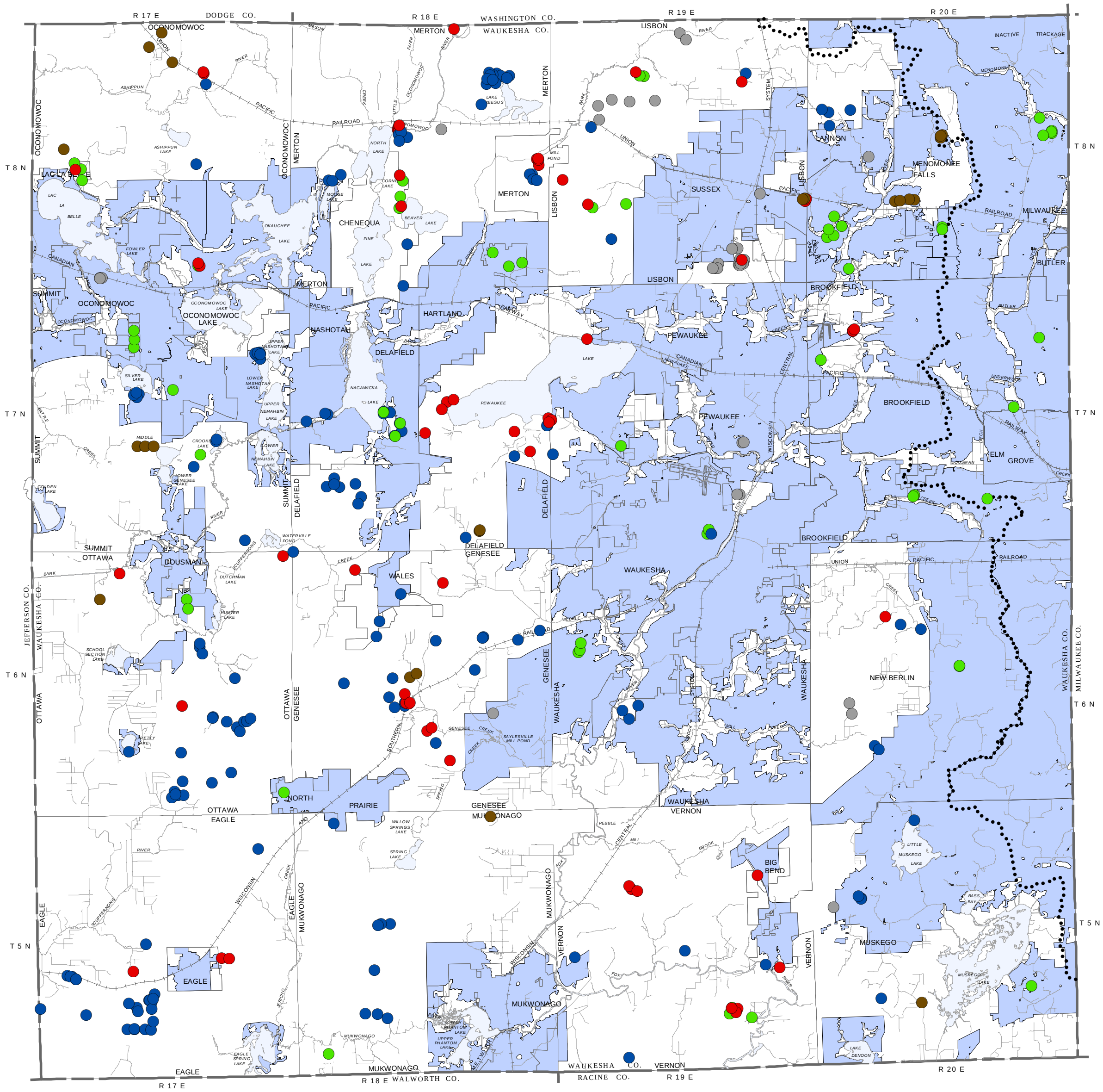
In 2035, 76 privately owned, self-supplied, water systems may be expected to be in operation in Waukesha County which provide water for institutional and recreational land uses. Of these, 28 are currently classified as high-capacity systems and 48 are classified as low-capacity systems. These systems all currently utilize groundwater as a source of supply through 140 low-capacity wells, and nine high-capacity wells, and 13 wells of indeterminate capacity. The locations of these systems are shown on Map 66. Selected characteristics of each system are presented in Table G-4 of Appendix G.

Agricultural Water Supply Systems

In 2035, 11 privately owned, self-supplied, water systems may be expected to be in operation in Waukesha County which provide water for irrigation and other purposes for agricultural land uses. All 11 systems are currently categorized as high-capacity systems, and all utilize groundwater as a source of supply through eight low-capacity wells and 15 high-capacity wells. The locations of these systems are shown on Map 60. Selected characteristics of each system are presented in Table G-5 of Appendix G.

Map 66

PROJECTED SELF-SUPPLIED INDUSTRIAL, COMMERCIAL, INSTITUTIONAL AND RECREATIONAL, AGRICULTURAL, AND IRRIGATION WATER SUPPLY SYSTEMS IN WAUKESHA COUNTY: 2035



LEGEND

SELF-SUPPLIED WATER SYSTEM WELLS

- INDUSTRIAL
- COMMERCIAL
- INSTITUTIONAL AND RECREATIONAL
- IRRIGATION
- AGRICULTURAL

AREA PROPOSED TO BE SERVED BY PUBLIC WATER

SUBCONTINENTAL DIVIDE

GRAPHIC SCALE

0 1 2 3 4 Miles

0 5,000 10,000 15,000 20,000 Feet

NOTE: The self-supplied water systems shown on this map include wells defined as Non-Community Transient and Non-Transient, and all Non-Community High-Capacity wells expected to remain through the plan design year 2035. The well locations shown on this map are approximate. More specific information on the number and location of self-supplied water systems is available from the Wisconsin Department of Natural Resources.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Irrigation Water Supply Systems
In 2035, 30 privately owned, self-supplied, water systems are expected to be in operation in Waukesha County which provide irrigation water for land uses other than agricultural uses, such as golf courses. All of these systems are categorized as high-capacity systems. These systems all utilize groundwater as a source of supply through 21 low-capacity wells, 31 high-capacity wells, and six wells of unknown capacity. The locations of these systems are shown on Map 66. Selected characteristics of each system are presented in Table G-6 of Appendix G.

Self-Supplied Residential Water Systems
In 2035, about 61,100 persons, or about 14 percent of the total resident year 2035 population of Waukesha County, may be expected to be served by private domestic wells. As shown on Map 65, areas totaling about 358 square miles may be expected to exist outside of the planned 2035 municipal water utility service areas within Waukesha County. Assuming an average use of 65 gallons per capita per day, these private domestic wells would withdraw about 3.97 million gallons per day from the shallow groundwater aquifer. The households served by private domestic wells may also be expected to be served by onsite sewage treatment and disposal systems. Thus, the majority—approximately 90 percent—of the water withdrawn by private wells, or about 3.57 million gallons per day, would be expected to be returned to the groundwater aquifer via onsite sewage disposal systems.

SUMMARY

One of the elements of the regional water supply planning effort consisted of the preparation of forecasts of future employment, population, and household levels within the Region for the plan design year 2035. These forecasts were then converted to future demands for land use and water demand. This chapter documents the 2035 forecasts made and the procedures used in developing the forecasts.

Municipal Water Supply System Forecasts
In 2000, there were 78 municipal water supply utility systems operating in the Region. Due to consolidation there were three less, or a total of 75, utilities operating in 2007. By the year 2035, it is anticipated that there is the potential for 23 additional municipal water supply systems will be developed to serve existing urban areas currently not served by municipal water supply. As presented in Table 77, the year 2000 total resident population served by municipal water utilities in the Region was about 1.56 million, or about 81 percent of the 1.93 million total population of the Region. In 2035, the total population planned to be served by municipal water utilities is projected to increase by about 536,000 to about 2.10 million residents, or about 92 percent of the 2035 population of about 2.30 million.

The area served by municipal water supply systems within the Region is expected to increase by about 117 percent between 2000 and 2035, from about 390 square miles in 2000 to about 847 square miles in 2035, as summarized in Table 77. A significant portion of the increase in urban land served is due to the expansion of existing municipal water service areas into developed areas currently served by self-supplied water systems, and the potential development of new utilities to serve existing areas that are largely developed, but served by private water supply systems. Table 77 summarizes forecast changes, on a county basis, for the population and urban area expected for the existing and planned municipal water service areas in the Region for the plan design year 2035.

Based upon the changes in population and land use within each of the municipal water service areas, projections were made of the future water use demands and pumpage for each utility, as summarized by county in Table 78. As shown in Table 78, the total water use demand on an average daily basis for the municipal water utilities in the Region is projected to increase from about 201 mgd in 2000, to about 258 mgd in 2035, an increase of about 28 percent. The corresponding pumpage is projected to increase from about 231 mgd to about 303 mgd, or by about 31 percent, on an average daily basis; and from about 347 mgd to about 471 mgd, or by about 36 percent, on a maximum daily basis.

Table 77

PROJECTED CHANGES IN MUNICIPAL WATER SUPPLY SERVICE AREAS IN THE SOUTHEASTERN WISCONSIN REGION: 2000 AND 2035

		Municipal Water Service Area						Total County Population		Population Served By Municipal Water Systems					
		Year 2000		Year 2035		2000-2035 Increment				Year 2000		Year 2035		2000-2035 Increment	
County	Total Area (square miles)	Area Served (square miles)	Percent of County	Area Served (square miles)	Percent of County	Area (square miles)	Percent	Year 2000 Population	Year 2035 Population	Population Served	Percent Served	Population Served	Percent Served	Number	Percent
Kenosha	278.4	29.8	10.7	108.7	39.0	78.9	264.8	149,600	210,100	111,000	74.1	199,900	95.1	88,900	80.1
Milwaukee	242.7	179.1	73.8	219.4	90.4	40.3	22.5	940,200	1,007,100	917,300	97.6	1,004,200	99.7	86,900	9.5
Ozaukee	235.5	17.5	7.4	52.1	22.1	34.6	197.7	82,300	101,100	45,400	55.2	86,800	85.8	41,400	91.3
Racine	340.6	37.6	11.0	98.4	28.9	60.8	161.7	188,800	213,600	146,400	77.5	196,200	91.8	49,800	34.0
Walworth	576.5	22.2	3.9	77.6	13.5	55.4	249.5	92,000	140,000	56,200[a]	61.1	112,100[a]	80.1	55,900[a]	99.5
Washington	435.6	21.4	4.5	68.3	15.7	46.9	219.2	117,500	157,300	66,800	56.8	113,000	76.8	46,200	69.2
Waukesha	580.5	82.1	14.1	222.6	38.3	140.5	171.1	360,800	446,800	218,400	60.5	385,000	86.2	166,600	76.3
Region	2,689.9	389.7	14.5	847.1	31.5	457.4	117.4	1,931,200	2,276,000	1,561,500	80.9	2,097,200	92.1	535,700	34.3

[a]*Does not include about 2,600 persons residing in a small service area in Jefferson County.*

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

Table 78

MUNICIPAL WATER SUPPLY SERVICE AREA DEMAND AND PUMPAGE BY COUNTY IN THE SOUTHEASTERN WISCONSIN REGION : 2000-2035

County	Year 2000								
	Lake Michigan Supply			Groundwater Supply			Total		
	Average Water Use Demand (gallons per day X 1,000)	Average Daily Pumpage (gallons per day X 1,000)	Maximum Daily Pumpage (gallons per day X 1,000)	Average Water Use Demand (gallons per day X 1,000)	Average Daily Pumpage (gallons per day X 1,000)	Maximum Daily Pumpage (gallons per day X 1,000)	Average Water Use Demand (gallons per day X 1,000)	Average Daily Pumpage (gallons per day X 1,000)	Maximum Daily Pumpage (gallons per day X 1,000)
Kenosha........	10,761	14,549	21,644	250	298	527	11,011	14,847	22,171
Milwaukee	124,832	138,612	203,822	- -	- -	- -	124,832	138,612	203,822
Ozaukee........	1,615	2,006	3,429	3,958	4,537	6,933	5,573	6,543	10,362
Racine...........	20,611	25,511	40,347	2,641	3,073	5,079	23,252	28,584	45,426
Walworth	- -	- -	- -	6,346	8,088	14,166	6,346	8,088	14,166
Washington ...	- -	- -	- -	6,426	7,577	12,074	6,426	7,577	12,074
Waukesha	4,669	5,746	8,510	18,435	21,216	30,379	23,104	26,962	38,889
Total	162,488	186,424	277,752	38,056	44,789	69,158	200,544	231,213	346,910

County	Year 2035								
	Lake Michigan Supply			Groundwater Supply			Total		
	Average Water Use Demand (gallons per day X 1,000)	Average Daily Pumpage (gallons per day X 1,000)	Maximum Daily Pumpage (gallons per day X 1,000)	Average Water Use Demand (gallons per day X 1,000)	Average Daily Pumpage (gallons per day X 1,000)	Maximum Daily Pumpage (gallons per day X 1,000)	Average Water Use Demand (gallons per day X 1,000)	Average Daily Pumpage (gallons per day X 1,000)	Maximum Daily Pumpage (gallons per day X 1,000)
Kenosha........	16,882	22,229	33,375	4,220	5,561	9,217	21,102	27,790	42,592
Milwaukee	132,317	147,277	222,372	- -	- -	- -	132,317	147,277	222,372
Ozaukee........	4,821	6,494	9,479	5,807	6,716	10,877	10,628	13,210	20,356
Racine...........	23,255	29,850	45,696	5,700	6,958	11,703	28,955	36,808	57,399
Walworth	- -	- -	- -	12,035	15,490	25,692	12,035	15,490	25,692
Washington ...	- -	- -	- -	11,681	13,767	21,699	11,681	13,767	21,699
Waukesha	6,438	7,958	13,541	35,317	41,039	67,009	41,755	48,997	80,550
Total	183,713	213,808	324,463	74,760	89,531	146,197	258,473	303,339	470,660

NOTE: The projected year 2035 demand and pumpage figures assume the use of the same supply sources within each county as were used in the year 2000. The future supply sources particularly within Kenosha, Ozaukee, Racine, Washington, and Waukesha Counties may change under the various alternative regional water supply plans considered, and under a recommended plan.

Source: SEWRPC.

For those municipal utilities currently served by Lake Michigan water supply, the total water use demand on an average daily basis is projected to increase from about 162 mgd in 2000 to about 184 mgd in 2035, an increase of about 14 percent. The corresponding pumpage is projected to increase from about 186 mgd to about 214 mgd, or by about 15 percent, on an average daily basis; and from about 278 mgd to about 324 mgd, or by about 17 percent, on a maximum daily basis. For those municipal utilities currently served by groundwater supplies, the total water use demand on an average daily basis is projected to increase from about 38 mgd in 2000 to about 75 mgd in 2035, an increase of about 98 percent. The corresponding pumpage is projected to increase from about 45 mgd to about 90 mgd, or by about 100 percent, on an average daily basis; and from about 69 mgd to about 146 mgd, or by about 112 percent, on a maximum daily basis. It should be noted that these projections of probable future demand and pumpage assume the use of the same sources of supply in 2035 within each county as were used in the year 2000. The future supply sources particularly within Kenosha, Ozaukee, Racine, and Waukesha Counties may change under the various alternative regional water supply plans considered, and under a recommended plan.

In addition to the existing municipal water utility water use and pumpage demands, the anticipated 23 new municipal utilities are projected to have a 2035 water use demand of about 8.3 mgd on an average daily basis, and corresponding pumpage of about 10.6 mgd and about 16.2 mgd on an average daily and maximum daily basis, respectively. These demand and pumpage projections are included in the projections presented in Table 78.

These pumpage estimates include water use demand based upon sales, water used for production and system maintenance, and unaccounted-for water. These estimates of water use and pumpage serve as the basis for the design of future 2035 municipal water supply systems under alternative plan conditions, as set forth in Chapter VIII of this report.

Residential Other-than-Municipal Community Systems

In 2035, it is expected that 25 of the privately owned, self-supplied, water systems will be operating in the Region which provide water supply services primarily to enclaves of residential land use, would remain in service. These systems serve residential development, such as mobile home parks, condominium complexes, and other residential groupings located beyond the municipal water supply service areas. The other self-supplied systems which existed in 2005 are expected to be connected to expanded municipal systems and no known new systems are currently planned. The remaining 25 systems utilize groundwater provided by 29 low-capacity, 11 high-capacity wells, and four wells of indeterminate capacity as a source of supply. Selected characteristics of these systems are presented in Table G-1 of Appendix G.

Industrial Water Supply Systems

In 2035, 63 privately owned, self-supplied, water systems may be expected to be in operation in the Region which provide water for industrial land uses. Of these, 16 systems are currently classified as a low-capacity system and 47 are classified as high-capacity systems. These systems currently all utilize groundwater as a source of supply through 62 low-capacity, 63 high-capacity wells, and one well of indeterminate capacity. Selected characteristics of each system are presented in Table G-2 of Appendix G.

Commercial Water Supply Systems

In 2035, 258 privately owned, self-supplied, water systems may be expected to be in operation in the Region which provide water for commercial land uses. Of these, 15 are currently classified as high-capacity systems and 243 are classified as low-capacity well systems. These systems all currently utilize groundwater as a source of supply through 10 high-capacity wells and 284 low-capacity wells. Selected characteristics of each system are presented in Table G-3 of Appendix G.

Institutional and Recreational Water Supply Systems

In 2035, 279 privately owned, self-supplied, water systems may be expected to be in operation in the Region which provide water for institutional and recreational land uses. Of these, 96 are currently classified as high-capacity systems and 183 are classified as low-capacity systems. These systems all currently utilize groundwater as a source of supply through 373 low-capacity wells, 37 high-capacity wells, and 29 wells of indeterminate capacity. Selected characteristics of each system are presented in Table G-4 of Appendix G.

Agricultural Water Supply Systems

In 2035, 53 privately owned, self-supplied, water systems may be expected to be in operation in the Region which provide water for irrigation and other purposes for agricultural land uses. Of these systems, all are currently categorized as high-capacity systems. These systems all utilize groundwater as a source of supply through 80 high-capacity and 17 low-capacity wells. Selected characteristics of each system are presented in Table G-5 of Appendix G.

Irrigation Water Supply Systems

In 2035, 80 privately owned, self-supplied, water systems may be expected to be in operation in the Region which provide irrigation water for land uses other than agricultural uses, such as golf courses. One of these systems is currently categorized as low-capacity and 79 are categorized as high-capacity systems. All of these systems utilize groundwater as a source of supply through 103 high-capacity, 33 low-capacity wells, and six wells of indeterminate capacity. Selected characteristics of each system are presented in Table G-6 of Appendix G.

Thermoelectric-Power-Generation Water Supply Systems

In 2035, there are expected to be six existing privately owned, self-supplied, water systems operating in the Region which will provide cooling water for thermoelectric-power-generation facilities. These facilities include the Pleasant Prairie Power Plant, a coal-based generating facility, and the Paris Generating Station facility, both in Kenosha County; the coal-based Valley Power Plant, and the Oak Creek Power Plant, both in Milwaukee County; the Port Washington Power Plant, a facility being converted, in 2006, from coal to an intermediate-load, natural gas facility in Ozaukee County; and the Germantown Power Plant, a combustion turbine gas-fired, intermittent-use facility in Washington County. Combined, these facilities are reported to use 2.36 billion gallons of water per day in 2000. Most of that water is utilized by the Valley Power Plant, the Oak Creek Power Plant, and the Port Washington Power Plant, all of which utilize Lake Michigan water for once-through cooling systems. These systems typically return over 99 percent of the cooling water used back to the Lake. The Pleasant Prairie Power Plant is located five miles west of the Lake Michigan shoreline, where a closed-loop system with large cooling towers is used. The amount of water used is reported to be about 11 million gallons per day, the majority which is make-up water for the plant cooling towers. Nearly 75 percent of the water used at this facility is evaporated to the atmosphere. The two small peaking combustion turbine power plants in the Village of Germantown and the Town of Paris use limited amounts of well water for cooling and for nitrogen oxide control on an intermittent-use basis.

Self-Supplied Residential Water Systems

As indicated in Table 77, in 2035, about 174,000 persons, or about 8 percent of the total resident year 2035 population of the Region, may be expected to be served by private domestic wells. Areas totaling about 1,843 square miles exist outside of the planned 2035 municipal water utility service areas within the Region. Assuming an average use of 65 gallons per capita per day, these private domestic wells would withdraw about 11.25 million gallons per day from the shallow groundwater aquifer. The households served by private domestic wells may also be expected to be served by onsite sewage treatment and disposal systems. Thus, the majority—approximately 90 percent—of the water withdrawn by private wells, or about 10.12 million gallons per day, would be expected to be returned to the groundwater aquifer via onsite sewage disposal systems.

The information presented in this chapter includes specific reported and estimated data for the years 2000 and 2035 on water use and pumpage for municipal water supply systems, self-supplied residential water systems, and thermoelectric-power-generation water supply systems. Such specific water use and water pumpage data are not presented for self-supplied residential other-than-municipal community, industrial, commercial, institutional, recreational, agricultural, and other irrigation water supply systems, since reported information necessary to develop the water use and pumpage data are not available on a consistent basis. Data are available on the approved pumpage amounts for the systems in these categories for the year 2000, and are set forth in Appendix D; and for the year 2035 in Appendix G. However, the approved pumpage is not an accurate measure of the actual pumpage, since pumping often occurs at a lower amount than the approved amount and the pumping is often intermittent. For purposes of the groundwater modeling used in the planning effort, estimates were developed for nonmunicipal pumping rates on an average daily pumpage basis. These estimates were developed on a regional basis for each of the model cells. The estimated nonmunicipal groundwater pumpage, including all private wells and other self-supplied water supply systems, is estimated to be about 22 million gallons per day in 2005, and about 17 million gallons per day in 2035.

Chapter V

PLANNING OBJECTIVES, PRINCIPLES, AND STANDARDS

INTRODUCTION

Planning is a rational process for formulating and meeting objectives. Therefore, the formulation of objectives is an essential task which must be undertaken before a comprehensive plan can be prepared and evaluated. Objectives guide the preparation of plans and, when converted to specific measures of plan effectiveness, termed standards, provide the structure for evaluating how well the plan meets planning objectives. Because planning objectives provide this basis for plan preparation and evaluation, the formulation of objectives is a particularly important step in the planning process. Accordingly, a set of recommended objectives with supporting principles and standards was formulated as a part of the water supply planning effort. The associated standards perform an important function in plan design since they provide the basis for relating the objectives to alternative plan configurations.

It is also important to note that the objectives, principles, and standards presented herein were formulated within the context of other objectives, principles, and standards previously adopted by the Regional Planning Commission. These other objectives, principles, and standards relate to socioeconomic, land use, and sewerage system development, and to environmental protection and enhancement within the Region. As such, the water supply plan development objectives, principles, and standards are intended to support these other regional development objectives, principles, and standards.

In considering the objectives and supporting standards set forth in this chapter, it should be recognized that the objectives and supporting standards are intended to be applied at the system planning level, as opposed to local-level planning. It should also be recognized that it is unlikely that any one plan proposal will meet all of the standards fully; and the extent to which each standard is met, exceeded, or violated must serve as a measure of the ability of each alternative plan considered to achieve the specific objectives which the given standard or standards compliment. It should be further recognized that certain objectives and standards inherently may be in conflict, requiring resolution through compromise; and that meaningful alternative plan evaluation can only take place through comprehensive assessment of each alternative plan considered against all of the objectives and standards. The selected plan will thus represent a compromise with respect to meeting conflicting objectives and supporting standards.

BASIC CONCEPTS AND DEFINITIONS

The terms “objective,” “principle,” “standard,” “plan,” “policy,” and “program” are subject to a range of interpretations. To clarify their meanings, the Regional Planning Commission has defined these terms as they are used within the context of this planning process as follows:

1. Objective: A goal or end toward the attainment of which plans, policies, and programs are directed.

2. Principle: A fundamental, 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.

This chapter deals primarily with only the first four of these terms. The objectives, principles, and standards developed to guide the preparation of a regional water supply plan are set forth in Table 79. Five water supply development objectives were formulated to guide the design, test, and evaluation of alternative regional water supply plans and the identification of a recommended plan. These objectives were defined as follows:

Objective No. 1—Support of Existing Land Use Patterns and Support and Direction of Planned Land Use Patterns
A regional water supply system which, through its capacity and efficiency, will effectively serve the existing regional land use pattern, promote the implementation of the regional land use plan, and identify any constraints to development in subareas of the Region which may require refinement of the regional land use plan.

Objective No. 2—Conservation and Wise Use of the Surface Water and Groundwater Supplies
A regional water supply plan which conserves and wisely utilizes the surface water and groundwater supplies of the Region so as to sustain those supplies for future, as well as existing needs.

Objective No. 3—Protection of Public Health, Safety, and Welfare
A regional water supply system which protects the public health, safety, and welfare.

Objective No. 4—Economical and Efficient Systems
The development of water supply facilities, operational improvements, and policies, that are both economical and efficient, best meeting all other objectives at the lowest practical cost, considering both long-term capital and operation and maintenance costs.

Objective No. 5—Responsive and Adaptive Plans
The development of water supply systems, operations, and policies which are flexible and adaptive in response to changing conditions.

A planning principle and one or more accompanying planning standards were formulated to complement each of the foregoing five water supply system development objectives. Each standard is directly related to the accompanying planning principle, as well as to the objective, and serves to facilitate application of the objectives in plan design, test, and evaluation. The planning standards provide the link between objectives and plan proposals by providing a measure of the ability of a plan proposed to meet stated objectives. This permits the comparative evaluation of alternative plans on the basis of their ability to meet the stated objectives.

RELATED OBJECTIVES AND STANDARDS

In addition to the objectives, principles, and standards formulated under the regional water supply planning program, certain objectives and standards adopted under the regional planning programs and by State regulatory agencies needed to be considered in the water supply plan design, test, and evaluation process. These include

Table 79

WATER SUPPLY SYSTEM DEVELOPMENT OBJECTIVES, PRINCIPLES, AND STANDARDS

OBJECTIVE NO. 1—SUPPORT OF EXISTING LAND USE PATTERNS AND SUPPORT AND DIRECTION OF PLANNED LAND USE PATTERNS

A regional water supply system which, through its capacity and efficiency, will effectively serve the existing regional land use pattern, promote the implementation of the regional land use plan, and identify any constraints to development in subareas of the Region which may require refinement of the regional land use plan.

PRINCIPLE

An adequate water supply is essential for the well being of the residents and for the economic prosperity of the Region. A sound regional water supply plan should support all of the necessary land use activities within the Region. The regional water supply plan should be designed to serve the needs of both urban and rural land uses, including agriculture and rural-density residential development.

STANDARDS

1. Public water supply systems should be designed to serve lands planned to be developed for urban uses,[a] in accordance with the adopted regional land use plan.

2. Areas of high potential for groundwater contamination should be excluded for the siting of potentially contaminating land uses or facilities.

3. Important groundwater recharge and discharge areas should be identified for preservation[b] or application of land development plans and practices which maintain the natural surface and groundwater hydrology, while protecting the groundwater quality.

4. Sources of water supply should be specifically allocated to adequately serve lands planned to be maintained in agricultural uses.

PRINCIPLE

The preservation of environmental corridors and isolated natural resource areas in essentially natural, open use yields many benefits, including recharge and discharge of groundwater and the maintenance of surface water and groundwater quality and quantity, as well as maintenance of base flows in and to surface waters; reductions in soil erosion; provision of wildlife habitat; protection of plant and animal diversity; protection of rare and endangered species; maintenance of scenic beauty; and provision of opportunities for recreational, educational, and scientific pursuits.[c]

STANDARDS

1. Primary environmental corridors should be preserved[d] in essentially natural, open uses, and the extension of urban services, including public water supply services, into such corridors should be avoided, except for corridor-dependent uses, such as recreational facilities and water transmission main, sewage conveyance facilities, and other utility crossings.

2. Secondary environmental corridors and isolated natural resource areas should be preserved in essentially natural, open uses to the extent practicable, as determined in county and local plans.

Uses considered to be compatible with the preservation of environmental corridors and isolated natural resource areas are indicated in Table 80.

PRINCIPLE

The preservation of productive agricultural land is important for meeting future needs for food and fiber. Agricultural areas, in addition to providing food and fiber, can provide groundwater recharge and wildlife habitat and contribute to the maintenance of an ecological balance between plants and animals. Moreover, the preservation of agricultural areas also contributes immeasurably to the maintenance of the scenic beauty and cultural heritage of the Region. The preservation of agricultural lands can maximize return on investments in agricultural soil and water conservation practices; minimize conflicts between farming operations and urban land uses; and help maintain an important component of the economic base of the Region.

Table 79 (continued)

STANDARD

1. The most productive soils, those designated by the U.S. Natural Resources Conservation Service as comprising agricultural soil capability Classes I and II, should be preserved for agricultural use, to the extent practicable, recognizing that certain Class I and Class II farmland will have to be converted to urban use in order to accommodate the orderly expansion of urban service areas within the Region. The extension of urban services, including public water supply services, into such areas should be avoided, except as these lands are converted to urban uses.

2. Development of water sources in areas to be preserved for agricultural uses should be carried out in a manner which preserves the agricultural uses of the land as envisioned in the adopted regional land use plan.

OBJECTIVE NO. 2—CONSERVATION AND WISE USE OF THE SURFACE WATER AND GROUNDWATER SUPPLIES

A regional water supply system which conserves and wisely utilizes the surface water and groundwater supplies of the Region, so as to sustain those supplies for future, as well as existing needs.

PRINCIPLE

The sustainability[e] of the surface water and groundwater supplies should be maintained through the careful design, operation and use of the water supply systems.

STANDARDS

1. The use of the deep sandstone aquifer should be managed so that the potentiometric surface in that aquifer is sustained or raised under use and recharge conditions within the Southeastern Wisconsin Region. Declines in the potentiometric surface of the aquifer within the Region due to uses in areas beyond the Region should be identified for purposes of promoting interregional planning and action.

2. The uses of the shallow aquifer should be managed so that the aquifer yields are sustainable.

3. The uses of the deep and shallow aquifers should be managed so as to minimize the ecological impacts on the surface water system of the Region.

4. Lake Michigan as a source of supply should be utilized recognizing the constraints of the current regulatory framework and the status and provisions of the Great Lakes-St. Lawrence River Basin Water Resources Compact.

PRINCIPLE

The lakes, rivers, and wetlands of the Region are intimately connected to each other and to the groundwater of the area. These resources provide scenic beauty, fish and wildlife habitat, fishing, swimming, and boating opportunities to residents and visitors to our Region. This, in turn, supports the business and jobs that depend on these activities. In addition, the tax base generated by the higher values of waterfront properties adds greatly to the economic wellbeing of the counties of our Region. Surface water quality and quantity are vital to the economic stability, social fabric, and community wellbeing of the area.

1. The use of groundwater and surface water for water supply purposes should be carried out in a manner which minimizes adverse impacts to the water resources system, including lakes, streams, springs, and wetlands.

PRINCIPLE

Conservation of water can help to sustain supplies, as well as reduce energy usage, reduce wastewater flows, and minimize water supply infrastructure development needs and operating costs. The effectiveness of water conservation programs will be dependent upon the willingness of users to conserve and the ability of suppliers to implement changes in policies and rules governing water use.

STANDARDS

1. Residential per capita water usages should be reduced to the extent practicable based upon the conclusions developed in SEWRPC Technical Report No. 43, *State-of-the-Art of Water Supply Practices*, and recognizing that differences in levels of conservation may be appropriate, depending upon the source of supply and related natural resources.

2. Both indoor and outdoor water uses should be optimized through conservation practices which do not adversely affect the public health.

Table 79 (continued)

3. Water uses for commercial, industrial, and institutional land uses should be reduced to the extent practicable through water conservation measures, duly considering the source of supply and related natural resources, as well as the economic viability and economic development needs of the Region.

4. Unaccounted-for water in utility systems should be minimized.

PRINCIPLE

Urban and rural land use development, including stormwater management and related land management practices, have important impacts on groundwater recharge with respect to the quantity of the recharge water.

STANDARDS

1. The type and extent of stormwater management and related land management practices should be determined through preparation of local stormwater management plans and land development practices and policies specifically considering the impact of those activities on groundwater recharge and should promote such practices which maintain or enhance the natural groundwater hydrology to the extent practicable, while protecting surface water and groundwater quality and quantity.

OBJECTIVE NO. 3—PROTECTION OF PUBLIC HEALTH, SAFETY, AND WELFARE

A regional water supply system which protects the public health, safety, and welfare.

PRINCIPLE

An adequate, high-quality water supply is essential to the social and economic welfare of an area. Public water supply facilities and sources should protect the public health, safety, and welfare by providing pure, safe, healthful drinking water in sufficient quantities and pressures to meet demands, including fire protection requirements. In order to do so, it is necessary to protect and enhance the quality of surface water and groundwater quality, as well as to provide appropriate protective measures between the sources of supply and the uses of that supply.

STANDARDS

1. Water supply systems should be designed, constructed and operated to deliver finished water to users which meets the drinking water standards established by the Wisconsin Department of Natural Resources to protect the public health, safety, and welfare. Those standards are set forth in this chapter and Appendix H.

2. Water supply systems should be designed, constructed, and operated consistent with technically sound water supply industry standards directed toward the protection of the public health, safety, and welfare.

3. The selection of sources of supply and the design, contribution and operation of related treatment facilities should be made cognizant of the potential presence of unregulated emerging pollutants, such as pharmaceuticals, personal care products, and certain viruses.

4. The reuse of wastewater should be evaluated for applications where there is no potential for direct human consumption and limited potential for direct human contact, unless the pre-use treatment level is such as to preclude risks to public health.

5. Surface water and groundwater supply treatment plants should be provided with state-of-the-art barriers to substances harmful to human health and safety.

6. Water supply sources and treatment processes should be selected to minimize potential problems with subsequent treatment and disposal of created waste streams.

7. Groundwater and surface water sources of water supply should be protected from sources of contamination by appropriate siting, design, and land use regulation.

PRINCIPLE

Urban and rural land use development and related land management practices, including stormwater management and waste disposal practices, have an impact on surface water and groundwater quality.

Table 79 (continued)

STANDARDS

1. The level of treatment and design provided at public sewage treatment plants and industrial wastewater discharge locations should be determined directly related to the achievement of adopted water use objectives and supporting surface water and groundwater standards. These objectives and standards are set forth in Appendices I and J for the receiving waters and the safety and public health requirement of any potentially affected water supplies.

2. The density, design, operation, and level of treatment of onsite sewage disposal systems should be related to the achievement of the groundwater quality standards and the safety and public health requirements of any potentially affected water supplies.

3. The type and extent of stormwater management or associated preventive land management practices to be applied in both urban and rural areas should be determined by State and local regulations, local stormwater management plans, county land and water management plans, and farm management plans directly related to protection of potentially affected water supplies and to the established water quality standards for the receiving surface water and groundwater systems.

4. There should be no known wastewater or stormwater discharges to the surface water or groundwater systems used for water supply of inorganic compounds, synthetic compounds, volatile organics, or other substances in quantities at levels known to be bioaccumulative, acutely or chronically toxic or hazardous to human health, fish or other aquatic life, wildlife, and domestic animals.

OBJECTIVE NO. 4—ECONOMICAL AND EFFICIENT SYSTEMS

The development of water supply facilities, operational improvements, and policies, that are both economical and efficient, best meeting all other objectives at the lowest practical cost, considering both long-term capital and operation and maintenance costs.

PRINCIPLE

The total financial resources in the Region are limited and investment in construction and operation of water supply facilities must recognize that resources applied in this area will not be available for investment in other areas. Total water supply costs, therefore, should be minimized while meeting and achieving other water supply objectives.

STANDARDS

1. The sum of water supply system operating and capital investment costs should be minimized. Costs for waste disposal byproducts of water treatment, long-term energy and operation and maintenance, and legal costs should be considered.

2. Maximum feasible use should be made of all existing and committed water supply facilities, which should be supplemented with additional facilities only as necessary to serve the anticipated water supply needs.[f]

3. The use of new or improved technologies and management practices should be allowed and encouraged if such technologies and practices offer economies in construction costs or by their superior performance lead to the achievement of water supply objectives at a lesser cost.

4. Water supply facilities should be designed for staged or incremental construction where feasible and economical so as to limit total investment in such facilities and to permit maximum flexibility to accommodate changes in the rate of population growth and the rate of economic activity growth or changes in the technology for water supply management.

OBJECTIVE NO. 5—RESPONSIVE AND ADAPTIVE PLANS

The development of water supply systems, operations, and policies which are flexible and adaptive in response to changing conditions, and redundant with respect to source of supply.

PRINCIPLE

As human understanding of the factors affecting water supply improves, the activities necessary for the achievement of the established water supply objectives and supporting standards may require modification for responding to varying short- and long-term changes in conditions and emerging challenges. The conduct of such activities requires that the adopted plan and the designated management agencies have sufficient operational flexibility and monitoring capacity to respond to changing conditions.

Table 79 (continued)

STANDARDS

1. The recommended regional water supply plan components should be adaptable to change in scope, capacity, and effectiveness to the extent practicable.

2. The recommended water supply plan should be designed to incorporate redundancy, system backup features, and emergency operation requirements to the extent practicable in order to insure a safe delivery of water.

3. The regional water supply plan components should be designed for staged incremental construction to the extent practical, so as to permit maximum flexibility to accommodate unanticipated changes in future conditions.

4. The regional water supply plan should be adaptable to changes in the regulatory structure, including the Great Lakes-St. Lawrence River Basin Water Resources Compact and the State of Wisconsin 2003 Act 310.

5. The regional water supply plan should consider the possibility of long-term climate cycles that can affect recharge rates and water demand.

6. The regional water supply plan should consider the possibility of changes in economic conditions, security issues, and regulations that can affect the demand for water supply and need for and types of water supply facilities.

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[a]*Urban development is defined as an area devoted to urban-density residential, commercial, industrial, governmental and institutional, recreational, and utility and communication uses. "Urban-density" residential development includes the following density ranges: high-density (at least 7.0 dwelling units per net residential acre); medium-density (2.3 to 6.9 dwelling units per net acre) and low-density (0.7 to 2.2 dwelling units per net acre). The term "urban service area" refers to areas that are intended to accommodate urban development insofar as they are served by basic urban services and facilities, including public sanitary sewer service and typically also including public water supply service and a local park, school, and shopping area.*

[b]*As used herein, the term "preserve" generally means to retain areas in existing, often natural, open, uses. In some cases, the plan may specifically indicate the types of uses that are able to be accommodated while maintaining the overall integrity of the natural resource base. This standard indicates that certain areas should be preserved; it does not indicate the measures—such as public acquisition, conservation easements, or land use regulation—that are recommended to be used to assure the desired preservation. Such measures are dealt with in the plan and plan implementation chapters of this report.*

[c]*Environmental corridors are elongated areas in the landscape which contain concentrations of natural resource features (lakes, rivers, streams, and their associated shorelands and floodlands; wetlands; woodlands; prairies; wildlife habitat areas; wet, poorly drained, and organic soils; and rugged terrain and high-relief topography) and natural resource-related features (existing park and open space sites; potential park and open space sites; historic sites; scenic areas and vistas; and natural areas and critical species habitat sites). Primary environmental corridors include a variety of these features and are at least 400 acres in size, two miles long, and 200 feet in width. Secondary environmental corridors also contain a variety of these features and are at least 100 acres in size and one mile in length. Isolated natural resource areas are smaller concentrations of natural resource features that are physically separated from the environmental corridors by intensive urban or agricultural uses; by definition, such areas are at least five acres in size.*

[d]*As used herein, the term "preserve" generally means to retain existing conditions. In some cases—for example, when used in relation to environmental corridors or isolated natural resource areas—this term has been specifically defined to indicate certain types of uses that are able to be accommodated while maintaining the overall integrity of the existing resources. The objectives and standards presented in this table indicate that certain areas should be preserved; they do not indicate the measures—such as public interest ownership, conservation easements, or land use regulation—that may be used to help assure the desired preservation. Such measures are dealt with in the plan and plan implementation chapters of this report.*

[e]*Sustainability may be defined as the condition of beneficially using water supply resources in such a way that the uses support the current and probable future needs, while simultaneously ensuring that the resource is not unacceptably damaged by such a beneficial use. For purposes of this water supply planning program, unacceptable damage is defined as a change in an important physical property of the groundwater or surface water system—such as water level, water quality, water temperature, recharge rate, or discharge rate—that approaches a significant percentage of the normal range of variability in that property. Impacts that are 10 percent or less of the annual or historic period of record range for any property will be considered acceptable, unless it can be shown that the cumulative effect of the change will cause a permanent change in an aquatic ecosystem by virtue of increasing the extremes of that property to levels known to be harmful.*

[f]*For purposes of regional water supply planning, the determination of excess, or available, capacity in existing and committed water supply facilities, as well as the reliability of that capacity, must be accomplished in close cooperation with the facility owners concerned.*

Source: SEWRPC.

Table 80

GUIDELINES FOR DEVELOPMENT CONSIDERED COMPATIBLE WITH ENVIRONMENTAL CORRIDORS AND ISOLATED NATURAL RESOURCE AREAS

Component Natural Resource and Related Features within Environmental Corridors[a]	Permitted Development																
	Transportation and Utility Facilities (see General Development Guidelines below)				Recreational Facilities (see General Development Guidelines below)												
	Streets and Highways	Utility Lines and Related Facilities	Engineered Stormwater Management Facilities	Engineered Flood Control Facilities[b]	Trails[c]	Picnic Areas	Family Camping[d]	Swimming Beaches	Boat Access	Ski Hills	Golf	Playfields	Hard-Surface Courts	Parking	Buildings	Rural-Density Residential Development (see General Development Guidelines below)	Other Development (see General Development Guidelines below)
Lakes, Rivers, and Streams	- -[e]	- -[f,g]	- -	- -[h]	- -[i]	- -	- -	X	X	- -	- -	- -	- -	- -	- -	- -	- -
Shoreland	X	X	X	X	X	X	- -	X	X	- -	X	- -	- -	X	X[j]	- -	- -
Floodplain	- -[k]	X	X	X	X	X	- -	X	X	- -	X	X	- -	X	X[l]	- -	- -
Wetland[m]	- -[k]	X	- -	- -	X[n]	- -	- -	- -	X	- -	- -[o]	- -	- -	- -	- -	- -	- -
Wet Soils	X	X	X	X	X	- -	- -	X	X	- -	X	- -	- -	X	- -	- -	- -
Woodland	X	X	X[p]	- -	X	X	X	- -	X	X	X	X	X	X	X[q]	X	X
Wildlife Habitat	X	X	X	- -	X	X	X	- -	X	X	X	X	X	X	X	X	X
Steep Slope	X	X	- -	- -	- -[r]	- -	- -	- -	- -	X[s]	X	- -	- -	- -	- -	- -	- -
Prairie	- -	- -[g]	- -	- -	- -[r]	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Park	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	- -	- -
Historic Site	- -	- -[g]	- -	- -	- -[r]	- -	- -	- -	- -	- -	- -	- -	- -	X	- -	- -	- -
Scenic Viewpoint	X	X	- -	- -	X	X	X	- -	X	X	X	- -	- -	X	X	X	X
Natural Area or Critical Species Habitat Site	- -	- -	- -	- -	- -[q]	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -

NOTE: An "X" indicates that facility development is permitted within the specified natural resource feature. In those portions of the environmental corridors having more than one of the listed natural resource features, the natural resource feature with the most restrictive development limitation should take precedence.

APPLICABILITY

These guidelines indicate the types of development that can be accommodated within primary and secondary environmental corridors and isolated natural resource areas while maintaining the basic integrity of those areas. Throughout this table, the term "environmental corridors" refers to primary and secondary environmental corridors and isolated natural resource areas.

Under the regional plan:

- As regionally significant resource areas, primary environmental corridors should be preserved in essentially natural, open use—in accordance with the guidelines in this table.
- Secondary environmental corridors and isolated natural resource areas warrant consideration for preservation in essentially natural open use, as determined in county and local plans and in a manner consistent with State and Federal regulations. County and local units of government may choose to apply the guidelines in this table to secondary environmental corridors and isolated natural resource areas.

GENERAL DEVELOPMENT GUIDELINES

- Transportation and Utility Facilities: All transportation and utility facilities proposed to be located within the important natural resources should be evaluated on a case-by-case basis to consider alternative locations for such facilities. If it is determined that such facilities should be located within natural resources, development activities should be sensitive to, and minimize disturbance of, these resources, and, to the extent possible following construction, such resources should be restored to preconstruction conditions.

The above table presents development guidelines for major transportation and utility facilities. These guidelines may be extended to other similar facilities not specifically listed in the table.

- Recreational Facilities: In general, no more than 20 percent of the total environmental corridor area should be developed for recreational facilities. Furthermore, no more than 20 percent of the environmental corridor area consisting of upland wildlife habitat and woodlands should be developed for recreational facilities. It is recognized, however, that in certain cases these percentages may be exceeded in efforts to accommodate needed public recreational and game and fish management facilities within appropriate natural settings.

  The above table presents development guidelines for major recreational facilities. These guidelines may be extended to other similar facilities not specifically listed in the table.

- Rural Density Residential Development: Rural density residential development may be accommodated in upland environmental corridors, provided that buildings are kept off steep slopes. The maximum number of housing units accommodated at a proposed development site within the environmental corridor should be limited to the number determined by dividing the total corridor acreage within the site, less the acreage covered by surface water and wetlands, by five. The permitted housing units may be in single-family or multi-family structures. When rural residential development is accommodated, conservation subdivision designs are strongly encouraged.

Table 80 (continued)

- Other Development: In lieu of recreational or rural density residential development, up to 10 percent of the upland corridor area in a parcel may be disturbed in order to accommodate urban residential, commercial, or other urban development under the following conditions: 1) the area to be disturbed is compact rather than scattered in nature; 2) the disturbance area is located on the edge of a corridor or on marginal resources within a corridor; 3) the development does not threaten the integrity of the remaining corridor; and 4) the development does not result in significant adverse water quality impacts; 5) development of the remaining corridor lands is prohibited by a conservation easement or deed restriction. Each such proposal must be reviewed on a site-by-site basis.

  Under this arrangement, while the developed area would no longer be part of the environmental corridor, the entirety of the remaining corridor would be permanently preserved from disturbance. From a resource protection point of view, preserving a minimum of 90 percent of the environmental corridor in this manner may be preferable to accommodating scattered homesites and attendant access roads at an overall density of one dwelling unit per five acres throughout the upland corridor areas.

- Pre-Existing Lots: Single-family development on existing lots of record should be permitted as provided for under county or local zoning at the time of adoption of the land use plan.

- All permitted development presumes that sound land and water management practices are utilized.

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[a]*The natural resource and related features are defined as follows:*

Lakes, Rivers, and Streams: Includes all lakes greater than five acres in area and all perennial and intermittent streams as shown on U.S. Geological Survey quadrangle maps.

Shoreland: Includes a band 50 feet in depth along both sides of intermittent streams; a band 75 feet in depth along both sides of perennial streams; a band 75 feet in depth around lakes; and a band 200 feet in depth along the Lake Michigan shoreline.
Floodplain: Includes areas, excluding stream channels and lake beds, subject to inundation by the 100-year recurrence interval flood event.
Wetlands: Includes areas that are inundated or saturated by surface water or groundwater at a frequency, and with a duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.
Wet Soils: Includes areas covered by wet, poorly drained, and organic soils.
Woodlands: Includes areas one acre or more in size having 17 or more deciduous trees per acre with at least a 50 percent canopy cover as well as coniferous tree plantations and reforestation projects; excludes lowland woodlands, such as tamarack swamps, which are classified as wetlands.
Wildlife Habitat: Includes areas devoted to natural open uses of a size and with a vegetative cover capable of supporting a balanced diversity of wildlife.
Steep Slope: Includes areas with land slopes of 12 percent or greater.
Prairies: Includes open, generally treeless areas which are dominated by native grasses; also includes savannas.
Park: Includes public and nonpublic park and open space sites.
Historic Site: Includes sites listed on the National Register of Historic Places. Most historic sites located within environmental corridors are archaeological features such as American Indian settlements and effigy mounds and cultural features such as small, old cemeteries. On a limited basis, small historic buildings may also be encompassed within delineated corridors.
Scenic Viewpoint: Includes vantage points from which a diversity of natural features such as surface waters, wetlands, woodlands, and agricultural lands can be observed.
Natural Area and Critical Species Habitat Sites: Includes natural areas and critical species habitat sites as identified in the regional natural areas and critical species habitat protection and management plan.

[b]*Includes such improvements as stream channel modifications and such facilities as dams.*

[c]*Includes trails for such activities as hiking, bicycling, cross-country skiing, nature study, and horseback riding, and excludes all motorized trail activities. It should be recognized that trails for motorized activities such as snowmobiling that are located outside the environmental corridors may of necessity have to cross environmental corridor lands. Proposals for such crossings should be evaluated on a case-by-case basis, and if it is determined that they are necessary, such trail crossings should be designed to ensure minimum disturbance of the natural resources.*

[d]*Includes areas intended to accommodate camping in tents, trailers, or recreational vehicles which remain at the site for short periods of time, typically ranging from an overnight stay to a two-week stay.*

[e]*Certain transportation facilities such as bridges may be constructed over such resources.*

[f]*Utility facilities such as sanitary sewers may be located in or under such resources.*

[g]*Electric power transmission lines and similar lines may be suspended over such resources.*

[h]*Certain flood control facilities such as dams and channel modifications may need to be provided in such resources to reduce or eliminate flood damage to existing development.*

[i]*Bridges for trail facilities may be constructed over such resources.*

[j]*Consistent with Chapter NR 115 of the* Wisconsin Administrative Code.

[k]*Streets and highways may cross such resources. Where this occurs, there should be no net loss of flood storage capacity or wetlands. Guidelines for mitigation of impacts on wetlands by Wisconsin Department of Transportation facility projects are set forth in Chapter Trans 400 of the* Wisconsin Administrative Code.

[l]*Consistent with Chapter NR 116 of the* Wisconsin Administrative Code.

[m]*Any development affecting wetlands must adhere to the water quality standards for wetlands established under Chapter NR 103 of the* Wisconsin Administrative Code.

[n]*Only an appropriately designed boardwalk/trail should be permitted.*

[o]*Wetlands may be incorporated as part of a golf course, provided there is no disturbance of the wetlands.*

[p]*Generally excludes detention, retention, and infiltration basins. Such facilities should be permitted only if no reasonable alternative is available.*

[q]*Only if no alternative is available.*

[r]*Only appropriately designed and located hiking and cross-country ski trails should be permitted.*

[s]*Only an appropriately designed, vegetated, and maintained ski hill should be permitted.*

Source: SEWRPC.

particularly and importantly the water use objectives and water quality standards promulgated by the Wisconsin Department of Natural Resources (WDNR). These objectives and standards include standards for drinking water supplies, groundwater quality, and surface water quality.

The currently adopted regional water use objective and standards are also an important consideration in the water supply planning program. In this regard, surface waters may be an important consideration when considering the potential impacts of groundwater withdrawals or the impact of groundwater recharge. In addition, there are specific standards for surface waters used as sources of public drinking water. Accordingly, this section describes the current water use objectives and standards as they relate to the regional water supply planning effort.

Drinking Water Standards

The WDNR has established standards for drinking water designed to protect the public health, safety, and welfare. Standards have been established for five groups of substances: inorganic compounds, synthetic compounds, volatile organics, radonuclides, and lead and copper. In many cases, these standards are based upon national primary drinking water standards promulgated by the U.S. Environmental Protection Agency, which is the department responsible for establishing and enforcing such standards. The standards have been expressed in terms of a “maximum contaminant level” (MCL) and a “maximum contaminant level goal” (MCLG). The former is defined as the maximum permissible level of a contaminant in water which is delivered to a public water supply system. The later is defined as the maximum level of a contaminant in drinking water at which no known or anticipated adverse affect on health may be expected to occur, given a margin of safety. For lead and copper the standards are expressed as “action level,” or the concentration of lead or copper in water which determines, in some cases, the treatment requirements that a public water supply system must meet. The WDNR has also established sampling and analytical requirements to accompany the drinking water standards. These requirements are documented in Chapter NR 809 of the *Wisconsin Administrative Code*.

The WDNR has also established secondary chemical and physical standards for selected water parameters. These standards set limits for constituents which are not considered hazardous to health, but may be objectionable to water users.

It should be noted that no standards have been established by the WDNR for some emerging pollutants, such as pharmaceuticals, personal care products, and certain viruses. It is, nevertheless, important to consider to the extent practicable such pollutants as the water supply planning proceeds.

The State established drinking water standards are set forth in Appendix H.

As already noted, the standards for lead and copper are set forth in terms of actions levels. The lead action level is exceeded if the concentration of lead in more than 10 percent of the tap water samples collected during any monitoring period is greater than 0.015 milligrams per liter (mg/l)—or parts per million (i.e. if the “90th percentile” lead level is greater than 0.015 mg/l). The copper action level is exceeded if the concentration of copper in more than 10 percent of tap water samples collected during any monitoring period is greater than 1.3 mg/l (i.e. if the “90th percentile” copper level is greater than 1.3 mg/l).

Groundwater Standards

Groundwater standards are an important consideration in that they form a basis for which to judge the potential need for water treatment technologies under alternative plans relying on groundwater as a source of supply. The WDNR has also established standards for groundwater quality, and for substances detected in, or having a reasonable probability of entering, the groundwater resources of the State. Standards have been established for three groups of substances: indicator parameters, substances of public health concern, and substances related to public welfare. These standards are set forth in Appendix I. For each groundwater quality indicator parameter, one criterion, a protective action limit, is established. Two criteria are set for each substance of public health concern or welfare: a preventive action limit and an enforcement standard.

The preventive action limits have three major purposes. They are intended to be used to inform the WDNR of potential groundwater contamination. In addition, they are intended to establish levels of contamination at which the Department is required to commence efforts to control contamination. Finally, they provide a basis for designing management criteria in administrative rulemaking.

The enforcement standards establish concentrations used to initiate regulatory responses. It is important to note in this respect, that Chapter NR 140 of the *Wisconsin Administrative Code* establishes procedures for granting exemptions when enforcement standards are attained or exceeded, in whole or in part, because of high background concentrations of substances in the groundwater reservoir concerned.

In addition to the groundwater quality standards, the WDNR has established standards for drinking water supplies that include a number of substances for which groundwater quality standards have not been issued. For example, though no groundwater quality standard has been issued for radium, the standards for drinking water supplies set forth in Chapter NR 809 of the *Wisconsin Administrative Code* set a maximum contaminant limit for radium in drinking water of five picoCuries per liter.

Surface Water Use Objectives (Classification) and Water Quality Standards (Criteria)
Surface water use objectives and standards are important considerations in water supply planning, as they include public health and welfare standards for public drinking water supplies. In addition, these objectives and standards form a basis for considering the discharge of contaminants from water supply treatment systems. Furthermore, the surface water objectives and current uses are an important consideration in evaluating the importance of groundwater recharge protection or enhancement. The WDNR currently has developed standards for the following water use objectives or classifications relating to fish and aquatic life for the streams and lakes in the planning area: 1) Great Lakes community, 2) coldwater community, 3) warmwater sportfish community, 4) warmwater forage fish community, 5) limited forage fish, and 6) limited aquatic life. In addition, the WDNR has developed standards, or criteria, for two recreational use classifications: 1) full recreational use and 2) limited recreational use. The Department has also developed standards, or criteria, for public health and welfare and for wildlife protection. For the purpose of an anti-degradation policy intended to prevent the lowering of existing levels of water quality, the WDNR has classified some waters as outstanding or exceptional resource waters. These waters, listed in Chapters NR 102.10 and NR 102.11 of the *Wisconsin Administrative Code*, are deemed to have significant value such as valuable fisheries, hydrologically or geographically unique features, outstanding recreational opportunities, and unique environmental settings, and they are not significantly impacted by human activities. Any discharge that may be allowed to these waters generally cannot be above background levels. These waters are considered “areas of special natural resource interest” for permitted activities under Chapter 30 of the *Wisconsin Statutes*.

The objectives or classifications for fish and aquatic life for all of the streams in the Region are shown on Map 67. All of the fish and aquatic life categories are considered to be in the full recreational use category, except where a special variance is noted.

The fish and aquatic life and the recreational use objectives or classifications are those most directly related to the regional water quality management plan. In addition, the WDNR has developed standards for wildlife and for public health and welfare. All streams are expected to meet the wildlife standards. The public health and welfare standards vary only depending upon whether or not the surface water is used as a source for a public drinking water supply. Thus, there is no variation in the public health and welfare objectives or category for all the surface waters in the Region, except Lake Michigan.

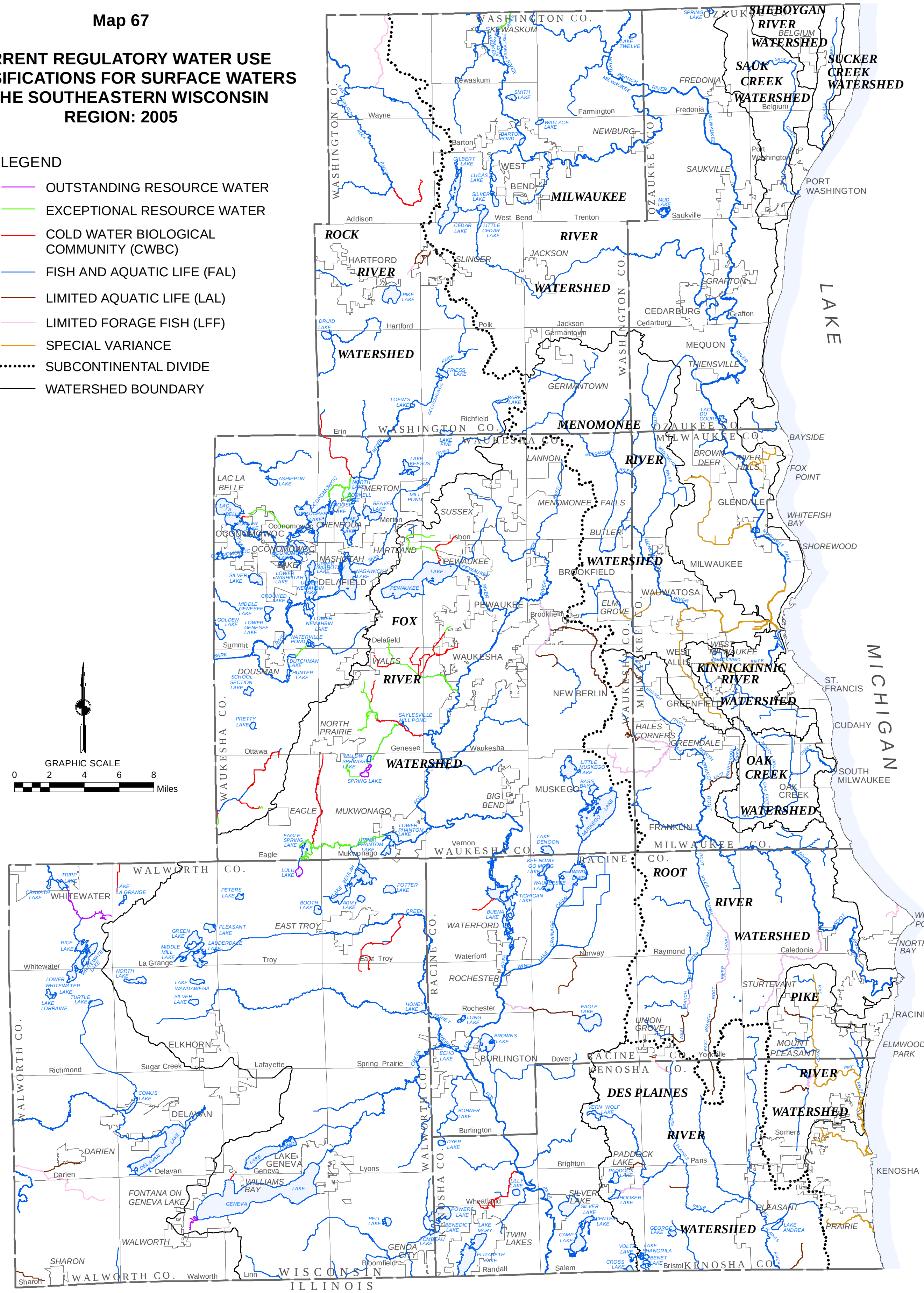
Chapter NR 103 of the *Wisconsin Administrative Code* establishes water quality-related rules for wetlands. The rules consist of: 1) a set of standards intended to protect the water quality-related functions of wetlands; and 2) implementation procedures for application of the water quality standards. Because the application of the rules set forth in Chapter NR 103 is site-specific and requires consideration of the specific activity proposed within, or adjacent to, a wetland, wetland water quality standards are not specifically addressed in this report. To determine

Map 67

CURRENT REGULATORY WATER USE CLASSIFICATIONS FOR SURFACE WATERS IN THE SOUTHEASTERN WISCONSIN REGION: 2005

LEGEND

- OUTSTANDING RESOURCE WATER
- EXCEPTIONAL RESOURCE WATER
- COLD WATER BIOLOGICAL COMMUNITY (CWBC)
- FISH AND AQUATIC LIFE (FAL)
- LIMITED AQUATIC LIFE (LAL)
- LIMITED FORAGE FISH (LFF)
- SPECIAL VARIANCE
- SUBCONTINENTAL DIVIDE
- WATERSHED BOUNDARY



Source: Wisconsin Department of Natural Resources and SEWRPC.

applicable standards, the procedures documented in Chapter NR 103 must be applied by the WDNR on a site-specific, case-by-case basis.

The applicable water quality standards for all water uses designated in Southeastern Wisconsin are set forth in Appendix J. The water quality standards are statements of the physical, chemical, and biological characteristics of the water that must be maintained if the water is to be suitable for the specified uses. Chapter 281 of the *Wisconsin Statutes* recognizes that different standards may be required for different waters or portions thereof. According to this chapter, in all cases the "standards of quality shall be such as to protect the public interest, which is defined to include the protection of the public health and welfare, and the present and prospective future use of such waters for public and private water supplies; propagation of fish and aquatic life and wildlife; domestic and recreational purposes; and agricultural, commercial, industrial, and other legitimate uses."[1]

Notwithstanding, there are minimum standards which apply to all waters. All surface waters must meet certain conditions at all times and under all flow conditions. Chapter NR 102 of the *Wisconsin Administrative Code* states that:

> Practices attributable to municipal, commercial, domestic, agricultural, land development or other activities shall be controlled so that all waters including the mixing zone and the effluent channel meet the following conditions at all times and under all flow conditions:
>
> (a) Substances that will cause objectionable deposits on the shore or in the bed of a body of water shall not be present in such amounts as to interfere with public rights in the waters of the State.
>
> (b) Floating or submerged debris, oil, scum or other material shall not be present in such amounts as to interfere with public rights in the waters of the State.
>
> (c) Materials producing color, odor, taste, or unsightliness shall not be present in such amounts as to interfere with public rights in the waters of the State.
>
> (d) Substances in concentrations or combinations which are toxic or harmful shall not be present in amounts found to be of public health significance, nor shall substances be present in amounts which are acutely harmful to animal, plant, or aquatic life.[2]

All surface waters of the State are also required to meet the human threshold and human cancer criteria for the protection of the public health and welfare. These criteria are set forth in Appendix J. The concentrations given in these criteria vary, depending upon whether or not the surface water is used for public drinking water supplies, and vary with the fish and aquatic life category designated for the waterbody. In addition, all surface waters providing a source for public drinking water supplies, and all surface waters classified as suitable coldwater or warmwater sportfish communities are required to meet the threshold taste and odor criteria set forth in Appendix J.

ENGINEERING DESIGN STANDARDS FOR WATER SUPPLY FACILITIES

The planning and design of water supply facilities are based, in part, upon forecasts of future water demand. Standards for preparing the necessary demand forecasts have been developed by the engineering profession for:

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[1]Wisconsin Statutes, *Section 281.15(1).*

[2]Wisconsin Administrative Code, *Chapter NR 102.04.*

- Residential demand,
- Commercial demand,
- Industrial demand,
- Public facilities demand,
- Fire fighting demand,
- Unaccounted-for water uses, and
- Unrecoverable water used in treatment.

An important objective in the planning and design of a public water supply system is to provide a continuous adequate supply of safe water to all customers. The system must be designed to supply the quantity of water needed by each individual customer and by all customers in aggregate; provide acceptable water pressures throughout the system; and have sufficient redundancy and reserve capacity to provide a continuous supply of water during probable emergencies, such as fires and anticipated equipment failures. Accordingly, planning and engineering design standards have been developed for:

- Peak water demands,
- System pressures,
- Fire flow considerations,
- Source capacity,
- Pumping and storage capacity, and
- Main looping and sizing.

The planning and design standards and criteria for the various needs and system characteristics identified above are documented in SEWRPC Technical Report No. 43, *State-of-the-Art of Water Supply Practices*, July 2007.

ECONOMIC EVALUATION

The economic evaluations conducted under the regional water supply planning program include the preparation of capital and annual operation and maintenance cost estimates. Capital costs include construction contract costs plus engineering, inspection, and contract administration costs. Operation and maintenance costs include labor, power, chemicals, utilities, materials and supplies, disposal of residuals, and related costs. The unit capital and operation and maintenance costs used are set forth in the aforenoted state-of-the-art of water supply practices report.

The cost-effective analyses conducted under the regional water supply planning program compare the 50-year present worth of alternatives. The present worth used includes initial and future capital expenditures, operation and maintenance costs, and salvage values based upon straight-line depreciation of structures and equipment. Capital costs are expressed in 2005 dollars based upon an *Engineering News-Record*, Construction Cost Index (CCI) of 9205, Milwaukee Index (Average of Chicago and Minneapolis indices). Project costs include 35 percent to account for engineering, administration, ordinary legal cost, and contingencies. Any special legal costs expected to be associated with any of the alternative or recommended plans, will be discussed conceptually along with other advantages and disadvantages associated with such plans. The interest rate used for the present worth analysis is 6 percent.

Chapter VI

SUMMARY OF WATER SUPPLY LAW AS APPLIED TO SOUTHEASTERN WISCONSIN

The legal framework governing actions intended to resolve development issues is always an important consideration in any planning effort. Water supply law was, however, a particularly important consideration in the development of the regional water supply plan given the status of State legislation concerning the ratification of the Great Lakes-St. Lawrence River Basin Water Resources Compact agreed upon by the governors of the eight Great Lakes States in Milwaukee on December 13, 2005.[1] This Compact has important potential implications for water supply planning in this Region given its intended regulation of the diversion of Lake Michigan water across the subcontinental divide traversing the Region. Moreover, potential changes in groundwater regulation are also under consideration pursuant to Wisconsin Act 310, adopted in 2003, which established a State-level Groundwater Advisory Committee charged with making recommendations for needed regulations for groundwater management.[2]

This chapter provides a succinct summary of the most relevant provisions of water supply law at all levels of government that may influence the preparation and implementation of a regional water supply plan for southeastern Wisconsin. This summary addresses water law applicable to the withdrawal and use of surface and groundwater for water supply, relevant law applicable to the operation of public water systems, and the legal means available for the promotion of regional cooperation in the use and development of water supply systems within the Region. While this summary focuses on existing law, the summary also describes a number of significant proposed changes to water law, and how those changes may affect the provision of water supply in southeastern Wisconsin. The information in this chapter is based upon SEWRPC Technical Report No. 44, *Water Supply Law*, which was prepared by Attorney Lawrie J. Kobza, Boardman, Suhr, Curry & Field, LLP.

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[1]*The Great Lakes-St. Lawrence River Basin Water Resources Compact was enacted into law by Wisconsin Act 227, adopted in 2007, and was formalized by a Congressional Consent Resolution signed by the President in October 2008.*

[2]*The Groundwater Advisory Committee was charged with preparing two reports. The first report,* 2006 Report to the Legislature on Groundwater Management Areas*, issued in December 2006, dealt with issues and recommendations related to management of groundwater resources within groundwater management areas. The second report,* 2007 Report to the Legislature*, assesses the effectiveness of the Wisconsin Act 310 and the adequacy of specific provisions in the law primarily related to surface water environmental protection.*

SURFACE WATER

Current State Statutes and Regulations

In most circumstances within the Region, a public utility will be allowed to build water supply facilities to withdraw water from Lake Michigan unless the withdrawal results in a large water loss, or results in a diversion of Great Lakes water outside the Great Lakes basin. Section 30.21, of the *Wisconsin Statutes*, authorizes public utilities to construct, maintain and operate water intake pipes and other water supply facilities on the bed of Lake Michigan, upon compliance with applicable Federal regulations and subject to Wisconsin Public Service Commission (PSC) regulation, provided a municipality located on Lake Michigan permits the public utility to install and operate such facilities. Any community located within 50 miles of Lake Michigan is deemed to be situated on Lake Michigan for purposes of this *Statute*. Concurrently with the construction of the water withdrawal facilities, the community must construct sewage treatment and disposal facilities adequate to completely treat all sanitary sewage generated within the municipality.

Construction of public water supply facilities is overseen by the Wisconsin Department of Natural Resources (WDNR) pursuant to Section 281.41, and by the PSC pursuant to Section 196.49 of the *Wisconsin Statutes*. These sections of the *Statutes* provide the WDNR and PSC broad authority to regulate public water supply system construction. Section 281.41, of the *Wisconsin Statutes*, provides that every entity owning a water supply plant or system must obtain approval of plans for the construction of any proposed plant or system improvements or extensions from the WDNR, before proceeding with construction of the facilities concerned. The *Statutes* do not set forth the standards the WDNR is to apply in determining whether or not to approve such plans, and do not specify limits on the conditions that may be attached to plan approval.

The PSC has the authority to review and approve construction projects by public water utilities pursuant to Section 196.49(2) of the *Wisconsin Statutes*. In PSC Section 184.03(2) of the *Wisconsin Administrative Code*, the projects requiring PSC review and approval include, but are not limited to, the construction of new sources of water supply such as intakes. The PSC has the authority to review a proposed project to determine whether public convenience and necessity requires the project. Under this broad review authority, the courts have said that the PSC may examine "public convenience and necessity" from the perspective of the public in general.[3] This could include examining a construction proposal from the view of parties that may be affected by the proposal.

If a proposed surface water withdrawal will result in a large water loss, additional requirements apply. A "water loss" is defined as` a loss of water from the basin from which it is withdrawn as a result of interbasin diversion or consumptive use or both.[4] If water is taken from the basin and then returned to the basin, it would not constitute a water loss under the *Statutes*.

Under Section 30.18(2)(b) of the *Wisconsin Statutes*, a user seeking to divert water from a lake or stream which would result in a water loss averaging two million or more gallons per day (gpd) in any 30-day period must obtain a permit from the WDNR. Similarly, under Section 281.35(4) of the *Wisconsin Statutes*, any withdrawal of water that results in a new or increased water loss of more than two million gpd is subject to WDNR approval. Section 281.35(5)(b), of the *Wisconsin Statutes* applies if the application would result in a new or increased water loss to the Great Lakes basin averaging more than five million gpd in any 30-day period. In that case, the WDNR is to notify each Great Lakes Governor and Premier of the application and follow the regional consultation procedure established by the Great Lakes Charter. The WDNR is to consider comments received from the Great Lakes Governors and Premiers in making its decision on the application.

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[3]Wis. Power & Light v Public Service Comm'n*, 148 Wis. 2d 881, 891-892, 437 N.W.2d 888 (Ct. App. 1989).*

[4]*Section 281.35(1)(L),* Wisconsin Statutes.

If the surface water withdrawal would result in a diversion of water from the Lake Michigan basin, Federal law provides that the diversion be prohibited unless it is first approved by the Governors of the eight Great Lakes states.[5] The Water Resources Planning Act of 1965 (and a series of subsequent acts, including the Water Resource Development Act of 1986)—"WRDA"—codified at 42 U.S.C. Section 1962d-20 specifically provides that:

> No water shall be diverted or exported from any portion of the Great Lakes within the United States, or from any tributary within the United States of any of the Great Lakes, for use outside the Great Lakes basin unless such diversion or export is approved by the Governor of each of the Great Lake States.

This limit on diversions does not apply to any diversion of water from any of the Great Lakes which was authorized on or prior to November 17, 1986.[6]

While WRDA prohibits diversions unless approval of all Great Lakes Governors is received, WRDA does not define what a diversion is. There is also no case law which defines the term "diversion" under WRDA. The WDNR has taken the position in the past that water taken and used outside the basin, but then returned to the basin, is not a diversion subject to WRDA. Such a situation may exist where a municipality located within the basin provides water to customers located outside the basin, but then collects wastewater from those customers and returns it to the basin. In a letter dated December 27, 2006, however, the then Wisconsin Attorney General disagreed with the WDNR's interpretation of the term "diversion," and opined that all withdrawals of water from a lake constitute a diversion because the withdrawal itself—even with return flow—results in the taking of water from its natural course.[7] The Attorney General further opined that although all withdrawals of water from a lake would constitute a diversion, only diversions of water "for use outside the Great Lakes basin" are covered by WRDA. Therefore, under this opinion of the Attorney General, any withdrawal of water from Lake Michigan which is taken for use outside of the Great Lakes basin would constitute a diversion covered by WRDA, regardless of return flow.[8]

The implications of the Attorney General's opinion are unclear. The City of New Berlin did, in 2006, request such approval from the WDNR. As of the date of this report, the WDNR has not publicly announced how it will respond to this request. Despite this uncertainty, the ban under WRDA on the diversion of water out of the Great Lakes basin has a significant limiting impact on the ability of communities in southeastern Wisconsin to use Lake Michigan water. While communities located within the Great Lakes basin have ready access to Lake Michigan water, communities outside of the Great Lakes basin can use Lake Michigan water only if: 1) its use does not constitute a "diversion," however that term is defined; 2) its use was authorized prior to November 17, 1986; or 3) all of the Governors of the eight Great Lakes states approve of the diversion.

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[5]*The Great Lakes states include the States of Illinois, Indiana, Michigan, Minnesota, Ohio, Pennsylvania, New York, and Wisconsin; 42 U.S.C. Section 1962d-20(c).*

[6]*42 U.S.C. Section 1962d-20(f).*

[7]*December 27, 2006 Letter from Wisconsin Attorney General Peggy A. Lautenschlager to Senator Robert Wirch, page 7.*

[8]Id. *at 8. The Attorney General's informal opinion also indicates that only Akron, Ohio has an approved diversion under WRDA. With regard to the Lake Michigan water diversion to Pleasant Prairie, Wisconsin, the Attorney General states: "Although three Great Lakes governors did not approve of the Town of Pleasant Prairie's proposed diversion of Lake Michigan water in 1990 that required return flows to the lake, other governors did. . . Although the legality of the diversion has been questioned, there was never a concession that the diversion was not subject to WRDA."* Id. *at 11.*

The areas outside of the Great Lakes basin, as defined by land surface topography, within the Southeastern Wisconsin Region where water was, in 2005, supplied from a Lake Michigan source and then returned to that source as spent water are shown on Map 68. Those areas, located in the greater Kenosha area and the Village of Menomonee Falls, comprise about 7.0 square miles. Map 68 also illustrates areas within the Region with groundwater-supplied systems and with sewerage systems which return the spent water to Lake Michigan. Areas in the Region which are served by groundwater supplies located outside the Great Lakes basin from which sewerage is returned as spent water to Lake Michigan comprise about 11.0 square miles.

Potential Future Statutes and Regulations Applicable to Withdrawal and Use of Surface Water for Water Supply

On December 13, 2005, Governors of the eight Great Lakes states signed the Great Lakes-St. Lawrence River Basin Water Resources Compact. If this Compact is ratified by the legislatures of all the eight Great Lakes states and consented to by Congress it would expand the existing regulations applicable to the use of Great Lakes basin water.[9]

Under the Compact, all "diversions" outside the Great Lakes basin would be prohibited with three limited exceptions.[10] A "diversion" is defined in the Compact to occur whenever water is transferred from the Great Lakes basin into another watershed by any means other than incorporation into a product.[11] The three exceptions from the diversion prohibition are for straddling communities, communities within straddling counties, and intra-basin transfers.[12]

The straddling community exception would allow any incorporated municipality, or equivalent, whose existing corporate boundaries lie partly within and partly outside the basin, to seek approval for a diversion from the State concerned, provided the water sought is to be used only for public water supply purposes within the straddling community, and all water withdrawn from the basin will be returned to the source watershed less an allowance for consumptive use.[13] In order to receive State approval of a diversion of over 100,000 gpd, the straddling community must show that: a) the need for the water cannot reasonably be avoided through the efficient use and conservation of existing water supplies; b) the withdrawal is limited to quantities considered reasonable for the purpose; c) the withdrawal will be implemented so as to ensure that it will result in no significant individual or cumulative adverse impacts to the waters and water dependent natural resources of the basin with consideration given to the potential cumulative impacts of any precedent-setting consequences associated with the proposal; and d) environmentally sound and economically feasible water conservation measures are to be implemented.[14] If the proposed diversion for a straddling community would result in a consumptive use of five million gpd or more, the proposal must also undergo the regional review process set forth in the Compact and the State concerned must consider the finding of that regional review process when deciding whether to approve the diversion.[15] The

[9]*The Great Lakes-St. Lawrence River Basin Water Resources Compact was enacted into law by Wisconsin Act 227, adopted in 2007, and was formalized by a Congressional Consent Resolution signed by the President in October 2008.*

[10]*Great Lakes-St. Lawrence River Basin Water Resources Compact, December 13, 2005, Sections 4.8 and 4.9.*

[11]Id. *at Section 1.2, Definition of "Diversion."*

[12]Id. *at Section 4.9.*

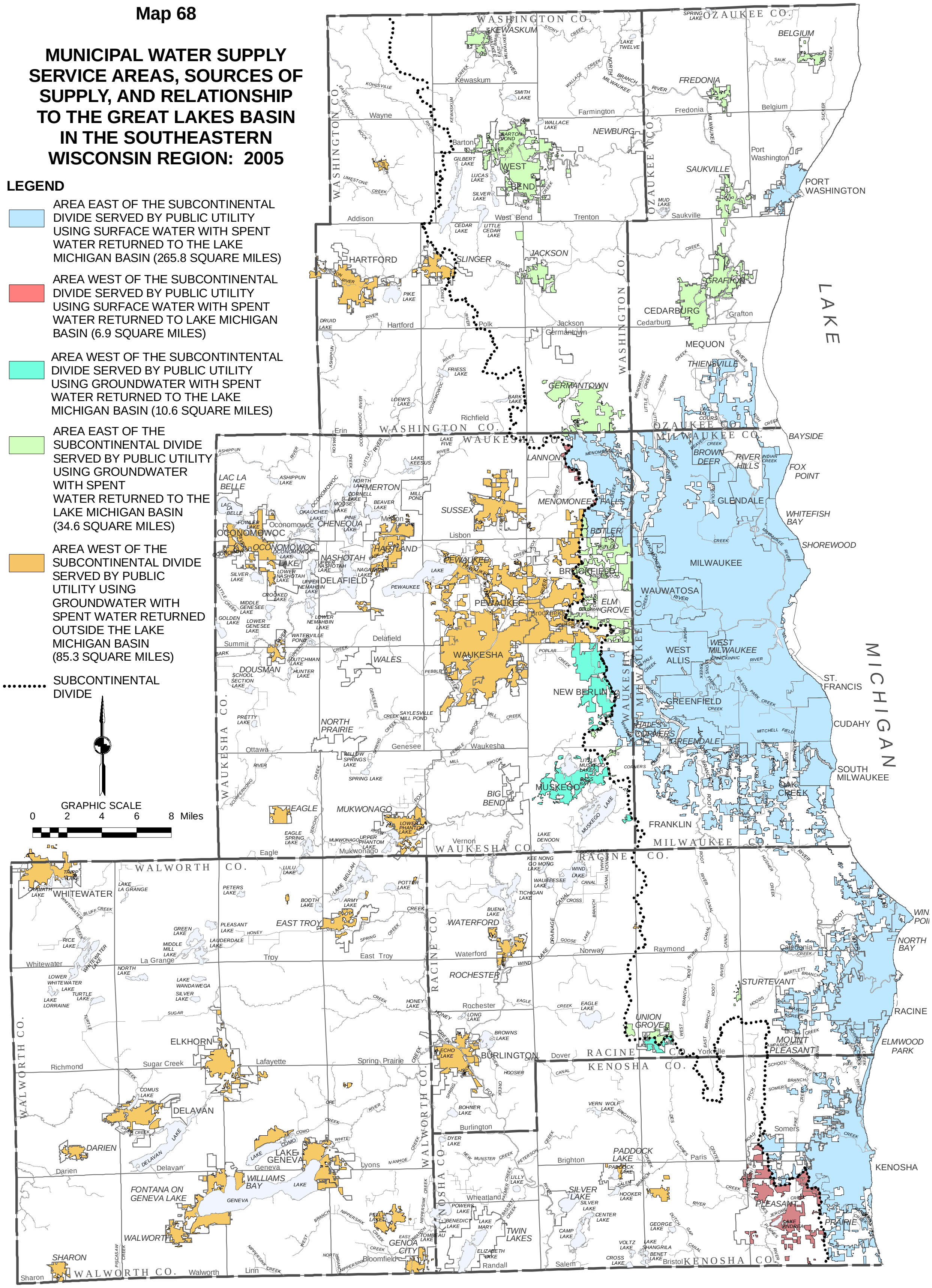
[13]Id. *at Section 4.9, Paragraph (1).*

[14]Id. *at Section 4.9, Paragraph (4).*

[15]Id. *at Section 4.5, Paragraphs (1)(c) and (5).*

Map 68

MUNICIPAL WATER SUPPLY SERVICE AREAS, SOURCES OF SUPPLY, AND RELATIONSHIP TO THE GREAT LAKES BASIN IN THE SOUTHEASTERN WISCONSIN REGION: 2005



Source: Wisconsin Department of Natural Resources and SEWRPC.

communities within the Southeastern Wisconsin Region which meet the definition of a straddling community are shown on Map 69. These communities comprise about 722 square miles, or about 27 percent of the area of the Region.

The community within a straddling county exception to the prohibition on diversions would allow a community within a straddling county to seek approval for a diversion from the eight Great Lakes Governors provided the water sought was to be used only for public water supply purposes within the straddling community, and all water withdrawn from the basin was to be returned to the source watershed less an allowance for consumptive use.[16] A community within a straddling county is defined as any incorporated municipality, or equivalent, that is located totally outside the basin, but wholly within a county that lies partly within the basin.[17] In order to obtain approval from the eight Great Lakes Governors, the community within a straddling county must show that: a) the water sought will be used only for public water supply purposes within a community located within a straddling county that is without adequate supplies of potable water; b) there is no reasonable water supply alternative within the basin in which the community is located, including conservation of existing water supplies; and c) the proposal meets the standards applicable to straddling communities.[18] Approval of a diversion of any size is granted only if the Governors of all eight Great Lakes states approve the application.[19] The Compact further urges caution in the granting of a diversion request by a community within a straddling county, and advises that a diversion should not be approved unless it can be shown that it will not endanger the integrity of the basin ecosystem.[20] The communities within the Southeastern Wisconsin Region which are within a straddling county are shown on Map 69. These communities comprise about 734 square miles, or also about 27 percent of the area of the Region.

The intra-basin transfer exception to the prohibition on diversions provides that a State concerned may authorize an intra-basin transfer unless it would result in a consumptive use of five million gpd or more.[21] An intra-basin transfer is defined as the transfer of water from the watershed of one of the Great Lakes into the watershed of another Great Lake.[22] If the intra-basin transfer is for 100,000 gpd or more, but less than five million gpd, the transfer must meet the standards applicable to straddling communities, and in addition there must be no feasible, cost-effective and environmentally sound water supply alternative within the Great Lakes watershed to which the water will be transferred.[23] If the proposal for an intra-basin transfer would result in a new or increased consumptive use of five million gallons a day or greater over any 90-day period, the proposal must receive the approval of the Governors of all of the eight Great Lakes states.[24]

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[16]Id. *at Section 4.9, Paragraph (3).*

[17]Id. *at Section 1.2, Definition of "Community within a Straddling County."*

[18]Id. *at Section 4.9, Paragraph (3).*

[19]Id. *at Section 4.9, Paragraph (3)(g).*

[20]Id. *at Section 4.9, Paragraph (3)(e).*

[21]Id. *at Section 4.9, Paragraph (2).*

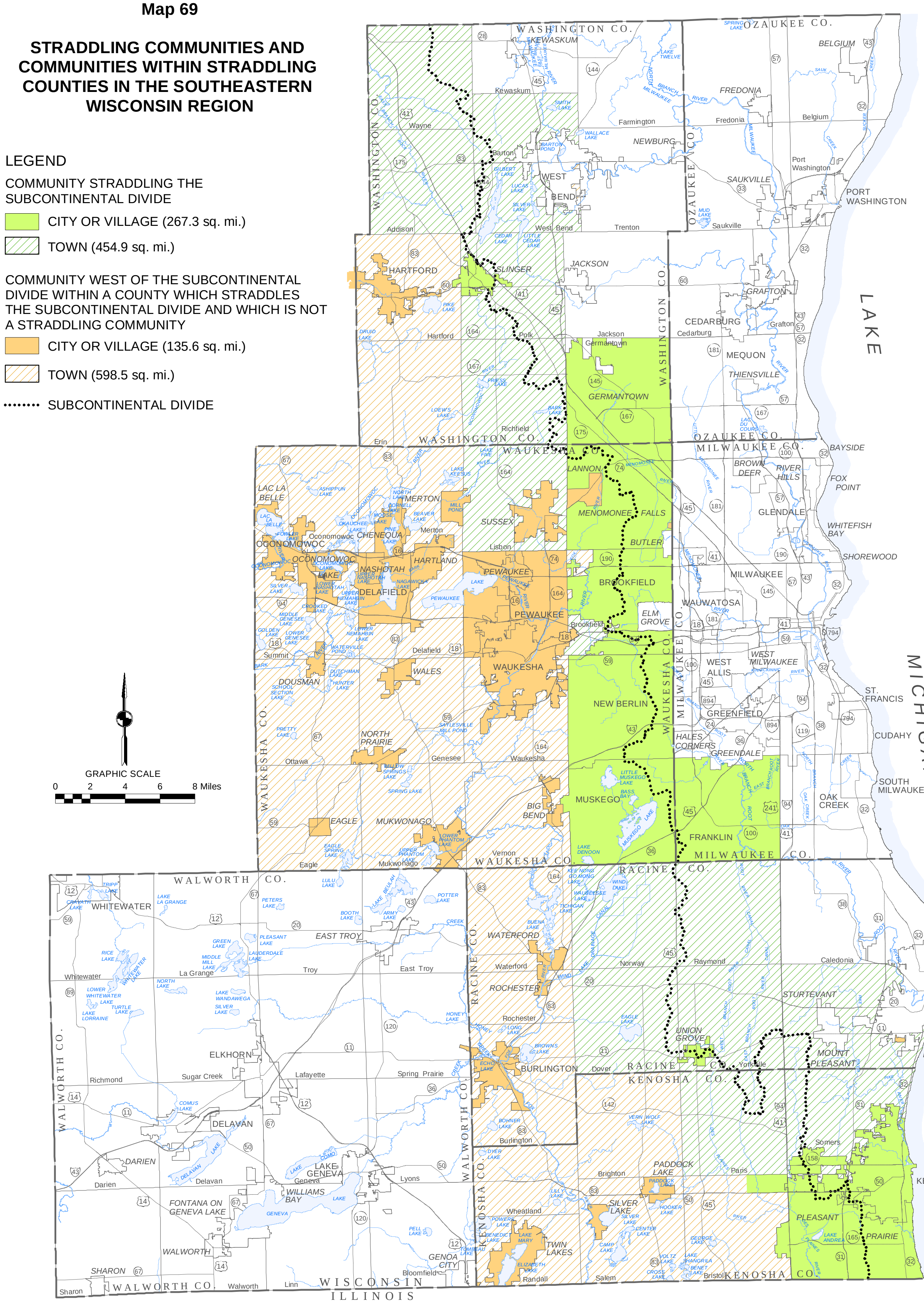
[22]Id. *at Section 1.2, Definition of "Intra-Basin Transfer."*

[23]Id. *at Section 4.9, Paragraph (2)(b)(ii).*

[24]Id. *at Section 4.9, Paragraph (2)(c).*

Map 69

STRADDLING COMMUNITIES AND COMMUNITIES WITHIN STRADDLING COUNTIES IN THE SOUTHEASTERN WISCONSIN REGION



Source: SEWRPC.

The second major requirement of the Compact is that each state must manage and regulate new or increased withdrawals and consumptive uses—not just diversions—of Great Lakes water within its state.[25] This would apply to both surface water and groundwater. Each state would be required to determine a baseline level for all its existing withdrawals in order to determine when an increased withdrawal occurs.[26] Each state would also set a threshold withdrawal and consumptive use level above which new or increased withdrawals and consumptive uses would trigger state review under the Compact.[27] Under the state review required by the Compact, new or increased withdrawals and consumptive uses of surface water or groundwater would, at a minimum, be required to be implemented to: a) return all water withdrawn to the source watershed less an allowance for consumptive use; b) result in no significant individual or cumulative adverse impact to the waters and water dependent natural resources; c) incorporate environmentally sound and economically feasible water conservation measures; and d) be reasonable and efficient.[28] If the state was considering a proposal for a new or increased consumptive use greater than five million gpd, the state would also be required to provide notice and an opportunity to comment to the other Great Lakes states and provinces.[29]

Table 81 summarizes the current regulations applicable to surface water withdrawals together with the changes proposed under the Compact.

Impacts Related to Withdrawal of Surface Water

While a withdrawal of surface water must meet all applicable laws and regulations, compliance with these laws and regulations does not mean that the withdrawal will have no impact on the environment, or on the rights of others. Other riparian owners and the general public also have the right to use the surface water. If a surface water withdrawal harms their interests, they may have a common law nuisance cause of action against the person or entity making the surface water withdrawal.

If a party's use of surface water substantially or unduly interferes with the use of a public place, or the activities of a community, a "public nuisance" claim may be brought against that party.[30] The public has rights to use surface water under the public trust doctrine.[31] As a result, the rights of riparian owners who seek to withdraw surface water are subordinate and subject to the paramount interest of the State and the public in these waters.[32] In determining whether a party's use of surface water substantially or unduly interferes with the rights of the public or a community, a court will likely look at whether the conduct involves a significant interference with public health, safety, comfort, or convenience; whether the conduct is prescribed by statute, ordinance or administrative regulation; or whether the conduct is of a continuing nature, or has produced a permanent or long-lasting effect which the party knows has a significant effect upon the public right.[33] Although not specifically noted in the Restatement of Torts, another factor a court might consider is the impact on the environment.

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[25]Id. *at Section 4.10.*

[26]Id. *at Section 4.12, Paragraph (2).*

[27]Id. *at Section 4.10.*

[28]Id. *at Section 4.11.*

[29]Id. *at Section 4.6.*

[30]State v. Quality Egg Farm, Inc., *104 Wis. 2d 506, 515, 311 N.W.2d 650 (1981).*

[31]*Wis. Const. art. IX, Section 1.*

[32]R. W. Docks & Slips v. State*, 2001 WI 73, Paragraph 21, 244 Wis. 2d 497, 628 N.W.2d 781.*

[33]*Restatement (Second) of Torts Section 821B.*

Table 81

SURFACE WATER WITHDRAWAL APPROVALS AND REVIEWS REQUIRED UNDER 2007 LAW AND UNDER THE GREAT LAKES-ST. LAWRENCE RIVER BASIN WATER RESOURCES COMPACT

Type of Water Withdrawal	Under 100,000 gpd	Over 100,000 gpd and Less than 5.0 mgd Consumptive Use	Over 5.0 mgd Consumptive Use
Surface Water Withdrawal in Basin; Water Stays in Basin	Current Requirements		
	WDNR/PSC review for public water systems	WDNR/PSC construction review for public water systems WDNR approval of water loss over 2.0 mgd	WDNR/PSC construction review for public water systems Regional notification required for water loss over 5.0 mgd
	Proposed Compact Requirements		
	State to decide whether to regulate	State approves in accordance with Compact standards	State approves in accordance with Compact standards; Great Lakes States and Provinces given an opportunity to review and comment
Surface water Withdrawal in Basin; Water Leaves Basin, But Return Flow Comes Back	Current Requirements		
	WDNR/PSC review for public water systems WRDA potentially applies	WDNR/PSC construction review for public water systems WDNR approval of water loss over 2.0 mgd WRDA potentially applies	WDNR/PSC construction review for public water systems Regional notification required for water loss over 5.0 mgd WRDA potentially applies
	Proposed Compact Requirements		
	Prohibited, except for: Straddling Community for public water supply use. State must approve according to Compact standards Community within a Straddling County for public water supply use. Unanimous approval by all eight Great Lakes Governors required	Prohibited, except for: Straddling Community for public water supply use. State must approve according to Compact standards Community within a Straddling County for public water supply use. Unanimous approval by all eight Great Lakes Governors required	Prohibited, except for: Straddling Community for public water supply use. State must approve according to Compact standards Community within a Straddling County for public water supply use. Unanimous approval by all eight Great Lakes Governors required
Surface Water Withdrawal in Basin; Water Leaves Basin and Does Not Come Back	Current Requirements		
	WDNR/PSC review for public water systems WRDA prohibits without eight Great Lakes Governors approval	WDNR/PSC construction review for public water systems WDNR approval of water loss over 2.0 mgd WRDA prohibits without eight Great Lakes Governors approval	WDNR/PSC construction review for public water systems Regional notification required for water loss over 5.0 mgd WRDA prohibits without eight Great Lakes Governors approval
	Proposed Compact Requirements		
	Prohibited	Prohibited	Prohibited

Table 81 (continued)

Type of Water Withdrawal	Under 100,000 gpd	Over 100,000 gpd and Less than 5.0 mgd Consumptive Use	Over 5.0 mgd Consumptive Use
Surface Water Withdrawal Outside the Basin	Current Requirements		
	WDNR/PSC review for public water systems	WDNR/PSC construction review for public water systems WDNR approval of water loss over 2.0 mgd	WDNR/PSC construction review for public water systems Regional notification required for water loss over 5.0 mgd
	Proposed Compact Requirements		
	Compact not applicable	Compact not applicable	Compact not applicable

Source: Lawrie J. Kobza, Boardman Law Firm and SEWRPC.

If a party's use of surface water causes serious harm, or substantially or unduly interferes with the private property interests of other riparian owners, a "private nuisance" claim may be brought against that party.[34] A riparian owner is limited in the amount of surface water it can withdraw by the rights of other riparian owners to co-share in the use of the surface water.[35] While each riparian owner has a right to use the surface water adjacent to the owner's property, that use cannot unreasonably interfere with the use of the surface water by other riparian owners. A party will be responsible for creating a private nuisance if the gravity of the harm outweighs the utility of the party's conduct, or the harm caused by its surface water withdrawal is serious and the financial burden of compensating for this and similar harm to others would not make the continuation of the conduct infeasible.[36]

A nuisance action may be brought by any party injured by the nuisance.[37] The fact that a water withdrawal may be permitted by the WDNR or PSC, does not exempt it from liability under the law of nuisance.[38] The remedy for a nuisance may be either an injunction to halt the nuisance, or damages to the parties who have suffered harm of a kind different from that suffered by the general public.[39] If a claim is brought against a municipal water utility for creating a nuisance, enjoining the activity, especially if it has been permitted by the WDNR and PSC, would be unlikely in most cases.[40] However, a court could order that damages be paid to the individuals harmed by the nuisance.

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[34]Prah v. Maretti, *108 Wis. 2d 223, 230-231, 321 N.W.2d 182 (1982).*

[35]Sterlingworth Condominium Ass'n v. Department of Natural Resources, *205 Wis. 2d 710, 731, 556 N.W.2d 791 (Ct. App. 1996).*

[36]*Restatement (Second) of Torts Section 826.*

[37]*Sections 30.294 and 823.01,* Wisconsin Statutes.

[38]Jost v. Dairyland Power Cooperative, *45 Wis. 2d 164, 177, 172 N.W.2d 647 (1969).*

[39]*Restatement (Second) of Torts Section 821C(1).*

[40]*Restatement (Second) of Torts Section 850A, comment (m).*

GROUNDWATER

Current State Statutes and Regulations

Wisconsin law requires groundwater wells, regardless of size, to be constructed in accordance with WDNR regulations.[41] If a groundwater well has the capacity to pump in excess of 100,000 gallons a day, or will in combination with all other wells on the same property have a capacity to pump more than 100,000 gallons a day, it is defined as a high-capacity well[42] and WDNR approval is required before it can be installed.[43]

In reviewing a high-capacity well application, the WDNR is to consider whether the proposed well will: 1) adversely affect or reduce the availability of water to a public utility; 2) be located in a groundwater protection area and cause significant environmental impact; 3) have a significant environmental impact on a spring; or 4) result in a water loss of more than 95 percent of the amount of water withdrawn.[44] Under this *Statute*, the WDNR is not required to consider whether the proposed well will negatively impact an existing private well.

If the proposed high-capacity well is located in a "groundwater protection area," the WDNR may not approve the well unless it includes in the approval any needed conditions to ensure that the well does not cause significant environmental impact within the groundwater protection area.[45] A groundwater protection area as defined under Section 281.34(1)(a) of the *Wisconsin Statutes* is an area within 1,200 feet of an outstanding resource water as identified under Section 281.15 of the *Statutes*, an exceptional resource water as identified under Section 281.15 of the *Statutes*, or a Class I, Class II, or Class III trout stream. The groundwater protection areas within the Southeastern Wisconsin Region are shown on Map 70. These areas total about 40 square miles, or about 1.5 percent of the Region.

If a proposed high-capacity well is located near a "spring," the WDNR may not approve the well unless it includes in the approval any needed conditions to ensure that the well does not cause significant environmental impact to the spring.[46] A spring is defined under Section 281.34(1)(f) of the *Statutes* as an area of concentrated groundwater discharge occurring at the surface of the land that results in a flow of at least one cubic foot per second at least 80 percent of the time. These limitations for high-capacity wells located in a groundwater protection area or near a spring do not apply to a proposed high-capacity well for a public utility engaged in supplying water to or for the public, if the WDNR determines that there is no other reasonable alternative location for the well.[47]

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[41]*NR Chapter 812,* Wisconsin Administrative Code.

[42]*Section 281.34(1)(b),* Wisconsin Statutes.

[43]*Section 281.34(2),* Wisconsin Statutes.

[44]*Section 281.34(5),* Wisconsin Statutes. *Consumptive use is determined in accordance with NR Section 142.04*, Wisconsin Administrative Code.

[45]*Section 281.34(5)(b),* Wisconsin Statutes.

[46]*Section 281.34(5)(d),* Wisconsin Statutes.

[47]*Section 281.34(5)(b)2. and (d)2.,* Wisconsin Statutes.

Map 70

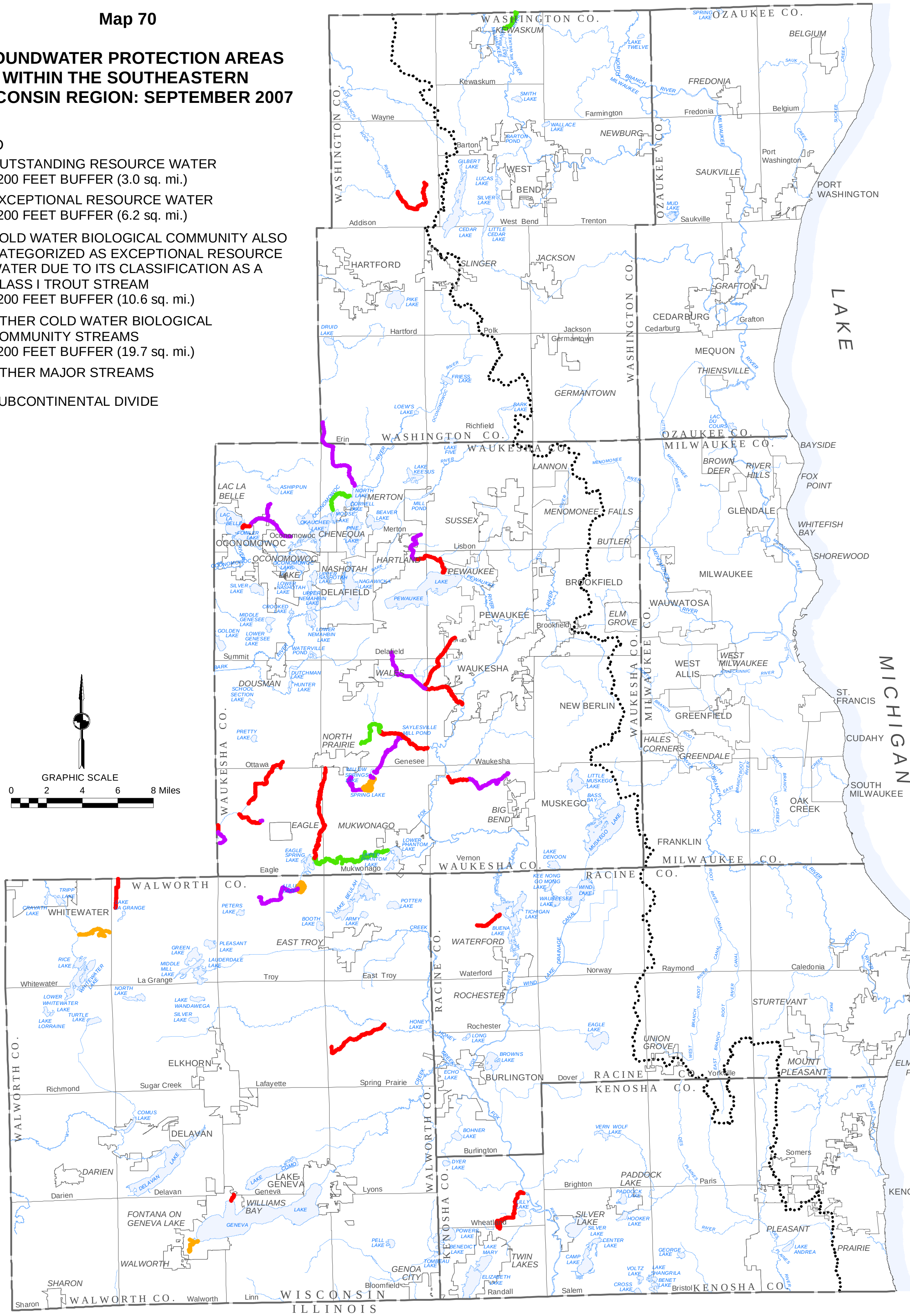
GROUNDWATER PROTECTION AREAS WITHIN THE SOUTHEASTERN WISCONSIN REGION: SEPTEMBER 2007

LEGEND

- OUTSTANDING RESOURCE WATER 1200 FEET BUFFER (3.0 sq. mi.)
- EXCEPTIONAL RESOURCE WATER 1200 FEET BUFFER (6.2 sq. mi.)
- COLD WATER BIOLOGICAL COMMUNITY ALSO CATEGORIZED AS EXCEPTIONAL RESOURCE WATER DUE TO ITS CLASSIFICATION AS A CLASS I TROUT STREAM 1200 FEET BUFFER (10.6 sq. mi.)
- OTHER COLD WATER BIOLOGICAL COMMUNITY STREAMS 1200 FEET BUFFER (19.7 sq. mi.)
- OTHER MAJOR STREAMS
- SUBCONTINENTAL DIVIDE

GRAPHIC SCALE

0 2 4 6 8 Miles



Source: *Chapters NR 102 and 820 of the* Wisconsin Administrative Code *and SEWRPC.*

If the proposed high-capacity well would result in a water loss of more than 95 percent of the amount of water withdrawn, the WDNR may not approve the high-capacity well unless it includes in the approval conditions to ensure that the high-capacity well does not cause significant environmental impact.[48] Water loss is defined to mean a loss of water from the basin from which it is withdrawn as a result of interbasin diversion or consumptive use or both.[49]

A high-capacity well approval will remain in effect unless the WDNR modifies or rescinds the approval because the high-capacity well, or the use of the well, is not in conformance with standards or conditions applicable to the well approval.[50]

The construction of public water supply facilities is overseen by the WDNR pursuant to Section 281.41 and by the PSC by Section 196.49 of the *Wisconsin Statutes* as described earlier. These *Statutes* provide the WDNR and PSC broad authority to review many aspects of public water supply system construction. With regard to well sites in particular, NR Section 811.13(b) of the *Wisconsin Administrative Code* requires the preparation of a well site investigation report which is to include information on test wells, water quality, pumping conditions, and drawdown effects on other nearby wells or the environment.[51]

WDNR regulations also require that a community installing a new well must develop a wellhead protection plan in order to protect the groundwater for water supply purposes.[52] The plan must identify the recharge area for the proposed well and the existing potential contamination sources within a one-half-mile radius of the proposed well. Importantly, the plan must include a management plan for addressing the potential contamination sources through such means as local ordinances, zoning requirements, monitoring programs, and other local initiatives.

As with surface water, there are special permit requirements for the withdrawal of groundwater that will result in high water loss. Under Section 281.35(4) of the *Wisconsin Statutes*, any withdrawal of water that results in a new or increased water loss of more than two million gpd is subject to WDNR approval. Section 281.35(5)(b), of the *Wisconsin Statutes* applies if the application would result in a new or increased water loss to the Great Lakes basin averaging more than five million gpd in any 30-day period.

In contrast to surface water, the WRDA[53] has never been held to apply to groundwater. While some have argued that WRDA should apply to groundwater, the United States Army Corps of Engineers has opined that WRDA pertains to surface water diversions only, and not to groundwater extraction.[54]

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[48]*Section 281.34(5)(c),* Wisconsin Statutes.

[49]*Section 281.34(1)(g),* Wisconsin Statutes.

[50]*Section 281.34(7),* Wisconsin Statutes.

[51]*NR Section 811.13(4)(j)L,* Wisconsin Administrative Code.

[52]*NR Section 811.16(5),* Wisconsin Administrative Code.

[53]*42 U.S.C. Section 1962d-20(c).*

[54]*See August 8, 1997, letter from William Breyfogle, St. Paul District, Army Corps of Engineers, to Mr. Rodney Harrill, President of the Crandon Mining Company.*

Potential Future Statutes and Regulations Applicable to Withdrawal and Use of Groundwater for Water Supply

2003 Wisconsin Act 310 includes provisions which encourage future legislation and regulation to address existing groundwater withdrawals that result in problems. Section 281.34(8)(d), of the *Statutes* authorizes the WDNR to develop a program to mitigate the effects of groundwater wells constructed before May 7, 2004, that are located near vulnerable waterbodies—i.e. groundwater protection areas. Although the WDNR has not yet adopted a mitigation program, a mitigation program could include the abandonment of existing wells, replacement of wells, or other management strategies.[55] In order for the WDNR to require mitigation, however, the WDNR would have to provide full funding for the cost of the mitigation, unless the well is required to be abandoned because of public health issues.

In addition, Section 281.34(9)(a) of the *Wisconsin Statutes* authorizes the WDNR to designate two groundwater management areas by rule where the groundwater potentiometric surface since development has declined by 150 feet or more. One of the groundwater management areas to be designated is centered on Waukesha County, and the other is centered on Brown County. The proposed groundwater management area centered on Waukesha County is called the Southeast Wisconsin Groundwater Management Area and is proposed to include all of Kenosha, Milwaukee, Ozaukee, Racine, and Waukesha Counties, and parts of Walworth and Washington Counties. The parts of Walworth County to be included in the groundwater management area include “the U.S. Public Land Survey Townships of East Troy, Spring Prairie, Lyons, Bloomfield, Linn and Geneva, with the exception of the Village of Williams Bay and the City of Elkhorn, and including the portion of the U.S. Public Land Survey Township of Troy that includes part of the Village of East Troy.”[56] All of Washington County is included with the exception of the “U.S. Public Land Survey Townships of Wayne and Kewaskum.” The *Statutes* require the WDNR to assist local governmental units and regional planning commissions in the groundwater management areas by providing advice, incentives and funding for research and planning related to groundwater management.[57] The groundwater management area in southeastern Wisconsin as defined under 2003 Action 310 is shown on Map 71. This area comprises all of five of the seven counties in the Southeastern Wisconsin Region and portions of the other two counties. In total, the groundwater management area totals about 2,254 square miles, or about 84 percent of the Region. The importance of the recharge areas in western Walworth County to the deep sandstone aquifer in the Region is another consideration. Walworth County is the only county in the Region which has a significant area outside the designated groundwater management area. Given these considerations, the entire Southeastern Wisconsin Region is considered a logical study area for groundwater management area plan preparation.

Additional statutes and regulations regarding groundwater management areas are still to be developed. Wisconsin Act 310, adopted in 2003, established a Groundwater Advisory Committee charged with making recommendations for additional legislation or regulation applicable to groundwater management areas.[58] In addition, the Committee is to make recommendations on: 1) legislation and administrative rules to address other areas of the State that could have problems in the future; 2) a coordinated strategy for addressing groundwater management issues by local governments; and 3) the factors to be considered by the WDNR in determining whether a high-capacity well causes significant environmental impact to a surface water.[59] The Committee was directed to

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[55]*Section 281.34(8)(d),* Wisconsin Statutes.

[56]*Proposed NR Section 820.20(1)(f),* Wisconsin Administrative Code.

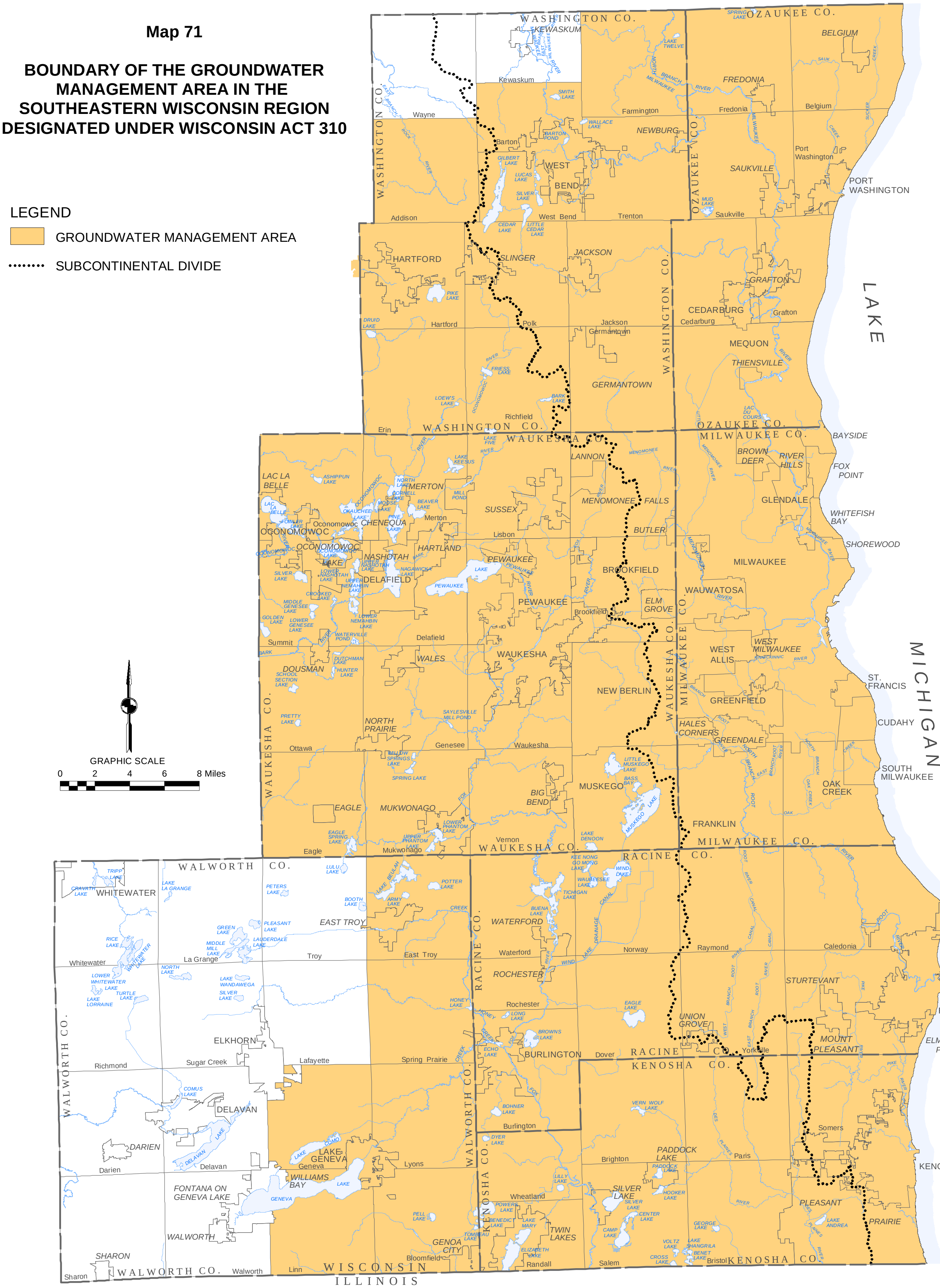
[57]*Section 281.34(9)(b),* Wisconsin Statutes.

[58]*2003 Wisconsin Act 310, Section 15.*

[59]Id.

Map 71

BOUNDARY OF THE GROUNDWATER MANAGEMENT AREA IN THE SOUTHEASTERN WISCONSIN REGION DESIGNATED UNDER WISCONSIN ACT 310



Source: Wisconsin Department of Natural Resources and SEWRPC.

complete its work related to groundwater management areas by December 31, 2006, and to complete its other work by December 31, 2007. The Groundwater Advisory Committee did develop a report[60] documenting its findings and recommendations related to groundwater management areas. That report recommends that a comprehensive groundwater plan be developed for each groundwater management area. The plan is intended to characterize groundwater issues and to set forth a basis for addressing those issues. The report generally prescribes the components of the comprehensive groundwater plans. Those components are all planned to be included within the regional water supply plan for southeastern Wisconsin and it is expected that the SEWRPC regional water supply plan can serve as the comprehensive groundwater plan.

The Groundwater Advisory Committee also developed a second report[61] which provided an assessment of the adequacy of the current law and regulations related to environmental protection of surface waters. The Committee concluded that Wisconsin Act 310 is working as intended, serving as a first step in integrated water management. The Committee reported that it reached agreement on the adequacy of the definition of the term "significant adverse environmental impact"[62] as currently set forth in Chapter NR 820 of the *Wisconsin Administrative Code* and formulated a recommendation to defer a revised determination of the threshold flow modification for springs until a comprehensive survey of springs is completed. The Committee reported it had debated the merits of the existing regulatory review process applicable to high-capacity wells within groundwater protection areas and the need for enhancement of the current regulatory framework. The Committee was unable to reach unanimous agreement on these issues. Rather, Committee members formulated a number of alternatives that range from maintaining the current structure and review process to suggesting that the system be restructured to provide what some believe to be a greater degree of environmental protection. Other alternatives suggest expansion of the scope of waters protected under the law and expanding the area of a groundwater protection area.

In addition to any new regulations that may result from the work of the Groundwater Advisory Committee, the adoption of the Great Lakes Compact by Wisconsin may impose new requirements on groundwater withdrawals within the Region. Since the withdrawal of groundwater within the Great Lakes basin is considered to be the same as the withdrawal of surface water from the basin for purposes of the Compact, the requirements of the Great Lakes Water Resources Compact described above also apply here. Table 82 compares the Compact to current law.

Statutes and Regulations Applicable to Artificial Recharge to Maintain Groundwater Levels

The artificial recharge of groundwater is regulated by Wisconsin law. The overarching regulation is found in Chapter 160, of the *Wisconsin Statutes*. Chapter 160 establishes a process for setting quantitative groundwater standards to protect public health and welfare. The standards are set forth in NR Chapter 140 of the *Wisconsin Administrative Code*. Chapter 160 of the *Statutes* also requires that all regulatory agencies ensure that its rules will obtain compliance with applicable groundwater standards.[63]

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[60]*Wisconsin Groundwater Advisory Committee,* 2006 Report to the Legislature on Groundwater Management Areas*, December 2006.*

[61]*Groundwater Advisory Committee,* 2007 Report to the Legislature*, December 2007.*

[62]*"Significant adverse environmental impact" means alteration of groundwater levels, groundwater discharge surface water levels, surface water discharge, groundwater temperature, surface water temperature, groundwater chemistry, surface water chemistry, or other factors to the extent such alterations cause significant degradation of environmental quality including biological and ecological aspects of the affected water resource. (s. NR 820.12(19),* Wisconsin Administrative Code*).*

[63]*Section 160.19,* Wisconsin Statutes*.*

Table 82

GROUNDWATER WITHDRAWAL APPROVALS AND REVIEWS REQUIRED UNDER 2007 LAW AND UNDER THE GREAT LAKES-ST. LAWRENCE RIVER BASIN WATER RESOURCES COMPACT

Type of Water Withdrawal	Under 100,000 gpd	Over 100,000 gpd and Less than 5.0 mgd Consumptive Use	Over 5.0 mgd Consumptive Use
Groundwater Withdrawal in Basin; Water Stays in Basin	Current Requirements		
	WDNR/PSC review for public water systems	WDNR approval for high-capacity wells WDNR/PSC construction review for public water systems WDNR approval of water loss over 2.0 mgd	WDNR approval for high-capacity wells WDNR/PSC construction review for public water systems Regional notification required for water loss over 5.0 mgd
	Proposed Compact Requirements		
	State to decide whether to regulate	State approves in accordance with Compact standards	State approves in accordance with Compact standards; Great Lakes States and Provinces given an opportunity to review and comment
Groundwater Withdrawal in Basin; Water Leaves Basin, But Return Flow Comes Back	Current Requirements		
	WDNR/PSC review for public water systems	WDNR approval for high-capacity wells WDNR/PSC construction review for public water systems WDNR approval of water loss over 2.0 mgd	WDNR approval for high-capacity wells WDNR/PSC construction review for public water systems Regional notification required for water loss over 5.0 mgd
	Proposed Compact Requirements		
	Prohibited, except for: Straddling Community for public water supply uses. State approves according to Compact standards Community within a Straddling County for public water supply use. Unanimous approval by all eight Great Lakes Governors required	Prohibited, except for: Straddling Community for public water supply uses State approves according to Compact standards Community within a Straddling County for public water supply use. Unanimous approval by all eight Great Lakes Governors required	Prohibited, except for: Straddling Community for public water supply uses. State approves according to Compact standards Community within a Straddling County for public water supply use. Unanimous approval by all eight Great Lakes Governors required
Groundwater Withdrawal in Basin; Water Leaves Basin and Does Not Come Back	Current Requirements		
	WDNR/PSC review for public water systems	WDNR approval for high-capacity wells	WDNR approval for high-capacity wells
		WDNR/PSC construction review for public water systems	WDNR/PSC construction review for public water systems
		WDNR approval of water loss over 2.0 mgd	Regional notification required for water loss over 5.0 mgd
	Proposed Compact Requirements		
	Prohibited	Prohibited	Prohibited

Table 82 (continued)

Type of Water Withdrawal	Under 100,000 gpd	Over 100,000 gpd and Less than 5.0 mgd Consumptive Use	Over 5.0 mgd Consumptive Use
Groundwater Withdrawal Outside the Basin	Current Requirements		
	WDNR/PSC review for public water systems	WDNR approval for high-capacity wells WDNR/PSC construction review for public water systems WDNR approval of water loss over 2.0 mgd	WDNR approval for high-capacity wells WDNR/PSC construction review for public water systems Regional notification required for water loss over 5.0 mgd
	Proposed Compact Requirements		
	Compact not applicable	Compact not applicable	Compact not applicable

Source: Lawrie J. Kobza, Boardman Law Firm and SEWRPC.

Consistent with Chapter 160 of the *Wisconsin Statutes*, the injection of any substance into the ground that would violate the provisions of Chapter 160 or that would result in endangerment of an underground drinking water source is prohibited.[64] For this reason, the disposal of stormwater runoff directly into groundwater is prohibited.[65] However, construction or use of a subsurface fluid distribution system for dispersal of stormwater runoff into unsaturated material overlying the uppermost underground source of drinking water is allowed if it is done in a manner that complies with the groundwater quality standards, complies with the requirements of the State plumbing code, and does not result in the endangerment of an underground source of drinking water.[66] Similarly, the injection of wastewater directly into groundwater is prohibited,[67]although the discharge of liquid wastewaters from a publicly owned treatment works, or privately owned domestic wastewater treatment works, to a subsurface fluid distribution system or other land disposal system may be allowed subject to the provisions of NR Chapter 206 of the *Wisconsin Administrative Code*.[68]

Notwithstanding the prohibition in Chapter 160, Chapter 160 does recognize some exceptions to the requirement that all State rules comply with applicable groundwater standards. One exception is for some private onsite wastewater treatment systems (POWTS). Section 160.255 of *Wisconsin Statutes* provides that a POWTS regulated solely by the Wisconsin Department of Commerce (DComm) is not required to comply with the groundwater standard for nitrate or the groundwater preventative action limit for chloride.[69] This exception,

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[64]*NR Section 815.09,* Wisconsin Administrative Code.

[65]*NR Section 815.11(5),* Wisconsin Administrative Code.

[66]Id.

[67]*NR Section 206.07(2)(d),* Wisconsin Administrative Code.

[68]*NR Section 815.11(3),* Wisconsin Administrative Code.

[69]*Section 145.01(12),* Wisconsin Statutes*; Comm Section 83.03(4),* Wisconsin Administrative Code.

however, does not apply to large POTWS which are regulated by both DComm and the WDNR[70] because although DComm will not require such systems to comply with all groundwater standards, the WDNR will.[71] A system is classified as a large POWTS if its design capacity exceeds 12,000 gpd.[72] The methods for determining whether this 12,000 gpd threshold has been met are set forth in the *Wisconsin Administrative Code*.[73]

Another exception is for aquifer storage and recovery systems under Section 160.257 of *Wisconsin Statute*s. Under the *Wisconsin Statutes* and attendant regulations, the injection of water treated to drinking water standards into the aquifer for storage and future use for water supply purposes is allowed provided certain requirements are met.[74] Only a municipal water system is allowed to construct an aquifer storage recovery (ASR) well or operate an ASR system. Only treated drinking water may be placed underground through an ASR system well, and water placed underground may extend out no further than 1,200 feet from that ASR well. All water that is retrieved through an ASR system must comply with drinking water standards, and must be treated to provide a disinfectant residual prior to recovery into the water utilities distribution system.

Potential Causes of Action Related to Withdrawal of Groundwater
A groundwater withdrawal may meet all applicable laws and regulations, but may still have an impact on the environment or the rights of others. Property owners have the right to use the groundwater under their property, and if a groundwater withdrawal by another harms their interests, they may have a common law nuisance claim against the person or entity making the groundwater withdrawal.

The Wisconsin Supreme Court adopted the reasonable use rule for groundwater set forth in the draft of Restatement (Second) of Torts Section 858A in *State v. Michels Pipeline*.[75] The rule adopted provides as follows:

> Section 858A. Non-liability for use of ground water - exceptions.
>
> A possessor of land or his grantee who withdraws ground water from the land and uses it for a beneficial purpose is not subject to liability for interference with the use of water by another, unless:
>
> (1) The withdrawal of water causes unreasonable harm through lowering the water table or reducing artesian pressure,
>
> (2) The ground water forms an underground stream, in which case the rules stated in Section 850A to 857 are applicable,
>
> (3) The withdrawal of water has a direct and substantial effect upon the water of a watercourse or lake, in which case the rules stated in Sections 850A to 857 are applicable.[76]

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[70]*Memorandum of Understanding Between the Department of Commerce and the Department of Natural Resources Regarding the Regulation of Onsite Sewage Systems, dated December 16, 1999, page 3.*

[71]*NR Section 206.07(1)(c),* Wisconsin Administrative Code.

[72]*NR Section 200.03(3)(d),* Wisconsin Administrative Code.

[73]*NR Section 200.03(4) & (5), and Comm Section 83.22(2)(b)6.a-g,* Wisconsin Administrative Code.

[74]*Section 160.257,* Wisconsin Statutes*; NR Sections 811.87 to 811.93,* Wisconsin Administrative Code.

[75]State v. Michels Pipeline Construction, Inc., *63 Wis. 2d 278, 302-303, 217 N.W.2d 339 (1974).*

[76]Id.

This version of the reasonable use rule gives more or less unrestricted freedom to the possessor of overlying land to develop and use groundwater.[77] A landowner has the right to use groundwater beneath the land provided that use does not cause unreasonable harm. In the event a landowner's use does cause unreasonable harm, the rule does not prohibit the use, but rather requires the landowner causing the unreasonable harm to bear the costs caused by his or her use.[78] Costs would be recovered through a nuisance action against the landowner causing the unreasonable harm.

The rule does not define what is an "unreasonable harm," and it may be expected that what is an unreasonable harm will vary with the circumstances.[79] However, water withdrawn in very large quantities for purposes not common to the locality may be determined to be unreasonable,[80] and as a result, public water suppliers would be expected to be responsible to those affected by a municipal well.[81] Damages could include costs such as the cost of deepening prior wells, installing pumps, and paying increased pumping.[82]

A legal question exists as to whether or not the public trust doctrine applies to groundwater in Wisconsin. To date, there is no reported case in which a Wisconsin court has extended the public trust doctrine to groundwater. However, this would not prevent a member of the public from bringing a nuisance action against an entity that withdraws groundwater if that party can prove that the groundwater withdrawal has substantially or unduly interfered with the use of a public place or the activities of a community.[83] If this showing can be made, a public nuisance cause of action may be brought against the party who withdrew the groundwater. The remedy for such a nuisance may be either an injunction to halt the nuisance, or damages to the parties who have suffered harm of a kind different from that suffered by the general public.[84]

WATER SYSTEM ORGANIZATIONAL STRUCTURE FOR INTERGOVERNMENTAL COOPERATION

Municipal Authority

A municipal public utility has the authority to construct, own and operate water utility property and facilities both inside and outside the municipality's corporate limits.[85] There is no requirement that all of a municipal public utility's facilities be located within the municipalities it is serving. A municipality may obtain needed property rights through negotiation and purchase, or condemnation. The *Wisconsin Statutes* specifically authorize a municipality to acquire property outside its borders by condemnation using the procedures set forth in Sections 32.05 or 32.06 of the *Statutes*. A utility is not required to seek approval of the local government in which the property is located prior to condemnation.

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[77]*Restatement (Second) of Torts Section 858, comment (b).*

[78]*Restatement (Second) of Torts Section 858, comment (e).*

[79]*Restatement (Second) of Torts Section 858, comment (f).*

[80]*Restatement (Second) of Torts Section 858, comment (e).*

[81]*Restatement (Second) of Torts Section 858, comment (f), illustration 1.*

[82]State v. Michels Pipeline Construction, Inc., *63 Wis. 2d at 303.*

[83]State v. Quality Egg Farm, Inc., *104 Wis. 2d 506, 515, 311 N.W.2d 650 (1981).*

[84]*Restatement (Second) of Torts Section 821C(1).*

[85]*Section 66.0803(1)(a),* Wisconsin Statutes.

If a city or village owns property outside, but near, its corporate limits, the city or village may annex that territory in accordance with Section 66.0223 of *Wisconsin Statutes*. The city or village use of that noncontiguous property, however, must be consistent with any valid town or county zoning regulations,[86] including shoreland zoning regulations. While town or county zoning controls for that property, the city or village may seek to exercise its extraterritorial zoning over property adjacent to the annexed property.[87]

In situations where one municipality seeks to install water supply facilities in another municipality, the municipality in which the facilities are to be located may seek to adopt ordinances to regulate, limit or prohibit the installation of those facilities within its borders. Local ordinances, however, to prevent the installation of municipal water supply wells have been struck down by the courts in the past as being preempted by State law.[88] Although municipalities have extensive authority to regulate for the health, safety and welfare of their citizens, this authority to regulate may be withdrawn by the State, and the courts have held that the legislature has acted to withdraw a municipality's ability to regulate the installation and use of high-capacity wells within its borders.

In the Southeastern Wisconsin Region, it has been common practice to locate water supply wells and storage facilities within the owner community boundaries. This sometimes involves annexation of parcels where it is planned to locate water supply facilities. The only known place in the Region where there are municipal water supply facilities located outside of the boundaries of the owning utility is in the Town of Eagle where two wells are located on a site owned by the Village of Eagle located south of the Village in the Town of Eagle.

The Wisconsin Attorney General, however, has recently opined that a town has the authority to adopt a groundwater protection ordinance. [89] Such an ordinance might limit the ability of a party to install a well in the town. The Attorney General opined that the preemption principles and holdings in prior case law are outdated, and that a court would no longer follow these cases.[90] Given the conflicting analysis demonstrated by the courts and the Wisconsin Attorney General regarding a municipality's authority to adopt ordinances limiting the installation of wells within its borders, this issue seems destined for further litigation. In this litigation, the fact that the WDNR and PSC have extensive authority over public utility construction under Sections 281.41 and 196.49 of the *Wisconsin Statutes* may prove important to a decision on this issue.

A municipal public utility also has the right to install pipeline facilities within public rights-of-way whether within or outside the municipality's borders, provided certain conditions are met. Section 86.16, of the *Wisconsin Statutes*, provides that utility facilities may be located in public rights-of-way provided written consent from the controlling authority is obtained. For state trunk highways, written consent must be obtained from the Wisconsin Department of Transportation. For county and municipal highways, written consent must be obtained from the local authorities with jurisdiction over those highways. While consent is required to use the rights-of-way, an authority is entitled to deny permission only if denial is necessary to prevent the proposed facilities from causing an unreasonable obstruction to traffic on a public highway. A local government cannot use its authority under Section 86.16 as a means of forcing a utility to provide services that the utility would not otherwise provide under

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[86]*Section 66.0223(2),* Wisconsin Statutes.

[87]*Section 62.23(7a),* Wisconsin Statutes.

[88]Fond du Lac v. Empire, *273 Wis. 333, 77 N.W.2d 699 (1956);* Town of Grand Rapids v. Water Works & Lighting Comm'n., *Case No. 90-1714 (Ct. App., Dist. IV, decided May 29, 1991).*

[89]*8/28/2006 Memo from Assistant Attorney General Thomas Dawson to Attorney General Peggy Lautenschlager, regarding State Preemption of Town of Richfield Groundwater Protection Ordinance.*

[90]Id. *at 34.*

its normal procedures and policies. If written consent is refused, or if the request has been on file with the Wisconsin Department of Transportation or local authority for 20 days and no action has been taken, the utility may appeal the request to the Wisconsin Division of Hearings and Appeals whose decision on the request will be final.

Options for Regional Water Supply Cooperation

Residents of southeastern Wisconsin receive water supply services from either public water systems or private wells. A public water system may be owned or operated by a governmental body, a corporation, individual, or association. In Wisconsin, most water systems that provide water to the public are owned and operated by municipalities.

Regional cooperation in providing water supply can be accomplished in many different ways depending upon the objectives of the parties wishing to cooperate. A common form of regional cooperation in water supply is an agreement for one municipality to provide either retail or wholesale water supply service to another. The City of Milwaukee, for example, has contracted to provide retail water service to some communities and wholesale water service to others.[91] Similarly, Kenosha, Oak Creek, and Racine all have water supply agreements with other municipalities. Although these agreements facilitate the provision of regional water supply, they do not necessarily promote regional decision-making as the supplying community retains the right to make the decisions on how water will be provided, subject to regulation by the PSC. The situations where one municipal water utility provides water supply to other municipalities and the basis for that provision are shown on Map 72.

Another option for accomplishing regional cooperation in providing water supply is for local governments to enter into an intermunicipal agreement under Section 66.0301 of the *Wisconsin Statutes*. Under such agreements, local governments may do jointly what each member could otherwise do separately. Since a local government can provide water supply, an intergovernmental agreement would allow a group of local governments to join together to provide water supply. Under such an agreement, one municipality could agree to provide wholesale or retail water supply to another, as described above, or an agreement could be used to provide for the creation of a totally new entity that would provide water. The North Shore Water Commission, for example, is a commission created by intergovernmental agreement between three different communities—the City of Glendale, and the Villages of Fox Point and Whitefish Bay—to provide water supply to these communities. If water service is to be provided, an intermunicipal agreement should provide a plan for the furnishing of that service. This plan may include the creation of a separate commission to oversee and administer the provision of the service. Groups of local governments in southeastern Wisconsin could, if they choose, agree to create separate commissions to manage and administer water supply for the communities concerned. A commission created by an intergovernmental agreement may be granted significant authority to meet its responsibilities by its enabling agreement, although it would not have the ability to tax.

Another option for accomplishing regional water supply is for local governments to form a joint local water authority by contract pursuant to Section 66.0823, of the *Wisconsin Statutes*. A joint local water authority is an entity made up of individual municipalities or Indian tribes or bands. The authority sells wholesale water to the individual municipalities, and the individual municipalities then sell water to their own customers. An authority is a political body of the State and has public powers separate from the member parties, but it does not have the ability to tax. A joint local water authority has broad authority. It can plan, build, and operate water supply

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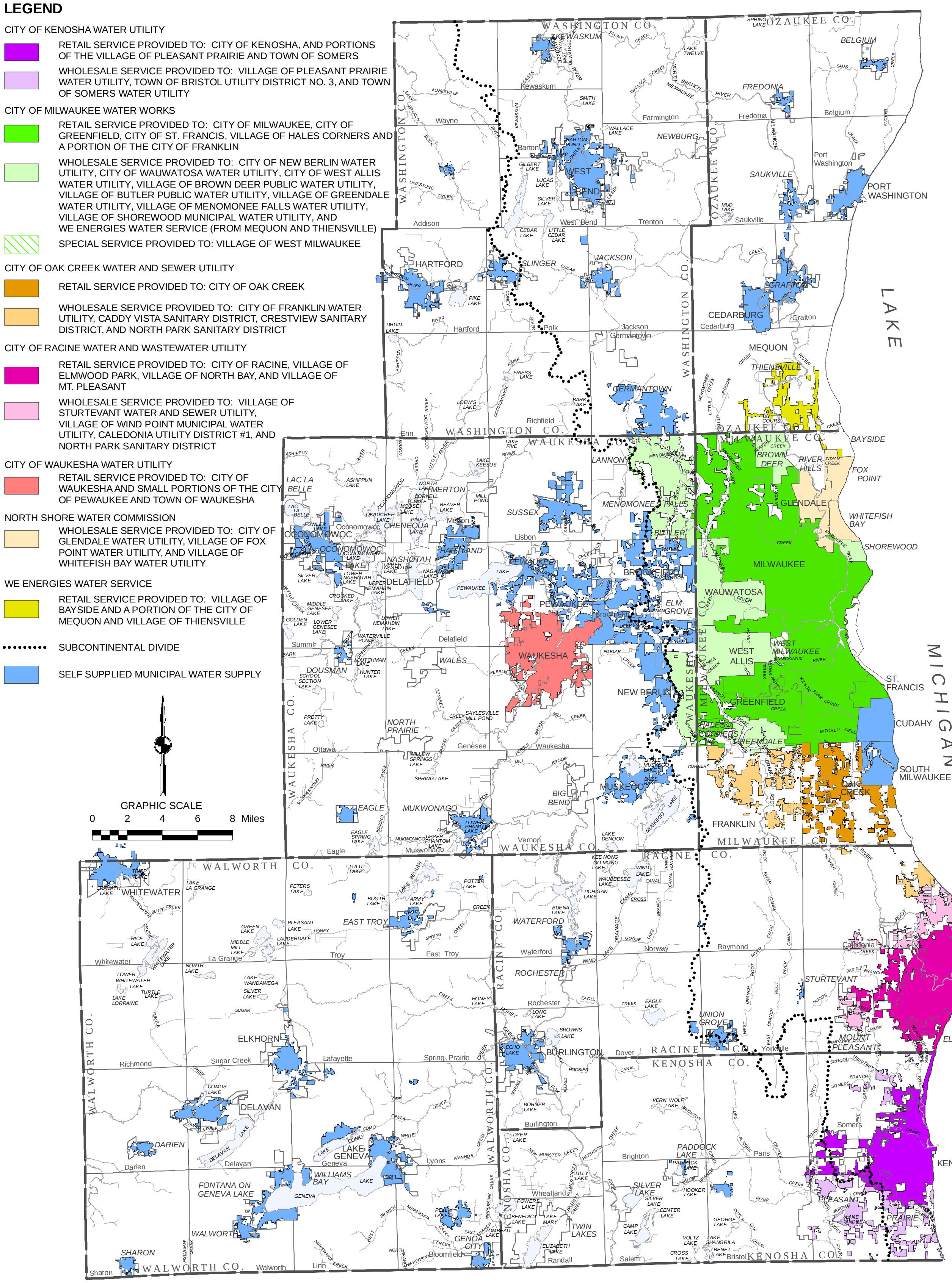
[91] *The Milwaukee Water Works provides retail service to all or part of the Cities of Greenfield, Franklin, Milwaukee, and St. Francis; and the Village of Hales Corners. It provides wholesale service to all or part of the Cities of New Berlin, Wauwatosa, and West Allis; and the Villages of Brown Deer, Greendale, Shorewood, Butler, and Menomonee Falls, and We Energies-Water Services serving the City of Mequon and the Village of Thiensville. The City of West Milwaukee has a unique arrangement with the City of Milwaukee Water Works as it receives billing services from the Milwaukee Water Works and maintains its own distribution system.*

Map 72

MUNICIPAL WATER SUPPLY SYSTEMS IN THE SOUTHEASTERN WISCONSIN REGION INVOLVED IN THE PROVISION OF WATER TO OTHER UTILITIES UNDER COOPERATIVE AGREEMENTS PROVIDING FOR WHOLESALE OR RETAIL SERVICE: 2005



Source: Water utilities and SEWRPC.

facilities, or it can contract with another entity for water supply. In order to obtain water supply, it may incur debts, liabilities or obligations, including the borrowing of money and the issuance of bonds. There are two primary benefits to use of a joint local water authority. First, the authority has all the powers set forth in Section 66.0823 of the *Wisconsin Statutes*. It is not limited to the powers of its least powerful member as a commission created by an intergovernmental agreement would be. Second, a joint local water authority has stronger financing powers than a commission created by an intergovernmental agreement. In situations where these benefits are important, the creation of a joint local water authority may be a good mechanism for the provision of regional water supply.

Another way to accomplish regional cooperation in the provision of water supply is for several municipalities to contract with a single third-party water system operator. Under this scenario, each municipality would enter into a separate contract with the third-party operator. The third-party could be a municipal entity, in which case an intergovernmental agreement would likely be used, or it could be a private party. Contracts for water supply services may take many different forms. The owner of a water system may contract for discrete services such as laboratory testing or meter reading, or it may contract for a third-party to operate the entire water system.

Another way to accomplish regional cooperation in the provision of water supply is the joint ownership or operation of regional facilities. One option for the joint ownership of regional facilities is for a regional entity, such as a joint local water authority, or an intergovernmental commission, to build and pay for new facilities to serve the regional entity. Another option would be for a regional entity to jointly manage existing facilities for regional use, and perhaps supplement those facilities with new facilities where needed. One way to accomplish this second option is for the ownership or management of existing facilities to be transferred to the new regional entity. If the transfer of utility assets involves the sale or lease of the entire utility, Section 66.0817 of the *Wisconsin Statutes* requires PSC review and approval, and the passage of a referendum by the selling community. If the regional cooperation would involve transferring an operating unit or system—but not the entire utility—to a new regional entity or a third-party, PSC approval will still be required, but no referendum would be required.[92]

These different models provide different methods for achieving regional cooperation in providing water supply. The type of arrangement that will work best will depend upon what the parties involved are trying to accomplish. Once the parties' objectives are determined, a model—which could be configured of parts of different models—can be developed to fit that situation.

CONCLUSIONS

The communities of southeastern Wisconsin face a variety of challenges as they seek to supply water to their residents. These challenges include the increasing decline in the potentiometric surface of the deep aquifer underlying the Region, the increasing decline in the quality of the water drawn from the deep aquifer; limitations on the use of the water from the shallow aquifer underlying the Region; limitations on the ability to use Lake Michigan surface water for water supply, and the potential for increasing conflicts between water uses. This report describes the existing legal framework that must be considered in addressing these challenges. This report also describes potential changes in that existing framework, particularly with regard to the proposed Great Lakes-St. Lawrence River Basin Water Resources Compact and the State groundwater law.

For purposes of the regional water supply planning program, the following specific, salient conclusions may be drawn from a review of the findings of the inventory of water supply law set forth in SEWRPC Technical Report No. 44, *Water Supply Law*, April 2007:

[92]*Section 196.80(1m)(e)*, Wisconsin Statutes.

1. With regard to proposals for the provision of Lake Michigan water to any areas of the Region located west of the subcontinental divide, a return flow component is required for consistency with the current regulations and the potential future regulations if the Great Lakes-St. Lawrence River Basin Water Resources Compact is adopted.

2. The provision of Lake Michigan water to areas in eastern Racine and Kenosha Counties where long-standing subregional and local water and sewerage system plans proposing such provision have been largely implemented, can continue to be accomplished in a manner consistent with current and potential future regulations governing diversion.

3. There are options available for the accomplishment of regional cooperation in the provision of water supply which can be considered for inclusion in plan implementation recommendations, if warranted, by the structure of the recommended physical plan.

4. The regional water supply plan should be designed to be flexible in meeting potential future regulations associated with diversion and groundwater management. In this regard, the recommendations set forth in the Region should be coordinated, to the extent possible, with the ongoing activities of the State Groundwater Advisory Committee.

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Chapter VII

PROBLEM AND ISSUE IDENTIFICATION

INTRODUCTION

The findings of the inventory and analysis phases of the water supply planning program presented in Chapters II, III, and IV of this report identified and characterized a number of water supply problems and issues within the Region. Within the context of this chapter, a problem is defined as a known undesirable state which must be resolved to fully meet the plan objectives. Within the context of this chapter, an issue is defined as a topic that is of general public concern and discussion. Most of the problems and issues identified were foreshadowed in the prospectus for the regional water supply planning program[1] which identified a number of factors that contributed to the need for a regional water supply planning program. This chapter describes the identified problems and issues, and sets forth the basis on which each problem or issue is addressed in the planning effort.

The problems and issues identified in this chapter are related to the water supply system development objectives and standards set forth in Chapter V of this report. The means for resolving, or otherwise addressing, each of the identified problems and issues are largely embodied in the alternative water supply plans designed to meet the agreed-upon water supply development objectives and associated standards. Based upon an evaluation of the alternatives, a recommended plan was formulated which best meets those objectives. For each identified problem and issue, this chapter describes the relationship to the planning objectives and supporting standards and provides information relative to the basis for resolution of the identified problems and issues.

PROBLEM IDENTIFICATION

The water supply problems which have been identified within the Region are related to the capacities of the existing water supply infrastructure to meet forecast water supply demands; to the quantity and quality of the groundwater supplies; and to the sustained ability of those supplies to meet probable future needs. Each of the identified problems is described in the following sections, along with the related planning objectives and standards and the basis for resolution.

Ability of Existing Water Supply Infrastructure to Meet Existing and Forecast Water Demands

Problem Description

Chapter III provides information on the existing and committed proposed capacity of the existing water supply systems within the Region. Each of the systems which included sources of supply was evaluated to determine the

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[1]*SEWRPC,* Regional Water Supply Planning Prospectus, *September 2002.*

capacity of the source of supply facilities. Source of supply facilities were defined as the facilities which provide the source, treatment, pumping, and storage of water for fire flow as well as average and maximum pumpage conditions. The results of that analysis are provided in Appendix K and are summarized in Table 83. In Table 83, the capacities of the sources of supply facilities are compared to the actual year 2000, and to the forecast year 2035, needed average and maximum day pumpages, as documented in Chapters III and IV. Review of Table 83 indicates that 64, or about 85 percent, of the water utilities existing in 2007 had sources of supply adequate to meet the existing maximum daily pumpage demands. In addition, 54, or about 72 percent, have adequate capacity to meet existing peak hourly and fire flow needs. Under year 2035 conditions, the existing year 2007 sources of supply for 44, or about 59 percent, of the 75 water utilities may be expected to be adequate to meet maximum daily pumpage demands. The existing year 2007 sources of supply for 38, or about 51 percent, may be expected to have adequate capacity for peak hourly and fire flow needs under 2035 conditions. In addition to the 75 existing water utilities with sources of supply, there may be expected to be up to 23 new water utilities within the Region which would need to develop sources of supply by the plan design year 2035.

Related Plan Objectives and Standards

One of the agreed-upon plan objectives, and one of the supporting standards are directly related to the problems associated with the need for expanded water supply system capacity to meet the forecast demands:

- Objective—A regional water supply system which, through its capacity and efficiency, will effectively serve the existing regional land use pattern, promote the implementation of the regional land use plan, and identify any constraints to development in subareas of the Region which may require refinement of the regional land use plan.

- Standard—Public water supply systems should be designed to serve lands planned to be developed for urban uses, in accordance with the adopted regional land use plan.

Basis for Problem Resolution

Each of the design year 2035 alternative plans is designed to provide sources of water supply capacity adequate to meet the forecast water demand conditions. Those conditions were developed utilizing the forecast socioeconomic and land use conditions associated with the adopted design year 2035 regional land use plan.[2] The selection of a recommended regional water supply plan is to be based upon a comparative evaluation of the ability of each of the alternative plans considered to meet the agreed-upon objectives and standards, including those related to water supply needs. Provision of sustainable water supply source capacity adequate to meet the forecast needs did not present a difficult problem in alternative plan design. Originally, it was envisioned that there was the potential for some constraints associated with the sustainability of the sources of supply to be found. Such constraints could have resulted in the identification of a need to refine or revise the design year 2035 land use plan on the basis of water supply considerations. No such constraints were found, and no major revisions to the adopted regional land use plan were found to be required on the basis of water supply. An exception to this finding related to the preservation of groundwater recharge areas, the protection of which included consideration for expansion of some of the primary environmental corridors as delineated in the adopted regional land use plan.

Groundwater Quantity and Sustainability

Problem Description

Chapter III provides information on the existing groundwater aquifers underlying the planning area. The information provided indicates that problems exist with regard to the quantity of groundwater available for use as manifested by the declines in groundwater aquifer levels caused by pumping. As documented in Chapter IV, a significant portion of the growth in population, employment, and urban land uses within the Region is occurring, and is planned to continue to occur, in areas which utilize groundwater as a source of supply. The current

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[2]*SEWRPC Planning Report No. 48*, A Regional Land Use Plan for Southeastern Wisconsin: 2035*, June 2006.*

Table 83

COMPARISON OF CURRENT AND FORECAST FUTURE WATER SUPPLY PUMPAGE DEMAND TO THE CAPACITY OF THE SOURCES OF SUPPLY FOR WATER SUPPLY UTILITIES IN THE SOUTHEASTERN WISCONSIN REGION

Utility	2000						2035					
	Average Day Pumpage (mgd)	Peak Day Pumpage (mgd)	Surplus Maximum Day Supply Capacity[a] (mgd)	Surplus Peak Hour Storage Capacity (MG)	Surplus Fire Flow Capacity (MG)	Surplus Emergency Supply Capacity (mgd)	Average Day Pumpage (mgd)	Peak Day Pumpage (mgd)	Surplus Maximum Day Supply Capacity[a] (mgd)	Surplus Peak Hour Storage Capacity (MG)	Surplus Fire Flow Capacity (MG)	Surplus Emergency Supply Capacity (mgd)
Kenosha County												
Kenosha Water Utility[b]	14.55	21.64	15.36	9.26	18.23	32.94	22.23	33.38	3.63	6.21	13.34	25.26
Village of Paddock Lake Municipal Water Utility	0.07	0.18	0.06	-0.02	-0.32	0.48	0.54	1.46	-1.22	-0.45	-1.23	0.02
Village of Pleasant Prairie Water Utility	1.70	1.82	- -[b]	- -[b]	- -[b]	- -[b]	5.10	6.95	- -[b]	- -[b]	- -[b]	- -[b]
Town of Bristol Utility District No. 1	0.23	0.35	0.95	0.18	-0.03	2.31	0.67	1.24	0.06	0.04	-0.73	1.87
Town of Bristol Utility District No. 3	0.02	0.03	- -[b]	- -[b]	- -[b]	- -[b]	0.94	1.81	- -[b]	- -[b]	- -[b]	- -[b]
Town of Somers Water Utility	0.37	0.61	- -[b]	- -[b]	- -[b]	- -[b]	2.14	3.43	- -[b]	- -[b]	- -[b]	- -[b]
Milwaukee County												
City of Cudahy Water Utility[c]	2.63	4.13	-4.13	0.24	-0.90	1.02	2.62	3.78	-3.78	0.20	-0.76	1.03
City of Franklin Water Utility	1.80	4.69	- -[d]	- -[d]	- -[d]	- -[d]	5.95	12.80	- -[d]	- -[d]	- -[d]	- -[d]
City of Glendale Water Utility[e]	4.24	7.99	6.41	3.94	5.76	6.89	4.89	9.65	4.75	3.52	5.14	6.24
City of Milwaukee Water Works[f]	126.77	181.67	60.83	62.38	53.63	- -[g]	133.91	213.05	29.45	53.21	40.34	- -[g]
City of Oak Creek Water and Sewer Utility[d]	7.05	15.52	-3.52[d]	3.16[d]	3.33[d]	15.92[d]	14.24	29.22	-17.22[d]	-0.84[d]	-2.39[d]	8.74[d]
City of South Milwaukee Water Utility	2.67	3.64	2.37	0.46	0.51	4.23	2.61	4.25	1.75	0.28	0.25	4.29
City of Wauwatosa Water Utility[f]	6.24	8.15	- -[f]	- -[f]	- -[f]	- -[f]	6.56	11.00	- -[f]	- -[f]	- -[f]	- -[f]
City of West Allis Water Utility[f]	6.95	9.08	- -[f]	- -[f]	- -[f]	- -[f]	6.90	10.01	- -[f]	- -[f]	- -[f]	- -[f]
Village of Brown Deer Public Water Utility[f]	1.55	2.56	- -[f]	- -[f]	- -[f]	- -[f]	1.60	2.98	- -[f]	- -[f]	- -[f]	- -[f]
Village of Fox Point Water Utility[e]	0.76	1.68	- -[e]	- -[e]	- -[e]	- -[e]	0.70	1.12	- -[e]	- -[e]	- -[e]	- -[e]
Village of Greendale Water Utility[f]	1.34	2.55	- -[f]	- -[f]	- -[f]	- -[f]	1.32	3.53	- -[f]	- -[f]	- -[f]	- -[f]
Village of Shorewood Municipal Water Utility[f]	1.25	2.08	- -[f]	- -[f]	- -[f]	- -[f]	1.30	2.11	- -[f]	- -[f]	- -[f]	- -[f]
Village of Whitefish Bay Water Utility[e]	1.32	2.28	- -[e]	- -[e]	- -[e]	- -[e]	1.35	3.01	- -[e]	- -[e]	- -[e]	- -[e]
We Energies-Water Services[e]	0.07	0.17	- -[e]	- -[e]	- -[e]	- -[e]	0.49	0.79	- -[e]	- -[e]	- -[e]	- -[e]
Ozaukee County												
City of Cedarburg Light and Water Commission	1.42	2.15	1.54	0.79	0.63	2.40	1.91	2.94	0.75	0.56	0.30	1.90
City of Port Washington Water Utility	1.33	1.70	2.30	0.88	1.00	4.67	1.95	3.13	-1.13	0.62	0.52	2.05
Village of Belgium Municipal Water Utility	0.27	0.61	0.62	0.27	-0.21	1.29	0.39	1.11	0.12	0.10	-0.44	1.17
Village of Fredonia Municipal Water Utility	0.17	0.40	0.25	0.17	-0.03	0.75	0.39	0.83	-0.18	0.03	-0.55	0.53
Village of Grafton Water and Wastewater Utility	1.42	2.04	1.36	0.44	0.16	1.19	2.37	3.83	-0.43	-0.15	-0.66	0.24
Village of Saukville Municipal Water Utility	1.26	1.74	0.54	0.60	0.35	2.83	1.58	2.07	0.21	0.49	0.19	2.51
We Energies-Water Services[f]	0.67	1.73	- -[f]	- -[f]	- -[f]	- -[f]	4.55	6.35	- -[f]	- -[f]	- -[f]	- -[f]
Racine County												
City of Burlington Municipal Waterworks	1.88	2.89	3.37	0.98	1.29	3.97	2.55	4.51	1.76	0.44	0.55	3.31
City of Racine Water and Wastewater Utility[h]	25.01	39.02	5.98	2.97	8.12	30.25	29.21	44.24	0.76	1.66	6.16	26.05
Village of Union Grove Municipal Water Utility	0.72	1.36	0.82	0.31	-0.06	-0.16	1.06	1.84	0.33	0.15	-0.28	-0.50
Village of Waterford Water and Sewer Utility	0.39	0.70	0.06	0.29	-0.19	1.84	0.62	1.23	-0.47	0.11	-0.43	1.61
Village of Wind Point Municipal Water Utility[h]	0.25	0.42	- -[h]	- -[h]	- -[h]	- -[h]	2.88	0.46	- -[h]	- -[h]	- -[h]	- -[h]
Village of Caledonia West Utility District (Oak Creek)[d]	0.05	0.20	- -[d]	- -[d]	- -[d]	- -[d]	0.11	0.32	- -[d]	- -[d]	- -[d]	- -[d]

Table 83 (continued)

Utility	2000 Average Day Pumpage (mgd)	2000 Peak Day Pumpage (mgd)	2000 Surplus Maximum Day Supply Capacity[a] (mgd)	2000 Surplus Peak Hour Storage Capacity (MG)	2000 Surplus Fire Flow Capacity (MG)	2000 Surplus Emergency Supply Capacity (mgd)	2035 Average Day Pumpage (mgd)	2035 Peak Day Pumpage (mgd)	2035 Surplus Maximum Day Supply Capacity[a] (mgd)	2035 Surplus Peak Hour Storage Capacity (MG)	2035 Surplus Fire Flow Capacity (MG)	2035 Surplus Emergency Supply Capacity (mgd)
Racine County (continued)												
Village of Caledonia West Utility District (Racine)[h]	0.61	0.70	- -[h]	- -[h]	- -[h]	- -[h]	3.21	4.37	- -[h]	- -[h]	- -[h]	- -[h]
Crestview Sanitary District	0.27	0.84	- -[d]	- -[d]	- -[d]	- -[d]	0.35	0.84	- -[d]	- -[d]	- -[d]	- -[d]
Village of Caledonia East Utility District (Oak Creek)[d]	0.18	0.29	- -[d]	- -[d]	- -[d]	- -[d]	0.19	0.30	- -[d]	- -[d]	- -[d]	- -[d]
Village of Caledonia East Utility District (Racine)[h]	0.79	1.29	- -[h]	- -[h]	- -[h]	- -[h]	0.84	1.35	- -[h]	- -[h]	- -[h]	- -[h]
North Cape Sanitary District	0.01	0.02	-0.02	0.00	-0.13	-0.01	0.02	0.03	0.03	0.00	-0.13	-0.02
Town of Yorkville Water Utility District No. 1	0.07	0.12	-0.12	0.34	-0.01	1.90	0.33	0.53	-0.53	0.20	-0.20	1.64
Walworth County												
City of Delavan Water and Sewerage Commission	0.90	1.55	1.38	1.30	1.88	5.09	2.28	4.02	-1.09	0.48	0.75	3.70
City of Elkhorn Light and Water	1.21	1.71	1.63	0.65	0.50	3.53	2.53	3.32	0.02	0.11	-0.24	2.21
City of Lake Geneva Municipal Water Utility	1.29	1.97	2.59	1.61	1.93	3.81	2.03	3.59	0.96	1.07	1.18	3.07
City of Whitewater Municipal Water Utility	1.89	3.28	2.66	0.83	0.86	5.66	2.39	3.98	1.95	0.59	0.53	5.16
Village of Darien Water Works and Sewer System	0.11	0.28	0.91	0.43	0.33	2.50	0.35	0.79	0.40	0.26	-0.20	2.26
Village of East Troy Municipal Water Utility	0.57	0.90	-0.11	0.39	-0.05	1.96	1.23	2.03	-1.24	0.01	-0.57	1.30
Village of Fontana Municipal Water Utility	0.51	1.09	0.87	0.43	0.15	2.65	0.54	0.72	1.24	0.56	0.32	2.63
Village of Genoa City Municipal Water Utility	0.28	0.49	0.38	0.35	0.25	0.68	0.94	1.41	-0.55	0.04	-0.49	0.03
Village of Sharon Waterworks and Sewer System	0.13	0.73	-0.15	0.03	-0.57	0.38	0.22	0.68	-0.11	0.04	-0.55	0.29
Village of Walworth Municipal Water and Sewer Utility	0.49	0.66	0.52	0.27	-0.14	1.38	0.92	1.25	-0.08	0.07	-0.41	0.95
Village of Williams Bay Municipal Water Utility	0.32	0.73	1.17	0.74	0.49	1.44	0.86	1.76	0.14	0.40	0.02	0.90
Town of East Troy Sanitary District No. 3	0.01	0.01	-0.01	0.00	-0.13	0.60	0.01	0.02	-0.02	-0.01	-0.13	0.59
Town of Troy Sanitary District No. 1	0.01	0.04	-0.04	-0.01	-0.32	0.00	0.01	0.02	-0.02	-0.01	-0.31	-0.01
Country Estates Sanitary District	0.02	0.04	0.53	0.09	-0.16	0.59	0.09	0.15	0.42	0.06	-0.20	0.52
Lake Como Sanitary District No. 1	0.13	0.29	0.43	0.17	-0.06	1.56	0.29	0.57	0.15	0.08	-0.50	1.41
Pell Lake Sanitary District No. 1	0.18	0.47	0.11	0.14	-0.08	0.66	0.52	0.96	-0.38	-0.03	-0.63	0.33
Washington County												
City of Hartford Water Utility[i]	1.50	2.42	-0.61[i]	-0.16	-0.25	2.61	2.46	3.70	-1.89[i]	-0.58	-0.84	1.65
City of West Bend Water Utility	2.91	4.07	3.69	1.87	3.47	8.98	4.81	6.47	1.29	1.17	2.47	7.09
Village of Germantown Water Utility	1.79	2.92	0.94	0.91	1.08	4.09	3.31	5.45	-1.59	0.17	0.02	2.57
Village of Jackson Water Utility	0.49	0.99	2.55	0.70	0.58	5.13	1.16	2.10	1.44	0.33	0.07	4.47
Village of Kewaskum Municipal Water Utility	0.47	0.91	0.88	0.47	0.02	1.71	0.75	1.36	0.43	0.32	-0.19	1.43
Village of Slinger Utilities	0.33	0.60	-0.10	0.34	-0.14	1.10	0.86	1.60	-1.10	0.01	-0.59	0.57
Allenton Sanitary District No. 1	0.09	0.16	0.31	0.22	0.02	0.65	0.20	0.68	-0.21	0.05	-0.53	0.54
Waukesha County												
City of Brookfield Municipal Water Utility (east and west)	3.66	4.55	8.98	3.50	5.22	1.69	6.05	9.37	4.15	2.10	3.21	-0.70
City of Delafield Municipal Water Utility	0.10	0.22	-0.22	0.63	0.45	1.47	1.50	2.98	-2.98	-0.29	-1.15	0.06
City of Muskego Public Water Utility	0.59	1.08	3.61	0.97	1.14	3.83	2.54	5.40	-0.72	-0.48	-0.84	0.43
City of New Berlin Water Utility-East[f]	1.78	2.55	2.24	0.43	0.23	3.54	2.22	3.82	0.97	0.05	-0.30	3.10
City of New Berlin Water Utility-Central	1.49	2.13	2.62	2.39	2.58	2.16	2.90	4.66	0.10	1.66	1.52	0.75

Table 83 (continued)

Utility	2000 Average Day Pumpage (mgd)	2000 Peak Day Pumpage (mgd)	2000 Surplus Maximum Day Supply Capacity[a] (mgd)	2000 Surplus Peak Hour Storage Capacity (MG)	2000 Surplus Fire Flow Capacity (MG)	2000 Surplus Emergency Supply Capacity (mgd)	2035 Average Day Pumpage (mgd)	2035 Peak Day Pumpage (mgd)	2035 Surplus Maximum Day Supply Capacity[a] (mgd)	2035 Surplus Peak Hour Storage Capacity (MG)	2035 Surplus Fire Flow Capacity (MG)	2035 Surplus Emergency Supply Capacity (mgd)
Waukesha County (continued)												
City of Oconomowoc Utilities	1.56	2.61	4.97	1.55	2.36	5.24	3.36	5.79	1.78	0.62	1.04	3.44
City of Pewaukee Water and Sewer Utility	1.15	1.79	3.41	1.10	1.30	2.84	2.51	4.94	0.26	0.05	-0.14	1.48
City of Waukesha Water Utility	7.77	10.15	-4.93	5.46	7.74	1.72	9.82	13.44	-8.22	4.50	6.37	-0.33
Village of Butler Public Water Utility[f]	0.40	0.67	0.11	0.21	-0.25	0.95	0.49	0.78	0.00	0.18	-0.30	0.86
Village of Dousman Water Utility	0.15	0.23	0.17	0.19	-0.17	0.53	0.48	0.81	-0.41	-0.01	-0.61	0.19
Village of Eagle Municipal Water Utility	0.15	0.57	0.06	0.03	-0.50	1.29	0.26	0.78	-0.15	-0.04	-0.59	1.18
Village of Hartland Municipal Water Utility	0.92	1.47	3.24	1.09	1.20	4.82	1.43	2.62	2.09	0.71	0.68	4.31
Village of Menomonee Falls Water Utility (west)	0.18	0.27	0.31	0.48	0.40	2.92	1.01	1.60	-1.03	0.26	-0.40	2.09
Village of Menomonee Falls Water Utility (east)[f]	3.57	5.29	4.79	2.27	3.47	9.06	5.25	8.94	1.15	1.20	1.95	7.37
Village of Mukwonago Municipal Water Utility	0.64	0.90	-0.10	0.65	0.32	3.44	1.51	2.22	-1.43	0.21	-0.29	2.57
Village of Pewaukee Water Utility	0.85	1.22	0.29	0.58	0.57	1.29	1.30	1.98	-0.47	0.33	0.22	0.84
Town of Brookfield Sanitary District No. 4	1.03	1.39	0.91	0.36	-0.10	1.55	1.22	1.69	0.61	0.26	-0.24	1.36

[a]The surplus maximum day supply capacity is based on a comparison of the 2000 and estimated 2035 maximum day pumpage to the "reliable capacity" of the facility defined as the capacity with one unit of any major component out of service. This "reliable capacity" is different than the requirements of NR 811 which requires duplicate units for most facilities, but when duplicate units exist, it does not require redundant units.

[b]Average and peak day pumpages for the indicated customer utilities are included in the volumes listed for Kenosha. Surplus capacity was evaluated for the City of Kenosha Water Utility water supply facilities.

[c]The year 2000 and 2035 pumpage amounts are those associated with the City of Cudahy Water Utility municipal system and exclude water provided directly to industrial users.

[d]Average and peak day pumpages for the indicated customer utilities are included in the volumes listed for Oak Creek Water and Sewer Utility. Surplus capacity was evaluated for the Oak Creek Water and Sewer Utility water supply facilities. During 2009, the City of Oak Creek Sewer and Water Utility initiated construction on a water treatment plant expansion designed to bring the plant capacity up to 28.0 mgd. The Utility is also considering preparation of a rerating analysis of the water treatment plant which could result in rerated plant capacity of 35.0 mgd upon completion of the 2009 plant expansion. Upon completion of these projects in 2010, the Utility would have surplus maximum day supply capacity of 11.5 mgd under year 2000 demand pumpage conditions, and the reliable capacity. Under 2035 demand, pumpage conditions will exceed the estimated maximum day demand with modest changes to the low lift pumping capacity.

[e]Average and peak day pumpages listed for Glendale include the other indicated customer utilities and We Energies for use in the Village of Bayside. North Shore Water Commission provides service to all indicated utilities. Surplus capacity was evaluated for the North Shore Water Commission water supply facilities.

[f]Average and peak day pumpages for the indicated customer utilities are included in the volumes listed for Milwaukee Water Works. Surplus capacity was evaluated for the Milwaukee Water Works water supply facilities.

[g]Emergency supply capacity is being evaluated by the utility.

[h]Average and peak day pumpages for the indicated customer utilities are included in the volumes listed for Racine Water and Wastewater Utility.

[i]During 2009, the City of Hartford Water Utility began development of a new shallow well and elevated storage tank and related facilities. These facilities are expected to be in service during 2010. Once these facilities are in place, the Utility will have a surplus maximum day supply capacity of 1.70 mgd under year 2000 demand pumpage conditions, and 0.4 mgd under estimated year 2035 pumpage conditions.

Source: Ruekert & Mielke, Inc., and SEWRPC.

conditions, coupled with the forecasts of increased groundwater use, as documented in Chapter IV, result in a significant water supply problem. Wisconsin Act 310, adopted in 2003, authorizes the Wisconsin Department of Natural Resources (WDNR) to designate most of the Southeastern Wisconsin Region as one of two groundwater management areas in which groundwater potentiometric surfaces have declined by 150 feet or more since settlement and development of the State by Europeans. That designation indicates a concern by State officials.

The declines in water levels caused by pumping are different for the shallow and the deep aquifers underlying the Region. Pumping from the shallow aquifer generally causes little regional drawdown because local surface water features—streams, lakes, and wetlands—act to offset the withdrawal. Often the major effects of pumping from these shallow wells is to reduce the amount of groundwater discharge to local surface water features, with potential adverse environmental affects. As described in Chapter III, drawdown levels characterized as constituting a problem occur in the Silurian dolomite portions of the shallow aquifer that occurs primarily in Ozaukee County and in parts of eastern Washington, northeastern Waukesha, and northern Milwaukee Counties. Compared to pre-development conditions, the drawdown in the Silurian dolomite approaches 200 feet around the high-capacity well pumping center in central Ozaukee County. The drawdown cone is also relatively deep in southern Ozaukee County where domestic wells in areas served by public sanitary sewers do not return spent water to the groundwater reservoir as do onsite sewage treatment and disposal systems; and, therefore, cause a net loss of water to the aquifer. Since 1999, We Energies Water Services Division has provided a Lake Michigan-based water supply to expanding portions of the City of Mequon and the Villages of Bayside and Thiensville. This source of supply replaces some of the groundwater based supplies previously used in these areas. This change has reduced the historic drawdown of the shallow aquifer in this area.

Increased drawdown over time is more dramatic in the deep sandstone aquifer where a single drawdown cone has developed. In the early 19th Century, wells constructed into this aquifer in the Waukesha area were artesian—that is, flowing at the surface under their own internal pressure. As described in Chapter III, pumping of the deep aquifer—currently in Waukesha County and historically also in Milwaukee County—has produced a regional cone of depression centered somewhat below the midpoint of the Milwaukee-Waukesha county line, with maximum drawdown in the deep sandstone aquifer potentiometric surface exceeding 500 feet. The cone of depression extends to the west under Waukesha County, to the north under Ozaukee and Washington Counties, to the south under Kenosha, Racine, and Walworth Counties, and to the east under Lake Michigan. The effect of pumping in northeastern Illinois is also evident in the drawdown contours shown in Figure 16 in Chapter III over the southern reaches of the planning area.

The drawdown of the shallow aquifer, and the related reduction in the amount of groundwater discharge to local surface water systems and wetlands, may be expected to increase under a continuation of historic trends, given the forecast increased use of groundwater, as identified in Chapter IV, and may be expected to be accompanied by adverse environmental effects on local lakes, streams, and wetlands. The adverse impacts on surface water conditions could be exacerbated by increased groundwater withdrawal from the shallow aquifer to compensate for reduced pumpage of the deep aquifer. This may be considered to be a water supply problem to be addressed in the regional water supply plan. The more extensive drawdown of the deep aquifer has the potential to result in increased water supply capital and operating costs associated with greater pumping depths. In addition, the quality of the groundwater in some wells finished in the deep sandstone aquifer has decreased as the water levels have decreased. This decline in water quality may be categorized as a significant problem which should be addressed in the regional water supply plan.

Related Plan Objectives and Standards

One plan objective and four standards are directly related to the problem associated with groundwater quantity and sustainability:

- Objective—A regional water supply system which conserves and wisely utilizes the surface water and groundwater supplies of the Region, so as to sustain those supplies for future, as well as existing needs.

- Standard—The use of the deep sandstone aquifer should be managed so that the potentiometric surface in that aquifer is sustained or raised under use and recharge conditions within the Southeastern Wisconsin Region. Declines in the potentiometric surface of the aquifer within the Region due to uses in areas beyond the Region should be identified for the purpose of promoting interregional planning and action.

- Standard—The uses of the shallow aquifer should be managed so that the aquifer yields are sustainable.

- Standard—The uses of the deep and shallow aquifers should be managed so as to minimize the ecological impacts on the surface water system of the Region.

- Standard—The use of groundwater and surface water for water supply purposes should be carried out in a manner which minimizes adverse impacts to the water resources system, including lakes, streams, springs, and wetlands.

Basis for Problem Resolution

Each of the design year 2035 alternative plans was evaluated with respect to the potential impact upon the water table of both the shallow and deep aquifers, as well as to the potential impact upon the surface water system, including the lakes, streams, and wetlands. As previously noted, the selection of a recommended regional water supply plan is to be based upon a comparative evaluation of the ability of each the alternative plans considered to meet the agreed-upon objectives and standards, including those related to groundwater quantity and sustainability. That evaluation was carried out through application of the regional groundwater system simulation model, with model inputs provided by the alternative plans. The model applications provided estimates of probable future groundwater level conditions under each plan. As also previously noted, the regional groundwater model contains a surface water linkage component module which may be used to estimate the probable impact of each alternative plan on the groundwater contributions to the baseflows of streams, to inland lake levels, and to wetlands at specific locations.

In addition to the groundwater and surface water modeling analyses, two special hydrogeologic studies were conducted as part of the regional water supply planning effort to assist in the development and evaluation of alternative plans, and in the selection of a recommended plan. The findings of the first of these studies are documented in a technical report[3] prepared under the regional water supply planning effort. Under the first of these two special studies, groundwater sustainability analyses were conducted in selected study areas. Each demonstration area was analyzed to determine the number of individual household wells, or comparable number of shared common wells, which could be sustained without significant impacts on the shallow groundwater aquifer system. The analyses were conducted using a series of focused groundwater flow models developed for the six selected study areas. These local flow models were developed using modifications of the regional groundwater aquifer simulation model, incorporating specific local geologic and hydrologic features that were not included in the broader-scale regional model. These localized models were focused on the shallow sand-and-gravel and interconnected Silurian dolomite aquifers. The localized models were used to evaluate the potential hydrologic stresses of drawdown and baseflow reduction caused by various development and attendant water-use scenarios.

Four development scenarios were evaluated for buildout conditions within each demonstration area. Only areas outside of the primary and secondary environmental corridors and isolated natural resource areas were considered developable. Densities of development were analyzed for 0.5, 1.0, 3.0, and 5.0 gross acres per single-family

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[3]*SEWRPC Technical Report No. 48,* Shallow Groundwater Quantity Sustainability Analysis Demonstration for the Southeastern Wisconsin Region, *November 2009.*

dwelling unit. Each scenario was evaluated under two wastewater disposal options. The first option assumed the use of onsite sewage disposal systems and the return of 90 percent of the water withdrawn to the groundwater system as wastewater. The second option assumed the use of a public sanitary sewer system which removes the wastewater from the groundwatershed concerned.

Groundwater sustainability analyses were conducted for the six study areas. Each analysis has a model nearfield area incorporating a portion of a town within the Region located beyond the limits of any areas currently committed to public sewer and water supply facilities through boundary or other types of agreements. The models also have a farfield area somewhat larger than the town demonstration area in order to properly establish boundary and calibration conditions. Demonstration areas were selected in the Towns of Wheatland, Kenosha County; Cedarburg, Ozaukee County; Raymond, Racine County; LaGrange, Walworth County; Jackson, Washington County; and Lisbon, Waukesha County. The results of the sustainability analyses were then used to assist in the development of recommendations regarding densities of development for incorporation into the regional water supply plan and for consideration in municipal, county, and regional land use planning.

Under the second special study water budget analyses were conducted to develop three groundwater performance indicators for use in evaluating each of the alternative plans to be considered. The findings of this second special study are also documented in a SEWRPC technical report.[4] The water budget analysis technique used is a refinement of an analysis technique originally developed by the U.S. Geological Survey. The first indicator, known as the demand to supply ratio, is defined as the ratio of net pumping demand on an aquifer to that aquifer's sustainable, or natural, supply. Generally, this indicator ranges from 0—representing no human impact—upward. Values over 1.0 indicate that more groundwater is being extracted than can be replaced through recharge in a long-term, sustainable fashion. This indicator is primarily applicable to the deep, confined aquifer, because the differences between extraction and recharge are much more significant in that aquifer than in the shallow aquifer. The second indictor, known as the human impact ratio, is defined as the ratio of human-induced groundwater inflows to total inflows minus the ratio of human-induced groundwater outflows to total outflows. This indicator is an expression of the relative magnitude of human alteration of the groundwater system. Values range from minus 1.0 in areas where wells have become the only discharge from an aquifer by reducing all other groundwater discharges, through 0 representing no net human impact, to plus 1.0 representing situations where human additions are the only inputs to the aquifer. The third indicator, known as the base flow reduction index, is defined as the ratio of the change in groundwater discharge due to pumping between a base time period and the time of interest divided by the base period discharge. In the study conducted, the simulated baseflow for the year 1900 were taken as the unaltered standard.

Using the aforedescribed modeling and special analyses, a recommended regional water supply plan is intended to be identified based upon a comparative evaluation of the alternative plans considered with regard to their effectiveness in meeting the planning objectives and standards, including those specifically related to groundwater quantity and sustainability. This evaluation is intended to identify the alternative plan which best provides for a balance between the amount of groundwater used and the recharge of the groundwater aquifers concerned.

Groundwater Quality

Problem Description

Chapter III provides information on existing groundwater quality. The information provided indicates that problems exist with regard to groundwater quality as manifested by detections of contaminants in groundwater at concentrations exceeding State preventative action limits or enforcement standards or by the presence of contaminants in finished water. The later, in some limited cases, exceed Federal and State maximum contaminant limit (MCL) standards. As documented in Chapter IV, significant growth in population, employment, and urban

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[4]*SEWRPC Technical Report No. 46,* Groundwater Budget Indices and Their Use in Assessing Water Supply Plans for Southeastern Wisconsin, *February 2010.*

land uses is occurring, and may be expected to continue to occur, in areas of the Region lying west of the subcontinental divide, and in such areas as north-central Washington County, which while located east of the subcontinental divide may lie beyond the cost-effective reach of water transmission mains from Lake Michigan. The current groundwater conditions, coupled with the forecasts of increased groundwater use, as documented in Chapter IV, combine to create a potential water supply problem.

Problems concerning groundwater quality within the Region may be classified into two categories. One category consists of problems caused by natural factors. The other category consists of problems related to contamination of groundwater resulting from human activities. Examples of groundwater quality problems caused by natural factors include high levels of hardness, arsenic, and radium in groundwater. As a result of the release of magnesium and calcium ions from the abundant dolomite material present in the bedrock underlying the Region, hardness is objectionably high in the groundwater reservoir underlying most of the Region. While hardness presents no risks to human health—indeed may actually be beneficial to human health—softening is required for almost all other water uses.

Consumption of arsenic-contaminated drinking water has been reported to be related to several potential health problems, including circulatory disorders, neurological disorders, various cancers, and diabetes. While data from the Wisconsin Department of Natural Resources Groundwater Reporting Network (GRN) database indicates that detectable concentrations of arsenic were present in the majority of wells tested in the Region, the concentrations detected exceeded the State and Federal MCL standard of 10 micrograms per liter in only about 5 percent of the wells tested. Locally, the percentage of wells exceeding the MCL standard may be higher. For example, the GRN databases indicates that about 15 percent of wells tested in Walworth County exceeded the MCL standard. As explained in Chapter III, two distinct mechanisms related to differences in mineralogy can release arsenic to groundwater: oxidation of sulfide-containing material under oxic conditions, and reduction of iron-hydroxide containing minerals under anoxic conditions.[5] Where release of arsenic into groundwater results from oxidation of sulfide-containing minerals, draw down of water levels in the aquifer to or below the rock layers containing the minerals may promote release of arsenic. While this appears to be a major mechanism of arsenic release to groundwater in some areas of Wisconsin, it is uncertain how important this mechanism is in the Southeastern Wisconsin Region. Reductive release of arsenic to groundwater from iron-hydroxide minerals is known to be an important source of arsenic in groundwater in southeastern Wisconsin. In the Region, these minerals are widely dispersed throughout the Quaternary sand and gravel aquifer.[6] Single samples collected from wells by the WDNR during 1999 and 2000 indicate that water from 32 public water systems, mostly “other than municipal, community” systems, and “nontransient, noncommunity” systems, in the Region had concentrations of arsenic in excess of the 10 micrograms per liter MCL standard, resulting in an estimate that of 4 to 5 percent of wells in the Region may be expected to exceed this standard.[7] Review of consumer confidence reports issued by the WDNR for municipal systems and “other than municipal, community” systems for 2006 showed only one system in violation of the MCL standard for arsenic within the Region.

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[5]*M.B. Gotkowitz, J.A, Simo, and M. Schreiber,* Geologic and Geochemical Controls on Arsenic in Groundwater in Northeastern Wisconsin, *Final Report submitted to the Wisconsin Department of Natural Resources, Wisconsin Geological and Natural History Survey Open File Report, 2003-01, 2003.*

[6]*Tara. L. Root,* Controls on Arsenic Concentrations in Groundwater from Quaternary and Silurian Units in Southeastern Wisconsin, *Ph.D. Dissertation, University of Wisconsin, 2005.*

[7]*E-mail communication from Charles A. Czarkowski, Wisconsin Department of Natural Resources to Paul Tellier, Waukesha County Environmental Health Division, June 10, 2005; e-mail communication from Charles A. Czarkowski to Blaine Delzer, Washington County Conservation Department, January 25, 2007.*

Concentrations of radium exceeding the State and Federal MCL standard of 5.0 picocuries per liter is also a problem in some locations within the Region. Long-term exposure to elevated levels of radium in drinking water may be related to a higher risk of bone cancer for the people exposed. Naturally occurring radium is released from some types of rock formations into groundwater in the deep sandstone aquifer. As reported in Chapter III, there were 17 municipal and “other than municipal” community water systems within the Region in 2006 that are required to comply with consent orders issued by the WDNR requiring reductions of radium concentrations in finished water below the MCL standard. These orders have a deadline of December 7, 2006. According to the WDNR, as of May 31, 2007, three of these systems were verified to have complied with their consent orders, while three other systems had completed projects leading to a potential return to compliance.[8] The remaining systems are in various stages of ongoing projects to comply with their consent orders. These systems have taken various approaches for meeting the MCL standard, including taking wells producing water with high radium concentrations offline from the distribution system, constructing new wells, blending water from high radium concentration wells with water with lower radium concentration from other wells, placing linings in wells to reduce radium concentrations, and adding additional treatment. As of 2009, all of the municipal utilities in the Region had achieved compliance with the radium standard, except for the City of Waukesha Water Utility which has taken major steps to achieving compliance. The City of Waukesha Water Utility is under a court order to fully achieve compliance with radium standards by June 30, 2018.

As already noted, some groundwater quality problems are related to human activities. As described in Chapter III, contaminants resulting from human activities include bacteria, nitrate, pesticides, viruses, and volatile organic compounds (VOCs), among others. The first three of these are not known to currently cause major problems within the Region. However, localized problems are known to occur. In some areas the WDNR has issued special well casing requirements to provide additional protection of drinking water quality in areas where shallower aquifers are known to be contaminated. These areas are listed in Table 31 and their locations are shown on Map 30 in Chapter III.

The coliform bacteria test has been used as an indication of contamination of wells with fecal material from a number of sources, including septic tanks, leaking sanitary sewer lines, feedlots, and manure pits and piles. While most coliform bacteria do not cause disease, their presence in a well may indicate fecal contamination, and may indicate the presence of waterborne disease agents. The presence of coliform bacteria may indicate a well that is too shallow or has been poorly constructed. As noted in Chapter III, while there are some localized exceptions, coliform bacteria have been detected in relatively low percentages of public water supply systems and private wells within the Region.

High concentrations of nitrate-nitrogen in water can produce toxic effects, especially in infants. Infants fed water or formula made with water containing high concentrations of nitrate-nitrogen may develop methemoglobinemia, or “blue baby” syndrome, a condition that can lead to coma and death. Nitrate-nitrogen can enter groundwater from a number of sources, including nitrogen-based fertilizers, animal waste storage facilities, feedlots, septic tanks, and municipal and industrial wastewater and sludge disposal sites. As noted in Chapter III, data from the Wisconsin Department of Natural Resources GRN database indicate that the State and Federal MCL standard of 10 mg/l for nitrate-nitrogen has been exceeded in a low percentage of wells tested within the Region. However, it is likely that there are an undetermined, but significant, number of wells which would exceed the standard if tested.

Pesticide contamination of groundwater results from a number of sources, including agricultural field applications, spills, misuse, or improper storage and disposal of pesticides. As noted in Chapter III, while several pesticides have been detected in groundwater in the Region, most have been detected in a small percentage of

[8]*Wisconsin Department of Natural Resources, Current Status of Radium Compliance Spreadsheet, May 31, 2007.*

wells. None were found present at concentrations that exceed State groundwater enforcement standards. One pesticide, pentachlorophenol, has been found to be present in a small percentage of wells at concentrations that exceed the State preventive action limit.

Waterborne bacteria and viruses can cause a number of diseases, including cholera, typhoid fever, infectious hepatitis, and gastroenteritis, among others, and several respiratory waterborne diseases. Enteric viruses, such as those responsible for gastroenteritis, are shed by infected individuals in feces, and thus can be present in groundwater contaminated with sanitary wastes. Few data are available on the incidences of viral contamination of wells in the Southeastern Wisconsin Region. As noted in Chapter III, the results of a statewide study suggest that incidences of such contamination are low in Wisconsin, and that instances of contamination may be transient.[9] A second study found that incidences of diarrheal illnesses, both of viral and bacterial etiology, in children were associated with the density of septic tanks within the residential areas in which the children lived. However, because viruses were not sampled for in the wells of case households, it is not certain that these illnesses were the result of contaminated groundwater.[10] The cases of bacterial illness examined in this study were shown not to be related to contaminated wells, suggesting that alternative routes of exposure, such as exposure from pathogens released from onsite sewage disposal systems to the land surface, were the likely cause of the relationship of incidences of bacterial diarrheal illness to septic tank density. This may also explain the relationship between septic tank density and the cases of viral etiology. While localized outbreaks of viral contamination of groundwater may occur, these studies suggest that the incidence of contamination of groundwater in the Region with enteric viruses is likely to be low.

Volatile organic compounds (VOCs) vary in the risk that they pose to human health. Some are known or suspected carcinogens. Sources of VOCs to groundwater include landfills, leaking underground storage tanks, and spills of hazardous substances, among others. As described in Chapter III, VOCs were detected in a small percentage of wells that were sampled, and the compounds exceeded State enforcement standards and preventive action limits in a very small percentage of wells that were sampled. Several factors may affect the vulnerability of wells to VOC contamination including proximity of the well to the source of contamination, the amount of VOCs released to the environment, the depth of the well casing, and local geology. While incidences of VOC contamination in wells of the Region are generally low, some portions of the Region have higher levels of contamination. In these areas, the WDNR has issued special well casing requirements to provide additional protection of drinking water quality in areas where aquifers are known to be contaminated. These areas are listed in Table 30 and their locations are shown on Map 31 in Chapter III.

Potential sources of groundwater contamination are many and varied because, in addition to some natural processes, such as dissolved and particulate matter in precipitation, decay of organic matter, natural radioactivity and dissolution of arsenic-containing minerals, many types of facilities or structures and many human activities may eventually contribute to groundwater quality problems. Potential sources of groundwater contamination include onsite sewage disposal systems; landfills; leaking underground storage tanks; wastewater biosolids application; agricultural activities, including major farm animal raising operations, and fertilizer and pesticide storage facilities. Other potential sources of contamination include the stockpiles of salt for highway de-icing, salvage yards, and bulk fuel storage sites.

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[9]*Mark A. Borchardt and others, "Incidence of Enteric Viruses in Groundwater from Household Wells in Wisconsin,"* Applied and Environmental Microbiology, *Volume 69, 2003.*

[10]*Mark A. Borchardt and others, "Septic System Density and Infectious Diarrhea in a Defined Population of Children,"* Environmental Health Perspectives, *Volume 111, 2003.*

One of the important potential sources of groundwater contamination are wells that are no longer used, but have not been properly sealed when abandoned. Proper well abandonment requires filling the well from the bottom up with cement grout or bentonite. The locations of old wells are often not well known, and buildings or roads may have been built over the top of open boreholes. These wells can serve as a means for transmission of contaminants from the land surface to an aquifer and can permit contaminated water to migrate freely from one aquifer to another. This is particularly critical within the Region where the open intervals of many wells penetrate more than one aquifer unit. Even in areas where groundwater contamination potential is ordinarily considered low because of favorable soil and geological properties, such as Milwaukee and eastern Waukesha Counties, large numbers of improperly abandoned or unaccounted-for old wells may pose a significant threat to groundwater quality.

Related Plan Objectives

One plan objective and five standards are directly related to the problem associated with groundwater quality:

- Objective—A regional water supply system which protects the public health, safety, and welfare.

- Standard—Water supply systems should be designed, constructed, and operated to deliver finished water to users which meets the drinking water standards established by the Wisconsin Department of Natural Resources to protect the public health, safety, and welfare.

- Standard—The selection of sources of supply and the design, contribution, and operation of related treatment facilities should be made cognizant of the potential presence of unregulated emerging pollutants, such as pharmaceuticals, personal care products, and certain viruses.

- Standard—Water supply sources and treatment processes should be selected to minimize potential problems with subsequent treatment and disposal of created waste streams.

- Standard—Groundwater and surface water sources of water supply should be protected from sources of contamination by appropriate siting, design, and land use regulation.

- Standard—The density, design, operation, and level of treatment of onsite sewage disposal systems should be related to the achievement of the groundwater quality standards and the safety and public health requirements of any potentially affected water supplies.

Basis for Problem Resolution

Each of the design year 2035 alternative plans includes components intended to address existing and anticipated groundwater quality problems. As previously noted, the recommended regional water supply plan is to be selected based upon a comparative evaluation of the ability of the alternative plans to meet the agreed-upon objectives and standards, including those related to groundwater quality. Given the dynamic nature of groundwater quality, it is to be expected that groundwater quality conditions at some locations may change, and that unanticipated groundwater quality problems may emerge over the course of plan implementation. Each of the alternative plans considered, however, include recommendations for continued groundwater quality monitoring and groundwater quality standard enforcement in order to identify and address these changing conditions.

The quality of the source water is an important determinant in the development of water supply systems. The WDNR has conducted source water assessments for all of the municipal water supply systems operating within the Region. Such assessments include information on source water quality and recommend needed protection measures. In the case of selected contaminants, including emerging and unregulated contaminants, such as pharmaceuticals and personal care products, proactive measures that prevent the discharge of the potential contaminants to the environment are more likely to be effective than corrective actions once such discharge has occurred. This approach also limits environmental exposure of aquatic communities to the contaminants. For such contaminants, programs, such as household hazardous waste and pharmaceutical collections will be needed. Such programs may be most effectively carried out on a county or subregional level, rather than being left to the individual water or wastewater utilities. Consideration of the need for, and governance of, such programs will be given in the development of the recommended water supply plan and the associated implementation strategy.

As previously noted, there are a number of important sources of groundwater contamination which have been considered in the regional water supply planning program. In most cases, regulations and programs are in place which are designed to prevent or mitigate such contamination. With regard to the sources of groundwater contamination, the regional water supply plan recommendations includes references to regulations and programs which are underway or proposed to prevent or mitigate groundwater contamination.

ISSUES TO BE ADDRESSED

The water supply issues which have been identified within the Region are primarily related to: the availability of Lake Michigan supply and diversion; the underutilization of existing Lake Michigan water supply capital facilities; groundwater-surface water interdependence; the relationship of water supply systems to other comprehensive plan elements; water conservation effectiveness; the relationship of recharge and use attributable to areas beyond the Region; impacts of land use development within the Region on groundwater recharge; surface water quality; and climate change. To the extent practicable, these issues should be addressed in the regional water supply plan. Each of the identified issues is described in the following sections, along with the related planning objectives and standards, and the recommended basis for addressing the issues.

Availability of Lake Michigan Supply and Lake Michigan Diversion

Issue Description

Because the subcontinental divide between the Mississippi River and the Great Lakes-St. Lawrence River drainage basins traverses the Region, the use of Lake Michigan water as a source of supply within much of the Region is problematic. In addition to the constraints on the use of such water imposed by the costs of transmission, legal constraints rooted in State and Federal law and in international treaty exist on the diversion—or loss—of water from the Great Lakes-St. Lawrence River basin. The legal constraints are complex. Prior to 2007, the extension of Lake Michigan water to areas lying west of the subcontinental divide was governed by the *Wisconsin Statutes* and by Federal law—the latter in the form of the Water Resources Development Act (WRDA), as described in Chapter VI. The extension of Lake Michigan water to areas lying west of the divide is legally practicable only if the spent water is returned to Lake Michigan. Such return is most positively assured by the return of spent water via sanitary sewerage systems.

As shown on Map 68 in Chapter VI, the service areas of major water utilities within the Region using Lake Michigan as a source of supply include areas in Kenosha and Waukesha Counties lying west of the divide. While the WRDA prohibits diversions unless approval of all of the Great Lakes Governors is received, the WRDA does not define what constitutes a diversion. There is also no case law which defines the term “diversion” under the WRDA. The WDNR has in the past taken the position that water taken and used outside the basin, but then returned to the basin, is not a diversion subject to the WRDA. Such a situation may exist where a municipality located within the basin provides water to customers located outside the basin, but then collects wastewater from those customers through sanitary sewerage facilities, and returns it to the basin. Water supply service areas lying west of the subcontinental divide were in the past permitted by the WDNR to use Lake Michigan water if the spent water was returned, and such use was not held to be a diversion subject to the WRDA. The areas west of the subcontinental divide served by Lake Michigan water all either currently return the water to the basin or are committed to do so by 2010.

Based, in part, upon the past interpretation of the term “diversion,” water utilities in the greater Kenosha area have made plans which have been largely implemented that provide Lake Michigan water to areas lying west of the subcontinental divide, with the spent water being returned to Lake Michigan via sanitary sewerage systems. The water utilities and communities involved have plans in place to provide water supply and sanitary sewer service to an existing and planned 84-square-mile urban service area, much of which is located west of the subcontinental divide, as shown on Map 33 in Chapter III. Intermunicipal agreements are in place and substantial infrastructure has been put in place to carry out the plans. The entire service area is proposed to be served by water supply provided by the Kenosha Water Utility which uses Lake Michigan as a source of supply, with the spent water being conveyed as sanitary sewage to the Kenosha Water Utility sewage treatment plant which discharges treated effluent to Lake Michigan.

On December 13, 2005, Governors of the eight Great Lakes states signed the Great Lakes-St. Lawrence River Basin Water Resources Compact. If this Compact is ratified by the legislatures of all the eight Great Lakes states and consented to by the Congress it would expand the existing regulations applicable to the use of Great Lakes basin water.[11] Under the Compact, all "diversions" outside the Great Lakes basin would be prohibited with three limited exceptions. A "diversion" is defined in the Compact to occur whenever water is transferred from the Great Lakes basin into another basin—or watershed—by any means other than incorporation into a product. The three exceptions concerned are for straddling communities, communities within straddling counties, and intra-basin transfers. The basis for meeting the exception requirements are described in Chapter VI. Such considerations may have far-reaching impacts on water supply alternatives in southeastern Wisconsin.

Related Plan Objectives

There are two plan objectives and two standards which are directly related to the issue of the availability of Lake Michigan supply and Lake Michigan diversion for additional sources of supply infrastructure to meet water demands:

- Objective—A regional water supply system which conserves and wisely utilizes the surface water and groundwater supplies of the Region, so as to sustain those supplies for future, as well as existing needs.

- Standard—Lake Michigan as a source of supply should be utilized recognizing the constraints of the current regulatory framework and the status and provisions of the Great Lakes Charter 2001 Annex.

- Objective—The development of water supply systems, operations, and policies which are flexible and adaptive in response to changing conditions, and redundant with respect to source of supply.

- Standard—The regional water supply plan should be adaptable to changes in the regulatory structure, including the 2001 Great Lakes Charter Annex being put forth by the Council of Great Lakes Governors and the State of Wisconsin 2003 Act 310.

Basis for Issue Resolution

The findings of the water supply law study conducted under the water supply planning program[12] indicate that, with regard to proposals for the provision of Lake Michigan water to any areas of the Region located west of the subcontinental divide, a return flow component is required for consistency under both current law and regulations and potential future law and regulations under the Great Lakes-St. Lawrence River Basin Water Resources Compact. Accordingly, it was determined to include a return flow component in any alternative plan which envisions the provision of Lake Michigan water to areas located west of the subcontinental divide. It was further determined that, for areas located west of the subcontinental divide, the provision of Lake Michigan water would be considered only for areas which meet the geographic exception provisions of the Compact.

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[11]*The Great Lakes-St. Lawrence River Basin Water Resources Compact was enacted into law by Wisconsin Act 227, adopted in 2007, and was formalized by a Congressional Consent Resolution signed by the President in October 2008.*

[12]*SEWRPC Technical Report No. 44,* Water Supply Law*, April 2007.*

The extent to which the recommended plans include the provision of Lake Michigan water to areas lying west of the divide was dependent upon an evaluation of the alternative plans with regard to the achievement of the plan objectives. It is noted, however, that the provision of Lake Michigan water to areas in eastern Kenosha County where long-standing subregional and local water supply and sewerage system plans recommended such provision and have been largely implemented, was treated a committed decision and made a component of all of the alternative plans considered.

Underutilization of Existing Lake Michigan Water Supply Capital Facilities

Issue Description

Nine public water supply treatment plants operated by eight water utilities within the Region use Lake Michigan as a source of supply. These plants provide water to 27 utilities within the Region. Together these plants provide an average of 186 million gallons of water per day to meet domestic, commercial, and industrial needs within their service areas. Table 84 provides information on the rated capacity and existing utilization of these treatment plants. The data provided indicate that seven of the eight water utilities utilizing Lake Michigan as a source have treatment capacity adequate to serve the existing and planned development within their service areas. The data indicate, however, that the water treatment plants operated by the City of Milwaukee Water Works, the City of Kenosha Water Utility, the City of Racine Water and Wastewater Utility, and the North Shore Water Commission have treatment capacity considerably in excess of that needed to serve existing and planned development within their service areas. In addition, the City of Oak Creek Water and Sewer Utility will have substantial excess capacity when the 2010 plant expansion is completed.

The current underutilization of the water treatment plants operated by the three aforenoted utilities presents an opportunity to utilize the capital investment in these plants in a more cost-effective manner by providing water to communities currently not served by Lake Michigan water in a manner consistent with the current and future regulations governing the use of Lake Michigan water, and within a cost-effective transmission distance of the plants concerned. Given the increasing demand being placed upon the groundwater resource, the potential for increased use of Lake Michigan water as a means of conserving the groundwater supply by more cost effectively using excess capacity in the Lake Michigan supplied water treatment plants should be assessed. It should be noted that while the use of Lake Michigan water has actually been declining since about 1985, the latent demand for Lake Michigan water may actually be increasing. Evidence of such increase is reflected in the recent extension of Lake Michigan water to areas in eastern Kenosha and Racine Counties and in the areas immediately adjacent to Milwaukee County. It should also be noted, however, that if the extension of Lake Michigan water results in significant increases in cost to users, then some large commercial and industrial users may revert to the use of groundwater through the reactivation of existing, or through the construction of new, onsite wells.

Clearly, the issue of underutilization of existing Lake Michigan water supply capital facilities should be addressed in the regional water supply plan. The issue being considered relating to the existing Lake Michigan treatment capacities must also consider the related transmission and storage facilities. It is recognized that any potential consolidation of facilities must also consider transmission and storage facility capacities which would be needed to carry out any consolidation considered. This issue requires consideration of the cost-effectiveness and fiscal impacts of potential facility consolidation. It also requires consideration of ownership and related political availability concerning any underutilized water supply facility capacity.

Related Plan Objectives and Standards

There is one plan objective and two standards which are directly related to the issue of the underutilization problems associated with the need of existing Lake Michigan water treatment plant capacities:

- Objective—The development of water supply facilities, operational improvements, and policies, that are both economical and efficient, best meeting all other objectives at the lowest practical cost, considering both long-term capital and operation and maintenance costs.

Table 84

CAPACITY AND USE OF LAKE MICHIGAN WATER TREATMENT PLANTS WITHIN SOUTHEASTERN WISCONSIN: 2000 AND 2035

Plant	Existing 2000 Pumpage[a] (mgd)		Estimated 2035 Pumpage[b] (mgd)		Existing Rated Plant Capacity (mgd)[c]	Reserve Capacity (mgd)[d]
	Average	Maximum Day	Average	Maximum Day		
City of Cudahy Water Utility	4.8	6.6	4.8	6.0	6.0	None
City of Kenosha Water Utility	14.5	21.6	22.2	33.4	42.0[e]	8.6[e]
City of Milwaukee Water Works	127.1	181.7	133.9	194.6	380.0	185.4
Linnwood Avenue	- -	- -	- -	- -	275.0	- -
Howard Avenue	- -	- -	- -	- -	105.0	- -
City of Oak Creek Water and Sewer Utility	7.0	15.5	14.2	29.2	20.0[f]	- -[f]
City of Port Washington	1.3	1.7	1.9	3.1	4.0	0.9
City of Racine Water and Wastewater Utility	25.0	39.0	29.2	44.2	60.0	15.8
City of South Milwaukee Water Utility	2.7	3.6	2.6	4.3	8.0	3.7
North Shore Water Commission	4.2	8.0	4.9	9.6	18.0	8.4

[a]*Based upon reports from the Public Service Commission of Wisconsin.*

[b]*Forecast pumpage data developed in Chapter IV.*

[c]*Based upon data from the Wisconsin Department of Natural Resources files. The capacity data given are based upon the capacity of the critical plant component. Other plant components may have higher capacities. Thus, some components may provide a higher reserve capacity than that based upon the capacity of the critical element used to construct the table.*

[d]*Difference between capacity and highest maximum day in 2000 or 2035.*

[e]*The City of Kenosha Water Utility water treatment plant two primary intakes have a capacity of 50 mgd and 85 mgd.*

[f]*The City of Oak Creek water treatment plant is designed to be expanded in increments up to 48 mgd. During 2009, the City of Oak Creek Sewer and Water Utility initiated construction on a water treatment plant expansion designed to bring the plant capacity up to 28.0 mgd. The Utility is also planning for the preparation of a rerating analysis of the water treatment plant which could result in rerated plant capacity of 35.0 mgd upon completion of the 2009 plant expansion. The potential rerated plant capacity exceeds the forecast 2035 demand by about 6.0 mgd.*

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

- Standard—The sum of water supply system operating and capital investment costs should be minimized. Costs for waste disposal byproducts of water treatment, long-term energy and operation and maintenance, and legal costs should be considered.

- Standard—Maximum feasible use should be made of all existing and committed water supply facilities, which should be supplemented with additional facilities only as necessary to serve the anticipated water supply needs.

Basis for Issue Resolution

Based upon the evaluation of the alternative regional water supply plans considered, a preliminary recommended plan was initially identified. Selection of the plan components included consideration of the abovenoted objectives and standards. The plan was then refined on the basis of a public review process soliciting comments from elected and appointed officials and the public. The plan includes recommendations for further second-level water supply utility system planning evaluations for cooperative facility development, systems integration, and consolidation of activities for selected utilities. The range of activities contemplated included interconnections among adjacent utilities; cooperative development of utility infrastructure, such as supply, treatment, and distribution infrastructure; and integration and consolidation of existing systems. The specific utilities identified as potential candidates for this type of second-level planning were so identified based upon consideration of excess water treatment capacity, distance between utilities, and age of the water supply facilities. The scope and extent of the activities implemented is most appropriately determined by the utilities and affected communities. In order to determine the fiscal impacts to the communities involved, a second-level fiscal analysis will have to be conducted as part of the plan implementation process. Thus, the regional water supply plan recommendations will be limited to identifying those utilities where system integration or consolidation appears to be potentially viable, and attendant plan recommendation suggest the conduct of second-level fiscal analyses by the utilities involved. The second-level analyses would be expected to include consideration of transmission and storage facility needs, as appropriate.

In addition to cost-effectiveness and fiscal impacts, this issue also requires consideration of the ownership and political availability of any underutilized water supply facility capacity. For purposes of the regional water supply planning effort, it was deemed appropriate to identify situations where potentially cost-effective consolidation may exist and in those situations to recommend further, more-detailed local fiscal analyses be conducted by the utilities involved. Given that the ownership and political availability of facility capacity may depend upon the fiscal analyses, and given that the political climate can change over the planning period, no specific recommendations were to be included in the plan to address this issue. Rather, resolution is intended to be left to the local units of government as an implementation issue.

The Relationship of Recharge and Use Attributable to Areas Beyond the Region

Issue Description

Information provided by a definitive inventory of the groundwater resources of the Region together with aquifer performance simulation modeling conducted under the regional water supply planning program indicated that areas beyond the Southeastern Wisconsin Region have an impact on the groundwater system within the Region in two ways. The first is through the heavy withdrawals of groundwater from the deep sandstone aquifer by pumping centers in adjacent counties located primarily to the west and south of the Region, which withdrawals contribute to the drawdown of that aquifer within the Region. The second impact is due to the fact that the deep sandstone aquifer underlying the Southeastern Wisconsin Region is recharged, in part, by water originating outside of the Region, as shown in Figure 33. Based upon groundwater modeling analyses,[13] about 18 percent of the water withdrawn from deep aquifer wells within the Region originates outside of the Region in areas located to the north and west. Most of this deep lateral flow occurs below and across the western boundaries of Washington, Waukesha, and Walworth Counties. Furthermore, analyses conducted using the regional groundwater model indicate that the regional groundwater divide in the deep sandstone aquifer has moved westward over time so as to currently be almost entirely outside of the Region. This is due largely to the effects of pumping within the Region. Even though some of the recharge of the deep sandstone aquifer occurs from outside the Region, the majority of the recharge occurs from within the Region, as shown in Figure 34. Conversely, the amount of water contributed to shallow aquifer wells from cross-boundary flow into the Region is negligible, because the direction of the shallow flow is controlled primarily by natural discharge location than pumping. Pumping has had very little effect on the direction of flow in the shallow aquifer.

Given these relationships, it may be concluded that under planned conditions, groundwater withdrawal from pumping centers outside the Region may continue to have potentially adverse impacts on the deep sandstone groundwater aquifer system underlying the Region. It may be further concluded that recharge of this aquifer from areas outside of the Region will continue to be a modest factor in the level of sustainability of the deep aquifer. It may also be concluded that groundwater withdrawal and recharge from outside the Region will not be significant factors in the shallow aquifer sustainability inside the Region.

Related Plan Objectives and Standards

There are two plan objectives and three standards which are directly related to the issue of the relationship of recharge and use attributable to areas beyond the Region:

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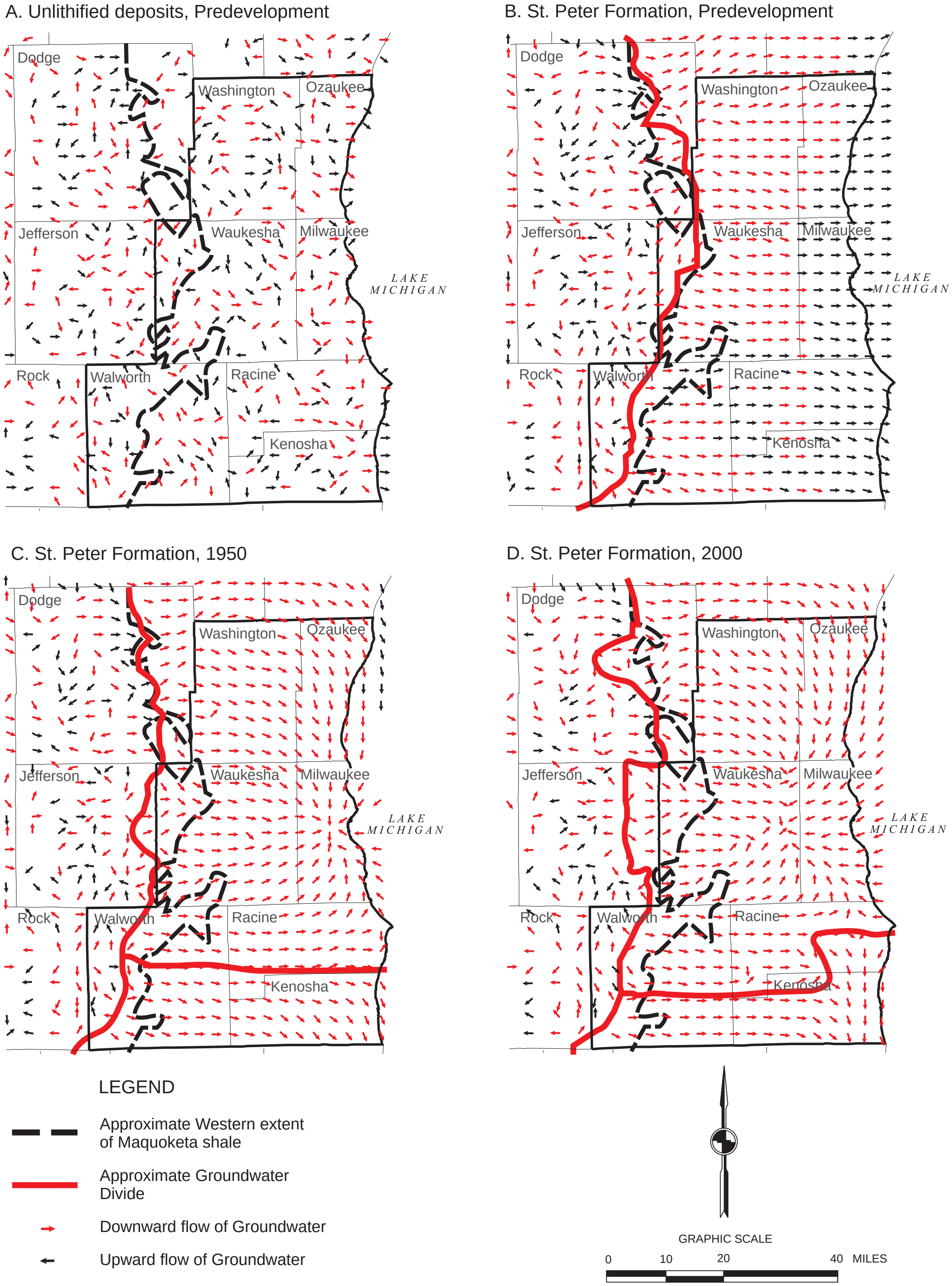
[13]*SEWRPC Technical Report No. 41,* A Regional Aquifer Simulation Model for Southeastern Wisconsin, Report 2: Model Results and Interpretation, *June 1, 2005.*

Figure 33

FLOW DIRECTIONS AND GROUNDWATER DIVIDES IN AND ADJACENT TO THE SOUTHEASTERN WISCONSIN REGION

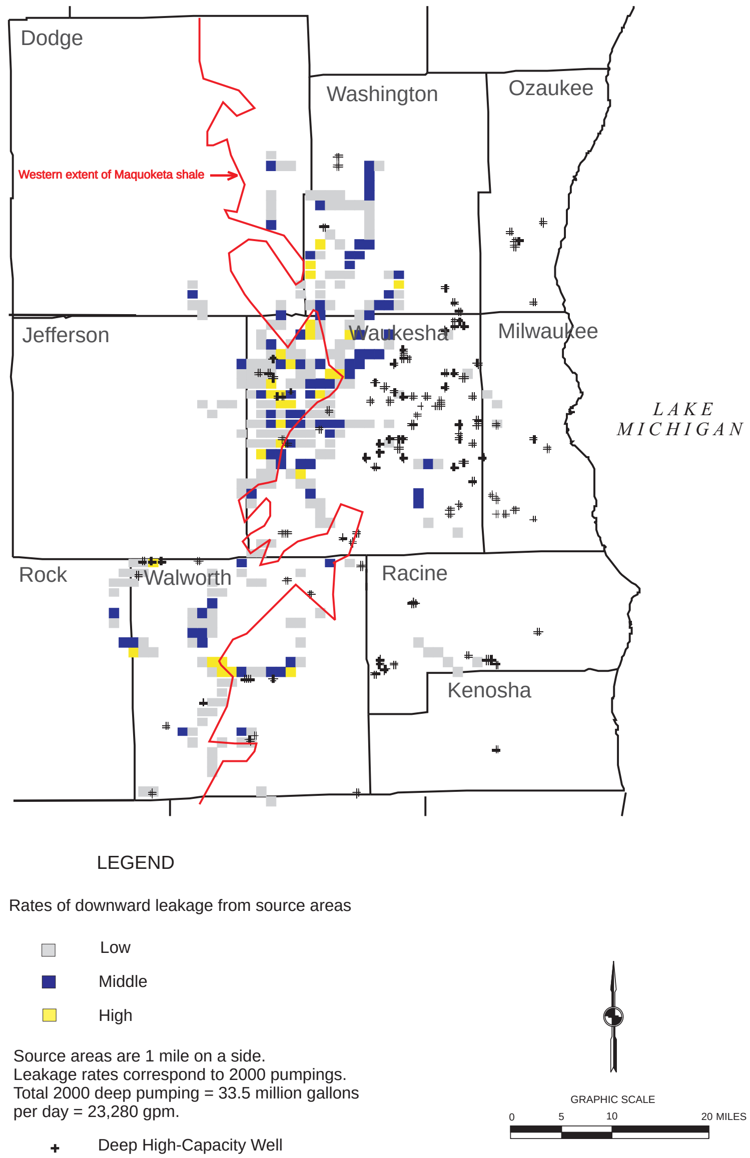


NOTE: Red arrows indicate downward flow. Blue arrows indicate upward flow.

Source: U.S. Geological Survey, Wisconsin Geological and Natural History Survey, University of Wisconsin-Extension, and SEWRPC.

Figure 34

SIMULATED CONTRIBUTING AREAS FOR DEEP WELLS IN THE SOUTHEASTERN WISCONSIN REGION: 2000 CONDITIONS



Source: U.S. Geological Survey, Wisconsin Geological and Natural History Survey, and University of Wisconsin-Extension.

- Objective—A regional water supply system which, through its capacity and efficiency, will effectively serve the existing regional land use pattern, promote the implementation of the regional land use plan, and identify any constraints to development in subareas of the Region which may require refinement of the regional land use plan.

- Standard—Areas of high potential for groundwater contamination should be excluded for the siting of potentially contaminating land uses or facilities.

- Standard—Important groundwater recharge and discharge areas should be identified for preservation or application of land development plans and practices which maintain the natural surface and groundwater hydrology, while protecting the groundwater quality.

- Objective—A regional water supply system which conserves and wisely utilizes the surface water and groundwater supplies of the Region, so as to sustain those supplies for future, as well as existing needs.

- Standard—The use of the deep sandstone aquifer should be managed so that the potentiometric surface in that aquifer is sustained or raised under use and recharge conditions within the Southeastern Wisconsin Region. Declines in the potentiometric surface of the aquifer within the Region due to uses in areas beyond the Region should be identified for the purpose of promoting interregional planning and action.

Basis for Issue Resolution

Because of the known relationships of areas within, and beyond, the Region to groundwater recharge and use within the Region, the regional aquifer simulation model was developed with a model domain consisting of a *nearfield* portion coincident with the Region and parts of three adjoining counties—Dodge, Jefferson, and Rock—and a *farfield* portion extending well into the State of Michigan to the east, into Illinois to the south, into the middle of Wisconsin to the west, and as far as Green Bay to the north. These areas are shown in Figure 35. The nearfield is the primary focus of the model analyses and is the area of greatest detail in the model. The nearfield extends beyond the seven-county area into Dodge, Jefferson, and Rock Counties in order to include the full extent of recharge areas for wells pumping within the Region. The hydrogeologic conditions assigned to the nearfield and farfield areas ensure that the correct amount of water enters or exits the study area at different depths at different times in response to stresses such as pumping. The database for the characteristics of hydrostratigraphic units in the nearfield area was extended to the farfield based on multi-state studies for Michigan, Illinois, and Wisconsin. Recharge and surface-water-groundwater interactions are not explicitly modeled in the farfield, except in areas immediately adjacent to the nearfield. This allows the delineation of boundary conditions for the nearfield area analyses.

Given the groundwater aquifer model domain, the relationships of recharge and use attributable to areas beyond the Region on the groundwater system within the Region can be quantified. For purposes of the alternative and recommended regional water supply plans, assumptions have to be made regarding potential future water withdrawal and recharge in areas beyond the Southeastern Wisconsin Region. If the analyses indicate that there are significant potential groundwater sustainability issues associated with changes in those assumptions, further analyses may be needed. Based upon the analyses conducted to develop the alternative and recommended water supply plans for the Southeastern Wisconsin Region, it was not found necessary to incorporate specific recommendations into the plan relating to areas beyond the Region. Such recommendations might have been related to the delineation and potential protection of important groundwater recharge areas, as recommended for areas within the Southeastern Wisconsin Region. However, the recommended plan includes a program for the continued monitoring of the water use and recharge conditions in areas adjacent to the Region.

Land Use Development Impacts on Groundwater Recharge

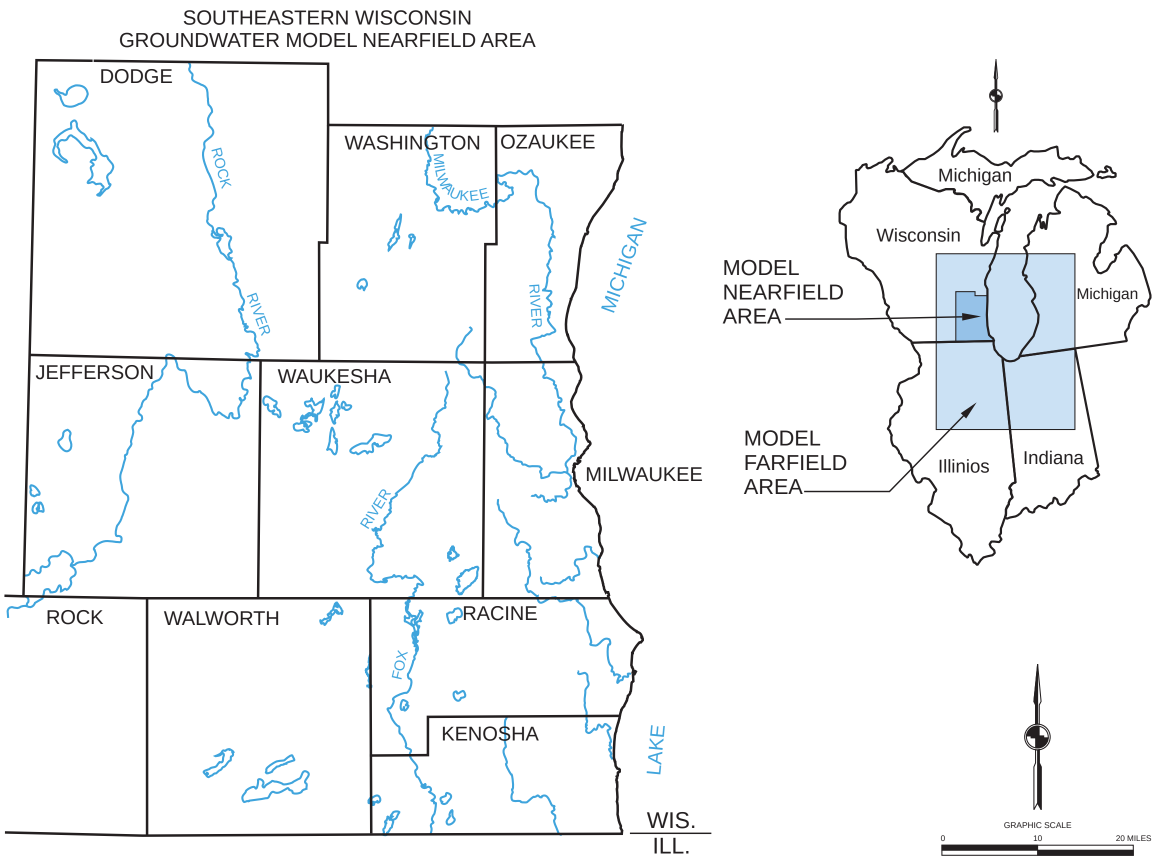
Issue Description

Recharge represents the means by which water enters into the groundwater system. Preservation of recharge will help to continue to make groundwater available for human use and for the sustenance of natural systems, such as rivers, lakes, and wetlands. Some areas of the Southeastern Wisconsin Region exhibit higher rates and volumes of recharge than others, and land use development decisions can affect the amount of recharge entering the groundwater system.

Groundwater recharge can be affected by a number of factors, including the amount and frequency of precipitation; depths and composition of soil and unconsolidated material; topography; bedrock composition; and the amount of pervious surface on the land. Land use development and associated stormwater management and wastewater disposal practices typically have significant impacts on groundwater and surface water hydrology. Such impacts may include increases in runoff and reductions in infiltration due to the development of impervious surfaces. While the magnitude of the reduction in groundwater recharge will vary based on local conditions, higher amounts of impervious surface on the land will tend to produce reductions in infiltration, and, thereby, in groundwater recharge.

Figure 35

AREA OF SOUTHEASTERN WISCONSIN SIMULATED IN GROUNDWATER MODEL



Source: U.S. Geological Survey, University of Wisconsin-Extension, Wisconsin Geological and Natural History Survey, and SEWRPC.

As agricultural lands are converted to urban land uses, the amount of impervious land surface typically increases. Table 85 shows that between 1963 and 2000, the percentage of impervious land surface within the Region increased from about 5.5 percent to about 8.2 percent. As a result of planned land use changes,[14] it is projected that the percentage of impervious land surface within the Region will increase to about 9.3 percent by 2035. In the absence of mitigation, this increase will be accompanied by a reduction in infiltration and groundwater recharge and an increase in runoff to surface waters.

Because, as already noted, some areas in the Region exhibit higher recharge rates and volumes, the impacts of new development are likely to depend upon the location, as well as the type and density of new development. Development with high amounts of impervious land surface in areas with high rates and volumes of recharge are likely to result in reductions in recharge, and attendant adverse effects on water levels in the aquifers. Lower-density urban development may also have an impact on groundwater recharge, either positively or negatively, depending upon the length of roadways involved, the type of roadway cross-sections, land disturbing activities and related compaction, and the type of stormwater management entailed. Reduction in the amount of recharge

[14]*SEWRPC Planning Report No. 48,* op. cit.

Table 85

PERCENT OF IMPERVIOUS SURFACE WITHIN SOUTHEASTERN WISCONSIN BY LAND USE CATEGORY: 1963, 1980, 2000, AND FORECAST 2035

Land Use Category	Percent of Land Use Category Typically Impervious	1963			1980			2000			2035		
		Total Square Miles	Square Miles Impervious	Percent of Land Impervious	Total Square Miles	Square Miles Impervious	Percent of Land Impervious	Total Square Miles	Square Miles Impervious	Percent of Land Impervious	Total Square Miles	Square Miles Impervious	Percent of Land Impervious
Urban													
Residential	18.0	180.0	32.4	18.0	269.1	48.4	18.0	- -	- -	- -	- -	- -	- -
High-Density	35.0	- -	- -	- -	- -	- -	- -	46.0	16.1	35.0	49.8	17.4	35.0
Medium-Density	25.0	- -	- -	- -	- -	- -	- -	109.0	27.3	25.0	161.8	40.5	25.0
Low-Density	10.0	- -	- -	- -	- -	- -	- -	178.0	17.8	10.0	190.0	19.0	10.0
Commercial	35.0	11.5	4.0	35.0	19.3	6.8	35.0	30.3	10.6	35.0	43.1	15.1	35.0
Industrial	40.0	13.5	5.4	40.0	22.0	8.8	40.0	32.9	13.2	40.0	38.2	15.3	40.0
Transportation, Communication, and Utilities	45.0	134.9	60.7	45.0	166.1	74.7	45.0	200.9	90.4	45.0	220.4	99.2	45.0
Governmental and Institutional	35.0	21.8	7.6	35.0	30.0	10.5	35.0	33.7	11.8	35.0	35.9	12.6	35.0
Recreational	5.0	26.0	1.3	5.0	39.3	2.0	5.0	50.4	2.5	5.0	58.1	2.9	5.0
Unused Urban	5.0	54.5	2.7	5.0	45.0	2.2	5.0	50.9	2.5	5.0	27.5	1.4	5.0
Subtotal	- -	442.4	114.1	25.8	590.8	153.4	26.0	732.1	192.2	26.3	824.8	223.4	27.1
Nonurban													
Sub-Urban Density Residential	10.0	- -	- -	- -	- -	- -	- -	29.1	2.9	10.0	38.1	3.8	10.0
Rural Density Residential	2.0	- -	- -	- -	- -	- -	- -	- -	- -	- -	5.9	0.1	2.0
Agricultural	2.0	1,637.1	32.7	2.0	1,475.4	29.5	2.0	1,259.4	25.2	2.0	1,155.5	23.1	2.0
Other Open Land	0.0	609.7	0.0	0.0	623.0	0.0	0.0	669.3	0.0	0.0	665.6	0.0	0.0
Subtotal	- -	2,246.8	32.7	1.5	2,098.4	29.5	1.4	1,957.8	28.1	1.4	1,865.1	27.0	1.4
Total	- -	2,689.2	146.8	5.5	2,689.2	182.9	6.8	2,689.9	220.3	8.2	2,689.9	250.4	9.3

NOTE: The values for the total area of the Region differ as given for the years 1963 and 1980 and the years 2000 and 2035. The difference of 0.7 square mile is due to such factors as the availability after 1980 of more accurate cadastral mapping which served to increase the precision of the Commission land use inventory.

Source: SEWRPC.

has the potential to intensify future water supply problems. This may be especially problematic for confined aquifers, such as the deep sandstone aquifer, due to the facts that recharge of these aquifers is restricted to rather specific and limited geographic areas, and that there are no natural compensatory mechanisms to a reduction in recharge. Reductions in recharge of the shallow aquifer may be offset, in part, by interaction with local surface water features, though a consequence of this may be to reduce the amount of groundwater discharge to these features.

It is important to note that some mitigation of the effects of impervious surface upon groundwater recharge can be provided by the stormwater infiltration requirements included in Chapter NR 151 of the *Wisconsin Administrative Code*. For nonagricultural areas and transportation facilities, Chapter NR 151 establishes performance standards for post-construction infiltration of stormwater.

Related Plan Objectives and Standards

There are two plan objectives and six standards which are directly related to the issue of the affects of land use development on groundwater recharge:

- Objective—A regional water supply system which, through its capacity and efficiency, will effectively serve the existing regional land use pattern, promote the implementation of the regional land use plan, and identify any constraints to development in subareas of the Region which may require refinement of the regional land use plan.

- Standard—Important groundwater recharge and discharge areas should be identified for preservation or application of land development plans and practices which maintain the natural surface and groundwater hydrology, while protecting the groundwater quality.

- Objective—A regional water supply system which conserves and wisely utilizes the surface water and groundwater supplies of the Region, so as to sustain those supplies for future, as well as existing needs.

- Standard—The use of the deep sandstone aquifer should be managed so that the potentiometric surface in that aquifer is sustained as determined by the use and recharge within the Southeastern Wisconsin Region. Declines in the potentiometric surface of the aquifer within the Region due to uses in the areas beyond the Region should be identified for the purposes of considering interregional planning and action.

- Standard—The uses of the shallow aquifer should be managed so that the aquifer yields are sustained.

- Standard—The uses of the deep and shallow aquifers should be managed so as to minimize the ecological impacts on the surface water system of the Region.

- Standard—The use of groundwater and surface water for water supply purposes should be carried out in a manner which minimizes adverse impacts to the water resources system, including lakes, streams, springs, and wetlands.

- Standard—The type and extent of stormwater management and related land management practices should be determined though preparation of local stormwater management plans and land development practices and policies specifically considering the impact of those activities on groundwater recharge and should promote such practices which maintain or enhance the natural groundwater hydrology to the extent practicable, while protecting surface water and groundwater quality and quantity.

Basis for Issue Resolution

As previously noted, a recommended plan is to be selected based upon a comparative evaluation of the ability of the alternative plans considered to meet the agreed-upon objectives and standards, including those related to the impact of land use development on groundwater recharge. That evaluation is to be carried out by application of the regional groundwater system simulation model with inputs designed to simulate the performance of the alternative plans in order to estimate future condition groundwater levels under each plan. As also previously noted, the regional groundwater model has a surface water linkage component module which can be utilized to estimate the impact of each alternative plan on the groundwater contribution to the base stream flows, lake levels, and wetlands at selected locations. The model application and analyses provide a means to assess the potential impacts of the alternative plans on recharge to the deep and shallow aquifers.

In addition to the groundwater and surface water modeling analyses, as already noted, three special studies were conducted as part of the regional water supply planning program to assist in the development and evaluation of alternative plans and design of the recommended plan. The findings of these studies are described in the foregoing section dealing with groundwater quantity and sustainability. The third special study[15] describes a mathematical model which was used to identify groundwater recharge amounts throughout the Southeastern Wisconsin Region. The model was used to develop maps illustrating the recharge potential for various areas of the Region. The findings of these studies have been considered in the design of the alternative and recommended water supply plans.

Groundwater-Surface Water Interdependence and Impacts

Issue Description

The issue of groundwater-surface water interdependence is directly related to the problem of groundwater quantity described above. Analyses conducted using the regional aquifer simulation model indicated that about 63 percent of the water extracted by wells from the shallow aquifer was derived from groundwater that, in the absence of pumping, would have been discharged to surface waters. Also, as shown in Table 86, over 25 percent of the water so extracted was derived directly from surface waters due to reversed hydraulic gradients at the groundwater-surface water interface. Thus, a total of about 88 percent of the water extracted from the shallow aquifer was diverted or extracted from surface waters. And, as shown in Table 87, over 71 percent of the groundwater extracted from the deep sandstone aquifer is water which would have been discharged to the surface water, or was induced flows from surface waters. The reductions in groundwater contributions to the surface water system are relatively modest on an areawide basis. For example, the USGS estimated that in the four-county area, including Kenosha, Milwaukee, Ozaukee, and Racine Counties, the reduction in groundwater contribution to the surface water system due to groundwater withdrawals was about 8.5 percent between 1864 and the year 2000. However, the impacts on a small area basis and/or involving high-quality streams, lakes, and wetlands can be significant.

As described in Chapter IV, an approximately 76 percent increase over the period from the year 2000 to 2035 may be expected in the use of water for water supply purposes by utilities currently using groundwater as a source of supply. The increased use of the groundwater for water supply has the potential to have a significant environmental impact by reducing the inflow of groundwater to the surface water system. This is an issue which must be considered in the regional water supply planning effort.

Related Plan Objectives and Standards

One plan objective and three standards are directly related to the problem associated with groundwater quantity and sustainability:

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[15]*SEWRPC Technical Report No. 47*, Groundwater Recharge in Southeastern Wisconsin Estimated By a GIS-Based Water-Balance Model*, July 2008.*

Table 86

SOURCES OF WATER TO SHALLOW AQUIFER WELLS IN THE SOUTHEASTERN WISCONSIN REGION: 2000

Source	Flux (mgd)	Percent Source
Shallow Aquifer Pumping	32.50	- -
Groundwater Flow Diverted from Surface Water		
Diverted Baseflow Which Was to Streams, Lakes, Wetlands	18.84	58.0
Diverted Shallow Discharge Which Was to Lake Michigan	1.51	4.6
Subtotal	20.35	62.6
Groundwater Flow Induced from Surface Water		
Induced Flow from Streams, Lakes, Wetlands	7.99	24.6
Induced Flow from Lake Michigan	0.30	0.9
Subtotal	8.29	25.5
Groundwater Storage Release (below seven-county Region)	3.73	11.5
Cross-Boundary Groundwater Flow Diverted		
Lateral Flow Across Seven-County Inland Boundaries	0.13	0.4
Total Sources	32.50	100.0

Source: U.S. Geological Survey and Wisconsin Geological and Natural History Survey.

Table 87

SOURCES OF WATER TO DEEP AQUIFER WELLS IN THE SOUTHEASTERN WISCONSIN REGION: 2000

Source	Flux (mgd)	Percent Source
Deep Aquifer Pumping	33.33	- -
Groundwater Flow Diverted from Surface Water		
Leakage Downward from Shallow Aquifer	19.69	59.1
Deep Discharge Toward Lake Michigan	2.84	8.5
Subtotal	22.53	67.6
Groundwater Flow Induced Downward from Shallow Aquifer Below Lake Michigan	1.30	3.9
Deep Groundwater Storage Release		
Release Below Lake Michigan	2.63	7.9
Release Below Region	1.00	3.0
Subtotal	3.63	10.9
Cross-Boundary Deep Groundwater Flow		
Diverted Lateral Flow Across Region Inland Boundaries	2.39	7.2
Induced Lateral Flow Across Region Inland Boundaries	3.48	10.4
Subtotal	5.87	17.6
Total Sources	33.33	100.0

Source: U.S. Geological Survey and Wisconsin Geological and Natural History Survey.

- Objective—A regional water supply system which conserves and wisely utilizes the surface water and groundwater supplies of the Region, so as to sustain those supplies for future, as well as existing needs.

- Standard—The uses of the deep and shallow aquifers should be managed so as to minimize the ecological impacts on the surface water system of the Region.

- Standard—The use of groundwater and surface water for water supply purposes should be carried out in a manner which minimizes adverse impacts to the water resources system, including lakes, streams, springs, and wetlands.

Basis for Problem Resolution

As previously noted, the recommended plan is to be selected based upon a comparative evaluation of the ability of the alternative plans to meet the agreed-upon objectives and standards, including those related to the impact on the surface water system inputs and base flows. That evaluation will be carried out with the assistance of the regional groundwater system simulation model using inputs designed to simulate the performance of the alternative plans in order to estimate future condition groundwater levels under each plan. As also previously noted, the regional groundwater model has a surface water linkage component module which can be utilized to estimate the impact of each alternative plan on the groundwater contribution to base stream flows, lake levels, and wetlands at selected sites.

In addition to the groundwater and surface water modeling analyses the findings of the special hydrogeologic studies previously described were useful in comparing alternative plans with regard to their impact on the surface water system. The baseflow reduction index, developed as a means of assessing water supply plans, and defined as the ratio of the change in groundwater discharge between a base time period and the time of interest divided by the base period discharge, was particularly useful in this respect.

Using the findings of the simulation modeling and special analyses, a recommended regional water supply plan was identified based upon a comparative evaluation of the alternative plans with regard to their effectiveness in meeting the planning objectives and standards, including those specifically related to the impacts on the surface water system.

Relationship of Water Supply Systems to Other Comprehensive Plan Elements

Issue Description

Good planning practice requires that a water supply plan be prepared within the framework of a comprehensive plan, thereby relating water supply planning to land use, transportation, sanitary sewerage, park and open space, and natural resource protection planning. The availability of safe, adequate, and sustainable public water supply is an absolute requirement for sound rural and urban development. Along with the availability of sanitary sewerage, and the level of accessibility as determined by the transportation system, the availability of public water supply influences the type, intensity, location, and extent of land use development in an area. Water supply facilities should form coordinated subsystems within the urban and urbanizing areas of a developing region, and should be designed to promote good land use development in accordance with adopted regional, county, and local municipal comprehensive plans. Such comprehensive plans are, in turn, required as a basis for the design of the location, configuration, and capacity of the public water supply facilities.

The natural resource conservation protection element of adopted regional, county, and local comprehensive plans should be a particularly important consideration in water supply system planning. The groundwater resources of an area constitute an integral part of the natural resource base. The groundwater reservoir sustains lake levels, provides the base flow of streams, and contributes to the health of wetlands. Great care must be taken, particularly, to assure that the location of major wells and well fields will not contribute to the decline of lake levels, decline of base flows in streams, and to the deterioration and destruction of wetlands, particularly relatively rare wetlands, such as fens, and the decline of the associated flora and fauna.

Related Plan Objectives and Standards

There are two plan objectives and two standards which are directly related to the issue of the relationship of water supply systems to land use, transportation, sanitary sewerage, and natural resource protection planning:

- Objective—A regional water supply system which, through its capacity and efficiency, will effectively serve the existing regional land use pattern, promote the implementation of the regional land use plan, and identify any constraints to development in subareas of the Region which may require refinement of the regional land use plan.

- Standard—Public water supply systems should be designed to serve lands planned to be developed for urban uses, in accordance with the adopted regional land use plan.

- Objective—A regional water supply system which conserves and wisely utilizes the surface water and groundwater supplies of the Region, so as to sustain those supplies for future, as well as existing needs.

- Standard—The use of groundwater and surface water for water supply purposes should be carried out in a manner which minimizes adverse impacts to the water resources system, including lakes, streams, springs, and wetlands.

Basis for Problem Resolution

As previously noted, each of the design year 2035 alternative plans are to be designed to have adequate sources of water supply capacity to meet the forecast water demand conditions. Those conditions were developed to meet the forecast socioeconomic and land use conditions associated with the adopted 2035 regional land use plan. Since the regional land use plan was also the basis for the development of the regional transportation, sanitary sewerage, and natural resource conservation plans, coordination and consistency may be expected to be achieved with the regional water supply plan. An important consideration in this regard is the coordination of sanitary sewerage system plans with water supply plans, given the need to return any water taken from the Great Lakes-St. Lawrence River basin. Such consideration has been a basic principle followed by the Commission in the design of the watershed plans and of the regional water quality management plan. These plans have included provision for a return flow component in all instances where Lake Michigan water supplies have been envisioned to be used in areas lying west of the subcontinental divide. In addition, the inclusion of plan objectives and standards relating to minimizing the negative impacts on groundwater and surface water systems is intended to provide consistency with water resources planning.

During the regional water supply planning effort, attention was given, and will need to continue to be given, in the subsequent plan implementation efforts, to coordinate the water supply planning with county and municipal comprehensive plans. It will be particularly important to incorporate the findings and recommendations of the regional water supply planning effort into the State-mandated—“smart growth”—comprehensive planning efforts being conducted within the Region at the County and municipal levels.

Water Conservation Effectiveness and Costs

Issue Description

Water conservation has become an issue of increasing concern within the United States, especially in areas of increasing water scarcity. Increased efficiency in water use and reductions in demand have the potential to protect the natural resource base, reduce the cost to individual water suppliers and users, and positively affect the reliability and sustainability of water supplies. Water conservation was highlighted in the prospectus for the regional water supply planning program as an important component of the proposed regional water supply plan. In considering the level of water conservation which can be effectively and practically achieved, it is important to note that there are two views that can be taken of water conservation. One view focuses on achieving efficiency in utility operations by minimizing the amount of water that must be produced and conveyed to meet user demand, primarily through the reduction of unaccounted-for water. The attendant practices include metering and system performance monitoring, leak detection and repair, and system operational refinements. Water supply efficiency programs and measures are well established but are system-specific in application. Water efficiency programs are a very effective and direct water conservation measure. The other view of water conservation is focused on reducing the demand for water. The attendant practices, include water rate modifications to discourage use, use of water-saving plumbing features, water recycling, and educational activities.

The types and levels of water conservation programs to be developed and implemented within the Region will be utility- or community-specific based upon a number of factors, including the composition of the community water users, the operational characteristics of the utility, the level of efficiency already being achieved, the water supply infrastructure in place, that needed to meet future demands, and the sustainability of the water supply. Another factor which must be considered is the need to develop water conservation programs which are consistent with current and anticipated future public policies and legal requirements. The water conservation programs developed by the water utilities will have to be specifically designed to meet the requirements of the ongoing WDNR rulemaking process. This rulemaking process is being carried out to meet the requirements of the Great Lakes-St. Lawrence River Basin Water Resources Compact and Wisconsin Act 227, related groundwater protection legislation, and the September 2006 Report to the Governor on Water Conservation. The Wisconsin Act 227 requires that the WDNR establish statewide water conservation and efficiency goals and objectives, and to establish rules specifying the requirements for water conservation and efficiency for applicants for new or increased diversions. The WDNR is to initiate the water conservation rulemaking process during the second half of 2009, with completion expected in late 2010. Any water conservation program developed should be flexible and adaptable to the requirements of such policies and regulations. In addition, the design and implementation of conservation plans will vary due to the large combinations of measures that each utility or community may choose to utilize. Similar considerations apply to self-supplied water users.

One of the issues that relates to water conservation is the level of effectiveness that water conservation programs may be expected, as a practical matter, to achieve. Another issue relates to the cost-effectiveness of such programs. Yet another such issue is related to the sustainability of the source of supply. A need to protect such sustainability may outweigh cost-effectiveness considerations. These issues are important and need to be considered under the regional water supply planning program.

Related Plan Objectives and Standards

One plan objective and four standards are directly related to the problem associated with the issue of water conservation effectiveness and costs:

- Objective—A regional water supply system which conserves and wisely utilizes the surface water and groundwater supplies of the Region, so as to sustain those supplies for future, as well as existing needs.

- Standard—Residential per capita water usages should be reduced to the extent practicable based upon the conclusions developed in SEWRPC Technical Report No. 43, *State-of-the-Art of Water Supply Practices*, and recognizing that differences in levels of conservation may be appropriate, depending upon the source of supply and related natural resources.

- Standard—Both indoor and outdoor water uses should be optimized through conservation practices which do not adversely affect the public health.

- Standard—Water uses for commercial, industrial, and institutional land uses should be reduced to the extent practicable through water conservation measures, duly considering the source of supply and related natural resources, as well as the economic viability and economic development needs of the Region.

- Standard—Unaccounted-for water in utility systems should be minimized.

Basis for Problem Resolution

In order to address the issues related to water conservation, detailed descriptions and estimates of costs and efficiencies of a wide range of water conservation measures have been developed under the regional water supply planning program. In addition, a review was made of an example water conservation program in an area similar to the Region, and the costs and effectiveness of three levels of water conservation programs were developed for various size example communities typical to the Southeastern Wisconsin Region. This information is presented in a report documenting the state-of-the-art of water supply practices prepared under the planning program.[16] Based upon the information presented in the state-of-the-art of water supply practices report, an estimated reduction in water demand was incorporated into the demand forecasts prepared for all of the alternative water supply utilities on a utility-specific basis. The utility specificity was based upon consideration of the utility source of supply and existing infrastructure capacity.

It should be noted that the expected reductions in water use incorporated into the alternative plans were intended to be the result of implementing additional water conservation measures over and above those currently in place. All of the water utilities operating within the Region currently practice water conservation, primarily in the form of water supply efficiency programs. Such programs may include meter testing for accuracy, leak detection and repair, and repair or replacement of water mains with identified problems.

The initial water conservation levels selected for use in the alternative plans were intended to be related to comprehensive water conservation programs, including both a supply side system efficiency element and demand side water conservation measures. The selected levels were also intended to represent an increase in water conservation effectiveness over and above the current levels which are the result of a number of water efficiency and water conservation measures already in place at most municipal utilities in the Region. Thus, the selected levels are not as high as would be the case in an area where no water conservation measures are in place. These initially assumed water conservation levels were reviewed and revised following the initial evaluation of the alternative plans if cost, environmental impact, or other factors relating to the achievement of plan objectives so dictated. Such revisions in water conservation levels was then incorporated into the recommended regional water supply plan. This approach to developing water conservation measure recommendations is considered to be an appropriate way to address the issues of effectiveness and cost associated with water conservation measures.

Surface Water Quality

Issue Description

Information on existing water quality in the nearshore Lake Michigan areas is summarized in Chapter III of this report and more detailed information is provided in SEWRPC Technical Report No. 39, *Water Quality Conditions and Sources of Pollution in the Greater Milwaukee Watersheds*, November 2007. The information provided indicates that Lake Michigan provides a high-quality source of supply for public water supply systems. The water taken from offshore deep water intakes is amenable to treatment by conventional methods. Finished water utilizing these methods typically meets, and generally exceeds, Federal and State drinking water quality requirements. Examples of raw water and finished water quality characteristics reported by selected water treatment plants in the Region are summarized in Appendix C of this report.

Several potential issues exist, however, with regard to surface water quality. These issues are related to a number of sources or effects of water pollution, including nonpoint source pollution, sanitary sewer overflows, the levels of pharmaceutical and personal care products found in wastewater, zebra and quagga mussel infestation, and nuisance algae growths, that have a variety of existing and potential impacts upon surface water quality.

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[16]*SEWRPC Technical Report No. 43,* State-of-the-Art of Water Supply Practices, *July 2007.*

Nonpoint Source Pollution
Nonpoint source pollution, also referred to as diffuse source pollution, consists of various discharges of pollutants to the surface waters which cannot be readily identified as point sources. Nonpoint source pollution is transported from the rural and urban land areas of a watershed to the surface waters by means of direct runoff from the land via overland routes, storm sewers, and channels; and by interflow during and shortly after rainfall or rainfall-snowmelt events. Nonpoint source pollution also includes pollutants conveyed to the surface waters via groundwater discharge which is a major source of stream flow between runoff events.

Nonpoint source pollution can cause toxic, organic, nutrient, pathogenic, sediment, radiological, and aesthetic pollution problems. In most of the surface waters of the Region, nonpoint sources are the major source of most pollutants. Accordingly, nonpoint source pollution is of increasing concern in water resources planning and engineering as efforts to abate point source pollution become increasingly successful. The control of nonpoint source pollution is a necessary step in the process of improving surface waters to render such waters suitable for their intended uses for recreation, fisheries, and water supply. While nonpoint source pollution has substantial impacts on the quality of inland lakes and streams within the Region, its effects on Lake Michigan have not been to date severe enough to limit the use of the Lake in the vicinity of southeastern Wisconsin for water supply and for recreational uses and fishery maintenance.

Sewer Overflows
Historically, sewer overflows have constituted a major surface water quality issue. Two types of sewer overflows occur within the Region that have the potential to contaminate surface waters: combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs).

Combined sewer overflows are overflows comprised of sanitary sewage and stormwater runoff. Approximately 25 square miles within the Region, located in the City of Milwaukee and the Village of Shorewood, are served by combined sewers. These sewers convey sanitary sewage along with stormwater runoff from adjacent lands. During dry weather, combined sewers function much like sanitary sewers, conveying sewage to intercepting sewers and a sewage treatment plant. During wet weather, inflow of stormwater can sometimes cause the capacity of the combined sewer system to be exceeded. This can result in excess flow being discharged into nearby surface waters. Effluent from CSOs generally contains a high proportion of stormwater. There are currently 117 combined sewer overflow outfalls in the Region. All of these 117 outfalls discharge either into Lake Michigan or into streams tributary to Lake Michigan.

Sanitary sewer overflows consist of raw sanitary sewage entering the surface water system of a watershed either directly from sanitary sewer overflows, or indirectly through flow-relief devices. This direct or indirect conveyance of sanitary sewage to the surface water system of a watershed occurs through various types of flow relief devices as a result of one or more of the following conditions: inadequate sanitary sewage conveyance capacity; excessive infiltration and inflow of clear water during wet weather conditions; and mechanical and/or power failures at sanitary sewage pumping facilities. In order to prevent damage to residential dwellings or to elements of the conveyance system as a result of the aforementioned system failures, a sanitary sewage flow relief device may be provided. Since the promulgation of the regional water quality management plan in 1979 and State and Federal clean water initiatives, it has been the policy within the Region to reduce reliance on such devices as general sewerage system upgrades are implemented.

The frequency of combined sewer overflows into Lake Michigan and into streams tributary to Lake Michigan in the Southeastern Wisconsin Region has decreased from about 50 overflows per year prior to 1994 to less than three per year since 1994 as a result of the completion of the Milwaukee Metropolitan Sewerage District's Water Pollution Abatement Program, including construction of the Inline Storage—or Deep Tunnel—System. Similar reductions have occurred in the frequency of sanitary sewer overflows. Water quality data indicate sewer overflows are no longer an important concern for water supply system source water in the Region.

Pharmaceuticals and Personal Care Products

Pharmaceuticals and personal care products (PPCPs) encompass thousands of substances that are ingested or externally applied, including prescription and over the counter drugs, fragrances, cosmetics, sunscreen agents, diagnostic agents, and nutritional supplements. Many of these compounds are specifically designed to be biologically active at low concentrations and their presence in drinking water may pose risks to human health and to the health of aquatic and other wildlife.

PPCPs are released into surface waters through a number of mechanisms. The most prevalent and well-documented route is through discharges of municipal and onsite wastewater treatment facilities. Other sources include both agricultural and urban runoff, as well as industrial discharges. While some of these compounds may be fully or partially removed by wastewater treatment facilities, removal efficiencies vary greatly by compound and among treatment plants. Municipal wastewater treatment plants are not specifically designed to remove these chemicals. In addition, in most instances where removal efficiencies have been examined, only the fate of the parent compound has been tracked. Metabolites and transformation products, which may exhibit biological activity, have not been included in these studies. The persistence of PPCPs in the environment varies. Some of these compounds are relatively resistant to breakdown. Others are degraded relatively rapidly in the environment. Despite this, the constant release of many of these substances to the environment may make them effectively persistent. For most, there is a paucity of data on their fate in the environment.

Most existing surface water treatment technologies incidentally remove some level of pharmaceuticals, personal care products, and endocrine disrupting chemicals. Coagulation and flocculation are not particularly effective on most of the substances concerned and, therefore, sedimentation and filtration are typically not very effective in their removal. The chemicals involved are typically synthetic organic compounds, and there are treatments for such compounds as set forth in Chapter IV of SEWRPC Technical Report No. 43, *State-of-the-Art Water Supply Practices*, which may be effective. Granular activated carbon can be effective in the removal of these chemicals, but release of the chemicals in large concentrations from the carbon appears to occur if regeneration of the carbon is not performed in a timely fashion. Oxidation appears to be effective in deactivating the chemicals involved, although little is, as yet, known about the effects of the compounds formed. Ozone appears to be the most effective oxidant for these contaminants. Chlorine and its derivatives are relatively ineffective, and ultraviolet irradiation has almost no effect. Oxidation appears to improve the removal of pharmaceuticals, personal care products, and endocrine disrupting chemicals by sand filtration. Reverse osmosis is effective at removing these chemicals directly, but its use is costly. Other membrane processes appear to be effective after oxidation of the chemicals concerned in the source water. The treatment technology selected will need to be specific for the compounds existing in the source water and multiple treatment technologies may be needed, depending upon the specific chemicals to be removed.

Few data exist on the presence of PPCPs in surface waters. In general, they have been detected in most places that have been examined for their presence. While few data are available for the nearshore areas of Lake Michigan, several of these compounds have been detected at low concentrations in water samples collected from the Milwaukee outer harbor, from streams tributary to Lake Michigan, and from offshore areas of the Lake. Although attention to the presence of these substances in the environment is relatively recent, the presence of PPCPs in surface water is probably not a new development. Their presence in the environment has become more widely evident in the last decade due, in part, to improvements in analytical methodologies which lower the limits of detection for many of these substances. It is likely that these compounds have been present in the environment for as long as they have been used commercially, although perhaps not in current quantities given historic changes in lifestyles and economic conditions.

With some exceptions, the risks posed to humans by PPCPs are essentially unknown. Few data are available on the presence of most PPCPs in drinking water or on the effects of exposure to humans and aquatic life.

Additional information on PPCPs in surface waters is presented in SEWRPC Technical Report No. 39, *Water Quality Conditions and Sources of Pollution in the Greater Milwaukee Watersheds*, November 2007.

Zebra Mussels and Quagga Mussels
The zebra mussel (*Dreissena polymorpha*) is an exotic mollusk that has invaded waters of the Great Lakes region, including Lake Michigan. Adult zebra mussels colonize solid substrates in waters with concentrations of dissolved calcium greater than 15 mg/l. These colonies can be very dense; beds of zebra mussels containing up to 100,000 mussels per square meter have been reported in Lake Erie.. Because they prefer to attach to hard substrate, zebra mussels can clog water intakes, increasing operating costs for drinking water treatment plants, electric power generation plants, and industrial installations. Left uncontrolled zebra mussel shells can block entire intake pipes over time. Zebra mussel control is typically done through velocity control or through periodic chemical treatment to remove the mussels. Utilizing a variety of pipe sizes and several intake pipes allows flexibility to maintain sufficient velocity to inhibit zebra mussel attachment. More recently, the quagga mussel (*Dreissena bugensis*) has been found in Lake Michigan and may become a problem similar to the zebra mussel. The quagga mussels are active year-round, while zebra mussels are dormant in the winter. Thus, year-round chemical controls may be needed for the quagga mussel. Intakes with limited control over velocity use biocides, often oxidizers, such as potassium permanganate, to eliminate the mussels. Chemical treatment is typically done intermittently as a preventative maintenance activity.

Nuisance Algae
Cyanobacteria, or blue-green algae, have become a concern in some surface waters. Some species of cyanobacteria produce toxins which can be released into water. Cyanobacteria can also create taste and odor problems in water. The conditions favorable to the growth of cyanobacteria are generally not associated with water supply system source water in the Region as drinking water supplies.

Related Plan Objectives
One plan objective and four standards are directly related to the issues associated with surface water quality:

- Objective—A regional water supply system which protects the public health, safety, and welfare.

- Standard—Water supply systems should be designed, constructed, and operated to deliver finished water to users which meets the drinking water standards established by the Wisconsin Department of Natural Resources to protect the public health, safety, and welfare.

- Standard—The selection of sources of supply and the design, contribution, and operation of related treatment facilities should be made cognizant of the potential presence of unregulated emerging pollutants, such as pharmaceuticals, personal care products, and certain viruses.

- Standard—Water supply sources and treatment processes should be selected to minimize potential problems with subsequent treatment and disposal of created waste streams.

- Standard—Groundwater and surface water sources of water supply should be protected from sources of contamination by appropriate siting, design, and land use regulation.

Basis for Problem Resolution
Each of the design year 2035 alternative regional water supply plans is to include components intended to address existing and anticipated surface water quality problems. As previously noted, the recommended regional water supply plan is to be selected based upon a comparative evaluation of the ability of the alternative plans to meet the agreed-upon objectives and standards, including those related to surface water quality. The quality of the source water for water supply systems using Lake Michigan as a source of supply is currently not considered to be a water supply problem, given proper treatment. Within the Region, the surface water supply treatment systems are considered to be well operated and include facilities designed to properly treat Lake Michigan source water. Given the dynamic nature of surface water quality, it is possible that surface water quality conditions at some locations may change, and that unanticipated surface water quality problems may emerge over the course of plan implementation. Each of the alternative plans considered, however, include recommendations for continued monitoring of raw and finished water quality in order to identify and address these changing conditions.

As previously noted, the quality of the source water is an important determinant in the development of water supply systems. The Wisconsin Department of Natural Resources has conducted source water assessments for all of the municipal water supply systems within the Region. Such assessments include information on source water quality and recommend needed protection measures. In the case of nonpoint source pollution source and sewer overflows, there are currently in place regulations and programs designed to reduce pollutant from these sources. Given that these pollution sources currently do not significantly currently limit the use of Lake Michigan as a source of supply within the Region, this may be considered to be adequately managed. In the case of selected contaminants, including many of the emerging and unregulated contaminants, such as pharmaceuticals and personal care products, it is likely to prove to be more effective to remove the chemicals prior to discharge to the environment. This approach also limits environmental exposure of aquatic community. For such contaminants, programs, such as household hazardous waste collections and pharmaceutical collections will be needed. Such programs may be most effectively carried out on a county or subregional level, rather than being left to the individual water or wastewater utilities. Consideration of the need for, and governance of, such programs are given in the development of the recommended water supply plan and the associated implementation strategy.

Climate Change

Issue Description

Changes in climate over the last century have been extensively studied in recent years. A broad scientific consensus has emerged that climate change—rapid warming—is occurring. While some debate is still occurring on how much of the changes result from human activities, this consensus includes anthropogenic influences as one driver of the changes.[17] These changes assessed from the historical meteorological record and modeled using global climate simulation models have the potential to affect both the supply of, and the demand for, water.

The documentation of climate change has been focused on global, hemispheric, continental, and oceanic scales. This reflects the fact that some of the changes are most apparent on a global or continental basis. Climate, however, varies over spatial and temporal scales: from daily cycles through annual cycles, to multi-decadal and millennial periodic cycles. These variations suggest that long-term trends can be very subtle and require large data sets and powerful analytical methods to detect, especially at smaller spatial and temporal scales.[18] More importantly, at smaller spatial and temporal scales, local conditions and trends may depart considerably from global- or continental-scale trends. The following four paragraphs summarize the observed trends in climate change most relevant to the issue of water supply within the Southeastern Wisconsin Region, and, where data availability permit, focus on observations relative to the Midwestern United States and Great Lakes region.

Over the period 1906 to 2005, mean global temperature has increased by about 1.3 degrees Fahrenheit.[19] A 1.3 degrees Fahrenheit increase in mean temperature over the period 1895 to 1999 has also been observed for the southern Great Lakes region.[20] Much of the warming in the United States has occurred during the winter and spring.[21] Changes have also been observed in temperature extremes. The diurnal temperature range appears to be

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[17]*Intergovernmental Panel on Climate Change (IPCC),* Climate Change 2007: The Physical Science Basis, *2007.*

[18]*P.Y. Groisman and others, "Changes in the Probability of Heavy Precipitation: Important Indicators of Climatic Change,"* Climatic Change, *Volume 42, 1999.*

[19]Ibid.

[20]*L.D. Mortsch and others, "Climate Change Impacts on the Hydrology of the Great Lakes-St. Lawrence System,"* Canadian Water Resources Journal, *Volume 25, 2000.*

[21]*T.R. Karl and others, "Indices of Climate Change for the United States,"* Bulletin of the American Meteorological Society, *Volume 77, 1996.*

getting smaller, due primarily to an increase in nighttime minimum temperatures that is greater than the observed increase in daytime maximum temperatures.[22] Fewer days appear to be occurring with extremely low minimum temperatures, particularly in winter, spring, and summer.[23] In the northeastern United States, the length of the frost-free period has increased due primarily to earlier spring warming and, to a lesser extent, to later fall cooling.[24]

Given that increases in atmospheric temperature may be expected to lead to increases in both the rates of evaporation and the water-holding capacity of the atmosphere, it likely that increases in surface temperatures would be accompanied by an increase in the water vapor content of the atmosphere. There is evidence that this increase in atmospheric water vapor content has occurred.[25] Globally averaged dew points, a measure of the water vapor content of the atmosphere, appear to have increased by about 0.45 degree Fahrenheit between 1950 and 2000.[26] This increase has also been accompanied by higher extreme dew points. For example, increasing extremes in summer dew points and increased humidity during summer heat waves were detected at three meteorological stations in northeastern Illinois.[27] The data suggest that during the 20th century the increase in the overall water vapor content of the atmosphere was on the order of 5 percent, with most of the increase having occurred since about 1970.[28]

While warming accelerates land surface drying, and increases the potential incidence and severity of droughts, higher water vapor content in the atmosphere makes more water available for precipitation. Changes have been observed in the amount and frequency of precipitation. Examination of data for eastern North America suggest that the annual amount of precipitation in the Southeastern Wisconsin Region may be increasing, and that a greater portion of that precipitation may be falling during heavy precipitation events. This is borne out by regional records summarized and analyzed by the SEWRPC.[29] Analyses to determine precipitation trends in the Great Lakes-St. Lawrence basin also indicate that total precipitation increased over the period from 1895 to 1995.[30] At

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[22]*D.R. Easterling and others, "Maximum and Minimum Temperature Trends for the Globe,"* Science, *Volume 277, 1997.*

[23]*D.R. Easterling and others, "Observed Variability and Trends in Extreme Climate Events: A Brief Review,"* Bulletin of the American Meteorological Society, *Volume 81, 2000.*

[24]*E.J. Cooter and S.K. Leduc, "Recent Frost Date Trends in the North-Eastern USA,"* International Journal of Climatology, *Volume 15, 1995.*

[25]*P.J. Robinson, "Temporal Trends in United States Dew Point Temperatures,"* International Journal of Climatology, *Volume 20, 2000.*

[26]*M. Ishii and others, "Objective Analysis of SST and Marine Meteorological Variables for the 20th Century Using ICOADS and the Kobe Collection,"* International Journal of Climatology, *Volume 25, 2005.*

[27]*J. Sparks, D. Changnon, and J. Starke, "Changes in the Frequency of Extreme Warm-Season Surface Dewpoints in Northeastern Illinois: Implications for Cooling-System Design and Operation,"* Journal of Applied Meteorology, *Volume 41, 2002.*

[28]*K.E. Trenberth, J. Fasullo, and L. Smith, "Trends and Variability in Column Integrated Atmospheric Water Vapor,"* Climate Dynamics, *Volume 24, 2005.*

[29]*SEWRPC Technical Report No. 40,* Rainfall Frequency in the Southeastern Wisconsin Region, *April 2000.*

[30]*Mortsch and others, 2000,* op. cit.

the same time, the fraction of precipitation deposited as snow decreased, and the fraction deposited as rain increased.[31]

A greater proportion of precipitation appears to be occurring in heavier events. In the United States, trends in one-day and multi-day heavy precipitation events show a tendency toward more days with heavy 24-hour precipitation totals.[32] The number of days annually exceeding two inches of precipitation has increased.[33] The largest increases have been observed in the southwest, Midwest, and Great Lakes regions, and increases in extreme events appear to be responsible for a disproportionate share of the observed increases in total annual precipitation.[34]

Considerable effort has also been made to generate projections of future climatic conditions through the 21st century. Such projections are based on results generated by analyzing a set of greenhouse gas emissions scenarios[35] and the results of the application of large-scale global climate simulation models that include coupling of atmospheric circulation to oceanic circulation. Compared to the area of the Southeastern Wisconsin Region, the grids utilized in these models are quite coarse. Depending upon the model, the sizes of the grid squares used are on the order of one to five degrees latitude by one to five degrees longitude. By way of comparison, most of the State of Wisconsin would fit into a grid of about five degrees latitude by six degrees longitude. While methods exist to scale down results in order to produce continental and regional projections, considerable uncertainty is attached to projections for relatively small areas, such as the Southeastern Wisconsin Region. In addition, these models also differ in many of their underlying assumptions. These differences can and do lead to disagreements among the projections produced by application of the different climate simulation models, especially for projections downscaled to small spatial scales or short time scales.

All of the climate simulation models predict increases in mean global temperature. Depending on the model used to generate the projections, mean global temperature for the period 2011 to 2030 is projected to be between 1.15 and 1.24 degrees Fahrenheit higher than mean global temperature during the period 1980 through 1999.[36] The rate of warming over the land area of the globe is projected to be about twice the global average.[37] Similarly, higher increases in mean temperature are projected for parts of North America. For the Great Lakes Region, it is projected that mean annual temperature will increase by 2.7 to 8.5 degrees Fahrenheit by 2050, depending on the

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[31]Ibid.

[32]*T.R. Karl and R.W. Knight, "Secular Trends of Precipitation Amount, Frequency, and Intensity in the United States,"* Bulletin of the American Meteorological Society, *Volume 79, 1998.*

[33]*Karl and others, 1996,* op. cit.

[34]*Groisman and others, 1999,* op. cit.

[35]*Nebojsa Nakićenović and Robert Smart (editors),* Special Report on Emission Scenarios: A Special Report of Working Group III of the Intergovernmental Panel on Climate Change, *Cambridge University Press, Cambridge, UK, 2000.*

[36]*IPCC, 2007,* op. cit.

[37]Ibid.

model used to generate the projection.[38] The projected increases in temperature are likely to be accompanied by a general reduction in snow depth during the winter due to later autumn snowfalls and earlier spring snow melts.[39]

The models also project global increases in rates of evaporation and evapotranspiration. The main factors affecting potential evaporation from a well-watered surface are: the amount of energy available for evaporating water, the moisture capacity of the atmosphere, and the rate of air movement across the surfaces. Because the moisture capacity of the atmosphere is a function of atmospheric temperature and the water vapor content of the atmosphere, an increase in temperature would be expected to lead to an increase in the moisture capacity of the atmosphere, and potentially to increased evaporation. Actual evaporation is constrained by water availability which is largely a function of soil moisture. Soil moisture is explicitly modeled in many of the climate simulation models. Some models predict reductions of soil moisture over mid-latitude areas of the northern hemisphere during summer. This would be expected to result from higher winter and spring evaporation caused by a combination of higher temperatures, reduced snow cover, and lower rainfall inputs during the summer.[40] It is important to note, however, that soil moisture is greatly affected by local conditions, including local trends in precipitation, soil characteristics, and the amount and type of vegetative cover. Because of this, conditions in relatively small regions such as the Southeastern Wisconsin Region may depart greatly from the hemispheric average. Projections have been also been made as to the simpler situation of evaporation over open water. One study comparing results from two global climate simulation models projected that evaporation from Lake Michigan during the period 2020 to 2040 would be 6 to 15 percent higher than evaporation from the Lake during the study's baseline period of 1961 to 1990.[41]

There is more disagreement among models in their projections of future precipitation trends. Many, but not all, of the models predict increases in mean annual precipitation for the eastern United States and the Great Lakes Region.[42] In addition, while most of the models predict increases in precipitation during the winter and spring, there is less agreement among the models in projections of precipitation trends during summer and autumn: some models predict increases during these seasons, others predict decreases.[43] Most models applications do agree that, in the Great Lakes Region, more precipitation will occur as rain and less as snow. Results from global climate simulation models for the eastern United States also project that the fraction of precipitation occurring in heavy events will increase.[44] Accompanying this increase in heavy events will be decreases in the number of moderate

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[38]*Great Lakes Water Quality Board of the International Joint Commission,* Climate Change and Water Quality in the Great Lakes Basin, *August 2003, http://ijc.org/php/publications/html/climate/.*

[39]Ibid.

[40]*J.M. Gregory, J.F.B. Mitchell, and A. J. Brady, "Summer Drought in Northern Midlatitudes in a Time-Dependent CO_2 Climate Experiment,"* Journal of Climate, *Volume 10, 1997.*

[41]*Brent M. Lofgren and others, "Evaluation of Potential Impacts on Great Lakes Water Resources Based on Climate Scenarios of Two GCMs,"* Journal of Great Lakes Research, *Volume 28, 2002.*

[42]*Great Lakes Water Quality Board of the International Joint Commission, 2003,* op. cit.*; Philip Chao, "Great Lakes Water Resources Climate Change Impact Analysis with Transient GCM Scenarios,"* Journal of the American Water Resources Association, *Volume 35, 1999.*

[43]*Great Lakes Water Quality Board of the International Joint Commission, 2003,* op. cit.

[44]*IPCC, 2007,* op. cit.

events, and increases in the number of dry days and days with light precipitation.[45] The increase in precipitation extremes is likely to be higher than the increase in mean annual precipitation.[46] It is important to note that the spatial patterns of projected precipitation change are very model dependent.

The projected changes in climate may have several different effects on availability of surface water and groundwater. All other things being equal, an increase in mean annual precipitation could lead to increases in mean annual surface runoff and stream discharge. This would tend to increase water levels in Lake Michigan. In addition, increased precipitation over groundwater recharge areas could tend to increase groundwater recharge. Increases in evaporation and evapotranspiration, on the other hand, would likely reduce runoff, soil moisture, and stream discharge. This could lead to lower water levels in Lake Michigan and to lower rates of groundwater recharge. A greater proportion of precipitation being deposited in heavier events coupled with a reduction in moderate precipitation events could lead to higher rates of runoff and higher peak streamflows. Under certain circumstances, the increase in the fraction of precipitation deposited in heavier events could also result in lower base flows in streams and lower soil moisture. A result of this could be a reduction in groundwater recharge. Consequently, the resultant impacts of climate change on the availability of surface water and groundwater in the Southeastern Wisconsin Region will depend on the relative magnitudes and cumulative effects of these and other changes and events. For the Southeastern Wisconsin Region and for the period from 2000 to 2035, the projections currently available from global climate simulation models do not provide a clear picture of what these resultant impacts will be. For the larger areas of which the Region is a part, different models show differences in the direction of changes projected to occur, by from 2035 to 2050, in the amount of precipitation deposited,[47] the amount of runoff,[48] and water levels in Lake Michigan.[49] For some of these impacts, such as the amount of runoff and water levels in Lake Michigan, the amount of change predicted by the models is within the background level of decadal variability observed over much of the 20th century. Thus, considerable uncertainty is attached to what the impacts of climate change will be on the availability of surface water and groundwater in the Southeastern Wisconsin Region over the period that the planning effort covers.

Related Plan Objectives and Standards

There is one plan objective and three standards which are directly related to the issue of climate change:

- Objective—The development of water supply systems, operations, and policies which are flexible and adaptive in response to changing conditions, and redundant with respect to source of supply.

- Standard—The recommended regional water supply plan components should be adaptable to change in scope, capacity, and effectiveness to the extent practicable.

- Standard—The regional water supply plan components should be designed for staged incremental construction to the extent practical, so as to permit maximum flexibility to accommodate unanticipated changes in future conditions.

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[45]*K.E. Trenberth, "Conceptual Framework for Changes of Extremes of the Hydrological Cycle with Climate Change,"* Climatic Change, *Volume 42, 1999.*

[46]*V.V. Kharin and F.W. Zwiers, "Changes in the Extremes in an Ensemble of Transient Climate Simulations with a Coupled Atmosphere-Ocean GCM," Journal of Climate, Volume 13, 2000.*

[47]*Chao, 1999,* op. cit.

[48]*David M. Wolock and Gregory J. McCabe, "Estimates of Runoff Using Water-Balance and Atmospheric General Circulation Models,"* Journal of the American Water Resources Association, *Volume 35, 1999.*

[49]*Lofgren and others, 2002,* op. cit.

- Standard—The regional water supply plan should consider the possibility of long-term climate cycles that can affect recharge rates and water demand.

Basis for Issue Resolution

While evidence of climate change over the last 100 years and projections of probable future climate change have been established in analyses conducted on global, continental, and oceanic scales, considerable uncertainty is attached to projections for relatively small areas such as the Southeastern Wisconsin Region. On these small spatial scales, the directions and magnitudes of projected changes and impacts over the next 30 to 40 years are model-dependent, with the suite of models used producing conflicting projections as to impacts relevant to issues of water availability. As a consequence of this, and of the coarse spatial resolution of the models, these projections cannot be directly applied to localized areas such as the Southeastern Wisconsin Region.

With respect to groundwater, the effects of climate change over the planning period, which extends to the year 2035, cannot be explicitly evaluated in the context of the aquifer simulation models. The aquifer simulation model utilized in the regional water supply plan was calibrated to current and historical conditions.[50] This model was developed to simulate and assess the effects of historical and current well withdrawals on groundwater conditions in the Southeastern Wisconsin Region. The steady state simulation was calibrated based on comparison of simulated results to water table data for the year 2000; the transient simulation developed from the steady state simulation was calibrated based on comparison of simulated results to water-level data over the period 1940 through 2000. The transient simulation was also calibrated to stream base flows in 2000. These simulations reproduced both predevelopment conditions before the onset of large-scale pumping and the response of water levels and fluxes to gradually increasing withdrawals between 1864 and 2000. These models approximated the current state of the climate and they are considered to adequately represent the anticipated climate regime over the relatively short planning period through the year 2035.

Given the foregoing, it was concluded that there is no practical way to make the effects of climate change quantitatively operational in the development of the regional water supply plan. Rather, it was determined to consider the issue by developing a recommended water supply plan which is flexible and adaptable to change.

SUMMARY

The chapter identified a number of water supply problems and issues to be addressed in the regional water supply planning program. The problems identified are related to the capacities of the existing water supply infrastructure to meet forecast water supply demands; to the quantity and quality of the groundwater supplies; and to the sustained ability of those supplies to meet probable future needs. The water supply issues which have been identified are primarily related to: the availability of Lake Michigan supply and diversion; the underutilization of existing Lake Michigan water supply capital facilities; the relationship of recharge and use attributable to areas beyond the Region; impacts of land use development within the Region on groundwater recharge; groundwater-surface water interdependence; the relationship of water supply systems to other comprehensive plan elements; water conservation effectiveness; surface water quality; and climate change. To the extent practicable, each of the problems and issues have been addressed in the regional water supply plan. The related planning objectives and standards, and the recommended basis for addressing the problems and issues is set forth in this chapter.

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[50] *SEWRPC Technical Report No. 41,* A Regional Aquifer Simulation Model for Southeastern Wisconsin, *June 2005.*

Chapter VIII

ALTERNATIVE PLANS: DESCRIPTION AND EVALUATION

INTRODUCTION

As noted in Chapter I, the primary purpose of the regional water supply planning program was to develop a water supply plan for the Southeastern Wisconsin Region that best meets the objectives set forth in Chapter V. The planning program was intended to develop a plan for the management of water supplies within the Southeastern Wisconsin Region identifying measures that could serve to abate existing and probable future water supply problems and preserve and protect the sources of supply. Chapter VII of this plan identified the water supply problems and issues to be addressed, and how those issues and problems are related to the water supply development and management objectives set forth in Chapter V. In order to resolve the identified water supply problems in a manner which best meets the plan objectives, it was necessary to consider alternative water supply plans and to comparatively evaluate those plans with regard to the extent to which each of the plans may be expected to achieve the agreed-upon objectives.

This chapter presents four alternative water supply plans and provides information on the costs of each plan, and on the potential impacts of the plans on the groundwater and surface water resources of the planning area. In addition, this chapter includes a description of the plan design criteria and procedures used to produce the alternative plans. In Chapter IX, these alternative plans are comparatively evaluated on the basis of the extent to which each plan may be expected to achieve the agreed-upon water supply development and management objectives, and on the technical, economic, and environmental performance of the plans. Based upon this comparative evaluation, an initially preferred regional water supply plan is set forth in Chapter IX.

Each of the alternative design year 2035 water supply plans is designed to provide an infrastructure capacity adequate to meet the existing and forecast water demand conditions. These forecast conditions were developed on the basis of the existing socioeconomic and land use conditions within the Region, and on the forecast socioeconomic and land use conditions associated with the adopted design year 2035 regional land use plan.[1] Pertinent data on the existing socioeconomic and land use conditions are presented in Chapter III, together with the related water supply conditions; while pertinent data on planned future socioeconomic and land use conditions are provided in Chapter IV, together with attendant water supply needs.

[1]*SEWRPC Planning Report No. 48*, A Regional Land Use Plan for Southeastern Wisconsin: 2035, *June 2006.*

WATER SUPPLY PLANNING CRITERIA AND ANALYTIC PROCEDURES

The procedures and criteria used in the development of the alternative water supply plans and the incorporated management measures are described in the following sections of this chapter. Also described are the procedures used in the comparative evaluation and economic analyses of those plans. The design and evaluation of the alternative water supply plans considered were accomplished in the following procedural steps:

1. Delineation of the geographic areas to be provided with centralized water supply service by municipal and private water supply systems;

2. Identification of the existing and forecast socioeconomic and land use conditions in the delineated geographic areas; the related water demands; and the ability of the existing water supply facilities to meet the existing and forecast water demands;

3. Identification of the attendant water supply problems and issues to be addressed;

4. Identification of various available water supply management measures and an evaluation as to the viability of these measures for inclusion in each of the alternative plans to be considered;

5. Estimation of capital and operating costs of each attendant plan;

6. Evaluation of the environmental and other impacts of the alternative plans; and

7. Comparative evaluation of those plans based upon the agreed-upon water supply objectives.

Initially, four alternative plans were prepared and based upon the comparative evaluation of these four alternative plans, an initially preferred plan was developed. In the development of that plan, consideration was given to the inclusion of desirable elements drawn from four alternative plans considered, together with other components developed on the basis of a review of the comparative evaluation of the four alternative plans considered. The comparative evaluation of the four alternative plans and the development of an initially preferred plan are described in Chapter IX.

Determination of Water Supply Service Areas for Municipal and Private Water Supply Systems

The existing year 2005 and design year 2035 water supply service areas associated with municipal and private water supply systems in the Region are set forth in Chapters III and IV. The existing year 2005 service areas were defined on the basis of an inventory of the existing water supply systems and related service areas of the municipal and private water supply systems then operating in the Region. The inventory utilized data provided by the existing water utilities within the Region, the Wisconsin Public Service Commission, and the Wisconsin Department of Natural Resources. That inventory also collected information on the sources of supply and the capacities of the systems involved. The inventory and its findings are described in Chapter III.

The design year 2035 regional land use plan served as the initial basis for the delineation of areas proposed to be served by municipal and private water supply systems within the Region. This delineation involved both expansion of the existing service areas and the establishment of new service areas. The proposed municipal water supply service areas were refined considering the location, extent and density of existing and planned urban development, distances to the nearest existing municipal water supply service area, aquifer characteristics, known local initiatives to further develop the existing municipal systems, and the potential for groundwater contamination. One-hundred and one municipal water supply service areas were so delineated as representative of plan design year 2035 conditions. Areas to be served by private water supply systems under planned conditions were similarly delineated. The proposed plan design year 2035 water supply service areas, as well as the procedures used in the delineation of those areas, are described in Chapter IV.

Identification of Existing and Future Socioeconomic and Land Use Conditions and Related Water Use and Pumpage

The existing socioeconomic and land use conditions and the related water use and pumpage demands associated with the public and private water supply systems in the Region are described in Chapter III. These conditions were defined through an inventory of the service areas of the existing municipal and private water supply systems, coupled with Commission small-area geographic information system data on population, household, and economic activity levels, and on land use. In addition, inventory data on water supply system water use and pumpage were obtained for the years 2000, 2004, and 2005 from the Public Service Commission, the Wisconsin Department of Natural Resources, and the municipal water utilities. The findings of that inventory are also documented in Chapter III.

As described in Chapter IV, the forecasts of probable future population, household, and employment levels and of attendant land use conditions used in the regional water supply planning program were derived from forecasts prepared for, and used in, the design of the adopted regional land use plan. These forecasts were developed using an alternative futures approach. Under this approach, a range of possible future population, household, and employment, levels within the Region—high, intermediate, and low—were projected based on consideration of such factors as changing birth and death rates, migration rates, and socioeconomic conditions. The intermediate projections were considered the most likely to be achieved by the design year 2035, and became the forecasts used in the preparation of the regional water supply plan. The high and low projections were intended to provide an indication of the potential range of population, household, and employment levels which could conceivably be achieved under significantly higher and lower, but nevertheless plausible, growth scenarios for the Region. While the intermediate-growth forecast was used in the preparation of the alternative regional water supply plans, consideration was given in the plan design to the range of possible future conditions. The socioeconomic and land use forecasts used are set forth in Chapter IV.

The forecast plan design year 2035 average daily water uses and pumpage demands were calculated by adding to the existing year 2000 demand the forecast incremental demand between the year 2000 and the design year 2035. This incremental demand was calculated by applying unit demand factors to the planned incremental land use development. That calculated demand was then reduced to reflect the implementation of recommended water conservation measures. The percent reduction used was determined and applied on a utility-specific basis considering the source of supply and existing infrastructure. The unit water demand factors and levels of water conservation were developed for, and are documented in SEWRPC Technical Report No. 43, *State-of-the-Art of Water Supply Practices*, July 2007. Alternative water use projections were also developed to illustrate the potential range of future water use conditions. The 2035 forecast of water use and pumpage demand are set forth in Chapter IV.

The water supply systems of each of the municipal water utilities in the Region were evaluated to determine the adequacy of the sources of supply, and the capacities of the treatment, pumping, and storage facilities under existing year 2000 and forecast year 2035 average and maximum day pumpage conditions. The findings of these analyses are documented in Chapter VII. In the development of the alternative plans described in this chapter, potential shortfalls in capacity were identified and measures were identified for the abatement of these shortfalls through the addition of the facility capacity needed to fully meet the forecast water use and pumpage demands.

Identification of Water Supply Problems and Issues

The findings of the inventory and analysis phases of the water supply planning program, as presented in Chapters III and IV of this report, identified and defined a number of water supply problems and issues within the Region. Most of these problems and issues were foreshadowed in the prospectus[2] for the regional water supply

[2]*Southeastern Wisconsin Regional Planning Commission*, Regional Water Supply Planning Program Prospectus, *September 2002.*

planning program which identified a number of factors contributing to the need for a regional water supply planning program. The identified problems and issues are directly related to the water supply system development and management objectives and standards set forth in Chapter V of this report. Means for resolving, or otherwise addressing, each of the identified problems and issues were identified by designing the alternative plans to achieve the objectives related to the problems and issues.

The identified water supply problems were related to the capacities of the existing water supply facilities to meet forecast water supply demands; to the quantity and quality of the groundwater supplies; and to the sustained ability of those supplies to meet probable future needs. The identified water supply issues were related to: the availability of Lake Michigan water supply and to the diversion of water out of the Lake Michigan basin; the underutilization of existing Lake Michigan water supply facilities; groundwater-surface water interdependence; the relationship of water supply systems to other comprehensive plan elements; water conservation effectiveness; the relationship of aquifer use and performance attributable to areas beyond the Region; impacts of land use development within the Region on groundwater recharge; surface water quality; and climate change. Each of the identified problems and issues is described in Chapter VII, along with the related water supply development and management objectives and supporting standards, and the recommended basis for addressing the issues. In most cases, the approach taken in the design of the future condition alternative water supply plans to was meet, to the extent practicable, the objectives and standards which are related to the water supply problems and issues, and to formulate a recommended plan which best meets those objectives.

Identification of Applicable Water Supply Management Measures

It was important that the regional water supply plan be based upon the utilization of best currently available technology. Therefore, one of the early work elements of the planning effort consisted of a review of the state-of-the-art of water supply and management technology. The findings of that review are set forth in SEWRPC Technical Report No. 43, *State-of-the-Art of Water Supply Practices*, July 2007. That report documents the findings of an inventory and review of current and potential future water supply technologies related to water supply source development, water treatment, groundwater infiltration, water transmission and water storage, and water conservation. That report provides the information required for the development of technically sound alternative water supply plans and the selection of a technically sound recommended plan. Particular attention was given to emerging technologies, such as the groundwater recharge, radionuclide removal, and water conservation. The report includes information on pertinent unit costs over the range of facility system capacities, which may be expected to be considered in the water supply planning process. Pertinent factors other than costs that may be involved in water supply facility improvement and management measures are also examined, such as system demand, hydraulics, quantity of supply, water quality, conservation impacts, and the sustainability of the groundwater aquifers. Pertinent engineering, planning, and design standards are provided in the report. The combination of technologies incorporated into the alternative plans presented in this chapter are based upon a judicious application of the information provided in the state-of-the-art report.

Development of the alternative plans, included an analyses of the capacity of the existing sources of supply, and of the attendant treatment, pumping, and storage facilities for each of the water utilities operating within the Region, and a comparison of those capacities to actual year 2000 and forecast year 2035 water use demands. Consideration was given to maximum daily and peak day pumpage demands and fire flow and emergency supply demands. The findings of those analyses are documented in Chapter VII. The procedures used in the analyses are more fully described in Appendix K of this report. For systems utilizing groundwater as the source of supply, the analyses assumed that the existing and forecast water supply demands could be met with the largest well out of service. For that reason, the number of wells included in each alternative plan was in excess of the minimum number of wells required to meet the design year demand. Similarly, for surface water systems, the facilities included in the alternative plans were designed to be able to meet the maximum day pumpage demands with one of each of the major treatment units being out of service. Additional details on the facility sizing criteria used is included in Appendix K.

For alternative plans which include the provision of a Lake Michigan supply to areas which were served by groundwater supplies either initially, or under some of the alternatives, the costs reflect the savings attendant to the elimination of point-of-entry treatment devices for water softening when Lake Michigan water is provided. These savings are possible in areas served by public water utilities where conversion from groundwater to Lake Michigan water supply is included in the alternative plans. In areas where private wells are replaced by a public water supply system, there are offsetting costs for the development of a water supply distribution system. In all such cases, both distribution system development costs and the savings in the cost of water softening are common to all of the alternative plans considered, and these costs and savings were not, therefore, included directly in any of the alternative plan costs.

Identification of Applicable Sources of Supply

In the design of the alternative plans, consideration was given to using the deep aquifer, the shallow aquifer, and Lake Michigan as sources of supply. The potential for directly using local surface water as a source of supply, such as the Fox and Rock Rivers, was considered. However, use of such surface water sources was not incorporated into any of the alternative plans because of issues related to reliability, environmental impacts, and costs. A study developed for the Waukesha Water Utility concluded that the low flows of the Fox and Rock Rivers were inadequate to support their use as a reliable source of supply, unless an impoundment reservoir were created.[3] Flow records were examined as part of the Waukesha Water Utility study. That review indicated that adequate flow in the Fox River during dry weather periods, including an allowance for baseflow, would be available in four of the 20 years for which the flow records were examined. Similarly, review of the flow records indicated that adequate flow in the Rock River during dry weather periods, including an allowance for baseflow, would have been available in 16 of the 20 years for which the flow records were examined.

The development of a reservoir and attendant dam on these rivers would pose a number of land acquisition, regulatory, and environmental concerns. Furthermore, the cost associated with treatment of the surface waters would be high, given the quality and variability of the stream flows. For these reasons, the use of surface water, other than Lake Michigan, was not considered to be as viable as the other available options and was not included in any of the alternative plans.

Another potential source of water considered was the rainfall runoff and groundwater seepage from major stone quarries operating in the Region. Such quarries exist on the north side of the City of Waukesha and in the vicinity of the Villages of Lannon and Sussex and in the Town of Lisbon. Under the aforementioned study of potential water supply sources prepared for the Waukesha Water Utility,[4] an analysis was made of the potential use of groundwater from two large quarries which are located north of the City of Waukesha along the Fox River just downstream from the confluence with the Pewaukee River. It was reported that these two quarries pump about two million gallons of rainfall, runoff, and groundwater seepage per day from the quarries to the Fox River. Given that the amount of water so available constitutes about 20 percent of water supply needed for the City of Waukesha, the quarry source was not considered further in the Waukesha Water Utility study as a primary source of water.

There are two other major quarries located south of the Village of Sussex in the Town of Lisbon which also remove groundwater seepage in a manner similar to the Waukesha quarries. Thus, the amounts of water potentially available could be significantly more than the amount considered in the Waukesha study. However, the amount available would not meet the City of Waukesha maximum demands or the total combined maximum demands of the City of Pewaukee and Villages of Pewaukee and Sussex. Additionally, all of the quarries

[3]*CH2M Hill in association with Ruekert & Mielke, Inc.,* Future Water Supply*, prepared for Waukesha Water Utility, March 2002.*

[4]Ibid.

concerned are expected to be actively operated in the long-term future. The dedication of the water pumped from the quarries for water supply purposes is not considered desirable because of the operation of heavy equipment and attendant fueling operations in the quarries, and the potential for the attendant pollution of the pumped water. The quality of the water collected may also be expected to vary significantly depending upon the quarrying activity and rainfall, both of which can contribute fine particulates to the collected water. The water concerned would be considered surface water requiring treatment for potable use. Accordingly, the use of collected water from the quarries was not considered to be as viable as other available options and was not included in any of the alternative plans.

In considering the use of groundwater sources of supply, the new wells included in the alternative plans were assumed to be located in areas within, or within a distance of one mile of, the planned 2035 water supply service areas of the utilities involved. This assumption was made to minimize concerns related to the development of wells in areas located beyond the limits of the utility service areas and the related municipal boundaries. It is recognized that reevaluation of the alternative plans concerned in subsequent local facility planning efforts may result in findings that would dictate the development of wells located in areas beyond those initially assumed.

Economic Evaluation

The concepts of economic analysis and economic selection are vital to the public planning process. Sound economic analysis should be an important guide to planners and decision makers in the selection of the most suitable plan from an array of alternatives. The costs presented in this report are sufficiently accurate for sound systems-level planning, but are subject to refinement during subsequent facilities planning and project engineering. At the systems level of planning, the cost information is used primarily in the comparative analysis of alternatives on a consistent basis.

The sources of the cost data are cited in the aforenoted state-of-the-art of water supply practices report. In most cases, these sources are national engineering publications supplemented by local project data. The estimated costs were adjusted to an *Engineering News Record* index value of 9563, which is the December 2005 average of the Chicago and Minneapolis indices. The level of precision in the estimates may be expected to fall between the range of Class 4 and Class 5 estimates, as defined by the Association for the Advancement of Cost Engineering (AACE) International. The accuracy of the cost estimates would typically be expected to range from minus 30 percent to plus 50 percent when relying on the use of national publication sources of cost data. However, given that local project cost data were available to supplement the national data, the accuracy of the estimates may be expected to be somewhat higher.

The cost estimates developed for the alternative and recommended plans were developed by estimating the costs of the individual plan components, these individual costs then being aggregated to provide the final estimates. As the costs for the various components are aggregated, the accuracy of the estimates for the plan as a whole, may be expected to be improved due to the offsetting impact of potentially high and low component costs. The impact on the accuracy of the estimates resulting from the consideration of actual local project cost data, and from the aggregation of component costs, is difficult to quantify. However, based upon a long history of Commission cost-estimation for regional sanitary sewerage system development, alternative plan costs that are estimated to be within 10 percent of one another on a present worth or equivalent annual basis may be considered to be equally cost-effective. This 10 percent guideline has been endorsed by Commission technical advisory committees over the almost 50 years of developing and updating regional plan elements.

The capital cost presented for all of the alternative plans represent those associated with all new, expanded, or upgraded facilities. For purposes of comparing the costs of alternative plans, Alternative Plan 1 was considered to be the base plan. The operation and maintenance costs for Alternative Plan 1 represent the incremental increases in costs associated with such new, expanded, or upgraded facilities, plus the costs for water conservation programs. The operation and maintenance costs of Alternative Plans 2, 3, 4, and the composite plan represent the net increase or decrease in operation and maintenance costs for all facilities compared to Alternative Plan 1, plus water conservation program costs. For example, if an alternative provides for the provision of Lake Michigan supply from an existing Lake Michigan-supplied water utility to an area currently served by groundwater, the operation and maintenance costs would include the incremental increased cost to produce and convey the increased amounts of treated Lake Michigan water, less the incremental operation and maintenance costs associated with the abandonment of the wells concerned and any associated treatment costs. For the purpose of comparative evaluation of alternative plans, the operation and maintenance costs associated with existing facilities under Alternative Plan 1 which are common to all alternatives are not included in any of the alternative plan costs. Those costs are, however, included in the costs of the final recommended plan.

Planning Period and Economic Life

The physical life of a facility is that period between its original construction and final disposal of the facility. The economic life is defined as the period after which the incremental benefits from continued use no longer exceed the incremental cost of operation. In the economic analyses conducted under the regional water supply plan, the time period over which the facility is totally depreciated was made equal to the economic life.

Although the plan design year for the regional water supply plan update is 2035, the economic life of certain planned facilities will extend beyond this design year. Accordingly, in the economic analyses, a salvage value was assigned to those facilities with an economic life extending beyond the end of the economic analysis period. For purposes of the economic analyses, an economic life of 50 years was assumed for water mains, wells, concrete structures, and storage tanks. Steel structures, electrical components, and certain stormwater management facilities, such as stormwater infiltration facilities, were assumed to have an economic life of 30 years; and pumps were assumed to have an economic life of 20 years. While the plan design period or planning period used was 31 years, from 2005 to 2035, the economic analysis period used was 2005 through 2054, or 50 years. All costs were expressed in 2005 dollars. An interest rate of 6 percent and, an analysis period of 50 years, was used in all of the economic analyses.

Following sound principles of engineering economic analyses, no escalation over time of construction, operation, maintenance, or replacement costs was considered. In the economic evaluations, provisions for the replacement of shorter-lived components were incorporated into the total economic costs through the selection of an economic life as described above. The economic analyses of alternatives assume replacement of facilities at specific life intervals. As already noted, a salvage value was credited to facilities whose economic life extended beyond the year 2054.

Construction Capital Costs

Construction costs used in this planning effort were estimated using 2005 unit prices, which reflect the type and size of facility or control measure, location, and regional labor and material costs. These construction costs were multiplied in the economic analyses by a factor of 1.35 to obtain total project capital costs. This 35 percent increase was intended to account for contingencies, engineering and legal fees, and administrative and financing costs.

Present Worth and Annual Costs

Four terms commonly used in preparing economic analyses of important engineering projects warrant definition here: the single payment present worth factor (PWF); the uniform series present worth factor (SPWF); the gradient series present worth factor (GPWF); and the capital recovery factor (CRF). In the regional water supply planning effort, the PWF, the SPWF, and the CRF were used. The gradient series present worth factor was not used, since the annual costs were developed as the average of the annual costs over the planning period.

The single payment present worth factor converts the cost of a single expenditure at some future time to an equivalent present value. The uniform series present worth factor converts a series of future uniform annual payments to an equivalent present worth value. The present worth of future single or uniform annual series payments is always less than the absolute value of the single payment or the sum of the annual payments. The capital recovery factor converts a lump payment at the beginning of a period, or a present worth value, into a series of uniform annual payments over the length of the period. The sum of these uniform annual payments is always greater than the lump sum payment.

It should be noted that, given the same interest rate and the same estimated series of costs, comparisons by annual cost lead to the same conclusions as comparisons by present worth. Economic analyses utilizing present worth and annual costs allow alternatives to be compared in monetary terms. This enables public officials to evaluate more objectively and explicitly the benefits and costs of alternative plans to assure that the public will receive the greatest possible benefits from the investment of limited monetary resources.

Evaluation of Environmental and Other Impacts

For each of the alternative plans, the potential impacts on the groundwater and surface water systems were estimated by simulating those systems utilizing the regional aquifer simulation model.[5] That model was used to estimate changes in the shallow and deep aquifers, as well as in the surface water system between the base year 2005 and the plan year 2035 attributable to conditions under each of the alternative plans considered. The base year 2005 was selected for consideration of the environmental impacts, since that year represents the same year for which facilities which were in place were considered to be sunk costs. Thus, the alternative plans consistently considered both new facilities and impacts which would be expected after 2005.

The environmental impacts of the alternative plans were estimated using the regional aquifer simulation model. Certain aspects of this model must be kept in mind when interpreting the simulation results. One of the model outputs consists of an estimate of the drawdown or drawup in the static water levels—or table—or the potentiometric surface of the groundwater aquifers concerned. The term "drawdown" is used to indicate a decrease in the level of the aquifer water table, or the potentiometric surface, compared to the level at a defined base time. The term "drawup" is used to indicate an increase in the level of the aquifer water table, or the potentiometric surface, compared to the level as a defined base time. Drawup may represent a partial or full recovery of historic drawdowns which occurred prior to the base year, but may also represent an increase in the water table level above pre-existing levels unaltered by pumping.

The dimensions of cells in the model grid limit the spatial resolution of this groundwater flow model. Although spatial variations in the groundwater system can occur at any scale, from feet to miles, the model does not compute water levels and flows everywhere within the model domain. For the model nearfield, including the Southeastern Wisconsin Region, most cells extend 2,500 feet from north to south and 2,500 feet from east to west. Model results in any cell correspond to average conditions over an approximately one-quarter square mile area. For example, simulated drawdown at a particular time due to pumping a specific group of wells represents an average decline in water levels over the area of the cell containing the wells. It does not reflect the presence of a cone of depression, for example, that might develop around a single well located somewhere within the cell. The vertical resolution of the model is also limited. In general, water levels, drawdowns, and volumetric flows per unit time correspond to single hydrostratigraphic units or subdivisions of units within the flow system. While the resolution of the model is sufficient to compare differences in impacts resulting from alternative plans, it may not be sufficiently fine to predict site-specific impacts, or to resolve differences in impacts between surface water or groundwater features that are in close proximity to one another.

The impacts of the alternative plans on the groundwater reservoirs in terms of drawdown and drawup were analyzed using model layers. The data are presented for both the glacial sand and gravel and the Silurian dolomite portions of the shallow aquifer, as well as for the deep sandstone aquifer. Data are presented for both the sand and gravel and the Silurian dolomite portions of the shallow aquifer since differences may exist in the water table due to the variable thickness, conductivity, and transmissivity of these two portions of the aquifer. Such differences are most pronounced in areas under the influence of pumping, recharge, and groundwater-surface water interactions.

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[5]*SEWRPC Technical Report No. 41,* A Regional Aquifer Simulation Model for Southeastern Wisconsin, *June 2005.*

The declines in water levels, or potentiometric surfaces, caused by pumping are different for the shallow and deep aquifers in the Southeastern Wisconsin Region. The Maquoketa shale acts to confine the deep aquifer over most of the Region. In the areas where this aquitard is present, the aggregate effect of pumping from deep wells can act to produce regional drawdowns in the deep aquifer. As a result, changes in water levels will be indicative of the potential impacts of alternative plans upon the deep aquifer. In general, pumping from shallow wells in the sand and gravel and Silurian dolomite aquifers causes little regional drawdown because local surface water features, such as lakes, streams, and wetlands, help to offset the withdrawals. Often, the major effect of pumping from shallow wells is to reduce the amount of groundwater discharge to local surface water features. This effect can be represented as baseflow depletion from surface waterbodies. Larger changes in water levels in the shallow aquifer in response to pumping from shallow wells may be expected in some local areas where the shallow aquifer is confined by overlying clay-rich glacial till. It is important to recognize that large changes in water levels in these local areas may be more indicative of the fact that the confined nature of the shallow aquifer in these areas severs the connection to surface waters eliminating the offsetting effects on water levels described above. Because of these considerations, the effects of alternative plans upon baseflow to surface water features will generally be more indicative of the impacts upon the shallow groundwater system than the associated changes in water levels in the sand and gravel and Silurian dolomite aquifers. Information on expected water level changes can, however, also be useful for making decisions related to water withdrawals. Thus information on water level changes associated with the alternative plans in both the sand and gravel and Silurian dolomite aquifers are presented in this report as part of the analysis of the environmental impacts of the alternative plans.

To arrive at a better understanding of the effect of pumping on the groundwater flow system and its impacts on the surface water system, it is useful to determine and quantify the sources of water that contribute to well discharge. Four sources can contribute: diverted flow from surface water; induced flow from surface water; storage release; and cross-boundary flow. Diverted flow represents groundwater flow to wells which in the absence of pumping would have discharged to surface water features. Induced flow represents flow from surface water features into groundwater resulting from pumping. Storage release represents removal of groundwater stored in aquifers. Cross-boundary flow represents groundwater flow into the planning area from outside its borders.

The impact of pumping on surface waters can be represented as baseflow depletion. Baseflow is the amount of flow in the waterbody from upgradient groundwater discharge. The overland flow component of total streamflow is not included in baseflow, and the simulation results do not include it, or account for it. Typically baseflow represents from about 10 percent to about 50 percent of streamflow on an annual basis. It can constitute higher proportions of total streamflow during low streamflow periods. Baseflow depletion may be defined as a decrease in baseflow between two periods, in this instance 2005 and 2035. Baseflow depletion to a waterbody can occur both through inflow depletion and outflow depletion. Inflow depletion results from a decrease in the amount of flow from groundwater into the waterbody. Outflow depletion results from an increase in the amount of flow from the waterbody to groundwater.

Groundwater-surface water modeling was used to estimate changes in the groundwater flow system and the resulting impacts on the surface water system associated with each alternative plan, more specifically to estimate the potential impacts of groundwater pumping on baseflows in the surface water system. The estimates of baseflow depletion are considered to be valid for distinguishing between alternative plans when considered in aggregate. Because of the cell size of the groundwater simulation model, however, the results are not applicable for determining the impact of a groundwater withdrawal on a site-specific basis. Such an evaluation would require refinement of the model by the inclusion of more-detailed hydrogeologic data and a refinement of the model cell size. The model has been specifically designed with a telescoping feature which allows for such more-detailed investigation on specific geographic locations using more-refined inset models.

An indication of the anticipated level of accuracy of the groundwater-surface water modeling can be inferred from the goodness of fit statistics generated during the calibration of the regional aquifer simulation model. In the calibration of the steady-state predevelopment simulation, the average distance by which simulated water levels in all of the wells used in the calibration varied from observed water levels approximated plus or minus 20 feet. When wells located in the shallow groundwater system and the deep groundwater system were examined separately, similar results were obtained: for both groups of wells the average absolute difference between simulated water levels and observed water levels being about 20 feet. Similar results were obtained in the calibration of the transient simulation of changing groundwater conditions between 1864 and 2000. When all wells used in the calibration were examined, simulated water levels varied, on average, from observed water levels by about 22 feet. Overall, the model showed little bias; however, when results from the deep sandstone aquifer were separated from results in more shallow units, some bias was present. The model tended to predict water levels that were somewhat higher than those observed in shallow wells, and water levels that were somewhat lower than those observed in deep wells. Model calibration also compared simulated baseflows in eight streams in the Region to observed streamflows. Because, as already noted, baseflow generally represents about 10 to 50 percent of total streamflow, the level of simulated baseflow should be between the level of streamflow exceeded 80 percent of the time and the level of streamflow exceeded 50 percent of the time. This was found to be the case for five of the eight streams in the Region that were used in the calibration of the model. For the other three streams, the level of simulated baseflow was near the level of streamflow exceeded 80 percent of the time. More detailed information on the calibration of the aquifer simulation model is provided in SEWRPC Technical Report No. 41, *A Regional Aquifer Simulation Model for Southeastern Wisconsin,* June 2005. Because the average difference between simulated and observed water levels in the calibration of the aquifer simulation model was about 20 feet it was determined that, for the purposes of comparatively evaluating alternative plans, any difference in modeled water levels among alternatives that were less than 20 feet would be considered as insignificant.

Each of the alternative plans includes a component providing for the implementation of current regulatory programs related to stormwater management infiltration requirements, including those associated with Chapter NR 151 and NR 216 of the *Wisconsin Administrative Code* and associated stormwater ordinances and permits. These programs are considered to be important for both surface water quality and groundwater infiltration protection purposes, particularly in localized situations. For groundwater and surface water modeling purposes, the impacts of the programs could only be generally characterized by maintaining the calibrated infiltration levels associated with the year 2000 land cover. This approach was considered sound for regional planning purposes as the projected increase in impervious surfaces between the years 2000 and 2035 was estimated to be limited to about 1 percent of the area of the Region, as documented in Chapter VII. That estimated increase in imperviousness assumes historic development practices. When this relatively low level of impervious surface change is coupled with the current requirements and policies to maintain the majority of the predevelopment infiltration, the impacts can only be approximated on a regional basis by maintaining the year 2000 infiltration level through the year 2035. Specific measures were included in Alternative Plan 3 to increase the amount of infiltration in areas located beyond those allocated to development sites. The impacts of those specific measures were quantitatively estimated using the groundwater and surface water model.

In addition to the estimated impacts on the groundwater system noted above, a water budget analysis was used to comparatively evaluate the alternative plans. The details of the water budget analysis technique, which utilizes three groundwater performance indicators, are documented in a separate technical report.[6] The first indicator, known as the demand to supply ratio, is defined as the ratio of net pumping demand on an aquifer to the amount of water that is replenished at a given point in time. For purposes of the alternative plan analyses, this indicator was calculated for 2005 and 2035 and compared to predevelopment conditions. Generally, this indicator ranges from zero—representing no human impact—upward. Values over one indicate that more groundwater is being extracted than can be replaced in a long-term, sustainable fashion. This indicator is primarily applicable to the deep, confined aquifer, because the differences between use and inputs is much more significant in that aquifer than in the shallow aquifer.

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[6]*SEWRPC Technical Report No. 46,* Groundwater Budgets Indices and Their Use in Assessing Water Supply Plans for Southeastern Wisconsin, *February 2010.*

The second indictor, known as the human impact ratio, is defined as the ratio of human-induced groundwater inflows to total inflows minus the ratio of human-induced groundwater outflows to total outflows. This indicator is an expression of the relative magnitude of human alteration of the groundwater system. Values range from minus one in areas where wells have become the only discharge from an aquifer by stopping all other groundwater discharges, through zero representing no net human impact, to plus one representing situations where human additions are the only inputs to the aquifer. For purposes of the alternative plan analyses, this indicator was calculated for 2005 and 2035 and compared to predevelopment conditions.

The third indicator, known as the baseflow reduction index, is defined as the ratio of the change in groundwater-derived baseflow discharge between a base period of time and the time of interest divided by the base period discharge. For purposes of the alternative plan analyses, this indicator was calculated for 2005 and 2035 compared to base year 2000 conditions.

The results of the groundwater modeling are presented, along with the description of each alternative plan. Following the description of all the alternative plans and the associated groundwater and surface water analyses, the results are compared to each other considering the results of the analysis for each alternative plan and groundwater performance indicators. In addition, a comparison is made between alternative plans based upon cost, environmental impacts, and implementability. Using the evaluations noted above, the alternative plans are then compared with regard to their ability to meet the plan objectives. This comparison of the alternative plans is presented in Chapter IX.

Finally, estimates were made of the electric power requirements for treating and transporting water under each of the alternative water supply plans. The methods used to make these estimates are described and the estimates are presented in Appendix L of this report. For the Region, the differences in the electric power requirements among the four alternative plans described below were within about 5 percent of one another.

DESCRIPTION OF ALTERNATIVE WATER SUPPLY PLANS AND RELATED IMPACTS

Four alternative water quality management plans were considered to address the problems and identified issues as described in Chapter VII of this report, and to meet the water supply development and management objectives and supporting standards presented in Chapter V. The first alternative plan considered was intended to represent a baseline condition; identifying anticipated design year 2035 performance of each utility system based upon existing or committed water supply facilities in place supplemented by similar committed new facilities as needed under forecast demand conditions as derived from the forecast socioeconomic and land use conditions. Each of the next three alternative plans were designed to include the components of the first alternative with some of those components being modified and additional components being added as found necessary to meet the forecast demands. Individual features of each of the plans and the associated groundwater and surface water impacts are described below.

Plan Description—Alternative Plan 1: Design Year 2035 Forecast Conditions under Existing Trends and Committed Actions

This alternative plan is intended to serve to identify the facilities needed to meet forecast design year 2035 water demands using the existing and committed water supply facilities. Alternative Plan 1 includes the following components:

- Existing year 2000 water supply facilities;
- New water supply facilities which were known to have been constructed from the base year 2000 through 2006;
- New water supply facilities considered to be committed, defined as having been funded as of the end of 2007;

- Expanded sources of groundwater supply and treatment of existing groundwater sources as needed to meet forecast 2035 water demands. The expanded sources are similar to the existing sources for each water utility, except where known quantity or quality problems preclude the use of such similar sources. In such cases, local plans, or in the absence of such plans staff judgment, were used to select alternative sources which were deemed to be most likely to be implemented. The selection of the general location of new facilities was made considering service areas, local plans, and applicable regulatory constraints. Under this alternative, it was assumed that all communities located west of the subcontinental divide and some communities located east of this divide, would continue to rely on groundwater-based systems, unless there were existing commitments to utilize Lake Michigan as a source of supply. The only known such commitments involved the City of Kenosha Water Utility and its contract service utilities: the Village of Pleasant Prairie Water Utility; the Town of Somers Water Utility; and the Town of Bristol Utility District No. 3, where the commitments are expressed as intermunicipal agreements which are in place, and existing major water supply and sewage system infrastructure providing for a Lake Michigan supply and a return flow component;

- Expanded Lake Michigan surface water supply facilities as needed to meet the forecast 2035 water demands for areas currently provided with Lake Michigan as a source of supply and areas considered to be committed to such a supply, as noted above;

- Water conservation programs implementation in the manner developed and documented in SEWRPC Technical Report No. 43, *State-of-the-Art of Water Supply Practices*, May 2007, and incorporated into Chapter IV;

- Implementation of current regulatory programs, such as the infiltration requirements of Chapter NR 151 of the *Wisconsin Administrative Code* and local stormwater ordinances and programs developed to meet the municipal separate sewer system permit program as required under Chapter NR 216 of the *Wisconsin Administrative Code* and the associated individual and general stormwater discharge permits; and

- The continued use of private water supply systems to serve residential and nonresidential land uses located beyond the planned water supply service areas, including agricultural land uses. Data on the number and location of such systems are provided in Chapter IV.

Under Alternative Plan 1, the sources of supply and the anticipated utilization of those sources may be summarized as follows:

- Design year 2035 total average annual groundwater pumpage is estimated to be about 106 million gallons per day (mgd), with about 67 mgd, or about 63 percent, from the shallow aquifer, and about 39 mgd, or about 37 percent, from the deep aquifer. This compares to the year 2005 total pumpage of about 77 mgd.

- Design year 2035 municipal water utility average annual groundwater pumpage is estimated to be about 89 mgd, with about 53 mgd, or about 60 percent, from the shallow aquifer, and about 36 mgd, or 40 percent, from the deep aquifer. This compares to the year 2005 groundwater pumpage of about 49 mgd.

- Design year 2035 municipal water supply pumpage of Lake Michigan water is estimated to approximate 214 mgd. This compares to the year 2005 pumpage of about 209 mgd.

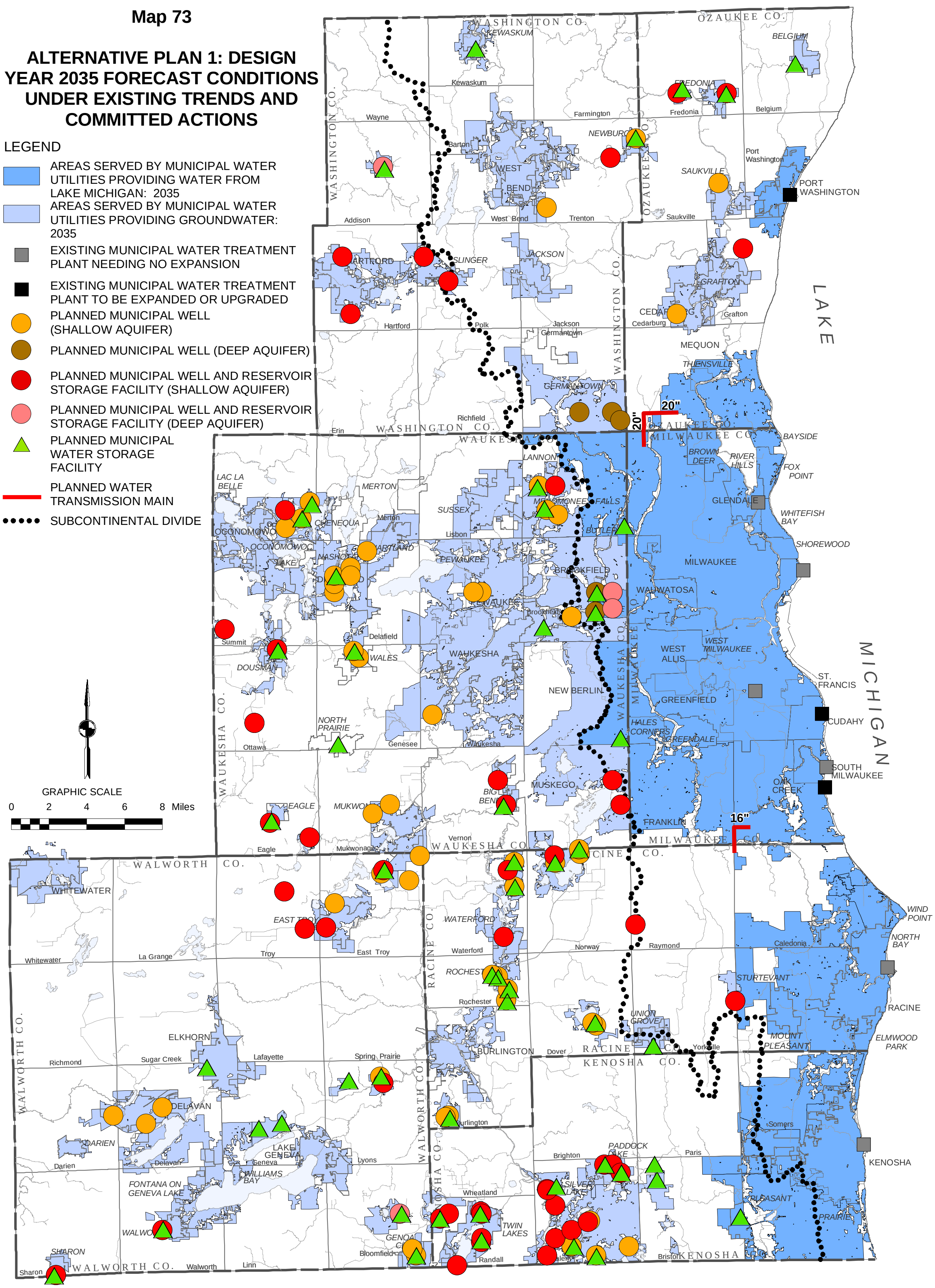
Map 73 illustrates the areas served by municipal utilities and the sources of supply for those utilities under Alternative Plan 1. The new sources of supply and attendant facilities for each water utility in the Region, and the costs of those facilities under Alternative Plan 1, are listed in Table 88. Alternative Plan 1 has an estimated capital

Map 73

ALTERNATIVE PLAN 1: DESIGN YEAR 2035 FORECAST CONDITIONS UNDER EXISTING TRENDS AND COMMITTED ACTIONS

LEGEND

- AREAS SERVED BY MUNICIPAL WATER UTILITIES PROVIDING WATER FROM LAKE MICHIGAN: 2035
- AREAS SERVED BY MUNICIPAL WATER UTILITIES PROVIDING GROUNDWATER: 2035
- EXISTING MUNICIPAL WATER TREATMENT PLANT NEEDING NO EXPANSION
- EXISTING MUNICIPAL WATER TREATMENT PLANT TO BE EXPANDED OR UPGRADED
- PLANNED MUNICIPAL WELL (SHALLOW AQUIFER)
- PLANNED MUNICIPAL WELL (DEEP AQUIFER)
- PLANNED MUNICIPAL WELL AND RESERVOIR STORAGE FACILITY (SHALLOW AQUIFER)
- PLANNED MUNICIPAL WELL AND RESERVOIR STORAGE FACILITY (DEEP AQUIFER)
- PLANNED MUNICIPAL WATER STORAGE FACILITY
- PLANNED WATER TRANSMISSION MAIN
- SUBCONTINENTAL DIVIDE



Source: Ruekert & Mielke, Inc. and SEWRPC.

Table 88

PRINCIPAL FEATURES AND COSTS OF NEW, EXPANDED, AND UPGRADED WATER SUPPLY FACILITIES AND PROGRAMS UNDER ALTERNATIVE PLAN 1, DESIGN YEAR 2035 FORECAST CONDITIONS UNDER EXISTING TRENDS AND COMMITTED ACTIONS

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Kenosha County					
City of Kenosha Water Utility	No additions	- -	41.7	657	42
Village of Paddock Lake Municipal Water Utility	Addition of two 0.25 MG elevated tanks, three shallow aquifer wells with 0.20 MG reservoir each	4,032	54.0	3,135	199
Village of Pleasant Prairie Water Utility	Addition of 0.75 MG elevated tank	1,620	39.7[d]	2,104	134
Town of Bristol Utility District No. 1	Addition of 0.50 MG elevated tank, 0.40 MG reservoir	1,404	21.0	1,465	93
Town of Bristol Utility District No. 3	No additions	- -	0.1[d]	2	0
Town of Somers Water Utility	No additions	- -	3.5[d]	55	3
Village of Silver Lake Planned Utility	Addition of three shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank	3,437	93.4	1,694	107
Village of Twin Lakes Planned Utility	Addition of five shallow aquifer wells with 0.1 MG reservoir each, two 0.3 MG elevated tanks	5,317	158.7	3,782	240
Town of Salem Planned Utility	Addition of eight shallow aquifer wells, four with 0.15 MG reservoirs, two 0.3 MG elevated tanks	7,294	288.9	5,710	362
Powers-Benedict-Tombeau Lakes Area Planned Utility	Addition of two shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank	2,584	57.9	1,694	107
Land acquisition for wells and storage tanks	31 acres	2,170	- -	2,170	137
Subtotal	21 Wells, 28 Storage Tanks	27,858	758.9	22,468	1,424
Milwaukee County					
City of Cudahy Water Utility	Duplicate rapid mix facility	100	7.5	118	7
City of Franklin Water Utility	No Additions	- -	13.4[d]	211	13
City of Glendale Water Utility	No Additions	- -	6.1[d]	96	6
City of Milwaukee Water Works	No Additions	- -	263.1	4,146	263
City of Oak Creek Water and Sewer Utility	Addition of 20 mgd coag-floc-sed, 14 mgd filtration, 17.5 mgd pumping	13,220	547.4[e]	21,169	1,343
City of South Milwaukee Water Utility	No Additions	- -	8.6	136	9
City of Wauwatosa Water Utility	No Additions	- -	19.6[d]	309	20
City of West Allis Water Utility	No Additions	- -	25.2[d]	397	25
Village of Brown Deer Public Water Utility	No Additions	- -	4.8[d]	76	5

Table 88 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Milwaukee County (continued)					
Village of Fox Point Water Utility	No Additions	- -	2.6[d]	41	3
Village of Greendale Water Utility	No Additions	- -	5.6[d]	88	6
Village of Shorewood Municipal Water Utility	No Additions	- -	1.4[d]	22	1
Village of Whitefish Bay Water Utility	No Additions	- -	5.8[d]	91	6
We Energies-Water Services	No Additions	- -	1.0[d]	16	1
Subtotal	0 Wells, 0 Storage Tanks, One Water Treatment Plant Expansion, One Water Treatment Plant Upgrade	13,320	912.1	26,916	1,708
Ozaukee County					
City of Cedarburg Light & Water Commission	Addition of one shallow aquifer well	650	35.1	1,157	73
City of Port Washington Water Utility	Addition of 2.0 mgd coag-floc-sed, filtration, 1.8 mgd pumping	3,888	33.1	2,622	166
Village of Belgium Municipal Water Utility	Addition of 0.45 MG reservoir at Well 3, service pumps at Wells 1 and 2	586	2.0	298	19
Village of Fredonia Municipal Water Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.20 MG reservoir	1,417	23.5	886	56
Village of Grafton Water and Wastewater Commission	Addition of one shallow aquifer well with 0.70 MG reservoir	1,535	39.5	828	53
Village of Saukville Municipal Water Utility	Addition of one shallow aquifer well	650	29.9	575	36
We Energies-Water Services	21,400 feet of 20 inch main in 107th Street and Granville Road to Donges Bay Road and in Donges Bay Road	3,809	231.8[d,f]	5,385	342
Town of Fredonia-Waubeka Area Planned Utility	Addition of one shallow aquifer well with 0.10 MG reservoir, 0.25 MG elevated tank	1,460	24.3	899	57
Land acquisition for wells and storage tanks	Seven acres	490	- -	490	31
Subtotal	Five Wells, Six Storage Tanks	14,485	419.2	13,140	833
Racine County					
City of Burlington Municipal Waterworks	No additions	- -	12.6	199	13
City of Racine Water and Wastewater Utility[g]	No additions	- -	45.9	724	46
Village of Caledonia West Utility District[h] (Oak Creek)	No additions	- -	0.4[d]	6	1
Village of Caledonia West Utility District[h] (Racine)	No additions	- -	3.1[d]	49	3
Village of Caledonia East Utility District[i] (Oak Creek)	No additions	- -	1.9[d]	30	2

Table 88 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Racine County (continued)					
Village of Caledonia East Utility District[i] (Racine)	No additions	- -	3.5[d]	55	4
Village of Union Grove Municipal Water Utility	Addition of 0.40 MG reservoir	526	5.1	606	38
Village of Waterford Water and Sewer Utility	Addition of one shallow aquifer well with 0.40 MG reservoir	1,151	15.7	1,481	94
Village of Wind Point Municipal Water Utility	No additions	- -	0.8[d]	13	1
North Cape Sanitary District	Addition of one shallow aquifer well with 0.10 MG reservoir	155	2.1	194	12
Town of Yorkville Water Utility District 1	Addition of one shallow aquifer well with 0.10 MG reservoir	787	7.2	982	62
Northwest Caledonia Area Planned Utility District	9,000 lineal feet of water transmission main	1,557	3.1[d,j]	726	46
Town of Burlington-Bohner Lake Area Planned Utility District	Addition of two shallow aquifer wells, 0.30 MG elevated tank	1,941	42.1	1,278	81
Town of Dover-Eagle Lake Area Planned Utility District	Addition of two shallow aquifer wells, 0.30 MG elevated tank	1,941	47.0	1,315	83
Town of Norway Area Planned Utility	Addition of four shallow aquifer wells, one with 0.15 MG reservoir, two 0.25 MG elevated tanks	4,024	112.9	2,825	179
Village of Rochester Area Planned Utility	Addition of two shallow aquifer wells, two 0.10 MG elevated tanks	1,844	27.6	1,125	71
Town of Rochester Area Planned Utility	Addition of two shallow aquifer wells, two 0.10 MG elevated tanks	1,844	30.7	1,148	73
Town of Waterford Area Planned Utility	Addition of three shallow aquifer wells, one with 0.15 MG reservoir, two 0.3 MG elevated tanks	3,485	114.4	2,571	163
Land acquisition for wells and storage tanks	28 acres	1,960	- -	1,960	124
Subtotal	18 Wells, 16 Storage Tanks	21,215	476.1	17,287	1,096
Walworth County					
City of Delavan Water and Sewerage Commission	Addition of three shallow aquifer wells with iron removal treatment	3,075	75.2	1,544	98
City of Elkhorn Light and Water	Addition of 0.35 MG treated water reservoir	467	11.3	390	25
City of Lake Geneva Municipal Water Utility	No additions	- -	11.3	178	11
City of Whitewater Municipal Water Utility	No additions	- -	13.7	216	14
Village of Darien Water Works and Sewer System	Increase Well 1 output from 325 to 425 gpm	- -	15.2	35	2
Village of East Troy Municipal Water Utility	Addition of three shallow aquifer wells, two with 0.10 MG reservoir each	2,199	55.6	1,792	114

Table 88 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Walworth County (continued)					
Village of Fontana Municipal Water Utility	No additions	- -	2.0	32	2
Village of Genoa City Municipal Water Utility	Addition of two shallow aquifer wells and 0.25 MG elevated tank	1,898	48.1	1,592	101
Village of Sharon Waterworks and Sewer System	Addition of one shallow aquifer well with 0.30 MG reservoir, 0.20 MG elevated tank	1,512	17.1	1,935	123
Village of Walworth Municipal Water and Sewer Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.15 MG reservoir	1,333	30.6	1,038	66
Village of Williams Bay Municipal Water Utility	No additions	- -	4.3	68	4
Town of Bloomfield Pell Lake Sanitary District No. 1	Addition of 0.2 MG elevated tank, one deep aquifer well with radium treatment and with 0.4 MG reservoir	1,891	39.6	2,416	153
Town of East Troy Sanitary District No. 3	Addition of one shallow aquifer well	130	0.1	136	8
Town of Geneva Lake Como Sanitary District No. 1	Addition of 0.20 MG elevated tank and 0.45 MG reservoir	1,066	12.4	1,206	77
Town of Troy Sanitary District No. 1	Addition of one shallow aquifer well with 0.12 MG reservoir	80	0.2	87	6
Country Estates Sanitary District	Addition of 0.20 MG elevated tank	480	10.8	719	46
Town of Lyons Area Planned Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.3 MG elevated tank	2,169	38.9	1,362	86
Town of East Troy-Potter Lake Area Planned Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.3 MG elevated tank	2,169	34.6	1,329	84
Land acquisition for wells and storage tanks	25 acres	1,750	- -	1,750	111
Subtotal	17 Wells, 18 Storage Tanks	20,219	421.0	17,825	1,131
Washington County					
City of Hartford Utilities	Addition of two shallow aquifer wells with 0.10 MG reservoir each, treat Wells 4 and 13	3,005	91.5	3,991	253
City of West Bend Water Utility	Addition of one shallow aquifer well	625	58.4	1,443	92
Village of Germantown Water Utility	Addition of three deep aquifer wells, each with radium treatment	4,005	175.5	4,500	286
Village of Jackson Water Utility	No additions	- -	7.4	117	7
Village of Kewaskum Municipal Water Utility	Addition of 0.25 MG reservoir	351	4.4	420	27
Village of Slinger Utilities	Addition of two shallow aquifer wells with 0.20 MG reservoir each	1,824	31.9	1,730	110

Table 88 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Washington County (continued)					
Allenton Sanitary District No. 1	Addition of 0.20 MG elevated tank, one deep aquifer well with 0.30 MG reservoir	1,672	20.3	1,374	87
Village of Newburg Area Planned Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.30 MG elevated tank	2,169	39.9	1,938	123
Land acquisition for wells and storage tanks	13 acres	910	- -	910	58
Subtotal	11 Wells, Nine Storage Tanks	14,561	429.3	16,423	1,043
Waukesha County					
City of Brookfield Municipal Water Utility (east and west)	Addition of one shallow aquifer well, emergency power at Well 4	625	86.0	1,899	120
City of Delafield Municipal Water Utility	Addition of five shallow aquifer wells, 0.40 MG elevated tank	4,019	110.1	3,259	207
City of Muskego Public Water Utility	Addition of two shallow aquifer wells with 0.40 and 0.35 MG reservoirs, respectively	2,243	63.5	1,047	66
City of New Berlin Water Utility (east)	Addition of 0.40 MG reservoir	526	8.5[d]	320	20
City of New Berlin Water Utility (central)	Addition of radium removal treatment at Wells 3, 5, and 7	3,971	72.7	6,269	398
City of Oconomowoc Utilities	No additions	- -	17.4	274	17
City of Pewaukee Water and Sewer Utility	Addition of two shallow aquifer wells, service pumps	1,300	54.9	1,996	127
City of Waukesha Water Utility	Addition of one shallow aquifer well, radium treatment at Wells 2, 5, 6, 7, and 9	12,074	685.5	23,676	1,502
Village of Butler Public Water Utility	Addition of 0.25 MG reservoir	351	0.8	307	19
Village of Dousman Water Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.40 MG reservoir	1,631	26.2	1,957	124
Village of Eagle Municipal Water Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.40 MG reservoir	1,631	17.8	1,850	117
Village of Hartland Municipal Water Utility	Addition of one shallow aquifer well	625	17.7	526	33
Village of Menomonee Falls Water Utility (east)	No additions	- -	12.2[d]	192	12
Village of Menomonee Falls Water Utility (west)	Addition of 0.20 MG elevated tank, two shallow aquifer wells	1,755	32.9	1,387	88
Village of Mukwonago Municipal Water Utility	Addition of three shallow aquifer wells	2,195	77.7	2,676	170
Village of Pewaukee Water Utility	Addition of radium removal treatment at Well 5	671	29.8	1,057	67
Village of Sussex Public Water Utility	Addition of radium removal treatment at Well 1	693	35.7	673	43

Table 88 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Waukesha County (continued) Town of Brookfield Sanitary District No. 4	Addition of 0.35 MG reservoir	467	6.0	562	36
Village of Big Bend Planned Utility	Addition of two shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank	2,584	76.1	1,822	116
Village of Elm Grove Planned Utility	Addition of four treated deep aquifer wells, two with 0.15 MG reservoirs, two 0.30 MG elevated tanks	7,178	210.3	5,279	335
Village of Lannon Planned Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.75 MG elevated tank	3,098	117.9	2,381	151
Village of North Prairie Planned Utility	Addition of 0.50 MG elevated tank	878	19.5	592	38
Village of Wales Planned Utility	Addition of two shallow aquifer wells, 0.30 MG elevated tank	1,941	41.8	1,277	81
Town of Eagle-Eagle Spring Lake Area Planned Utility	Addition of one shallow aquifer well with 0.15 MG reservoir	853	5.2	454	29
Town of Oconomowoc-Okauchee Lake Area Planned Utility	Addition of four shallow aquifer wells, one with 0.15 MG reservoir, two 0.30 MG elevated tanks	4,110	116.6	2,899	184
Town of Ottawa-Pretty Lake Area Planned Utility	Addition of one shallow aquifer well with 0.10 MG reservoir	787	3.1	409	26
Town of Summit-Golden Lake Area Planned Utility	Addition of one shallow aquifer well with 0.10 MG reservoir	787	2.1	403	26
Land acquisition for wells and storage tanks	48 acres	3,360	- -	3,360	213
Subtotal	36 Wells, 28 Storage Tanks	60,353	1,948.0	68,803	4,365
Total	108 Wells, 105 Storage Tanks, Two Water Treatment Plant Expansions	172,011	5,364.6	182,862	11,605

[a] *All utilities' programs include water conservation programs.*

[b] *Costs presented are those associated with the costs for new, expanded, or upgraded facilities. The operation and maintenance costs are for increased incremental costs associated with new, expanded, or upgraded facilities and for water conservation measures. Alternative Plan 1 is being considered as the base for alternative plans evaluation.*

[c] *The estimated annual cost for water conservation is included as an operation and maintenance cost for all utilities.*

[d] *Water utilities which purchase water on a wholesale basis will have continued or increased costs for the purchase of water. For purposes of the cost-effectiveness analyses of the alternative water supply plans, only the incremental operation and maintenance cost associated with any increased water supply facility water production costs are considered. Alternative Plan 1 is being used as the base to which the other alternative plans will be compared. For this base alternative, only the operation and maintenance cost for new, expanded, or upgraded facilities are included. The cost for operation and maintenance of existing facilities which are common to all alternatives are not included for any alternatives.*

Footnotes to Table 88 (continued)

[e]There is expected to be an estimated average reduction of $376,000 per year for savings associated with existing residences which would be able to discontinue their point-of-entry water treatment systems in the Cities of Oak Creek and Franklin. However, there is also an expected cost involved in developing local water distribution systems. The cost savings due to discontinuation of the point-of-entry water treatment system and the costs of the local distribution systems are common to all alternative plans and are not specifically accounted for in this table.

[f]The annual O&M cost for the We Energies-Water Services Mequon and Thiensville service area includes an estimated average annual water production cost of $219,000 per year based upon the estimated incremental cost of $230 per million gallons for water production at the City of Milwaukee Water Works treatment process. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed cost and other costs. There is also expected to be an estimated average reduction of $1,520,000 per year for savings associated with existing residences which would be able to discontinue their point-of-entry water treatment systems. However, there are also expected costs involved in developing a local water distribution system. The cost savings due to discontinuation of the point-of-entry water treatment system and the cost of the local distribution system are common to all alternative plans and are not specifically accounted for in this table.

[g]Includes the Village of Sturtevant Water Utility which was purchased by the City of Racine Water and Wastewater Utility in 2007 and is now served by the City Utility on a retail basis.

[h]Includes the former Crestview Sanitary District and the former North Park Sanitary Districts which were consolidated in 2007 to form the Caledonia East Utility District.

[i]Includes the former Caddy Vista Sanitary District and the former Caledonia Utility District No. 1 which were consolidated in 2006 to form the Caledonia West Utility District.

[j]The annual O&M cost for the Northwest Caledonia Area does not include the incremental cost for water production, as that cost is included in the expanded City of Oak Creek Water Utility costs.

Source: Ruekert & Mielke, Inc., and SEWRPC.

cost of about $172.0 million and an annual operation and maintenance cost of about $5.4 million. Based upon an analysis period of 50 years and an annual interest rate of 6 percent, the estimated present worth cost of this alternative is about $182.9 million, and the equivalent annual cost is about $11.6 million.

Groundwater and Surface Water Impacts of Alternative Plan 1

The potential impacts of Alternative Plan 1 on the groundwater and surface water systems of the Region under the attendant pumping conditions to the design year were estimated using the regional aquifer simulation model under the groundwater pumping conditions for Alternative Plan 1 and by a parallel water budget analysis.

Groundwater Impacts in the Deep Aquifer

Simulated Water Levels in the Deep Aquifer

Results of the groundwater simulation modeling suggest that under Alternative Plan 1 conditions, additional drawdowns may be expected to occur in the deep aquifer over most of the Region. It should be noted that there will remain impacts on the deep aquifer from pumping in areas to the south of the Region in northeastern Illinois. These impacts can be seen on Map 74 and are most evident in Kenosha and Walworth Counties where those impacts appear to approximate 20 feet of drawdown due to pumping in areas located beyond the Region. For analysis, pumpage in northeastern Illinois was held at the year 2000 level for the planning period of 2000 through 2035. At the time that these analyses were conducted, no comprehensive areawide water supply plan was in place for the northeastern Illinois area. Therefore, no basis existed for forecasting potential changes in the pumpage concerned, and the impacts under future conditions may be somewhat different than those developed under this planning program. However, the relative differences between the alternative plans considered may be expected to be valid.

Table 89 summarizes the simulated drawdowns in the upper sandstone aquifer over the period 2005 to 2035. All model cells in the Southeastern Wisconsin Region show drawdowns over 2005 levels in the upper sandstone aquifer under Alternative Plan 1 conditions. Average drawdowns projected in this aquifer range from about 10 feet for cells showing drawdowns in Walworth County, to about 22 feet for cells showing drawdowns in Kenosha and Milwaukee Counties. Maximum drawdowns projected for this aquifer range from about 32 feet for cells showing drawdowns in Walworth County, to 64 feet for cells showing drawdowns in Washington County. Table 89 also indicates that the model results project no drawups in the upper sandstone aquifer will occur over the period 2005 to 2035 under Alternative Plan 1 conditions.

Table 90 summarizes the variation in drawdown in terms of the percentage of cells showing simulated drawdowns over the period 2005 to 2035 greater than the given thresholds. In much of the Region, drawdowns greater than 10 feet are common in the upper sandstone aquifer under Alternative Plan 1 conditions, ranging from about 48 percent of the cells in Walworth County to 100 percent of the cells in Kenosha, Milwaukee, and Racine Counties. Drawdowns in excess of 50 feet were found in Ozaukee, Washington, and Waukesha Counties, but accounted for less than a maximum 3 percent of cells in those Counties.

Map 74 shows the distribution of simulated drawdowns in the upper sandstone aquifer throughout the Region. The simulation results show additional drawdowns over 2005 levels in excess of five feet throughout most of the Region. The model projects one large area of greater additional drawdown, centered in the Village of Menomonee Falls, Waukesha County. The model also projects smaller, more localized areas with greater drawdowns over 2005 levels in western Racine County, central and southeastern Walworth County, and western Washington County.

Previous model results suggest that the top of the Sinnipee Group dolomite below the Maquoketa shale has become unsaturated as of the year 2000 in central Waukesha County.[7] The simulation shows similar results for

[7]*SEWRPC Technical Report No. 41,* op. cit.

Table 89

AVERAGE AND MAXIMUM SIMULATED DRAWDOWN AND DRAWUP IN THE UPPER SANDSTONE AQUIFER UNDER ALTERNATIVE PLAN 1 CONDITIONS: 2005-2035[a]

County	Drawdown			Drawup		
	Percent of Model Cells	Average (feet)	Maximum (feet)	Percent of Model Cells	Average (feet)	Maximum (feet)
Kenosha	100	21.9	49.5	0	0	0
Milwaukee	100	22.2	49.4	0	0	0
Ozaukee	100	14.6	62.0	0	0	0
Racine	100	17.3	34.5	0	0	0
Walworth	100	10.2	31.8	0	0	0
Washington	100	19.3	64.0	0	0	0
Waukesha	100	21.5	59.2	0	0	0

[a]*Results are from Layer 11 in the groundwater simulation model.*

Source: U.S. Geological Survey.

Table 90

SIMULATED DRAWDOWN IN THE UPPER SANDSTONE AQUIFER UNDER ALTERNATIVE PLAN 1 CONDITIONS: 2005-2035[a]

County	Percent of Model Cells Showing Drawdown Beyond Greater than:				
	One Foot	Five Feet	10 Feet	50 Feet	100 Feet
Kenosha	100.0	100.0	100.0	0.0	0.0
Milwaukee	100.0	100.0	100.0	0.0	0.0
Ozaukee	100.0	85.0	54.2	0.4	0.0
Racine	100.0	100.0	100.0	0.0	0.0
Walworth	93.2	63.9	48.4	0.0	0.0
Washington	100.0	93.1	77.1	2.6	0.0
Waukesha	100.0	95.8	84.9	1.4	0.0

[a]*Results are from Layer 11 in the groundwater simulation model.*

Source: U.S. Geological Survey.

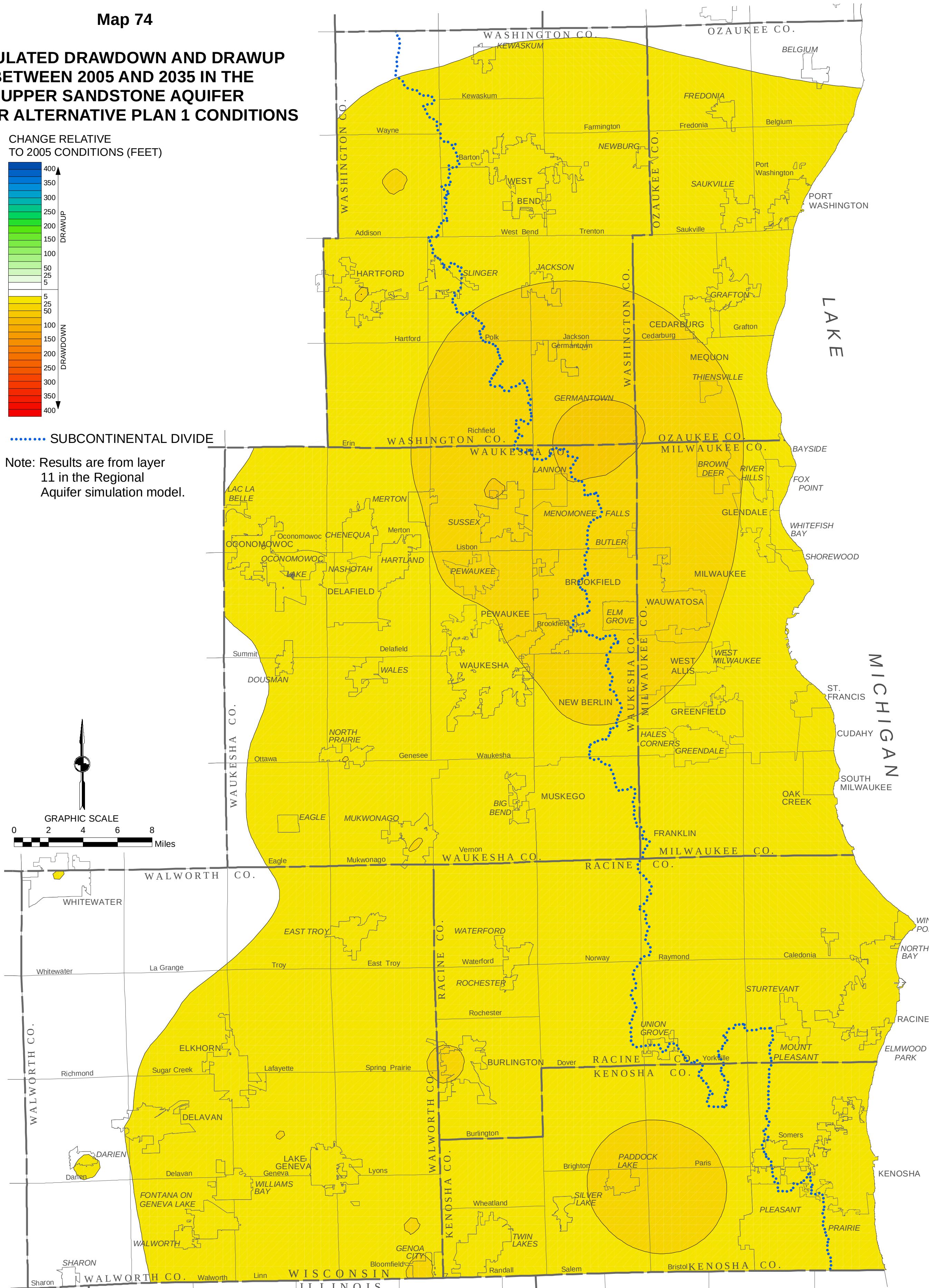
2035 under Alternative Plan 1 conditions, as shown on Map 75. An unsaturated condition at this depth, depending on how it might spread, could influence well yields and groundwater geochemistry around deep wells open to the Sinnipee Group, the St. Peter Formation, and below. Because of the model resolution and because the model does not explicitly simulate unsaturated flow, however, determination of the potential for this condition would require further more-detailed evaluation if such conditions are expected under the recommended plan.

Water Budget Analyses

Table 91 shows findings by County of a water budget analysis for the deep groundwater system under Alternative Plan 1 conditions. This analysis derived the anticipated values of two groundwater performance indicators—the demand to supply ratio and the human influence ratio—under Alternative Plan 1 conditions for the years 2005 and 2035. The analysis indicates that in 2005 the demand to supply ratio would range from about 0.10 in Kenosha County to about 5.77 in Waukesha County under Alternative Plan 1 conditions. Under these conditions, the values

Map 74

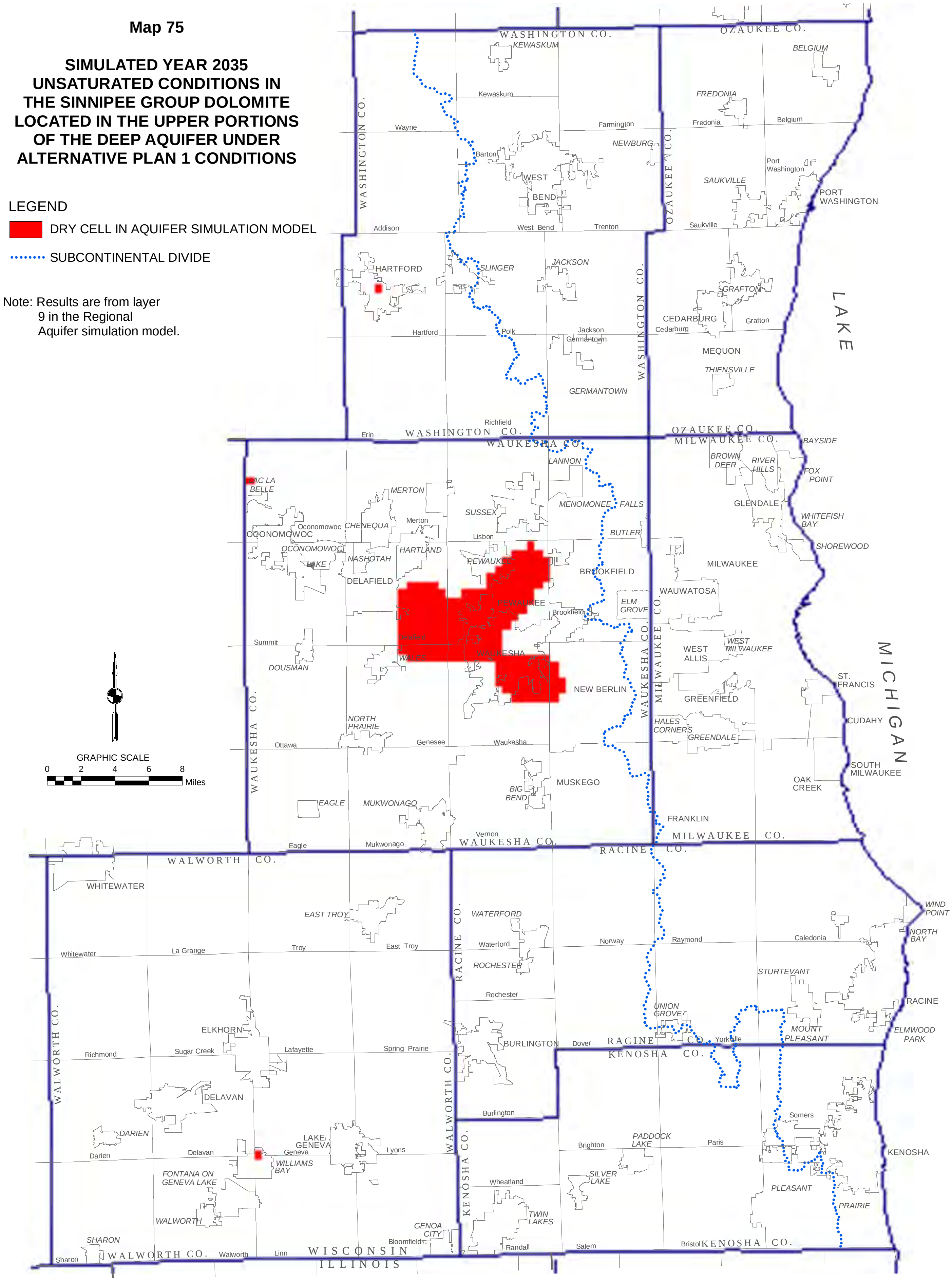
SIMULATED DRAWDOWN AND DRAWUP BETWEEN 2005 AND 2035 IN THE UPPER SANDSTONE AQUIFER UNDER ALTERNATIVE PLAN 1 CONDITIONS



Source: U.S. Geological Survey.

Map 75

SIMULATED YEAR 2035 UNSATURATED CONDITIONS IN THE SINNIPEE GROUP DOLOMITE LOCATED IN THE UPPER PORTIONS OF THE DEEP AQUIFER UNDER ALTERNATIVE PLAN 1 CONDITIONS



Source: U.S. Geological Survey.

Table 91

PROJECTED GROUNDWATER PERFORMANCE INDICATORS FOR THE SANDSTONE AQUIFERS UNDER ALTERNATIVE PLAN 1 CONDITIONS: 2005 AND 2035

County	Demand to Supply Ratio[a]		Human Influence Ratio[b]	
	2005	2035	2005	2035
Kenosha	0.101	0.539	-0.041	-0.204
Milwaukee	0.567	0.567	-0.197	-0.176
Ozaukee	1.040	1.075	-0.317	-0.302
Racine	1.963	2.293	-0.500	-0.555
Walworth	0.745	1.034	-0.326	-0.409
Washington	0.453	1.369	-0.191	-0.483
Waukesha	5.773	6.906	-0.881	-0.949

[a]*The demand to supply ratio is defined as the ratio of net pumping demand on an aquifer to the amount of water that is replenished at a given point in time. Generally, this indicator ranges from 0—representing no human impact—upward. Values over 1.0 indicate that more groundwater is being extracted than can be replaced in a long-term, sustainable fashion. The year 2005 and 2035 conditions for this indicator are compared to predevelopment conditions.*

[b]*The human impact ratio, is defined as the ratio of human-induced groundwater inflows to total inflows minus the ratio of human-induced groundwater outflows to total outflows. This indicator is an expression of the relative magnitude of human alteration of the groundwater system. Values range from minus 1.0 in areas where wells have become the only discharge from an aquifer by stopping all other groundwater discharges, through 0 representing no net human impact, to plus 1.0 representing situations where human additions are the only inputs to the aquifer. The year 2005 and 2035 conditions for this indicator are compared to predevelopment conditions.*

Source: University of Wisconsin-Milwaukee.

of the demand to supply ratio for Ozaukee, Racine, and Waukesha Counties in 2005 are expected to exceed one, indicating water budget deficits in the deep aquifer underlying these counties. The analysis also projects that under Alternative Plan 1 conditions the demand to supply ratio would range from about 0.54 in Kenosha County to about 6.91 in Waukesha County in 2035. Under these conditions, the values of this indicator are anticipated to increase in every County of the Region except Milwaukee County between 2005 and 2035. For 2035, the values of the demand to supply ratio for Ozaukee, Racine, Walworth, Washington, and Waukesha Counties exceed one, indicating water budget deficits in the deep aquifer underlying these Counties.

The analysis also indicates, as shown in Table 91, that in 2005 the human impact ratio would range from about minus 0.88 in Waukesha County to about minus 0.04 in Kenosha County under Alternative Plan 1 conditions and projects that in 2035 this indicator would range from about minus 0.95 in Waukesha County to about minus 0.18 in Milwaukee County under Alternative Plan 1 conditions. These values suggest that the net effect of human activities under these conditions would be to remove water from the deep groundwater system. In particular, the values for Waukesha County suggest that pumping dominates all outflows from deep aquifer in this County under Alternative Plan 1 conditions. In Kenosha, Racine, Walworth, Washington, and Waukesha Counties, the projected values of this indicator for 2035 are lower than the 2005 values, indicating that the influence of human withdrawals on the water budget of the deep groundwater would be expected to increase in these Counties under Alternative Plan 1 conditions. In Milwaukee and Ozaukee Counties, the projected values of this indicator for 2035 are higher than the 2005 values, indicating a reduction in the influence of human withdrawals on the water budget of the deep groundwater system would be expected in these Counties under Alternative Plan 1 conditions. Despite this anticipated reduction, under these conditions the deep groundwater systems in Milwaukee and Ozaukee Counties are anticipated to remain heavily influenced by human activities in 2035.

Groundwater Impacts in the Shallow Aquifer

As previously noted, except in those portions of the Region where the shallow aquifers are confined by overlying clay-rich glacial tills, the effects of alternative plans upon baseflow to surface water features will generally be more indicative of the impacts upon the shallow groundwater system than the associated changes in water levels in the sand and gravel and Silurian dolomite aquifers.

Impacts to Groundwater-Derived Baseflow to Surface Waters

On a Regional scale, simulated pumpage under Alternative Plan 1 conditions increased from about 77.1 mgd in 2005, to about 105.9 mgd in 2035, representing a total increase in pumping of 28.9 mgd. The model indicates that about 14.9 mgd, or about 52 percent, of this additional extracted water was derived from groundwater flow that in the absence of pumping would have discharged to surface water features. An additional about 7.9 mgd, or about 27 percent, was derived directly from surface water features due to reversed hydraulic gradients at the groundwater-surface water interface. The remaining about 6.1 mgd, or about 21 percent, was derived from release from storage in both unconfined and confined aquifers and cross-boundary flow into the planning area.

Major streams, rivers, and lakes in the surface water system in the Southeastern Wisconsin Region are represented in the model by 3,756 cells designated as stream nodes. The simulation model results indicated that under 2005 pumping conditions, about 92 percent of these nodes were receiving baseflow from groundwater, while about 5 percent were losing baseflow to groundwater. By 2035, these percentages would change slightly under Alternative Plan 1 conditions, with about 90 percent of these nodes expected to receive baseflow from groundwater, and about 7 percent losing baseflow to groundwater. As previously noted, the analyses conducted consider only the impacts on the groundwater-derived baseflow of the streamflow. Groundwater-derived baseflow typically comprises from 10 to 50 percent of total streamflow.

Table 92 summarizes simulated changes in baseflow to surface waters in the Southeastern Wisconsin Region under Alternative Plan 1 conditions over the period 2005 to 2035. In aggregate, by 2035 surface waterbodies in the Region may be expected to experience a baseflow depletion of about 15.9 mgd. The amounts of depletion would vary among the Counties, ranging from no baseflow depletion in Ozaukee County, to about 6.5 mgd in Waukesha County. Within the Region as a whole, about 9.9 mgd, or 62 percent, would result from inflow depletion. The remaining about 6.0 mgd, or 38 percent, would result from outflow depletion. These aggregate totals, however, obscure differences in site-specific baseflow changes within each County. While the County totals project overall depletions within each County, individual waterbodies may experience either depletion or augmentation on a site-specific basis.

Model nodes showing greater than 10 percent and greater than 25 percent baseflow depletion under Alternative Plan 1 conditions are shown on Maps 76 and 77, respectively. As previously noted, these data are considered as being valid when considered in aggregate for comparison of alternative plans. Model refinement would be needed for consideration of site-specific impacts. Several notable areas of baseflow depletion are indicated in the model results. Nodes for which the simulation analyses indicated greater than 10 percent baseflow reduction include those representing portions of Sauk Creek in Ozaukee County; the Root River Canal and its East and West Branches in Racine County; the Fox River between the City of Pewaukee and the Village of Mukwonago in Waukesha County including some portions of Vernon Marsh; the Wind Lake subwatershed of the Fox River watershed in Waukesha and Racine Counties, including Big Muskego, Little Muskego, and Wind Lakes and the Muskego and Wind Lake Drainage Canals; Lake Beulah in Walworth County; the Bark River between the City of Delafield and the Village of Dousman in Waukesha County; the White River in Walworth County; Darien Creek in Walworth County; and the Des Plaines River near Union Grove in Racine County. Maps 76 and 77 also highlight those streams which receive a significant amount of wastewater treatment plant effluent, and are, thus, somewhat less sensitive to reductions in baseflows. Most of the major rivers within the Region impacted by baseflow reductions do receive wastewater treatment plant effluent. Thus, from a quantity consideration, the baseflow reductions are mitigated. However, impacted headwater reaches, and smaller streams and related wetlands do not have such offsetting inflows.

Table 92

SIMULATED BASEFLOW DEPLETION TO SURFACE WATERS UNDER ALTERNATIVE PLAN 1 CONDITIONS: 2005-2035

Baseflow to Surface Water	2000 Baseflow (million gallons per day)	2035 Baseflow (million gallons per day)	Difference (million gallons per day)[a]	Percent Change[a]
Kenosha County				
Inflow to Surface Water	41.63	40.67	-0.96	-2.3
Outflow from Surface Water	0.40	1.11	-0.71	-177.2
Subtotal	41.23	39.56	-1.67	-4.1
Milwaukee County				
Inflow to Surface Water	11.45	11.35	-0.10	-0.8
Outflow from Surface Water	2.98	2.99	-0.01	-0.5
Subtotal	8.47	8.36	-0.11	-1.3
Ozaukee County				
Inflow to Surface Water	17.34	17.41	0.07	0.4
Outflow from Surface Water	0.46	0.53	-0.07	-14.2
Subtotal	16.88	16.88	0.00	0.0
Racine County				
Inflow to Surface Water	41.70	41.50	-0.20	-0.5
Outflow from Surface Water	0.07	0.52	-0.45	-664.6
Subtotal	41.63	40.98	-0.65	-1.6
Walworth County				
Inflow to Surface Water	104.00	101.49	-2.51	-2.4
Outflow from Surface Water	8.99	10.55	-1.56	-17.4
Subtotal	95.01	90.94	-4.07	-4.3
Washington County				
Inflow to Surface Water	63.52	61.45	-2.07	-3.3
Outflow from Surface Water	2.52	3.33	-0.81	-32.2
Subtotal	61.00	58.12	-2.88	-4.7
Waukesha County				
Inflow to Surface Water	89.55	85.42	-4.13	-4.6
Outflow from Surface Water	1.28	3.66	-2.38	-185.4
Subtotal	88.27	81.76	-6.51	-7.4
Southeastern Wisconsin Region				
Inflow to Surface Water	369.19	359.29	-9.90	-2.7
Outflow from Surface Water	16.70	22.69	-5.99	-35.9
Total	352.49	336.60	-15.89	-4.5

[a]*A positive difference or change represents augmentation of baseflow to surface waters, a negative difference or change represents depletion of baseflow to surface waters.*

Source: U.S. Geological Survey.

Model nodes simulated to show greater than 25 percent baseflow reduction include those representing upper portions of Sauk Creek in Ozaukee County; the East Branch of the Root River Canal in Racine County; portions of the Vernon Marsh in Waukesha County; upper portions of the Wind Lake subwatershed of the Fox River watershed in Waukesha and Racine Counties, including Big Muskego, Little Muskego, and Wind Lakes and the Muskego Canal and a portion of the Wind Lake Drainage Canal; and the Des Plaines River near Union Grove in Racine County.

Map 76

AQUIFER SIMULATION MODEL NODES WITH MORE THAN 10 PERCENT BASEFLOW DEPLETION OR BASEFLOW AUGMENTATION BETWEEN 2005 AND 2035 UNDER ALTERNATIVE PLAN 1 CONDITIONS

LEGEND

- SURFACE WATER FEATURES IN AQUIFER SIMULATION MODEL
- SUBCONTINENTAL DIVIDE
- MODEL NODES WITH MORE THAN 10 PERCENT BASEFLOW DEPLETION
- MODEL NODES WITH MORE THAN 10 PERCENT BASEFLOW AUGMENTATION
- MODEL NODES ON STREAM SYSTEM WHICH RECEIVES SEWAGE TREATMENT PLANT EFFLUENT

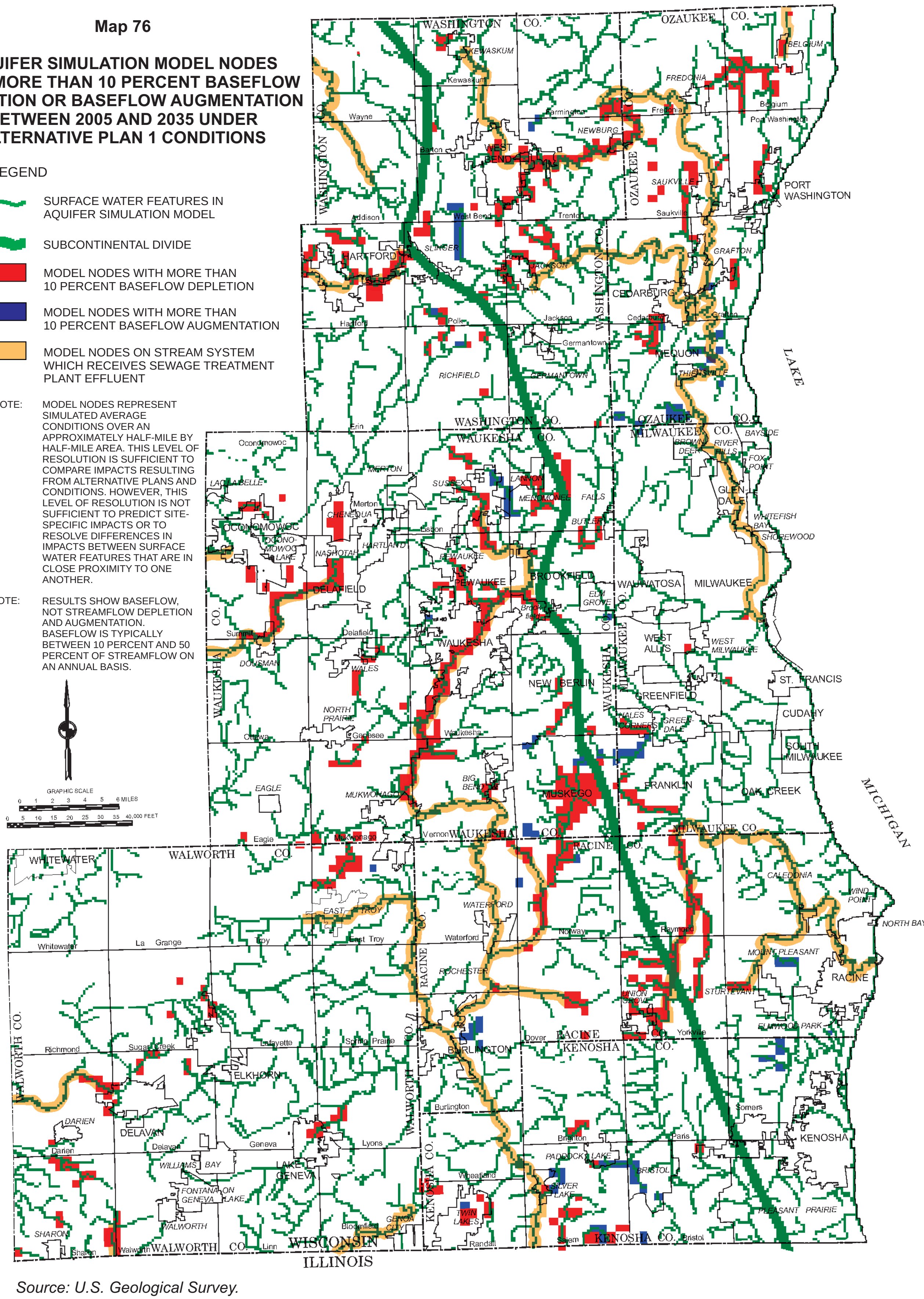
NOTE: MODEL NODES REPRESENT SIMULATED AVERAGE CONDITIONS OVER AN APPROXIMATELY HALF-MILE BY HALF-MILE AREA. THIS LEVEL OF RESOLUTION IS SUFFICIENT TO COMPARE IMPACTS RESULTING FROM ALTERNATIVE PLANS AND CONDITIONS. HOWEVER, THIS LEVEL OF RESOLUTION IS NOT SUFFICIENT TO PREDICT SITE-SPECIFIC IMPACTS OR TO RESOLVE DIFFERENCES IN IMPACTS BETWEEN SURFACE WATER FEATURES THAT ARE IN CLOSE PROXIMITY TO ONE ANOTHER.

NOTE: RESULTS SHOW BASEFLOW, NOT STREAMFLOW DEPLETION AND AUGMENTATION. BASEFLOW IS TYPICALLY BETWEEN 10 PERCENT AND 50 PERCENT OF STREAMFLOW ON AN ANNUAL BASIS.

GRAPHIC SCALE

0 1 2 3 4 5 6 MILES

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



Source: U.S. Geological Survey.

Map 77

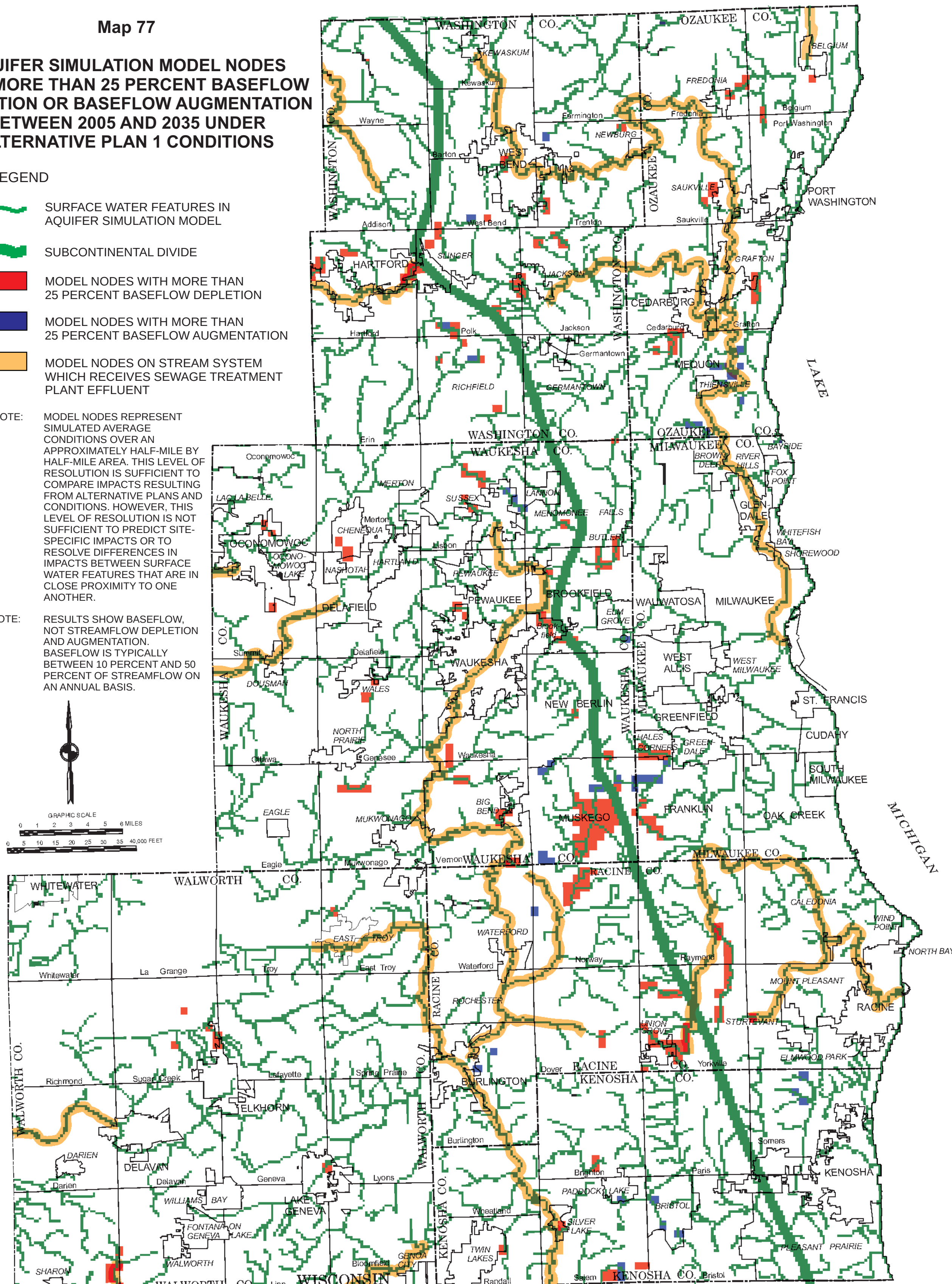
AQUIFER SIMULATION MODEL NODES WITH MORE THAN 25 PERCENT BASEFLOW DEPLETION OR BASEFLOW AUGMENTATION BETWEEN 2005 AND 2035 UNDER ALTERNATIVE PLAN 1 CONDITIONS

LEGEND

- SURFACE WATER FEATURES IN AQUIFER SIMULATION MODEL
- SUBCONTINENTAL DIVIDE
- MODEL NODES WITH MORE THAN 25 PERCENT BASEFLOW DEPLETION
- MODEL NODES WITH MORE THAN 25 PERCENT BASEFLOW AUGMENTATION
- MODEL NODES ON STREAM SYSTEM WHICH RECEIVES SEWAGE TREATMENT PLANT EFFLUENT

NOTE: MODEL NODES REPRESENT SIMULATED AVERAGE CONDITIONS OVER AN APPROXIMATELY HALF-MILE BY HALF-MILE AREA. THIS LEVEL OF RESOLUTION IS SUFFICIENT TO COMPARE IMPACTS RESULTING FROM ALTERNATIVE PLANS AND CONDITIONS. HOWEVER, THIS LEVEL OF RESOLUTION IS NOT SUFFICIENT TO PREDICT SITE-SPECIFIC IMPACTS OR TO RESOLVE DIFFERENCES IN IMPACTS BETWEEN SURFACE WATER FEATURES THAT ARE IN CLOSE PROXIMITY TO ONE ANOTHER.

NOTE: RESULTS SHOW BASEFLOW, NOT STREAMFLOW DEPLETION AND AUGMENTATION. BASEFLOW IS TYPICALLY BETWEEN 10 PERCENT AND 50 PERCENT OF STREAMFLOW ON AN ANNUAL BASIS.



Source: U.S. Geological Survey.

Maps 76 and 77 also depict model nodes which show potential augmentations of baseflow under Alternative Plan 1 conditions greater than 10 percent and greater than 25 percent, respectively. As previously noted, these results are considered to be valid for the purpose of comparing alternative plans. Additional analyses would be needed for consideration of site-specific impacts. Several notable areas of baseflow augmentation are indicated by the model results. Nodes for which simulation analyses indicated greater than 10 percent potential baseflow augmentation include those representing Little Cedar Lake and portions of Cedar Creek downstream from Little Cedar Lake in Washington County; Trinity Creek in Ozaukee County; Lake Denoon in Waukesha County; Tess Corners Creek in Milwaukee County; Browns Lake in Racine County; and Silver Lake and Salem Branch in Kenosha County.

Model nodes simulated to show greater than 25 percent potential baseflow augmentation include those representing Trinity Creek in Ozaukee County; Lake Denoon in Waukesha County; and Tess Corners Creek in Milwaukee County.

These simulated baseflow reductions and augmentations need to be carefully interpreted. As noted above, the groundwater model simulates changes in baseflow, not changes in total streamflow. A change in baseflow does not necessarily indicate a change in total streamflow. For example, in some streams much of a reduction in baseflow may be returned to the surface water system through discharge from wastewater treatment plants. This is the case for the Fox River where 15 municipal wastewater treatment plants discharge treated effluent into the River or its tributaries. Increase in runoff due to changes in land use may also serve to augment streamflow in streams experiencing baseflow reductions. In addition, because of the resolution provided by the model grid, any simulated change in baseflow represents an average change over a significant area. Because variations may occur within the area represented by a model cell, this average may not be totally representative of individual surface water features within the cell, particularly small surface water features in cells containing multiple surface water features.

Simulated baseflow changes between 2005 and 2035 were evaluated at 100 model nodes representing surface water evaluation sites. Decreases in baseflow under Alternative Plan 1 conditions were found to occur at 74 evaluation sites, or 74 percent of evaluation sites; with decreases in excess of 10 percent of 2005 baseflow found at 19, or 19 percent, of these sites; and simulated decreases in excess of 25 percent of 2005 baseflow found at six, or 6 percent, of these sites. Increases in baseflow were found to occur at 14 evaluation sites, or 14 percent of evaluation sites, with increases in excess of 10 percent of 2005 baseflow found at four, or 4 percent, of these sites; and increases in excess of 25 percent of 2005 baseflow found at three, or 3 percent, of these sites. The remaining 12 evaluation sites, or 12 percent of evaluation sites, were found to either experience no change in baseflow or were not simulated as having streamflow in 2005.

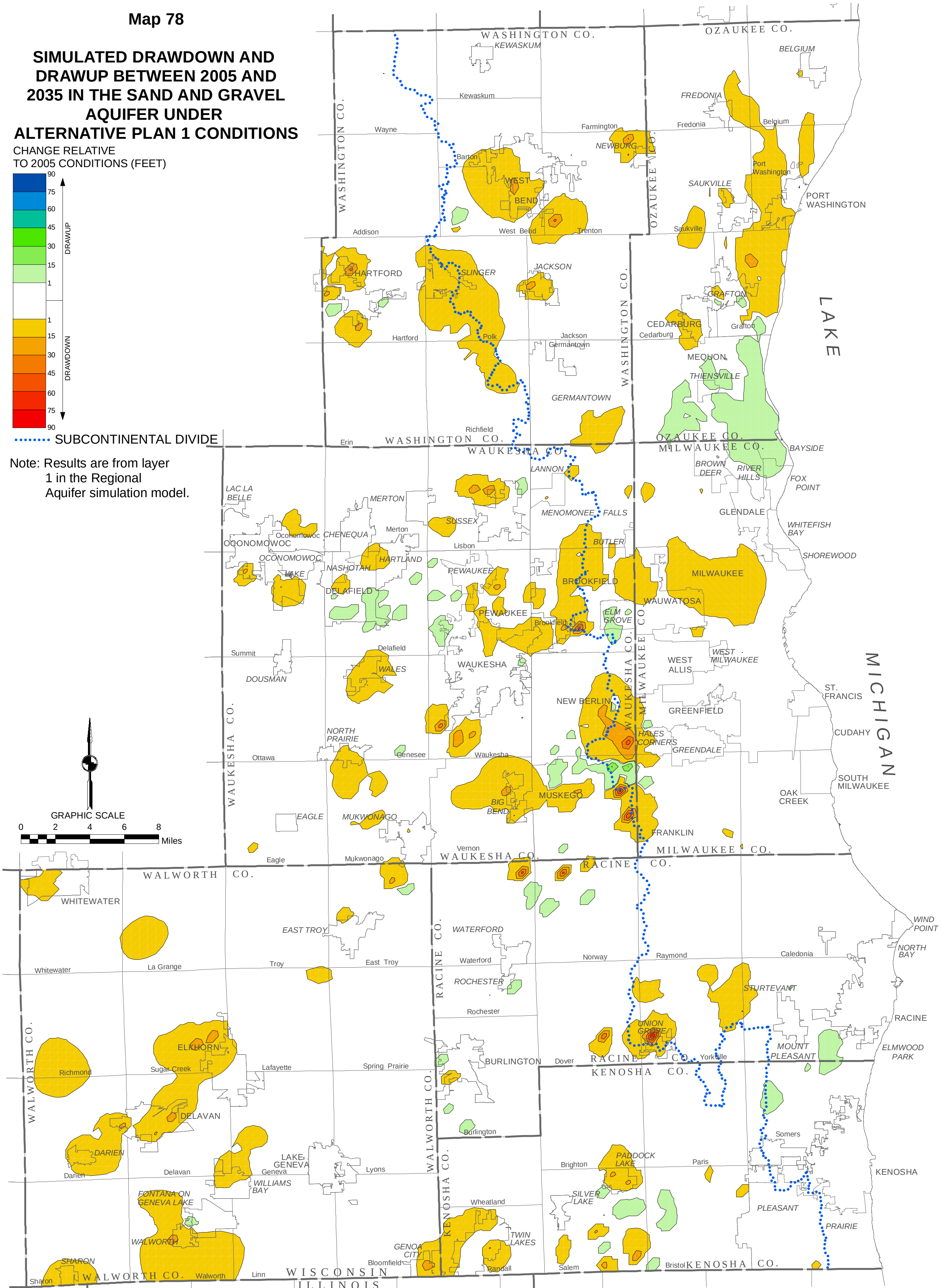
Simulated Water Levels in the Shallow Aquifer

The results of the simulation modeling indicate that under Alternative Plan 1 conditions, additional drawdowns may be expected to occur in the shallow aquifer over much of the Region. These impacts are shown on Maps 78 and 79. Table 93 provides a summary of the simulated drawdowns and drawups in the glacial sand and gravel aquifer over the period 2005 to 2035. The percentage of cells in the model showing drawdowns over 2005 levels ranges from about 59 percent in Kenosha County to about 96 percent in Walworth County. Average drawdowns projected in this aquifer are relatively small, ranging from about 0.6 foot for cells showing drawdowns in Kenosha and Milwaukee Counties, to about 1.2 feet for cells showing drawdowns in Waukesha County, the cells being about one-quarter square mile in area. This reflects, in part, the damping effect that surface waters have on changes in the shallow groundwater system. Often the major effect of pumping from shallow wells is to reduce groundwater discharge to local surface water features. The maximum drawdowns projected for this aquifer are considerably higher, ranging from about six feet for cells showing drawdowns in Milwaukee County to about 76 feet for cells showing drawdowns in Racine County.

Table 94 summarizes the variation among model cells in terms of the percentage of the cells showing simulated drawdowns over the period 2005 to 2035 greater than the given thresholds. In much of the Region, drawdowns

Map 78

SIMULATED DRAWDOWN AND DRAWUP BETWEEN 2005 AND 2035 IN THE SAND AND GRAVEL AQUIFER UNDER ALTERNATIVE PLAN 1 CONDITIONS

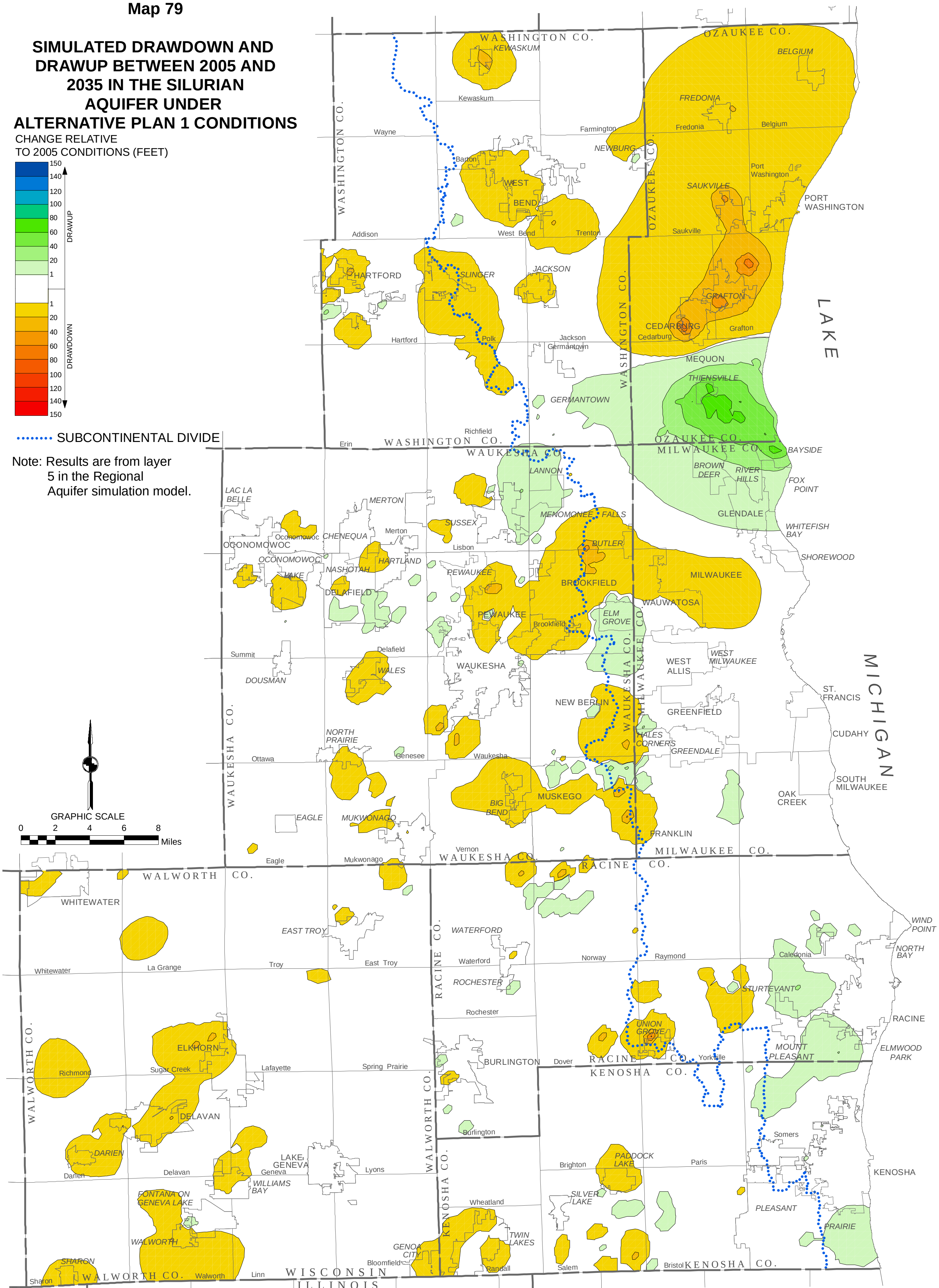


Note: Results are from layer 1 in the Regional Aquifer simulation model.

Source: U.S. Geological Survey.

Map 79

SIMULATED DRAWDOWN AND DRAWUP BETWEEN 2005 AND 2035 IN THE SILURIAN AQUIFER UNDER ALTERNATIVE PLAN 1 CONDITIONS



Source: U.S. Geological Survey.

Table 93

AVERAGE AND MAXIMUM SIMULATED DRAWDOWN AND DRAWUP IN THE GLACIAL SAND AND GRAVEL AQUIFER UNDER ALTERNATIVE PLAN 1 CONDITIONS BY COUNTY: 2005-2035[a]

County	Drawdown			Drawup		
	Percent of Model Cells	Average (feet)	Maximum (feet)	Percent of Model Cells	Average (feet)	Maximum (feet)
Kenosha	59.0	0.6	30.4	41.0	0.2	8.2
Milwaukee	76.6	0.6	6.0	23.4	0.4	5.3
Ozaukee	78.5	0.9	27.6	21.5	1.4	9.4
Racine	62.8	0.7	75.8	37.2	0.2	9.0
Walworth	96.0	0.6	29.5	4.0	0.1	3.8
Washington	92.1	0.8	34.6	7.9	0.2	4.0
Waukesha	79.6	1.2	63.9	20.4	0.6	30.8

[a]*Results are from Layer 1 in the groundwater simulation model.*

Source: U.S. Geological Survey.

Table 94

SIMULATED DRAWDOWN IN THE GLACIAL SAND AND GRAVEL AQUIFER UNDER ALTERNATIVE PLAN 1 CONDITIONS BY COUNTY: 2005-2035[a]

County	Percent of Model Cells Showing Drawdown Beyond Greater than:				
	One Foot	Five Feet	10 Feet	50 Feet	100 Feet
Kenosha	6.3	1.4	0.8	0.0	0.0
Milwaukee	12.0	0.1	0.0	0.0	0.0
Ozaukee	15.7	3.0	0.7	0.0	0.0
Racine	5.1	1.9	0.7	0.2	0.0
Walworth	13.5	2.1	0.7	0.0	0.0
Washington	14.1	3.3	1.0	0.0	0.0
Waukesha	15.5	4.9	2.2	0.1	0.0

[a]*Results are from Layer 1 in the groundwater simulation model.*

Source: U.S. Geological Survey.

greater than 10 feet are relatively rare in the shallow aquifer under Alternative Plan 1 conditions. None of the model cells in Milwaukee County and fewer than 1 percent of the model cells in Kenosha, Ozaukee, Racine, and Walworth Counties indicate drawdowns in excess of 10 feet. Drawdowns in excess of 10 feet were more common in Washington and Waukesha Counties, ranging from 1 percent of the cells in Washington County to about 2 percent of cells in Waukesha County.

Model cells showing simulated drawdowns were distributed throughout the Region; however, there were areas that exhibited a high proportion of cells with drawdowns greater than one foot. These areas included western Kenosha County; eastern Ozaukee County; northern Milwaukee County; south-central Racine County; western Walworth County; and central Washington County. Areas with a high proportion of cells showing drawdowns greater than one foot are also scattered throughout Waukesha County as shown on Map 78.

Table 93 also summarizes simulated drawups in the glacial aquifer over the period 2005 to 2035. The percentage of cells in the model showing drawups over 2005 levels ranges from about 4 percent in Walworth County to about 41 percent in Kenosha County. Average drawups projected in this aquifer are relatively small, ranging from 0.1 foot for cells showing drawups in Walworth County, to 1.4 feet for cells showing drawups in Ozaukee County. Maximum simulated drawups in this aquifer range from about four feet in Walworth and Washington Counties to about 31 feet in Waukesha County. While model cells showing simulated drawups in the glacial aquifer were distributed throughout the Region, areas containing high proportions of cells showing drawups greater than one foot were found mostly along the Milwaukee-Ozaukee county line and in central and eastern Waukesha County.

Table 95 presents a summary of simulated drawdowns and drawups in the Silurian aquifer over the period 2005 to 2035. The percentage of cells in the model showing drawdowns over 2005 levels ranges from about 61 percent in Kenosha County, to over 98 percent in Walworth County. With one exception—Ozaukee County—average drawdowns projected in this aquifer are relatively small, ranging from about 0.6 foot for cells showing drawdowns in Kenosha, Milwaukee, and Walworth Counties, to about 1.5 feet for cells showing drawdowns in Waukesha County. As already noted, the small average drawdown in this aquifer over most of the Region reflects, in part, the damping effect that surface waters have on changes in the shallow groundwater system.

Maximum drawdowns projected for the Silurian aquifer are considerably higher than the average drawdowns, ranging from about six feet for cells showing drawdowns in Milwaukee County, to almost 79 feet for cells showing drawdowns in Ozaukee County. Table 96 summarizes the variation among the model cells in terms of the percentage of the cells showing simulated drawdowns over the period 2005 to 2035 greater than the given thresholds. In much of the Region, drawdowns greater than 10 feet are relatively rare in the Silurian aquifer under Alternative Plan 1 conditions. Fewer than 2 percent of cells in Kenosha, Milwaukee, Racine, Walworth, and Washington Counties showed drawdowns in excess of 10 feet. Drawdowns in excess of 10 feet were more common in Ozaukee and Waukesha Counties, ranging from less than 3 percent of cells in Waukesha County to over 22 percent of cells in Ozaukee County. Model cells showing simulated drawdowns were distributed throughout the Region; however, there were areas that exhibited a high proportion of cells with drawdowns greater than one foot. At the resolution of the model, these areas include western Kenosha County, northern and central portions of Ozaukee County, western Milwaukee County, southern Racine County, western Walworth County, and central Washington County. Areas with high proportions of cells showing drawdowns greater than one foot are also scattered throughout Waukesha County.

Table 95 also summarizes simulated drawups in the Silurian aquifer over the period 2005 to 2035. The percentage of cells in the model showing drawups over 2005 levels ranges from about 2 percent in Walworth County to about 40 percent in Racine County. With one exception—Ozaukee County—average drawups projected in this aquifer are relatively small, ranging from about 0.2 foot for cells showing drawups in Walworth County to about 4.6 feet for cells showing drawups in Milwaukee County. Maximum simulated drawups in this aquifer range from about five feet in Walworth County to about 73 feet in Ozaukee County. While model cells showing simulated drawups in the Silurian aquifer were distributed throughout the Region, areas that contain a high proportion of cells showing drawups greater than one foot were found in southern Ozaukee County, in northern Milwaukee County along the Milwaukee-Ozaukee county line, and in eastern Waukesha County. Much of the simulated drawup in southern Ozaukee and northern Milwaukee Counties probably results from the shifting of the source of water supply in Mequon from areas served by public sanitary sewer system private wells to Lake Michigan as envisioned under Alternative Plan 1. Smaller areas containing high proportions of cells showing drawups greater than one foot were found in northwestern Racine County and in eastern Racine and Kenosha Counties.

Water Budget Analysis

Table 97 shows results by County from a water budget analysis for the shallow groundwater system under Alternative Plan 1 conditions. This analysis derived the anticipated values of three groundwater performance indicators—the demand to supply ratio, the human influence ratio, and the baseflow reduction index—under Alternative Plan 1 conditions for the years 2005 and 2035. The analysis indicates that in 2005 the demand to supply ratio would range from about 0.04 in Walworth County to about 0.20 in Ozaukee County under

Table 95

AVERAGE AND MAXIMUM SIMULATED DRAWDOWN AND DRAWUP IN THE SILURIAN AQUIFER UNDER ALTERNATIVE PLAN 1 CONDITIONS: 2005-2035[a]

County	Drawdown			Drawup		
	Percent of Model Cells	Average (feet)	Maximum (feet)	Percent of Model Cells	Average (feet)	Maximum (feet)
Kenosha	61.1	0.6	31.2	38.9	0.8	19.7
Milwaukee	63.2	0.6	6.1	36.8	4.6	71.7
Ozaukee	82.0	8.9	79.0	18.0	28.1	73.2
Racine	59.7	0.7	62.7	40.3	0.9	26.6
Walworth	98.1	0.6	39.4	1.9	0.2	5.0
Washington	89.0	1.0	28.6	11.0	1.1	27.2
Waukesha	81.0	1.5	50.0	19.0	1.5	27.0

[a]*Results are from Layer 5 in the groundwater simulation model.*

Source: U.S. Geological Survey.

Table 96

SIMULATED DRAWDOWN IN THE SILURIAN AQUIFER UNDER ALTERNATIVE PLAN 1 CONDITIONS: 2005-2035[a]

County	Percent of Model Cells Showing Drawdown Beyond Greater than:				
	One Foot	Five Feet	10 Feet	50 Feet	100 Feet
Kenosha	6.8	1.4	0.6	0.0	0.0
Milwaukee	11.7	0.4	0.0	0.0	0.0
Ozaukee	77.7	44.0	22.4	0.2	0.0
Racine	6.2	1.3	0.6	0.1	0.0
Walworth	14.0	2.1	0.7	0.0	0.0
Washington	20.6	3.7	1.2	0.0	0.0
Waukesha	20.5	6.6	2.6	0.0	0.0

[a]*Results are from Layer 5 in the groundwater simulation model.*

Source: U.S. Geological Survey.

Alternative Plan 1 conditions. The analysis projects that in 2035 this indicator would range from about 0.07 in Racine County to about 0.19 in Ozaukee County under Alternative Plan 1 conditions. While increases in this indicator are projected to occur in Kenosha, Racine, Walworth, Washington, and Waukesha Counties, all values of the demand to supply ratio for the shallow aquifer are projected to be well below 1.0, indicating little evidence of a water budget deficit in the shallow aquifer.

The analysis also indicates that in 2005 the human impact ratio would range from about minus 0.19 in Ozaukee County to about minus 0.04 in Walworth County under Alternative Plan 1 conditions. The analysis projects that in 2035 this indicator would range from about minus 0.18 in Ozaukee County to about minus 0.07 in Racine County under Alternative Plan 1 conditions. These values suggest that the net effect of human activities under these conditions would be to remove water from the shallow groundwater system. In Kenosha, Racine, Walworth, Washington, and Waukesha Counties, the projected values of this indicator for 2035 are lower than the 2005

Table 97

PROJECTED GROUNDWATER PERFORMANCE INDICATORS FOR THE GLACIAL SAND AND GRAVEL AND SILURIAN DOLOMITE AQUIFERS UNDER 2005 AND 2035 ALTERNATIVE PLAN 1 CONDITIONS

County	Demand to Supply Ratio[a]		Human Influence Ratio[b]		Baseflow Reduction[c] from 2005 Levels percent
	2005	2035	2005	2035	2035
Kenosha	0.047	0.089	-0.047	-0.087	-5.0
Milwaukee	0.159	0.131	-0.150	-0.127	0.2
Ozaukee	0.199	0.188	-0.188	-0.183	1.6
Racine	0.061	0.073	-0.060	-0.072	-1.6
Walworth	0.045	0.077	-0.044	-0.075	-5.2
Washington	0.083	0.118	-0.081	-0.115	-4.6
Waukesha	0.089	0.141	-0.086	-0.137	-7.6

[a]The demand to supply ratio is defined as the ratio of net pumping demand on an aquifer to the amount of water that is replenished at a given point in time. Generally, this indicator ranges from 0—representing no human impact—upward. Values over 1.0 indicate that more groundwater is being extracted than can be replaced in a long-term, sustainable fashion. The year 2005 and 2035 conditions for this indicator are compared to predevelopment conditions.

[b]The human impact ratio, is defined as the ratio of human-induced groundwater inflows to total inflows minus the ratio of human-induced groundwater outflows to total outflows. This indicator is an expression of the relative magnitude of human alteration of the groundwater system. Values range from minus 1.0 in areas where wells have become the only discharge from an aquifer by stopping all other groundwater discharges, through 0 representing no net human impact, to plus 1.0 representing situations where human additions are the only inputs to the aquifer. The year 2005 and 2035 conditions for this indicator are compared to predevelopment conditions.

[c]The base flow reduction index is defined as the ratio of the change in groundwater-derived baseflow discharge due to pumping to the groundwater-derived baseflow at a defined base time. The year 2035 conditions for this indicator are compared to year 2005 conditions.

Source: University of Wisconsin-Milwaukee.

values, indicating that the influence of human withdrawals on the water budget of the shallow groundwater would be expected to increase in these Counties under Alternative Plan 1 conditions. In Milwaukee and Ozaukee Counties, the projected values of this indicator for 2035 are higher than the 2005 values, indicating that a reduction in the influence of human withdrawals on the water budget of the shallow groundwater system may be expected in these Counties under Alternative Plan 1 conditions. Despite the anticipated reductions, the shallow groundwater systems in Milwaukee and Ozaukee Counties are anticipated to remain more heavily influenced by human activities in 2035 than those in most of the other counties of the Region.

Finally, the analysis indicates that in 2035 the baseflow reduction index would range from a minus 7.6 percent in Waukesha County to a plus 1.6 percent in Ozaukee County. Under Alternative Plan 1 conditions, the value of the baseflow reduction index in Kenosha, Racine, Walworth, Washington, and Waukesha Counties in 2035 is anticipated to be less than zero, indicating that reductions in average groundwater-derived baseflow to surface waters could be expected. The positive value of the indicator in Milwaukee and Ozaukee Counties indicates that the average level of groundwater-derived baseflow to surface waters in these Counties may be expected to increase under Alternative Plan 1 conditions. It should be noted that these are countywide averages developed for purposes of comparing alternative plans at the systems level of planning. Within any county, changes in baseflow may be expected to vary among waterbodies. It should be noted that a change in baseflow does not indicate a change in total streamflow. The index only considers the groundwater component of streamflow. The impact on streamflow will typically be less in terms of percent reduction or increase. For those streams which receive discharges of sewage treatment plant effluent, the baseflow and streamflow amounts will be artificially increased and make surface water flows less sensitive to changes in groundwater-derived baseflow. Finally, it should be noted that for all seven Counties, the 2005 and 2035 magnitudes of average baseflow reduction under Alternative Plan 1 conditions are less than 10 percent, suggesting small average reductions relative to 2005 conditions.

Other Surface Water Impacts

For most of the utilities within the Region, Alternative Plan 1 makes use of expanded sources of groundwater that are similar to the existing sources. Because of this, it is anticipated that this alternative will produce few changes in surface water quality within the Region, other than those associated with changes in groundwater-derived baseflows.

Conclusions Concerning Groundwater and Surface Water Impacts of Alternative Plan 1

The results of the simulation modeling indicate that under Alternative Plan 1 conditions, additional drawdowns of the deep aquifer may be expected to occur in all of the model cells in the Region over the plan design period. The magnitude of the average drawdowns over 2005 conditions in this aquifer may be expected to range between 10 and 22 feet by county. The maximum drawdown over 2005 conditions in this aquifer may be expected to approximate 64 feet in the vicinity of the Village of Germantown in Washington County. In all counties of the Region, drawdowns over 2005 conditions in excess of 10 feet may be expected to be common. The drawdowns expected in Kenosha and Walworth Counties are due, in part, to the influence of groundwater use in northeastern Illinois. Water budget analyses indicate that the deep groundwater system is likely to be heavily influenced by human activities under Alternative Plan 1 conditions, with the net effect of human activities being to remove water from the deep groundwater system. This analysis also indicates that most counties of the Region may experience water budget deficits in the deep aquifer under Alternative Plan 1 conditions.

Although the results of the simulation modeling indicate that average drawdowns over 2005 conditions in the deep aquifer system in much of the Region under Alternative Plan 1 are expected to be on the order of 10 to 22 feet, some local areas may be expected to experience much greater drawdowns. For example, areas of drawdown in excess of 50 feet may be expected to occur in the Village of Germantown under Alternative Plan 1 conditions as shown on Map 74. These areas of higher drawdown appear to result, at least in part, from the addition of three deep municipal wells in and around the Village as envisioned under Alternative Plan 1.

On a regional scale, groundwater pumpage under Alternative Plan 1 conditions may be expected to increase 29 mgd to about 106 mgd between 2005 and 2035. The model indicates that about one-half of this additional extracted water will be derived from groundwater flow that in the absence of pumping would have discharged to surface water features, and about 27 percent will be derived directly from surface water features due to reversed hydraulic gradients at the groundwater-surface water interface. The impact of pumping on surface waters can be represented as groundwater-derived baseflow depletion. Groundwater-derived baseflow is the amount of flow in the waterbody from upgradient groundwater discharge. The overland component of total streamflow and any discharge of treated wastewater are not included in baseflow, and the simulation modeling results do not include it, or account for, these components. Typically baseflow represents about 10 percent to 50 percent of streamflow on an annual basis. In aggregate, by 2035 surface waterbodies in the Region may be expected to experience a baseflow depletion relative to 2005 conditions of about 16 mgd, or about 5 percent. On average, baseflow reduction under Alternative Plan 1 conditions are less than 10 percent, suggesting small average reductions relative to 2005 conditions. This aggregate total and average, however, obscure differences in baseflow changes among specific sites within each county. While the county totals project overall depletions within each county, individual waterbodies may experience either depletion or augmentation. The reductions in groundwater-derived baseflow at 19 of 100 surface water evaluation sites were in excess of 10 percent.

The results of the simulation indicate that under Alternative Plan 1 conditions, additional drawdowns over 2005 conditions may be expected to occur in the shallow aquifer over much of the Region. However, the magnitude of the drawdowns is estimated to be relatively small; in most Counties, the drawdown may be expected to average less than 1.5 feet in both sand and gravel and the Silurian portions of the shallow aquifer. The relatively small magnitude of the drawdown may be attributed to the buffering effects of surface water baseflow interactions.

In the glacial sand and gravel aquifer, additional drawdowns may be expected to occur in 59 percent to 96 percent of model cells by county over the period 2005 to 2035. The magnitude of average drawdowns over 2005 conditions in this aquifer was found to be small, less than 1.5 feet in all counties of the Region. While the maximum drawdown over 2005 conditions in this aquifer may be expected to be about 76 feet, only a small percentage of model cells were simulated to experience drawdowns over 2005 conditions in excess of 10 feet. With some exceptions, similar impacts were simulated to occur in the Silurian dolomitic aquifer. Additional drawdowns may be expected to occur in this aquifer in 61 percent to 98 percent of model cells by county over the planning period. While the maximum drawdown over 2005 conditions in this aquifer was simulated to be about 79 feet, only a small percentage of model cells in most counties were simulated to experience drawdowns over 2005 conditions in excess of 10 feet. Water budget analyses indicate that in most counties of the Region, the influence of human activities on the shallow groundwater system will increase under Alternative Plan 1 conditions. In those counties in which the influence of human activities are expected to decrease, the shallow groundwater system will remain heavily influenced by human activities. While the net effect of human activities in all counties of the Region will result in the removal of water from the shallow groundwater system, there is little evidence that a water budget deficit will occur where more groundwater will be extracted than can be replaced in a long-term sustainable fashion in the shallow groundwater system. This is likely due, in large part, to the buffering effects of surface waters.

Although the results of the simulation indicate that the changes in the shallow aquifer system are expected to be relatively small in much of the Region under Alternative Plan 1 conditions, some larger changes may be expected to occur. Most of central and northern Ozaukee County may be expected to experience additional drawdowns in the Silurian dolomitic aquifer, in excess of 10 feet in much of the County and in excess of 50 feet in some locations. These drawdowns appear to result, at least in part, from both the continued reliance upon the shallow groundwater system as a major source of water supply in much of this County, and the addition of five shallow municipal wells that are envisioned in Alternative Plan 1. By contrast, the simulation modeling results indicate that large drawups may be expected to occur in the Silurian dolomitic aquifer under Alternative Plan 1 conditions in southern Ozaukee and northern Milwaukee Counties. These drawups may be attributed to shifting the source of water supply in areas served by the public sanitary sewer system in Mequon from private wells to Lake Michigan as envisioned under Alternative Plan 1.

Plan Description—Alternative Plan 2: Design Year 2035 Forecast Conditions with Limited Expansion of Lake Michigan and Shallow Groundwater Aquifer Supplies

This future 2035 condition alternative plan scenario is similar to Alternative Plan 1, but incorporates a limited expansion in the use of Lake Michigan water in selected areas located east of the subcontinental divide, consisting of the Village of Germantown Water Utility, the eastern portion of the City of Brookfield Municipal Water Utility service area, the Town of Yorkville Utility District No. 1, and the Village of Elm Grove; and located west of, or straddling, that divide where a return flow component currently exists, namely, the central portion of the City of New Berlin Water Utility and the City of Muskego Public Water Utility sanitary sewerage service areas. All of these areas currently have a return flow component through their sanitary sewerage systems which are connected to the Milwaukee Metropolitan Sewerage District sewerage system or, in the case of the Town of Yorkville Utility District No 1, a return flow via a local sewerage system discharging treated effluent to a Lake Michigan tributary. Reliance is placed on groundwater as a source for most of the other utility systems in a manner similar to Alternative Plan 1. However, this alternative plan assumes changes in the aquifers used as sources of supply, through new wells or modifications of existing wells, or provision of treatment, in situations where groundwater quality problems exist, such as radium removal. Alternative Plan 2 includes the following components:

- For most utilities existing or committed year 2007 water supply and treatment facilities where no existing or potential water quantity or quality conditions problems indicate changes are needed;
- Water conservation program implementation at the same levels assumed under Alternative Plan 1;
- Implementation of current regulatory programs relating to stormwater runoff and infiltration as also assumed under Alternative Plan 1;

- Conversion to Lake Michigan as a source of supply for selected utilities, or portions of utility service areas located east of the subcontinental divide, consisting of the Village of Germantown Water Utility, the eastern portion of the City of Brookfield Municipal Water Utility service area, the Town of Yorkville Utility District No. 1, and the Village of Elm Grove; and for utilities located west of, or straddling, that divide, which currently have a return flow to Lake Michigan, consisting of the central portion of the City of New Berlin Water Utility, and the City of Muskego Public Water Utility located in the Milwaukee Metropolitan Sewerage District sanitary sewer service areas;

- For all systems expected to rely on groundwater as a source of supply, expanded sources of supply and/or treatment of existing groundwater sources are included as needed to meet 2035 forecast water demands. The expanded sources are similar to the existing sources for each water utility as under Alternative Plan 1, except where existing or potential water quality problems may exist which require treatment, such as radium removal. In such cases, local plans, if available, or staff judgments were used to select alternative groundwater-based sources which were considered a viable option. In the case of the City of Waukesha, under Alternative Plan 2, the groundwater pumpage was shifted to the shallow aquifer for the portion of the deep aquifer pumpage requiring treatment for radium removal. For purposes of this alternative plan, it was assumed that new shallow aquifer wells would be located within, or immediately adjacent to, the planned water supply service area. It is recognized that other locations beyond the planned service areas may also be considered. However, such options would likely be somewhat more costly; and

- The continued use of private wells to serve residential and nonresidential land uses located beyond the planned water supply service areas, including agricultural land uses. The number and location of such wells is set forth in Chapter IV.

With regard to the alternative plan element providing for Lake Michigan as a source of supply for the selected new utilities noted above, three subalternatives were considered. The three subalternatives are shown in graphic summary form on Maps 80, 81, and 82 and the components and costs of each option are summarized in Tables 98, 99, and 100.

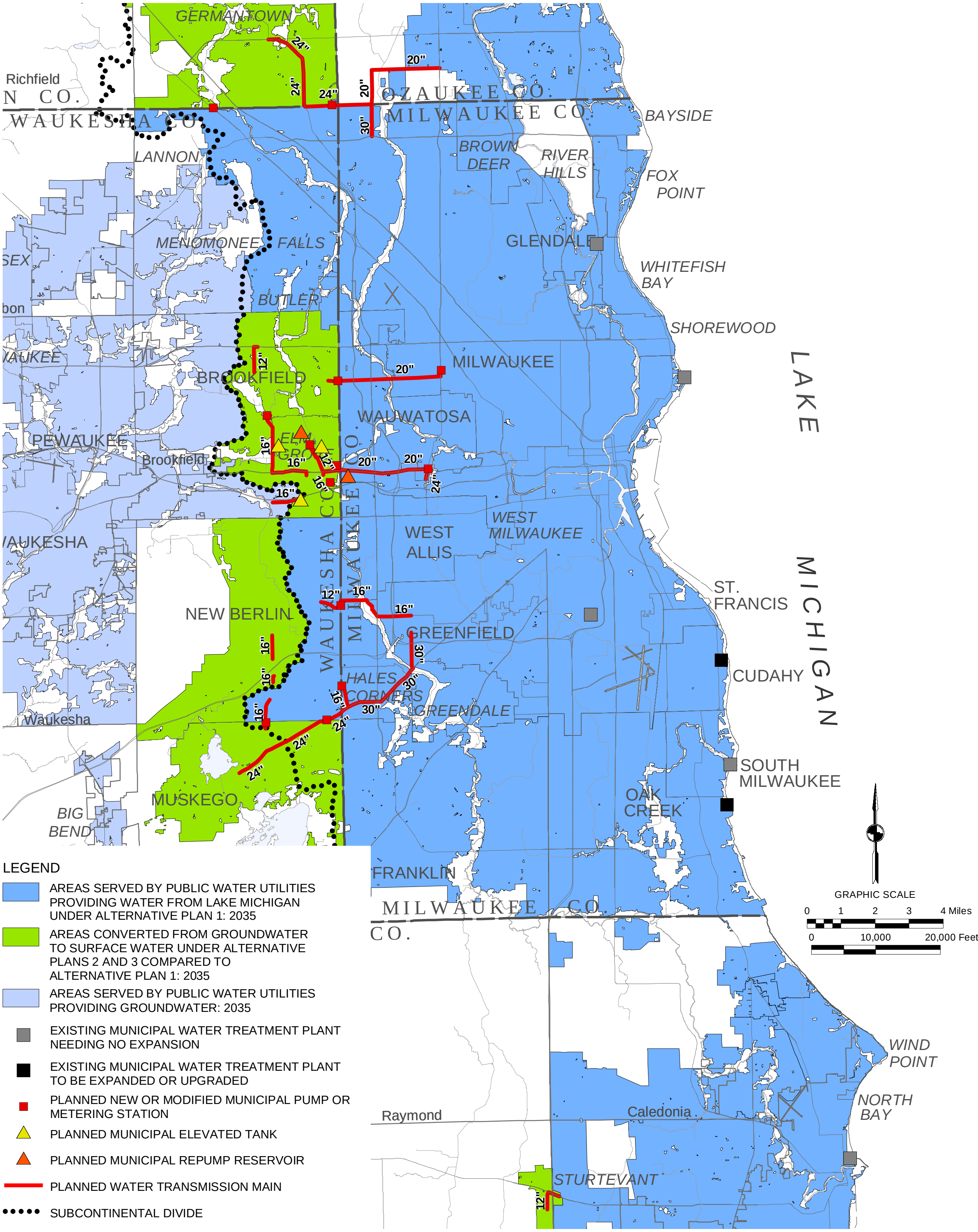
Subalternative 1 for the provision of Lake Michigan water supplies to new areas under Alternative Plan 2 provides for a direct water supply from the City of Milwaukee Water Works to the Village of Germantown Water Utility; the eastern portion of the City of Brookfield Municipal Water Utility sewer area; the City of New Berlin Water Utility, the City of Muskego Public Water Utility, and the Village of Elm Grove. The City of Racine Water and Wastewater Utility would provide the water supply to the Town of Yorkville Utility District No. 1.

Subalternative 1 is shown on Map 80 and the components and costs are summarized in Table 98. Subalternative 1 has an estimated capital cost of about $50.9 million and an annual operation and maintenance cost of $1.3 million. Based upon an analysis period of 50 years and an annual interest rate of 6 percent, the estimated present worth cost of this option is about $73.3 million, and the equivalent annual cost is about $4.6 million.

Subalternative 2 for the provision of Lake Michigan water supplies to new areas under Alternative Plan 2 provides for a direct water supply from the City of Milwaukee Water Works to the City of Muskego Public Water Utility and, the City of New Berlin Water Utility as in Alternative Plan 1. The Village of Germantown Water Utility would be provided with water through a connection to the Village of Menomonee Falls Water Utility system which is, in turn, connected to the City of Milwaukee Water Works system. The eastern portion of the City of Brookfield Municipal Water Utility service area and the Village of Elm Grove would be provided with water through connections to the City of Wauwatosa Water Utility system which is, in turn, connected to the Milwaukee Water Works system. The City of Racine Water and Wastewater Utility would provide the water supply to the Town of Yorkville Utility District No. 1. Subalternative 2 is shown on Map 81 and the components and costs are summarized in Table 99.

Map 80

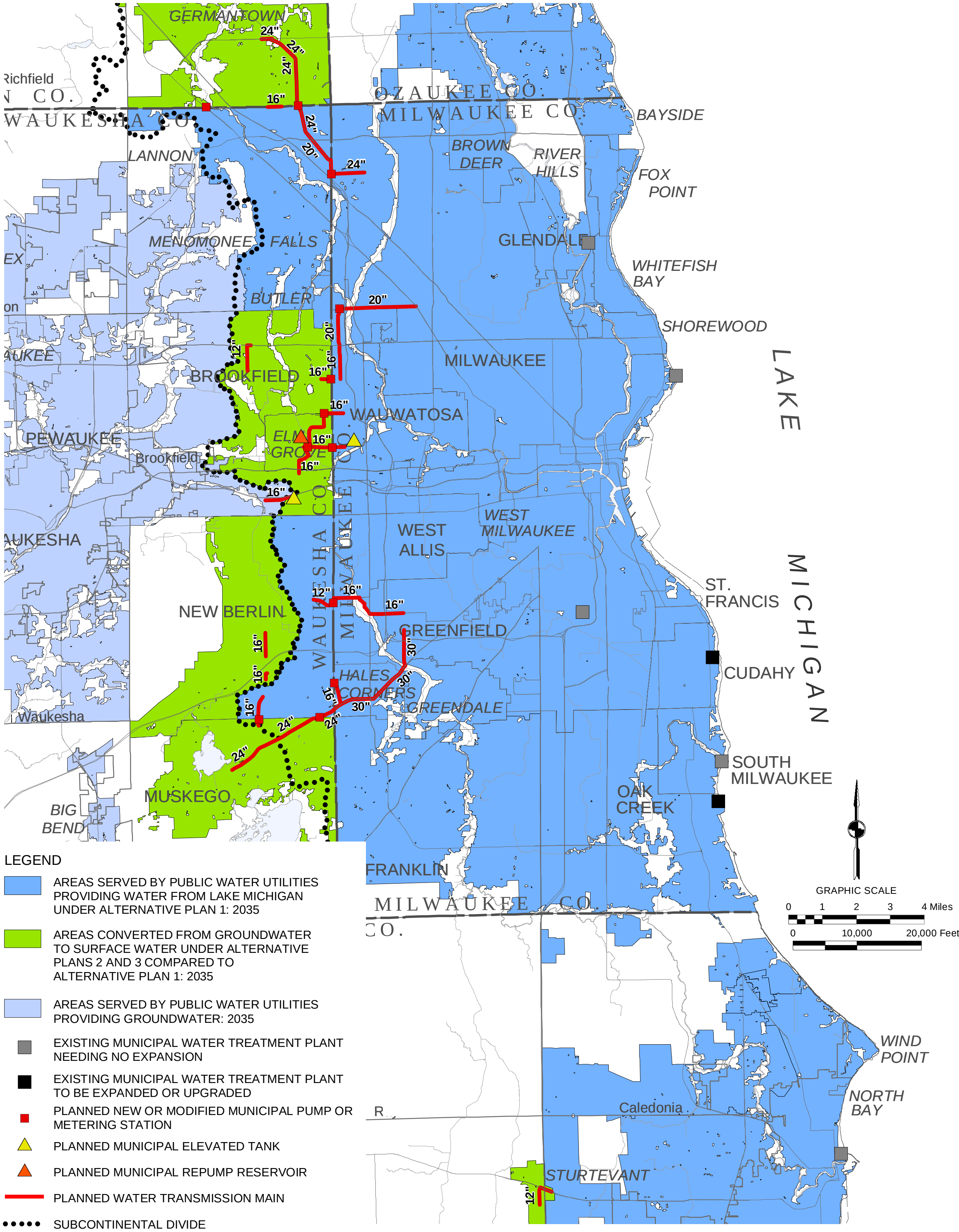
SUBALTERNATIVE 1 FOR NEW LAKE MICHIGAN SUPPLY COMPONENT FOR ALTERNATIVE PLAN 2 LIMITED EXPANSION OF LAKE MICHIGAN SUPPLY



Source: Ruekert & Mielke, Inc. and SEWRPC.

Map 81

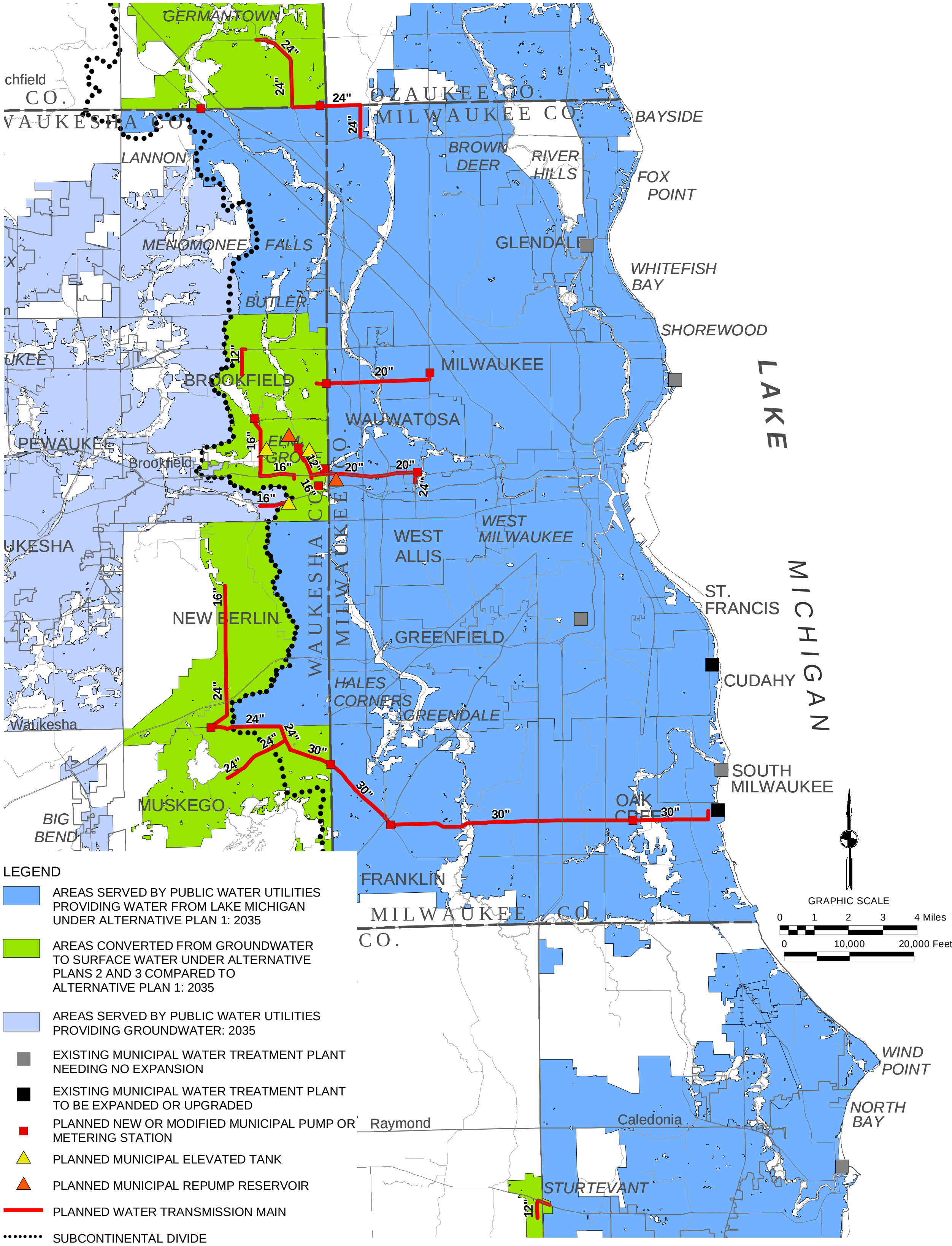
SUBALTERNATIVE 2 FOR NEW LAKE MICHIGAN SUPPLY COMPONENT FOR ALTERNATIVE PLAN 2 LIMITED EXPANSION OF LAKE MICHIGAN SUPPLY



Source: Ruekert & Mielke, Inc. and SEWRPC.

Map 82

SUBALTERNATIVE 3 FOR NEW LAKE MICHIGAN SUPPLY COMPONENT FOR ALTERNATIVE PLAN 2
LIMITED EXPANSION OF LAKE MICHIGAN SUPPLY



Source: Ruekert & Mielke, Inc. and SEWRPC.

Table 98

PRINCIPAL FEATURES AND COSTS OF NEW, EXPANDED, AND UPGRADED WATER SUPPLY FACILITIES AND PROGRAMS UNDER SUBALTERNATIVE 1 FOR THE NEW LAKE MICHIGAN SUPPLY COMPONENT OF ALTERNATIVE PLAN 2: DESIGN YEAR 2035 FORECAST CONDITIONS WITH LIMITED EXPANSION OF LAKE MICHIGAN SUPPLY

Utility	Project Description	Project Location	Capacity	Units	Unit Cost	Number of Units	Capital Cost	Total Capital Cost
Germantown	Pumping station-Milwaukee	Germantown	6.0	mgd	$1,535,718	1	$ 1,535,718	
Germantown	24-inch mains	Germantown	- -	Lineal feet	198	19,100	3,781,800	
Germantown	Pumping station-Menomonee Falls	Germantown	2.0	mgd	936,405	1	936,405	- -
Germantown	24-inch mains	Milwaukee County	- -	Lineal feet	198	9,500	1,881,000	
Germantown	Miscellaneous internal system upgrades	Milwaukee County	- -	- -	- -	- -	470,000[a]	
- -	- -	- -	- -	- -	- -	- -	$ 8,604,923	$ 8,604,923
Brookfield	Burleigh Road pumping station	Brookfield	3.5	mgd	$1,204,769	1	$ 1,204,769	
Brookfield	16-inch mains	Brookfield	- -	Lineal feet	173	25,400	4,394,200	
Brookfield	12-inch mains	Brookfield	- -	Lineal feet	146	4,600	671,600	
Brookfield	Bluemound Road pumping station	Brookfield	1.2	mgd	743,987	1	743,987	
Brookfield	Bluemound Road pumping station 0.2 mg reservoir	Brookfield	- -		290,000	1	290,000	
Brookfield	Pilgrim Parkway pumping station	Brookfield	2.0	mgd	936,405	1	936,405	
Brookfield	Elevated tank	Brookfield	0.3	MG	690,000	1	690,000	- -
Brookfield	Zone 2 pressure boosting/reducing stations	Brookfield	- -	- -	- -	- -	505,000	
Brookfield	Lisbon booster station expansion	Milwaukee County	3.5	mgd	1,204,769	1	1,204,769	
Brookfield	Bluemound booster station expansion	Milwaukee County	2.5	mgd	1,035,386	1	1,035,386	
Brookfield	20-inch mains	Milwaukee County	- -	Lineal feet	184	28,600	5,262,400	
Brookfield	24-inch mains	Milwaukee County	- -	Lineal feet	198	3,500	693,000	
Brookfield	Miscellaneous internal system upgrades	Milwaukee County	- -	- -	- -	- -	2,050,000[a]	
- -	- -	- -	- -	- -	- -	- -	$19,681,516	$19,681,516
Elm Grove	Pumping station	Elm Grove	1.3	mgd	$ 771,292	1	$ 771,292	
Elm Grove	Reservoir	Elm Grove	0.5	MG	646,000	1	646,000	- -
Elm Grove	Elevated tank	Elm Grove	0.3	MG	690,000	2	1,380,000	
- -	- -	- -	- -	- -	- -	- -	$ 2,797,292	$ 2,797,292
New Berlin	Pumping station upgrades	New Berlin	- -	- -	- -	- -	$ 650,000	
New Berlin	12-inch mains	New Berlin	- -	Lineal feet	$ 238	3,000	714,000	
New Berlin	16-inch mains	New Berlin	- -	Lineal feet	173	8,500	1,470,500	- -
New Berlin	16-inch mains	Milwaukee County	- -	Lineal feet	173	17,800	3,079,400	
New Berlin	Miscellaneous internal system upgrades	Milwaukee County	- -	- -	- -	- -	770,000[a]	
- -	- -	- -	- -	- -	- -	- -	$ 6,683,900	$ 6,683,900

Table 98 (continued)

Utility	Project Description	Project Location	Capacity	Units	Unit Cost	Number of Units	Capital Cost	Total Capital Cost
Muskego	Pumping station-Milwaukee	Muskego	6.0	mgd	$1,535,718	1	$ 1,535,718	
Muskego	Pumping station-New Berlin	Muskego	2.0	mgd	936,405	1	936,405	
Muskego	24-inch mains	Muskego	- -	Lineal feet	198	18,600	3,682,800	
Muskego	16-inch mains	Muskego	- -	Lineal feet	173	2,400	415,200	- -
Muskego	30-inch mains	Milwaukee County	- -	Lineal feet	257	18,000	4,626,000	
Muskego	24-inch mains	Milwaukee County	- -	Lineal feet	198	1,300	257,400	
Muskego	Miscellaneous internal system upgrades	Milwaukee County	- -	- -	- -	- -	1,221,000[a]	
- -	- -	- -	- -	- -	- -	- -	$12,674,523	$12,674,523
Yorkville U.D.1	12-inch mains	Racine County		Lineal feet	$ 139	3,300	$ 459,000	$ 459,000
- -	- -	- -	- -	- -	- -	- -	- -	$50,902,154

Present Worth of Capital Cost	- -	$53,286,000
O&M Cost for New Mains, Tanks, and Pumping Stations	$ 451,000	- -
O&M Cost for Water Production and Pumping	817,000	- -
Total O&M Cost	$1,268,000	- -
Present Worth of Total O&M Cost	- -	$19,984,000
Total Present Worth Cost	- -	$73,270,000
Equivalent Annual Cost	- -	$ 4,649,000

[a]*Allowance of 25 percent to cover internal system improvements for the Milwaukee Water Works water supply system.*

Source: Ruekert & Mielke, Inc., and SEWRPC.

Table 99

PRINCIPAL FEATURES AND COSTS OF NEW, EXPANDED, AND UPGRADED WATER SUPPLY FACILITIES AND PROGRAMS UNDER SUBALTERNATIVE 2 FOR THE NEW LAKE MICHIGAN SUPPLY COMPONENT OF ALTERNATIVE PLAN 2: DESIGN YEAR 2035 FORECAST CONDITIONS WITH LIMITED EXPANSION OF LAKE MICHIGAN SUPPLY

Utility	Project Description	Project Location	Capacity	Units	Unit Cost	Number of Units	Capital Cost	Total Capital Cost
Germantown	Pumping station-Fond du Lac Avenue	Germantown	6.00	mgd	$1,535,718	1	$ 1,535,718	
Germantown	24-inch mains	Germantown	- -	Lineal feet	198	13,900	2,752,200	
Germantown	Pumping station-Appleton Avenue	Germantown	2.00	mgd	936,405	1	936,405	
Germantown	Upgrade Bradley Road pumping station	Menomonee Falls	5.50	mgd	1,476,710	1	1,476,710	
Germantown	20-inch mains	Menomonee Falls	- -	Lineal feet	184	7,000	1,288,000	- -
Germantown	24-inch mains	Menomonee Falls	- -	Lineal feet	198	6,000	1,188,000	
Germantown	16-inch mains	Menomonee Falls	- -	Lineal feet	173	2,300	397,900	
Germantown	24-inch mains	Milwaukee	- -	Lineal feet	198	5,300	1,049,400	
Germantown	Miscellaneous internal system upgrades	Milwaukee	- -	- -	- -	- -	262,000[a]	
- -	- -	- -	- -	- -	- -	- -	$10,866,333	$10,866,333
Brookfield/Elm Grove	Pumping station-Burleigh Road	Brookfield	3.50	mgd	$1,204,769	1	$ 1,204,769	
Brookfield/Elm Grove	16-inch mains	Brookfield	- -	Lineal feet	173	6,500	1,124,500	
Brookfield/Elm Grove	12-inch mains	Brookfield	- -	Lineal feet	146	4,600	671,600	
Brookfield/Elm Grove	Elevated tank	Brookfield	0.75	MG	1,543,000	1	1,543,000	
Brookfield/Elm Grove	Zone 2 pressure boosting/reducing stations	Brookfield	- -	- -			505,000	
Brookfield/Elm Grove	North Avenue pumping station	Elm Grove	1.00	mgd	685,346	1	685,346	
Brookfield/Elm Grove	Watertown Plank Road pumping station	Elm Grove	1.50	mgd	822,629	1	822,629	
Brookfield/Elm Grove	Village Park pumping station	Elm Grove	2.50	mgd	1,035,386	1	1,035,386	
Brookfield/Elm Grove	Village Park repump reservoir	Elm Grove	0.50	MG	646,000	1	646,000	- -
Brookfield/Elm Grove	16-inch mains	Elm Grove	- -	Lineal feet	173	17,600	3,044,800	
Brookfield/Elm Grove	20-inch mains	Milwaukee	- -	Lineal feet	184	12,000	2,208,000	
Brookfield/Elm Grove	Miscellaneous internal system upgrades	Milwaukee	- -	- -	- -	- -	552,000[a]	
Brookfield/Elm Grove	Pumping station-119th Street	Wauwatosa	6.00	mgd	1,535,718	1	1,535,718	
Brookfield/Elm Grove	Elevated tank	Wauwatosa	0.75	MG	1,543,000	1	1,543,000	
Brookfield/Elm Grove	20-inch mains	Wauwatosa	- -	Lineal feet	184	7,200	1,324,800	
Brookfield/Elm Grove	16-inch mains	Wauwatosa	- -	Lineal feet	173	7,900	1,366,700	
Brookfield/Elm Grove	Miscellaneous internal system upgrades	Wauwatosa	- -	- -		7,900	1,443,000[b]	
- -	- -	- -	- -	- -	- -	- -	$21,256,248	$21,256,248
New Berlin	Pumping station upgrades	New Berlin	- -	- -	- -	- -	$ 650,000	
New Berlin	12-inch mains	New Berlin	- -	Lineal feet	$ 238	3,000	714,000	
New Berlin	16-inch mains	New Berlin	- -	Lineal feet	173	8,500	1,470,500	- -
New Berlin	16-inch mains	Milwaukee County	- -	Lineal feet	173	17,800	3,079,400	
New Berlin	Miscellaneous internal system upgrades	Milwaukee County	- -	- -	- -	- -	770,000[a]	
- -	- -	- -	- -	- -	- -	- -	$6,683,900	$ 6,683,900

Table 99 (continued)

Utility	Project Description	Project Location	Capacity	Units	Unit Cost	Number of Units	Capital Cost	Total Capital Cost
Muskego	Pumping Station-Milwaukee	Muskego	6.00	mgd	$1,535,718	1	$ 1,535,718	
Muskego	Pumping Station-New Berlin	Muskego	2.00	mgd	936,405	1	936,405	
Muskego	24-inch mains	Muskego	- -	Lineal feet	198	18,600	3,682,800	
Muskego	16-inch mains	Muskego	- -	Lineal feet	173	2,400	415,200	- -
Muskego	30-inch mains	Milwaukee County	- -	Lineal feet	257	18,000	4,626,000	
Muskego	24-inch mains	Milwaukee County	- -	Lineal feet	198	1,300	257,400	
Muskego	Miscellaneous internal system upgrades	Milwaukee County	- -	- -	- -	- -	1,221,000[a]	
- -	- -	- -	- -	- -	- -	- -	$12,674,523	$12,674,523
Yorkville U.D. 1	12-inch mains	Racine County	- -	Lineal feet	$ 139	3,300	$ 458,700	$ 458,700
- -	- -	- -	- -	- -	- -	- -	- -	$51,959,704

Present Worth of Capital Cost	- -	$53,853,000
O&M Cost for New Mains, Tanks, and Pumping Stations	$ 804,000	- -
O&M Cost for Water Production and Pumping	817,000	- -
Total O&M Cost	$1,621,000	
Present Worth of Total O&M Cost	- -	$25,547,000
Total Present Worth Cost	- -	$79,400,000
Equivalent Annual Cost	- -	$ 5,038,000

[a]*Allowance of 25 percent to cover internal system improvements for the Milwaukee Water Works water supply system.*

[b]*Allowance of 25 percent to cover internal system improvements for the City of Wauwatosa Water Utility water supply system.*

Source: Ruekert & Mielke, Inc., and SEWRPC.

Table 100

PRINCIPAL FEATURES AND COSTS OF NEW, EXPANDED, AND UPGRADED WATER SUPPLY FACILITIES AND PROGRAMS UNDER SUBALTERNATIVE 3 FOR THE NEW LAKE MICHIGAN SUPPLY COMPONENT OF ALTERNATIVE PLAN 2: DESIGN YEAR 2035 FORECAST CONDITIONS WITH LIMITED EXPANSION OF LAKE MICHIGAN SUPPLY

Utility	Project Description	Project Location	Capacity	Units	Unit Cost	Number of Units	Capital Cost	Total Capital Cost
Germantown	Pumping Station-Milwaukee	Germantown	6.0	mgd	$1,535,718	1	$ 1,535,718	
Germantown	24-inch mains	Germantown	- -	Lineal feet	198	19,100	3,781,800	
Germantown	Pumping Station-Menomonee Falls	Germantown	2.0	mgd	936,405	1	936,405	- -
Germantown	24-inch mains	Milwaukee County	- -	Lineal feet	198	9,500	1,881,000	
Germantown	Miscellaneous internal system upgrades	Milwaukee County	- -	- -	- -	- -	470,000[a]	
- -	- -	- -	- -	- -	- -	- -	$ 8,604,923	$8,604,923
Brookfield	Burleigh Road pumping station	Brookfield	3.5	mgd	$1,204,769	1	$ 1,204,769	
Brookfield	16-inch mains	Brookfield	- -	Lineal feet	173	25,400	4,394,200	
Brookfield	12-inch mains	Brookfield	- -	Lineal feet	146	4,600	671,600	
Brookfield	Bluemound Road pumping station	Brookfield	1.2	mgd	743,987	1	743,987	
Brookfield	Bluemound Road pumping station reservoir	Brookfield	0.2	MG	290,000	1	290,000	
Brookfield	Pilgrim Parkway pumping station	Brookfield	2.0	mgd	936,405	1	936,405	
Brookfield	Elevated tank	Brookfield	0.3	MG	690,000	1	690,000	- -
Brookfield	Zone 2 pressure boosting/reducing stations	Brookfield	- -	- -	- -	- -	505,000	
Brookfield	Lisbon booster station expansion	Milwaukee County	3.5	mgd	1,204,769	1	1,204,769	
Brookfield	Bluemound booster station expansion	Milwaukee County	2.5	mgd	1,035,386	1	1,035,386	
Brookfield	20-inch mains	Milwaukee County	- -	Lineal feet	184	28,600	5,262,400	
Brookfield	24-inch mains	Milwaukee County	- -	Lineal feet	198	3,500	693,000	
Brookfield	Miscellaneous internal system upgrades	Milwaukee County	- -	- -	- -	- -	2,049,000[a]	
- -	- -	- -	- -	- -	- -	- -	$19,680,516	$19,680,516
Elm Grove	Pumping station	Elm Grove	1.3	mgd	$ 771,292	1	$ 771,292	
Elm Grove	Reservoir	Elm Grove	0.5	MG	646,000	1	646,000	- -
Elm Grove	Elevated tank	Elm Grove	0.3	MG	690,000	2	1,380,000	
- -	- -	- -	- -	- -	- -	- -	$ 2,797,292	$ 2,797,292
Muskego/New Berlin	30-inch mains	Oak Creek	- -	Lineal feet	$ 257	30,500	$ 7,838,500	
Muskego/New Berlin	30-inch mains	Franklin	- -	Lineal feet	257	36,400	9,354,800	
Muskego/New Berlin	30-inch mains	Muskego	- -	Lineal feet	257	8,300	2,133,100	
Muskego/New Berlin	24-inch mains	Muskego	- -	Lineal feet	198	24,100	4,771,800	
Muskego/New Berlin	24-inch mains	New Berlin	- -	Lineal feet	198	13,900	2,752,200	
Muskego/New Berlin	16-inch mains	New Berlin	- -	Lineal feet	173	9,300	1,608,900	- -
Muskego/New Berlin	Pumping station at County Line	Muskego	10.0	mgd	1,932,902	1	1,932,902	
Muskego/New Berlin	Pumping station at College Avenue	New Berlin	5.0	mgd	1,414,673	1	1,414,673	
Muskego/New Berlin	Treatment plant expansion	Oak Creek	10.0	mgd	7,800,000	1	7,800,000	
Muskego/New Berlin	Pumping station to lift to Oak Creek west zone	Oak Creek	10.0	mgd	1,932,902	1	1,932,902	
Muskego/New Berlin	Pumping station to lift to Franklin west zone	Franklin	10.0	mgd	1,932,902	1	1,932,902	
- -	- -	- -	- -	- -	- -	- -	$43,472,679	$43,472,679

Table 100 (continued)

Utility	Project Description	Project Location	Capacity	Units	Unit Cost	Number of Units	Capital Cost	Total Capital Cost
Yorkville U.D. 1	12-inch mains	Racine County	- -	Lineal feet	$ 139	3,300	$ 458,700	$ 458,700
- -	- -	- -	- -	- -	- -	- -	- -	$75,014,110

Present Worth of Capital Cost	- -	$78,258,000
O&M Cost for New Mains, Tanks, and Pumping Stations O&M Cost for Water Production and Pumping	$ 678,000 817,000	- - - -
Total O&M Cost	$1,495,000	
Present Worth of Total O&M Cost	- -	$ 23,561,000
Total Present Worth Cost	- -	$101,819,000
Equivalent Annual Cost	- -	$ 6,461,000

[a]*Allowance of 25 percent to cover internal system improvements for the Milwaukee Water Works water supply system.*

Source: Ruekert & Mielke, Inc., and SEWRPC.

Subalternative 2 has an estimated capital cost of $52.0 million and an annual operation and maintenance cost of about $1.6 million. Based upon an analysis period of 50 years and an annual interest rate of 6 percent, the estimated present worth cost of this option is about $79.4 million, and the equivalent annual cost is about $5.0 million.

Subalternative 3 for provision of Lake Michigan water supplies to new areas under Alternative Plan 2 provides for a direct water supply from the City of Milwaukee Water Works to the eastern portion of the City of Brookfield Municipal Water Utility service area, the Village of Elm Grove, and the Village of Germantown Water Utility, as in Alternative Plan 1. The City of New Berlin Water Utility for the central portion of the City and the City of Muskego Public Water Utility would be served by the City of Oak Creek Water and Sewer Utility system through the City of Franklin Water Utility system. The City of Racine Water and Wastewater Utility would provide the water supply to the Town of Yorkville Utility District No. 1.

Subalternative 3 is shown on Map 82 and the components and costs are summarized in Table 100. Subalternative 3 has an estimated capital cost of about $75.0 million and an annual operation and maintenance cost of about $1.5 million. Based upon an analysis period of 50 years and an annual interest rate of 6 percent, the estimated present worth cost of this option is about $101.8 million, and the equivalent annual cost is about $6.5 million.

As indicated by the data provided in Tables 98, 99, and 100, the difference in the present worth and equivalent annual costs of Subalternatives 1 and 2 under Alternative Plan 2 are less than 10 percent. The cost of Subalternative 3 is more than 28 percent higher than either Subalternative 1 or 2. Accordingly, the costs associated with Subalternative 1 were included as an approximation of the cost of providing Lake Michigan as a source of supply to the additional areas considered for such service under Alternative Plan 2.

Under Alternative Plan 2, the sources of supply and the anticipated utilization of those sources may be summarized as follows:

- Design year 2035 total average annual groundwater pumpage is estimated to be about 93 mgd, with about 72 mgd, or about 77 percent, from the shallow aquifer and about 21 mgd, or about 23 percent, from the deep aquifer. This represents a reduction of about 13 mgd, or about 12 percent, in total groundwater pumpage compared to Alternative Plan 1.

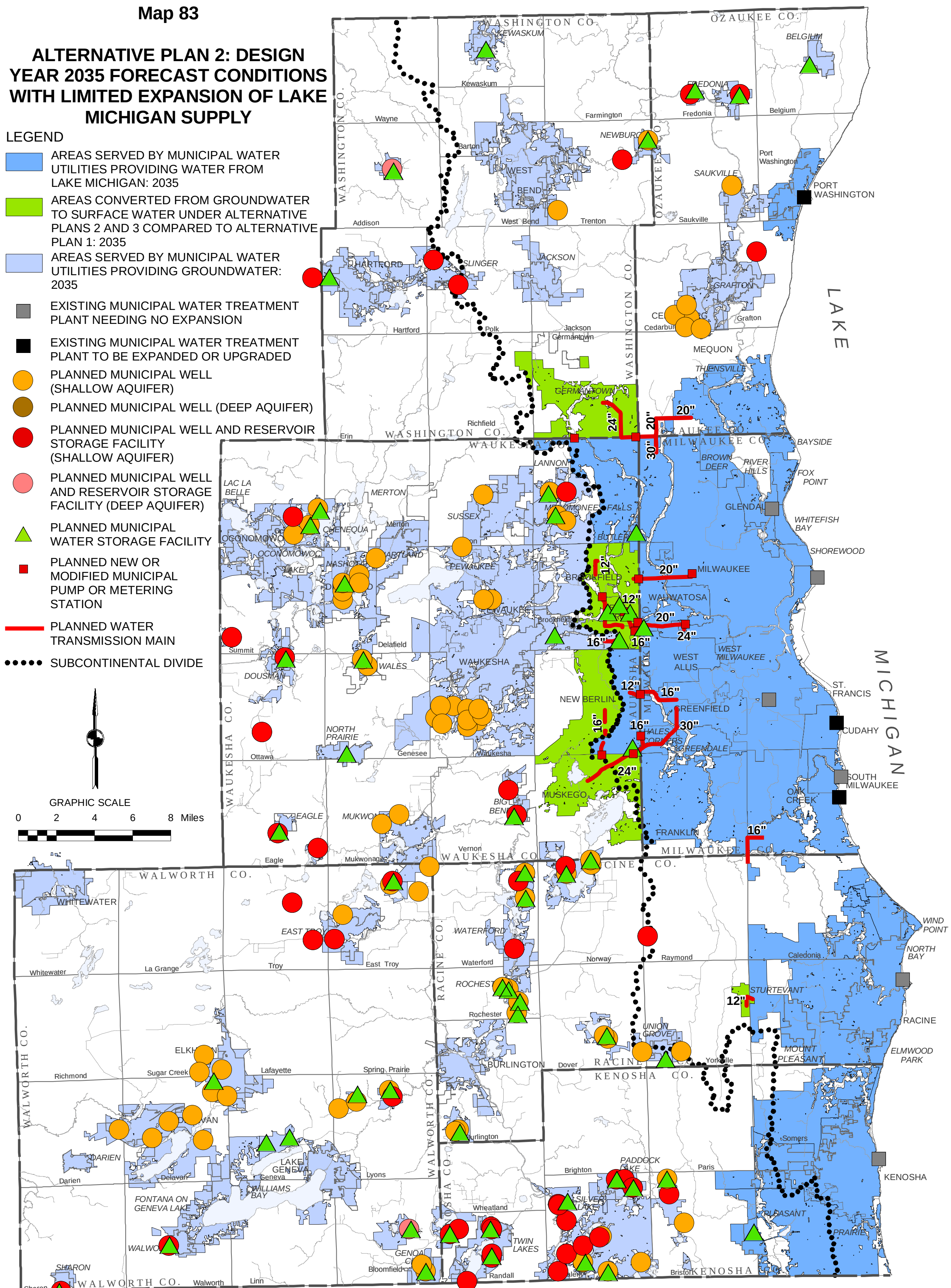
- Design year 2035 municipal water utility average annual groundwater pumpage is estimated to be about 76 mgd, a reduction of about 13 mgd, or about 15 percent, compared to Alternative Plan 1. Of this amount, approximately 58 mgd, or about 76 percent, would be from the shallow aquifer and 18 mgd, or about 24 percent, from the deep aquifer, representing an increase of about 5 mgd and a decrease of about 18 mgd, or about 9 percent and about 50 percent, respectively, compared to the pumpages under Alternative Plan 1.

- Design year 2035 municipal water supply pumpage of Lake Michigan water is estimated to approximate 227 mgd, an increase of about 13 mgd, or about 6 percent, compared to Alternative Plan 1.

Map 83 illustrates the areas served by municipal utilities and the sources of supply for those utilities under Alternative Plan 2. The new sources of supply for each water utility in the Region under Alternative Plan 2 are listed in Table 101. Alternative Plan 2 has an estimated capital cost of about $253.6 million and an annual savings in operation and maintenance cost of about $0.7 million compared to Alternative Plan 1. Based upon an analysis period of 50 years and an annual interest rate of 6 percent, the estimated present worth cost of this alternative is about $175.2 million, and the equivalent annual cost is about $11.1 million. The operation and maintenance cost used for purposes of comparison with Alternative Plan 1 is the net amount arrived at by combining the operation and maintenance costs of the proposed new facilities; the expected savings due to the elimination of individual residential point-of-entry treatment devices; and the reductions in costs due to the elimination of existing facilities which were required under Alternative Plan 1, but are not required under Alternative Plan 2.

Map 83

ALTERNATIVE PLAN 2: DESIGN YEAR 2035 FORECAST CONDITIONS WITH LIMITED EXPANSION OF LAKE MICHIGAN SUPPLY



Source: Ruekert & Mielke, Inc. and SEWRPC.

Table 101

PRINCIPAL FEATURES AND COSTS OF NEW, EXPANDED, AND UPGRADED WATER SUPPLY FACILITIES AND PROGRAMS UNDER ALTERNATIVE PLAN 2, DESIGN YEAR 2035 FORECAST CONDITIONS WITH LIMITED EXPANSION OF LAKE MICHIGAN SUPPLY

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Kenosha County					
City of Kenosha Water Utility	No additions	- -	41.7	657	42
Village of Paddock Lake Municipal Water Utility	Addition of two 0.25 MG elevated tanks, three shallow aquifer wells with 0.20 MG reservoir each	4,032	54.0	3,135	199
Village of Pleasant Prairie Water Utility	Addition of 0.75 MG elevated tank	1,620	39.7[d]	2,104	134
Town of Bristol Utility District No. 1	Addition of three shallow aquifer wells to replace deep aquifer wells, 0.50 MG elevated tank, 0.40 MG reservoir	3,274	-57.0[e]	2,542[e]	161[e]
Town of Bristol Utility District No. 3	No additions	- -	0.1[d]	2	0
Town of Somers Water Utility	No additions	- -	3.5[d]	55	3
Village of Silver Lake Planned Utility	Addition of three shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank	3,437	93.4	1,694	107
Village of Twin Lakes Planned Utility	Addition of five shallow aquifer wells with 0.1 MG reservoir each, two 0.3 MG elevated tanks	5,317	158.7	3,782	240
Town of Salem Planned Utility	Addition of eight shallow aquifer wells, four with 0.15 MG reservoirs, two 0.3 MG elevated tanks	7,294	288.9	5,710	362
Powers-Benedict-Tombeau Lakes Area Planned Utility	Addition of two shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank	2,584	57.9	1,694	107
Land Acquisition for Wells and Storage Tanks	34 acres	2,380	- -	2,380	151
Subtotal	24 Wells, 28 Storage Tanks	29,938	680.9	23,755	1,506
Milwaukee County					
City of Cudahy Water Utility	Duplicate rapid mix facility	100	7.5	118	7
City of Franklin Water Utility	No additions	- -	13.4[d]	211	13
City of Glendale Water Utility	No additions	- -	6.1[d]	96	6
City of Milwaukee Water Works	No additions	- -	263.1	4,146	263
City of Oak Creek Water and Sewer Utility	Addition of 20 mgd coag-floc-sed, 14 mgd filtration, 17.5 mgd pumping	13,220	547.4[f]	21,169	1,343
City of South Milwaukee Water Utility	No additions	- -	8.6	136	9
City of Wauwatosa Water Utility	No additions	- -	19.6[d]	309	20
City of West Allis Water Utility	No additions	- -	25.2[d]	397	25

Table 101 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Milwaukee County (continued)					
Village of Brown Deer Public Water Utility	No additions	- -	4.8[d]	76	5
Village of Fox Point Water Utility	No additions	- -	2.6[d]	41	3
Village of Greendale Water Utility	No additions	- -	5.6[d]	88	6
Village of Shorewood Municipal Water Utility	No additions	- -	1.4[d]	22	1
Village of Whitefish Bay Water Utility	No additions	- -	5.8[d]	91	6
We Energies-Water Services	No additions	- -	1.0[d]	16	1
Subtotal	0 Wells, 0 Storage Tanks, Two Treatment Plant Upgrades	13,320	912.1	26,916	1,708
Ozaukee County					
City of Cedarburg Light & Water Commission	Addition of five shallow aquifer wells and replacing dolomite aquifer pumping	3,250	-35.0[e]	2,760[e]	175[e]
City of Port Washington Water Utility	Addition of 2.0 MGD coag-floc-sed, filtration, 1.8 MGD pumping	3,888	33.1	2,622	166
Village of Belgium Municipal Water Utility	Addition of 0.45 MG reservoir at Well 3, service pumps at Wells 1 and 2	586	2.0	298	19
Village of Fredonia Municipal Water Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.20 MG reservoir	1,417	23.5	886	56
Village of Grafton Water and Wastewater Commission	Addition of one shallow aquifer well with 0.70 MG reservoir	1,535	39.5	828	53
Village of Saukville Municipal Water Utility	Addition of one shallow aquifer well	650	29.9	575	36
We Energies-Water Services	5,300 feet of 30 inch main (shared with Village of Germantown) in 107th street, 16,100 feet of 20 inch main in Granville Road and Donges Bay Road	3,300	231.8[d,g]	5,153	327
Town of Fredonia-Waubeka Area Planned Utility	Addition of one shallow aquifer well with 0.10 MG reservoir, 0.25 MG elevated tank	1,460	24.3	899	57
Land Acquisition for Wells and Storage Tanks	11 acres	770	- -	770	49
Subtotal	Nine Wells, Six Storage Tanks, One Treatment Plant Upgrade	16,856	349.1	14,791	938
Racine County					
City of Burlington Municipal Waterworks	No additions	- -	12.6	199	13
City of Racine Water and Wastewater Utility[h]	No additions	- -	45.9	724	46
Village of Caledonia West Utility District[i] (Oak Creek)	No additions	- -	0.4[d]	6	1

Table 101 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Racine County (continued) Village of Caledonia West Utility District[i] (Racine)	No additions	- -	3.1[d]	49	3
Village of Caledonia East Utility District[j] (Oak Creek)	No additions	- -	1.9[d]	30	2
Village of Caledonia East Utility District[j] (Racine)	No additions	- -	3.5[d]	55	4
Village of Union Grove Municipal Water Utility	Addition of two shallow aquifer wells, 0.40 MG reservoir, replacing one deep aquifer well	1,776	-31.4[e]	1,255[e]	80[e]
Village of Waterford Water and Sewer Utility	Addition of one shallow aquifer well with 0.40 MG reservoir	1,151	15.7	1,481	94
Village of Wind Point Municipal Water Utility	No additions	- -	0.8[d]	13	1
North Cape Sanitary District	Addition of one shallow aquifer well with 0.10 MG reservoir	155	2.1	194	12
Town of Yorkville Water Utility District 1	Lake Michigan supply connection	459[k]	-38.0[l]	-140[l]	-9[l]
Northwest Caledonia Area Planned Utility District	9,000 lineal feet of water transmission main	1,557	3.1[d,m]	726	46
Town of Burlington-Bohner Lake Area Planned Utility District	Addition of two shallow aquifer wells, 0.30 MG elevated tank	1,941	42.1	1,278	81
Town of Dover-Eagle Lake Area Planned Utility District	Addition of two shallow aquifer wells, 0.30 MG elevated tank	1,941	47.0	1,315	83
Town of Norway Area Planned Utility	Addition of four shallow aquifer wells, one with 0.15 MG reservoir, two 0.25 MG elevated tanks	4,024	112.9	2,825	179
Village of Rochester Area Planned Utility	Addition of two shallow aquifer wells, two 0.10 MG elevated tanks	1,844	27.6	1,125	71
Town of Rochester Area Planned Utility	Addition of two shallow aquifer wells, two 0.10 MG elevated tanks	1,844	30.7	1,148	73
Town of Waterford Area Planned Utility	Addition of three shallow aquifer wells, one with 0.15 MG reservoir, two 0.3 MG elevated tanks	3,485	114.4	2,571	163
Land Acquisition for Wells and Storage Tanks	29 acres	2,030	- -	2,030	129
Subtotal	19 Wells, 15 Storage Tanks, One Lake Michigan Supply Connection	22,207	394.4	16,884	1,072
Walworth County City of Delavan Water and Sewerage Commission	Addition of five shallow aquifer wells with iron removal treatment, replacement of treated shallow pumping	5,125	59.2[e]	1,318[e]	84[e]
City of Elkhorn Light and Water	Addition of five shallow aquifer wells, 0.35 MG treated water reservoir	3,529	-178.5[e]	-1,705[e]	-108[e]
City of Lake Geneva Municipal Water Utility	No additions	- -	11.3	178	11

Table 101 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Walworth County (continued)					
City of Whitewater Municipal Water Utility	No additions	- -	13.7	216	14
Village of Darien Water Works and Sewer System	Increase Well 1 output from 325 to 425 gpm	- -	15.2	35	2
Village of East Troy Municipal Water Utility	Addition of three shallow aquifer wells, two with 0.10 MG reservoir each	2,199	55.6	1,792	114
Village of Fontana Municipal Water Utility	No additions	- -	2.0	32	2
Village of Genoa City Municipal Water Utility	Addition of two shallow aquifer wells and 0.25 MG elevated tank	1,898	48.1	1,592	101
Village of Sharon Waterworks and Sewer System	Addition of one shallow aquifer well with 0.30 MG reservoir, 0.20 MG elevated tank	1,512	17.1	1,935	123
Village of Walworth Municipal Water and Sewer Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.15 MG reservoir	1,333	30.6	1,038	66
Village of Williams Bay Municipal Water Utility	No additions	- -	4.3	68	4
Town of Bloomfield Pell Lake Sanitary District No. 1	Addition of 0.2 MG elevated tank, one deep aquifer well with radium treatment and with 0.4 MG reservoir	1,891	39.6	2,416	153
Town of East Troy Sanitary District No. 3	Addition of one shallow aquifer well	130	0.1	136	8
Town of Geneva Lake Como Sanitary District No. 1	Addition of 0.20 MG elevated tank and 0.45 MG reservoir	1,066	12.4	1,206	77
Town of Troy Sanitary District No. 1	Addition of one shallow aquifer well with 0.12 MG reservoir	80	0.2	87	6
Country Estates Sanitary District	Addition of two shallow aquifer wells, 0.20 MG elevated tank	1,730	-2.8[e]	1,793[e]	114[e]
Town of Lyons Area Planned Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.3 MG elevated tank	2,169	38.9	1,362	86
Town of East Troy-Potter Lake Area Planned Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.3 MG elevated tank	2,169	34.6	1,329	84
Land Acquisition for Wells and Storage Tanks	34 acres	2,380	- -	2,380	151
Subtotal	26 Wells, 18 Storage Tanks	27,211	201.6	17,208	1,092
Washington County					
City of Hartford Utilities	Addition of one shallow aquifer well, treatment system, 0.75 MG elevated tank, and interconnecting piping	7,500	39.4[e]	6,979[e]	443[e]
City of West Bend Water Utility	Addition of one shallow aquifer well	625	58.4	1,443	92
Village of Germantown Water Utility	Lake Michigan supply connection[k]	8,404[k]	-1,724.0[n]	-18,400[n]	-1,167[n]

Table 101 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Washington County (continued)					
Village of Jackson Water Utility	No additions	- -	7.4	117	7
Village of Kewaskum Municipal Water Utility	Addition of 0.25 MG reservoir	351	4.4	420	27
Village of Slinger Utilities	Addition of two shallow aquifer wells with 0.20 MG reservoir each	1,824	31.9	1,730	110
Allenton Sanitary District No. 1	Addition of 0.20 MG elevated tank, one deep aquifer well with 0.30 MG reservoir	1,672	20.3	1,374	87
Village of Newburg Area Planned Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.30 MG elevated tank	2,169	39.9	1,938	123
Land Acquisition for Wells and Storage Tanks	10 acres	700	- -	700	44
Subtotal	Seven Wells, Eight Storage Tanks, One Lake Michigan Supply Connection	23,245	-1,522.3	-3,699	-234
Waukesha County					
City of Brookfield Municipal Water Utility (east)	Lake Michigan supply connection[k]	19,682[k]	-1,119[o]	2,956[o]	187[o]
City of Brookfield Municipal Water Utility (west)	No additions, abandon one well with radium treatment	0	-111.0[e]	-255[e]	-16[e]
City of Delafield Municipal Water Utility	Addition of five shallow aquifer wells, 0.40 MG elevated tank	4,019	110.1	3,259	207
City of Muskego Public Water Utility	Lake Michigan supply connection	12,675[k]	-1,508[p]	-10,679[p]	-678[p]
City of New Berlin Water Utility (east)	Addition of 0.40 MG reservoir	526	8.5[d]	320	20
City of New Berlin Water Utility (central)	Lake Michigan supply connection[k]	6,685[k]	-1,377[q]	-14,811[q]	-939[q]
City of Oconomowoc Utilities	No additions	- -	17.4	274	17
City of Pewaukee Water and Sewer Utility	Addition of two shallow aquifer wells, service pumps, abandon one well with radium treatment	1,410	12.3[e]	1,895[e]	120[e]
City of Waukesha Water Utility	Addition of 10 to 20 shallow aquifer wells,[r] abandon radium treatment wells	43,910	2,700.0[e]	75,368[e]	4,782
Village of Butler Public Water Utility	Addition of 0.25 MG reservoir	351	0.8	307	19
Village of Dousman Water Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.40 MG reservoir	1,631	26.2	1,957	124
Village of Eagle Municipal Water Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.40 MG reservoir	1,631	17.8	1,850	117
Village of Hartland Municipal Water Utility	Addition of one shallow aquifer well	625	17.7	526	33
Village of Menomonee Falls Water Utility (east)	No additions	- -	12.2[d]	192	12

Table 101 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Waukesha County (continued)					
Village of Menomonee Falls Water Utility (west)	Addition of 0.20 MG elevated tank, two shallow aquifer wells	1,755	32.9	1,387	88
Village of Mukwonago Municipal Water Utility	Addition of three shallow aquifer wells	2,195	77.7	2,676	170
Village of Pewaukee Water Utility	Addition of one shallow aquifer well	625	36.2	989	63
Village of Sussex Public Water Utility	Addition of one shallow aquifer well	625	42.9	642	41
Town of Brookfield Sanitary District No. 4	Addition of 0.35 MG reservoir	467	6.0	562	36
Village of Big Bend Planned Utility	Addition of two shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank	2,584	76.1	1,822	116
Village of Elm Grove Planned Utility	Lake Michigan supply connection[k]	2,797[k]	-470.0[s]	-4,497[s]	-285[s]
Village of Lannon Planned Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.75 MG elevated tank	3,098	117.9	2,381	151
Village of North Prairie Planned Utility	Addition of 0.50 MG elevated tank	878	19.5	592	38
Village of Wales Planned Utility	Addition of two shallow aquifer wells, 0.30 MG elevated tank	1,941	41.8	1,277	81
Town of Eagle-Eagle Spring Lake Area Planned Utility	Addition of one shallow aquifer well with 0.15 MG reservoir	853	5.2	454	29
Town of Oconomowoc-Okauchee Lake Area Planned Utility	Addition of four shallow aquifer wells, one with 0.15 MG reservoir, two 0.30 MG elevated tanks	4,110	116.6	2,899	184
Town of Summit-Golden Lake Area Planned Utility	Addition of one shallow aquifer well with 0.10 MG reservoir	787	2.1	403	26
Town of Ottawa-Pretty Lake Area Planned Utility	Addition of one shallow aquifer well with 0.10 MG reservoir	787	3.1	409	26
Land Acquisition for Wells and Storage Tanks	60 acres	4,200	- -	4,200	266
Subtotal	50 Wells, 22 Storage Tanks, Four Lake Michigan Supply Connections	120,847	-1,084.0	79,355	5,035
Total	135 Wells, 97 Storage Tanks, Six Lake Michigan Supply Connections, Two Treatment Plant Expansions	253,624	-68.2	175,210	11,117

[a] *All utilities' programs include water conservation programs.*

[b] *Costs presented are those associated with the costs for new, expanded, or upgraded facilities. The operation and maintenance costs are for increased incremental costs associated with new, expanded, or upgraded facilities and for water conservation measures. Alternative Plan 1 is being considered as the base for alternative plans evaluation. The costs for Alternative Plans 2, 3, and 4 include an adjustment in the operation and maintenance costs to reflect existing facilities not used under these alternative plans compared to Alternative Plan 1.*

Footnotes to Table 101 (continued)

[c]The estimated annual cost for water conservation is included as an operation and maintenance cost for all utilities.

[d]Water utilities which purchase water on a wholesale basis will have continued or increased costs for the purchase of water. For purposes of the cost-effectiveness analyses of the alternative water supply plans, only the incremental operation and maintenance cost associated with any increased water supply facility water production costs are considered. Alternative Plan 1 is being used as the base to which the other alternative plans will be compared. For this base alternative, only the operation and maintenance cost for new, expanded, or upgraded facilities are included since the cost for operation and maintenance of existing facilities which are common to all alternatives are not included for any alternatives.

[e]The annual O&M cost includes a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 2.

[f]There is expected to be an estimated average reduction of $376,000 per year for savings associated with existing residences which would be able to discontinue their point-of-entry water treatment systems in the Cities of Oak Creek and Franklin. However, there is also an expected cost involved in developing local water distribution systems. The cost savings due to discontinuation of the point-of-entry water treatment system and the costs of the local distribution systems are common to all alternative plans and are not specifically accounted for in this table.

[g]The annual O&M cost for the We Energies-Water Services Mequon and Thiensville service area includes an estimated average annual water production cost of $219,000 per year based upon the estimated incremental cost of $230 per million gallons for water production at the City of Milwaukee Water Works treatment process. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed costs and other costs. There is also expected to be an estimated average reduction of $1,520,000 per year for savings associated with existing residences which would be able to discontinue their point-of-entry water treatment systems. However, there are also expected costs involved in developing a local water distribution system. The cost savings due to discontinuation of the point-of-entry water treatment system and the cost of the local distribution system are common to all alternative plans and are not specifically accounted for in this table.

[h]Includes the Village of Sturtevant Water Utility which was purchased by the City of Racine Water and Wastewater Utility in 2007 and is now served by the City Utility on a retail basis.

[i]Includes the former Crestview Sanitary District and the former North Park Sanitary Districts which were consolidated in 2007 to form the Caledonia East Utility District.

[j]Includes the former Caddy Vista Sanitary District and the former Caledonia Utility District No. 1 which were consolidated in 2006 to form the Caledonia West Utility District.

[k]See Table 98 for details.

[l]The annual O&M cost for the Town of Yorkville Utility District No. 1 includes an estimated annual water production cost of $17,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 2. The annual O&M costs also include an expected average reduction of $28,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.

[m]The annual O&M cost for the Northwest Caledonia Area does not include the incremental cost for water production, as that cost is included in the expanded City of Oak Creek Water Utility costs.

[n]The annual O&M cost for the Village of Germantown Water Utility includes an estimated annual water production cost of $215,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 2. The annual O&M costs also include an expected average reduction of $1,720,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.

[o]The annual O&M cost for the City of Brookfield Water Utility for the eastern portion of the City includes an estimated annual water production cost of $205,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 2. The annual O&M costs also include an expected average reduction of $1,440,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.

Footnotes to Table 101 (continued)

[p]*The annual O&M cost for the City of Muskego Water Utility includes an estimated annual water production cost of $133,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 2. The annual O&M costs also include an expected average reduction of $1,519,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.*

[q]*The annual O&M cost for the City of New Berlin Water Utility for the central portion of the City includes an estimated annual water production cost of $185,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 2. The annual O&M costs also include an expected average reduction of $1,260,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.*

[r]*Number of wells needed varies with expected well capacity, with the range based upon wells of 0.5 mgd to 1.0 mgd.*

[s]*The annual O&M cost for the Village of Elm Grove includes an estimated annual water production cost of $62,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs also include an expected average reduction of $596,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.*

Source: Ruekert & Mielke, Inc., and SEWRPC.

Groundwater and Surface Water Impacts of Alternative Plan 2

The potential impacts of Alternative Plan 2 on the groundwater and surface water systems of the Region under the attendant pumping conditions to the design year 2035 were estimated by simulation modeling and by a parallel water budget analysis.

Groundwater Impacts in the Deep Aquifer

Simulated Water Levels in the Deep Aquifer

Results of the groundwater simulation indicate that under Alternative Plan 2 conditions, drawups relative to 2005 conditions may be expected to occur in the deep aquifer over most of the Region. These impacts are shown on Map 84 and are most evident in portions of central Waukesha County where the impacts exceed 150 feet of drawup; in portions of central and eastern Waukesha County, in much of Milwaukee County, southern Ozaukee County, and southeastern Washington County where those impacts exceed 100 feet of drawup. It should be noted that there will remain impacts on the deep aquifer from pumping in areas to the south of the Region in northeastern Illinois. The impacts of pumping in areas located beyond the Region account for the smaller drawups shown in Kenosha and Walworth Counties on Map 84. For analytical purposes, the pumping in northeastern Illinois was held at the year 2000 level for the planning period of 2000 through 2035. At the time that these analyses were conducted, no comprehensive areawide water supply plan was in place for the northeastern Illinois area. Therefore, no basis existed for forecasting potential changes in the pumpage concerned, and the impacts under future conditions may be somewhat different than developed under this planning program. However, the relative differences between the alternative plans considered may be expected to be valid.

Table 102 summarizes the simulated drawdowns in the upper sandstone aquifer over the period 2005 to 2035. In most counties, fewer than 0.1 percent of model cells show drawdowns over 2005 levels in the upper sandstone aquifer under Alternative Plan 2 conditions. Exceptions occur in Walworth County where about 25 percent of model cells show drawdowns over the 2005 levels in the upper sandstone aquifer under Alternative Plan 2 conditions. Average drawdowns projected in this aquifer range from less than one foot for cells showing drawdowns in Kenosha County, to about six feet for cells showing drawdowns in Waukesha County. Maximum drawdowns projected for this aquifer range from less than one foot for cells showing drawdowns in Kenosha County, to about 10 feet for cells showing drawdowns in Walworth County.

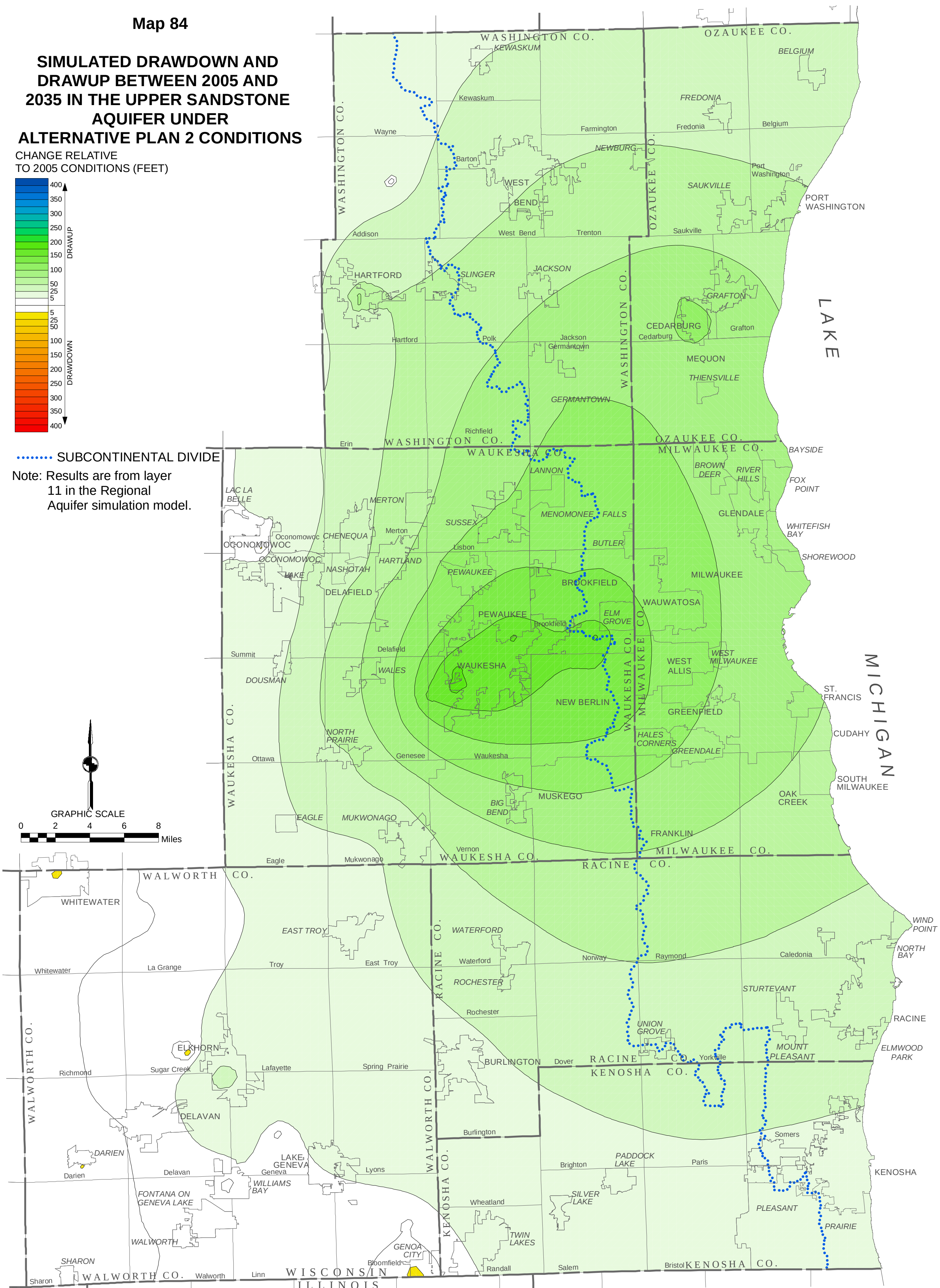
There was relatively little variation in drawdown levels indicated in terms of the percentage of cells showing simulated drawdowns over the period 2005 to 2035 greater than the given thresholds under Alternative Plan 2 conditions. Model cells showing simulated drawdowns were rare in all counties except Walworth County. No drawdowns greater than 10 feet in the upper sandstone aquifer may be expected to occur in that County, while about 0.5 percent of model cells showing drawdowns in Walworth County showed drawdowns greater than five feet.

Table 102 also summarizes simulated drawups in the upper sandstone aquifer over the period 2005 to 2035 under Alternative Plan 2 conditions. The percentage of cells in the model showing drawups over 2005 levels ranges from about 75 percent in Walworth County to 100 percent in Milwaukee, Ozaukee, and Racine Counties. Average drawups in this aquifer are projected to range from less than eight feet for cells showing drawups in Walworth County, to about 92 feet for cells showing drawups in Milwaukee County. Maximum simulated drawups in this aquifer range from about 34 feet in Kenosha County to about 237 feet in Washington County. Model cells in most of the Region exhibited simulated drawups in the upper sandstone aquifer under Alternative Plan 2 conditions greater than five feet as shown Map 84. Exceptions to this were located in southern and western Walworth County and in a small portion of northwestern Waukesha County.

Table 103 summarizes the variation in drawup in terms of the percentage of cells showing simulated drawups over the period 2005 to 2035 greater than the given thresholds. In much of the Region, drawups in excess of 10 feet were common in the upper sandstone aquifer under Alternative Plan 2 conditions, representing over 93 percent of model cells in all Counties except for Walworth County. In much of the Region, drawups in excess of 50 feet were common in the upper sandstone aquifer under Alternative Plan 2 conditions. While no model cells

Map 84

SIMULATED DRAWDOWN AND DRAWUP BETWEEN 2005 AND 2035 IN THE UPPER SANDSTONE AQUIFER UNDER ALTERNATIVE PLAN 2 CONDITIONS



Source: U.S. Geological Survey.

Table 102

AVERAGE AND MAXIMUM SIMULATED DRAWDOWN AND DRAWUP IN THE UPPER SANDSTONE AQUIFER UNDER ALTERNATIVE PLAN 2 CONDITIONS: 2005-2035[a]

County	Drawdown			Drawup		
	Percent of Model Cells	Average (feet)	Maximum (feet)	Percent of Model Cells	Average (feet)	Maximum (feet)
Kenosha	0.1	0.1	0.1	99.9	19.7	33.8
Milwaukee	0.0	0.0	0.0	100.0	91.7	128.8
Ozaukee	0.0	0.0	0.0	100.0	65.6	115.2
Racine	0.0	0.0	0.0	100.0	42.8	71.4
Walworth	24.6	0.7	10.1	75.4	7.9	43.2
Washington	0.0	4.6	4.6	100.0	49.6	237.3
Waukesha	0.0	5.9	5.9	100.0	78.1	195.2

[a]*Results are from Layer 11 in the groundwater simulation model.*

Source: U.S. Geological Survey.

Table 103

SIMULATED DRAWUP IN THE UPPER SANDSTONE AQUIFER UNDER ALTERNATIVE PLAN 2 CONDITIONS: 2005-2035[a]

County	Percent of Model Cells Showing Drawup Beyond Greater than:						
	One Foot	Five Feet	10 Feet	50 Feet	100 Feet	150 Feet	200 Feet
Kenosha	99.8	98.0	92.7	0.0	0.0	0.0	0.0
Milwaukee	100.0	100.0	100.0	100.0	30.9	0.0	0.0
Ozaukee	100.0	100.0	100.0	59.2	2.7	0.0	0.0
Racine	100.0	100.0	99.9	29.6	0.0	0.0	0.0
Walworth	60.5	40.0	26.8	0.0	0.0	0.0	0.0
Washington	99.9	99.9	94.3	45.6	2.8	0.1	0.1
Waukesha	99.9	98.3	93.4	66.2	38.1	6.3	0.0

[a]*Results are from Layer 11 in the groundwater simulation model.*

Source: U.S. Geological Survey.

in Kenosha or Walworth Counties show drawups in excess of 50 feet, drawups in excess of 50 feet were found in Milwaukee, Ozaukee, Racine, Washington, and Waukesha Counties, ranging from about 30 percent of cells in Racine County to 100 percent of cells in Milwaukee County. Drawups in excess of 100 feet were found in four Counties under Alternative Plan 2 conditions. In Milwaukee and Waukesha Counties, such drawups represented about 31 percent and 38 percent of cells, respectively. Drawups in excess of 100 feet were less common in Ozaukee and Washington Counties, accounting for less than 3 percent of model cells in each of these Counties.

Previous model results suggest that the top of the Sinnipee Group dolomite below the Maquoketa shale had become unsaturated by the year 2000 in central Waukesha County.[8] The simulation results suggest that under Alternative Plan 2 conditions, such unsaturated conditions would occur over a much smaller geographical area.

[8]Ibid.

An unsaturated condition at this depth, depending on how it might spread, could influence well yields and groundwater geochemistry around deep wells open to the Sinnipee Group, the St. Peter Formation, and below. Because of the model resolution and because the model does not explicitly simulate unsaturated flow, however, determination of the potential for this condition would require further more-detailed evaluation if such condition is expected under the recommended plan.

Water Budget Analyses

Table 104 shows the findings by County of a water budget analysis for the deep groundwater system under Alternative Plan 2 conditions. This analysis derived the anticipated values of two groundwater performance indicators—the demand to supply ratio and the human influence ratio—under Alternative Plan 2 conditions for the years 2005 and 2035. The analysis indicates that in 2005 the demand to supply ratio would range from about 0.10 in Kenosha County to about 5.77 in Waukesha County under Alternative Plan 2 conditions. Under these conditions, the values of the demand to supply ratio for Ozaukee, Racine, and Waukesha Counties in 2005 are expected to exceed one, indicating water budget deficits in the deep aquifer underlying these counties. The analysis also projects that under Alternative Plan 2 conditions in the demand to supply ratio would range from about 0.02 in Ozaukee County to about 3.29 in Waukesha County in 2035. Under these conditions, the values of this indicator are anticipated to increase in Racine and Walworth Counties and to decrease in Kenosha, Milwaukee, Ozaukee, Washington, and Waukesha Counties between 2005 and 2035. For 2035, the values of the demand to supply ratio for Racine and Waukesha Counties exceed one, indicating water budget deficits in the deep aquifer underlying these Counties.

The analysis also indicates, as shown in Table 104, that in 2005 the human impact ratio would range from about minus 0.88 in Waukesha County to about minus 0.04 in Kenosha County under Alternative Plan 2 conditions, and projects that in 2035 this indicator would range from about minus 0.78 in Waukesha County to about minus 0.01 in Ozaukee County under Alternative Plan 2 conditions. These values suggest that the net effect of human activities under these conditions would be to remove water from the deep groundwater system. In particular, the values for Waukesha County suggest that pumping dominates all outflows from deep aquifer in this County under Alternative Plan 2 conditions. In Milwaukee, Racine, and Walworth Counties, the projected values of this indicator for 2035 are lower than the 2005 values, indicating that the influence of human withdrawals on the water budget of the deep groundwater would be expected to increase in these Counties under Alternative Plan 2 conditions. In Kenosha, Ozaukee, Washington, and Waukesha Counties, the projected values of this indicator for 2035 are higher than the 2005 values, indicating a reduction in the influence of human withdrawals on the water budget of the deep groundwater system would be expected in these Counties under Alternative Plan 2 conditions. Despite this anticipated reduction, under these conditions the deep groundwater systems in Kenosha, Ozaukee, Washington, and Waukesha Counties are anticipated to remain heavily influenced by human activities in 2035.

Groundwater Impacts in the Shallow Aquifer

As previously noted, except in those portions of the Region where the shallow aquifers are confined by overlying clay-rich glacial tills, the effects of alternative plans upon baseflow to surface water features will generally be more informative of the impacts upon the shallow groundwater system than the associated changes in water levels in the sand and gravel and Silurian dolomite aquifers.

Impacts to Groundwater-Derived Baseflow to Surface Waters

On a Regional scale, simulated pumping under Alternative Plan 2 conditions increased from about 76.8 mgd in 2005, to about 93.7 mgd in 2035, representing a total increase in pumping of about 16.9 mgd. In addition, the model indicates that under Alternative Plan 2 conditions a net amount of about 7.5 mgd of water from the Region are contributed to accumulation in storage in the confined and unconfined aquifers and to cross-boundary flow out of the planning area. Thus, in a mass balance analysis for sources of water to wells from waterbodies in southeastern Wisconsin there needs to be an accounting for 24.4 mgd. The model indicates that 11.5 mgd, or about 47 percent, of this additional extracted water was derived from groundwater flow that in the absence of pumping would have been discharged to surface water features. An additional 12.9 mgd, or about 53 percent, was derived directly from surface water features due to reversed hydraulic gradients at the groundwater-surface water interface.

Table 104

PROJECTED GROUNDWATER PERFORMANCE INDICATORS FOR THE SANDSTONE AQUIFERS UNDER ALTERNATIVE PLAN 2 CONDITIONS: 2005 AND 2035

County	Demand to Supply Ratio[a]		Human Influence Ratio[b]	
	2005	2035	2005	2035
Kenosha	0.101	0.057	-0.041	-0.020
Milwaukee	0.567	0.369	-0.197	-0.225
Ozaukee	1.040	0.017	-0.317	-0.008
Racine	1.963	2.293	-0.500	-0.563
Walworth	0.745	0.883	-0.326	-0.390
Washington	0.453	0.294	-0.191	-0.153
Waukesha	5.773	3.287	-0.881	-0.784

[a]*The demand to supply ratio is defined as the ratio of net pumping demand on an aquifer to the amount of water that is replenished at a given point in time. Generally, this indicator ranges from 0—representing no human impact—upward. Values over 1.0 indicate that more groundwater is being extracted than can be replaced in a long-term, sustainable fashion. The year 2005 and 2035 conditions for this indicator are compared to predevelopment conditions.*

[b]*The human impact ratio, is defined as the ratio of human-induced groundwater inflows to total inflows minus the ratio of human-induced groundwater outflows to total outflows. This indicator is an expression of the relative magnitude of human alteration of the groundwater system. Values range from minus 1.0 in areas where wells have become the only discharge from an aquifer by stopping all other groundwater discharges, through 0 representing no net human impact, to plus 1.0 representing situations where human additions are the only inputs to the aquifer. The year 2005 and 2035 conditions for this indicator are compared to predevelopment conditions.*

Source: University of Wisconsin-Milwaukee.

As already noted, major streams, rivers, and lakes in the surface water system in the Southeastern Wisconsin Region are represented in the model by 3,756 cells designated as stream nodes. The simulation model results indicated that under 2005 pumping conditions, about 92 percent of these nodes were receiving baseflow from groundwater, while about 5 percent were losing baseflow to groundwater. By 2035, these percentages would change slightly under Alternative Plan 2 conditions, with about 90 percent of these nodes expected to receive baseflow from groundwater, and about 7 percent as losing baseflow to groundwater. As previously noted, the analyses conducted consider only the impacts on the groundwater-derived baseflow of the streamflow. Groundwater-derived baseflow typically comprises from 10 to 50 percent of total streamflow.

Table 105 summarizes simulated changes in baseflow to surface waters in the Southeastern Wisconsin Region under Alternative Plan 2 conditions over the period 2005 to 2035. In aggregate, by 2035 surface waterbodies in the Region may be expected to experience a baseflow depletion of about 18.7 mgd. The amounts of depletion would vary among the Counties, ranging from an augmentation of baseflow of about 0.2 mgd in Milwaukee County, to a depletion of about 9.1 mgd in Waukesha County. Within the Region as a whole, about 8.1 mgd, or 43 percent, would result from inflow depletion. The remaining 10.6 mgd, or 57 percent, would result from outflow depletion. These aggregate totals, however, obscure differences in site-specific baseflow changes within each County. While the County totals project overall depletions within each County, individual waterbodies may experience either depletion or augmentation on a site-specific basis.

Model nodes showing greater than 10 percent and greater than 25 percent potential baseflow depletion under Alternative Plan 2 conditions are shown on Maps 85 and 86, respectively. As previously noted, these data are valid when considered in aggregate for comparison of alternative plans. Model refinement would be needed for consideration of site-specific impacts. Several notable areas of baseflow depletion are indicated in the model results. Nodes for which the simulation analyses indicated greater than 10 percent baseflow reduction include those representing portions of Mole Creek, Pigeon Creek, and Sauk Creek in Ozaukee County; the mainstem of

Table 105

SIMULATED BASEFLOW DEPLETION TO SURFACE WATERS UNDER ALTERNATIVE PLAN 2 CONDITIONS: 2005-2035

Baseflow to Surface Water	2000 Baseflow (million gallons per day)	2035 Baseflow (million gallons per day)	Difference (million gallons per day)[a]	Percent Change[a]
Kenosha County				
Inflow to Surface Water	41.63	40.49	-1.14	-2.8
Outflow from Surface Water	0.40	1.13	-0.73	-180.4
Subtotal	41.23	39.36	-1.87	-4.5
Milwaukee County				
Inflow to Surface Water	11.45	11.60	0.15	1.3
Outflow from Surface Water	2.98	2.96	0.02	0.6
Subtotal	8.47	8.64	0.17	2.0
Ozaukee County				
Inflow to Surface Water	17.34	17.15	-0.19	-1.1
Outflow from Surface Water	0.46	0.51	-0.05	-11.1
Subtotal	16.88	16.64	-0.24	-1.5
Racine County				
Inflow to Surface Water	41.70	41.68	-0.02	<-0.1
Outflow from Surface Water	0.07	0.45	-0.38	-567.3
Subtotal	41.63	41.23	-0.40	-1.0
Walworth County				
Inflow to Surface Water	104.00	101.39	-2.61	-2.5
Outflow from Surface Water	8.99	10.52	-1.53	-17.1
Subtotal	95.01	90.87	-4.14	-4.4
Washington County				
Inflow to Surface Water	63.52	61.23	-2.28	-3.6
Outflow from Surface Water	2.52	3.31	-0.79	-31.5
Subtotal	61.00	57.92	-3.08	-5.0
Waukesha County				
Inflow to Surface Water	89.55	87.52	-2.03	-2.3
Outflow from Surface Water	1.28	8.39	-7.11	-554.6
Subtotal	88.27	79.13	-9.14	-10.4
Southeastern Wisconsin Region				
Inflow to Surface Water	369.19	361.06	-8.13	-2.2
Outflow from Surface Water	16.70	27.27	-10.57	-63.3
Total	352.49	333.79	-18.70	-5.3

[a]*A positive difference or change represents augmentation of baseflow to surface waters, a negative difference or change represents depletion of baseflow to surface waters.*

Source: U.S. Geological Survey.

the Milwaukee River between West Bend and Newburg in Washington County; Quaas Creek in Washington County; the Rubicon River and the East Branch of the Rubicon River in Washington County; the Fox River between the City of Pewaukee in Waukesha County and Palmer Creek in Kenosha County including some portions of Vernon Marsh; portions of several tributaries to the Fox River in Waukesha County including Pebble Brook, Pebble Creek, the Pewaukee River, and Sussex Creek; Lake Beulah in Walworth County; a portion of the White River in Walworth County; Turtle Creek in Walworth County; Delavan Lake in Walworth County; Jackson

Map 85

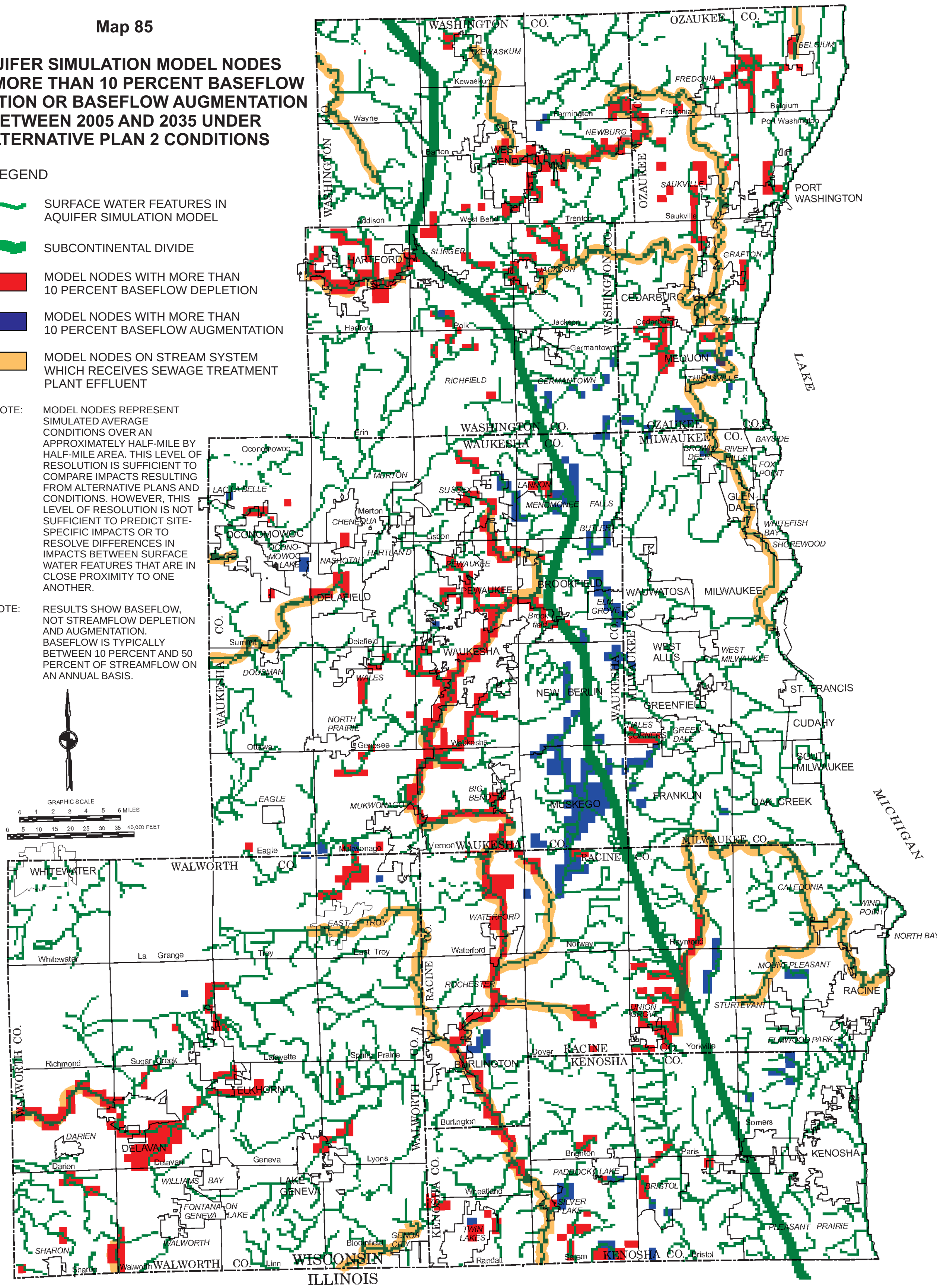
AQUIFER SIMULATION MODEL NODES WITH MORE THAN 10 PERCENT BASEFLOW DEPLETION OR BASEFLOW AUGMENTATION BETWEEN 2005 AND 2035 UNDER ALTERNATIVE PLAN 2 CONDITIONS

LEGEND

- SURFACE WATER FEATURES IN AQUIFER SIMULATION MODEL
- SUBCONTINENTAL DIVIDE
- MODEL NODES WITH MORE THAN 10 PERCENT BASEFLOW DEPLETION
- MODEL NODES WITH MORE THAN 10 PERCENT BASEFLOW AUGMENTATION
- MODEL NODES ON STREAM SYSTEM WHICH RECEIVES SEWAGE TREATMENT PLANT EFFLUENT

NOTE: MODEL NODES REPRESENT SIMULATED AVERAGE CONDITIONS OVER AN APPROXIMATELY HALF-MILE BY HALF-MILE AREA. THIS LEVEL OF RESOLUTION IS SUFFICIENT TO COMPARE IMPACTS RESULTING FROM ALTERNATIVE PLANS AND CONDITIONS. HOWEVER, THIS LEVEL OF RESOLUTION IS NOT SUFFICIENT TO PREDICT SITE-SPECIFIC IMPACTS OR TO RESOLVE DIFFERENCES IN IMPACTS BETWEEN SURFACE WATER FEATURES THAT ARE IN CLOSE PROXIMITY TO ONE ANOTHER.

NOTE: RESULTS SHOW BASEFLOW, NOT STREAMFLOW DEPLETION AND AUGMENTATION. BASEFLOW IS TYPICALLY BETWEEN 10 PERCENT AND 50 PERCENT OF STREAMFLOW ON AN ANNUAL BASIS.



Source: U.S. Geological Survey.

Map 86

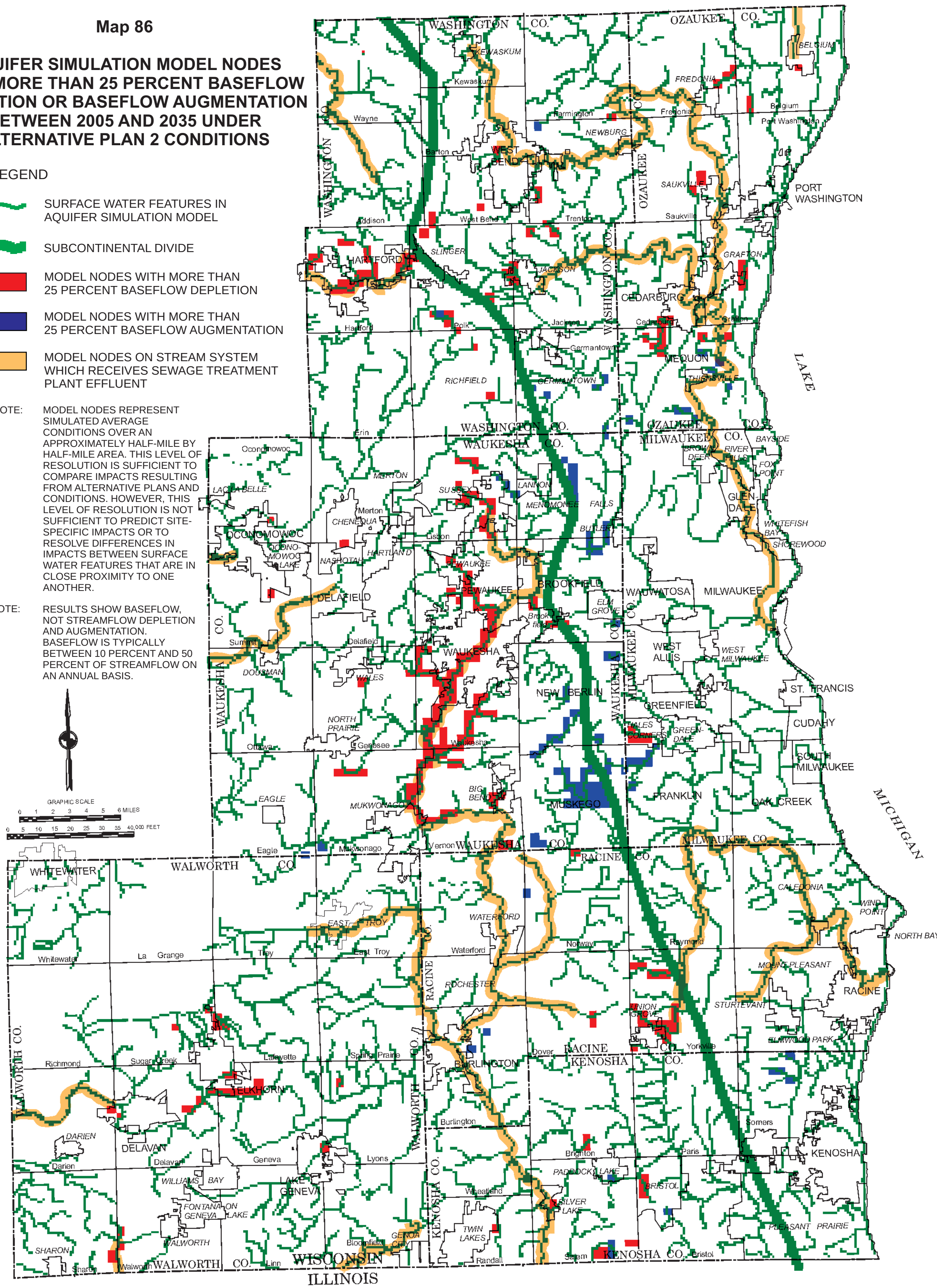
AQUIFER SIMULATION MODEL NODES WITH MORE THAN 25 PERCENT BASEFLOW DEPLETION OR BASEFLOW AUGMENTATION BETWEEN 2005 AND 2035 UNDER ALTERNATIVE PLAN 2 CONDITIONS

LEGEND

- SURFACE WATER FEATURES IN AQUIFER SIMULATION MODEL
- SUBCONTINENTAL DIVIDE
- MODEL NODES WITH MORE THAN 25 PERCENT BASEFLOW DEPLETION
- MODEL NODES WITH MORE THAN 25 PERCENT BASEFLOW AUGMENTATION
- MODEL NODES ON STREAM SYSTEM WHICH RECEIVES SEWAGE TREATMENT PLANT EFFLUENT

NOTE: MODEL NODES REPRESENT SIMULATED AVERAGE CONDITIONS OVER AN APPROXIMATELY HALF-MILE BY HALF-MILE AREA. THIS LEVEL OF RESOLUTION IS SUFFICIENT TO COMPARE IMPACTS RESULTING FROM ALTERNATIVE PLANS AND CONDITIONS. HOWEVER, THIS LEVEL OF RESOLUTION IS NOT SUFFICIENT TO PREDICT SITE-SPECIFIC IMPACTS OR TO RESOLVE DIFFERENCES IN IMPACTS BETWEEN SURFACE WATER FEATURES THAT ARE IN CLOSE PROXIMITY TO ONE ANOTHER.

NOTE: RESULTS SHOW BASEFLOW, NOT STREAMFLOW DEPLETION AND AUGMENTATION. BASEFLOW IS TYPICALLY BETWEEN 10 PERCENT AND 50 PERCENT OF STREAMFLOW ON AN ANNUAL BASIS.



Source: U.S. Geological Survey.

Creek in Walworth County; a portion of Darien Creek in Walworth County; the West Branch of the Root River Canal in Racine County; and the Des Plaines River near Union Grove in Racine County. Maps 85 and 86 also highlight those streams which receive a significant amount of wastewater treatment plant effluent, and are, thus, less sensitive to reductions in baseflows. It is important to note that several of the streams expected to show baseflow reductions in excess of 10 percent under Alternative Plan 2 conditions receive wastewater treatment plant effluent. In those streams, the impacts of a reduced groundwater-derived baseflow are generally mitigated from a streamflow perspective. Some water quality impacts may be a consideration in these streams.

Model nodes showing greater than 25 percent potential baseflow reductions include those representing portions of Pigeon Creek in Ozaukee County; portions of the Rubicon River and the East Branch of the Rubicon River in Washington County; the Fox River between the City of Pewaukee and the Village of Mukwonago in Waukesha County including some portions of the Vernon Marsh; portions of several tributaries to the Fox River in Waukesha County including portions of Pebble Brook, Pebble Creek, the Pewaukee River, and Sussex Creek; Jackson Creek in Walworth County; a portion of the West Branch of the Root River Canal in Racine County; and a portion of the Des Plaines River near Union Grove in Racine County. Some of the streams simulated to show baseflow reductions in excess of 25 percent under Alternative Plan 2 conditions receive wastewater treatment plant effluent (see Map 86). As noted above, this condition tends to mitigate the impacts of the losses of groundwater-derived baseflow losses from a streamflow perspective.

Maps 85 and 86 also depict model nodes which show potential augmentations of baseflow under Alternative Plan 2 conditions greater than 10 percent and greater than 25 percent, respectively. As previously noted, these results are considered to be valid for the purpose of comparing alternative plans. Additional analysis would be needed for consideration of site-specific impacts. Several notable areas of baseflow augmentation are indicated by the model results. Nodes for which simulation analyses indicated greater than 10 percent potential baseflow augmentation include those representing portions of the Nor-X-Way Channel in Washington and Waukesha Counties; Trinity Creek in Ozaukee County; Butler Ditch, Hale Creek, Underwood Creek, Lake Denoon and portions of Deer Creek in Waukesha; the Wind Lake subwatershed of the Fox River watershed in Waukesha and Racine Counties, including Big Muskego, Little Muskego, and Wind Lakes and the Muskego and Wind Lake Drainage Canals; Tess Corners Creek in Milwaukee County; Browns Lake and portions of the East Branch of the Root River Canal in Racine County; and Silver Lake in Kenosha County.

Model nodes simulated to show greater than 25 percent potential baseflow augmentation include those representing Trinity Creek in Ozaukee County; Butler Ditch, Hale Creek, and Lake Denoon in Waukesha County; and upper portions of the Wind Lake subwatershed of the Fox River watershed in Waukesha County.

These simulated baseflow reductions and augmentations need to be carefully interpreted. As noted above, the groundwater model simulates changes in baseflow, not changes in total streamflow. A change in baseflow does not necessarily indicate a change in total streamflow. For example, in some streams much of a reduction in baseflow may be returned to the surface water system through discharge from wastewater treatment plants. This is certainly the case for the Fox River where 15 municipal wastewater treatment plants discharge treated effluent into the River or its tributaries. Increase in runoff due to changes in land use may also serve to augment streamflow in streams experiencing baseflow reductions. In addition, because of the resolution provided by the model grid, any simulated change in baseflow represents an average change over the approximately one-quarter square mile area of a model cell. Because variations may occur within the area represented by a model cell, this average may not be totally representative of individual surface water features within the cell, particularly small surface water features in cells containing multiple surface water features.

Simulated baseflow changes between 2005 and 2035 were evaluated at 100 model nodes representing surface water evaluation sites. Decreases in baseflow under Alternative Plan 2 conditions were found to occur at 63 evaluation sites, or 63 percent of evaluation sites; with decreases in excess of 10 percent of 2005 baseflow found at 23, or 23 percent, of these sites; and simulated decreases in excess of 25 percent of 2005 baseflow found at 10, or 10 percent, of these sites. Increases in baseflow were found to occur at 23 evaluation sites, or 23 percent of evaluation sites, with increases in excess of 10 percent of 2005 baseflow found at seven, or 7 percent, of these sites; and simulated increases in excess of 25 percent of 2005 baseflow found at three, or 3 percent, of these sites. The remaining 14 evaluation sites, or 14 percent of evaluation sites, were found to either experienced no change in baseflow or were not simulated as having streamflow in 2005.

Simulated Water Levels in the Shallow Aquifers

The results of the simulation indicate that under Alternative Plan 2 conditions, additional drawdowns may be expected to occur in the shallow aquifer over much of the Region. These impacts are shown on Maps 87 and 88. Table 106 provides a summary of the simulated drawdowns and drawups in the glacial sand and gravel aquifer over the period 2005 to 2035. The percentage of cells in the model showing drawdowns over 2005 levels ranges from about 37 percent in Racine County to about 82 percent in Ozaukee County. Average drawdowns projected in this aquifer are relatively small, ranging from about 0.6 foot for cells showing drawdowns in Milwaukee County, to about 1.2 feet for cells showing drawdowns in Waukesha County. This reflects, in part, the damping effect that surface waters have on changes in the shallow groundwater system. Often the major effect of pumping from shallow wells is to reduce groundwater discharge to local surface water features. The maximum drawdowns projected for this aquifer are considerably higher, ranging from about 4.5 feet for cells showing drawdowns in Milwaukee County, to about 76 feet for cells showing drawdowns in Racine County.

Table 107 summarizes the variation among model cells in terms of the percentage of the cells showing simulated drawdowns over the period 2005 to 2035 greater than the given thresholds. In most of the Region, drawdowns greater than 10 feet are relatively rare in the glacial sand and gravel aquifer under Alternative Plan 2 conditions. None of the model cells in Milwaukee County and fewer than 1 percent of the model cells in Kenosha, Ozaukee, Racine, and Walworth Counties indicate drawdowns in excess of 10 feet. Drawdowns in excess of 10 feet may be expected to be somewhat more common in Washington and Waukesha Counties, representing about 1 percent of cells in each of these Counties.

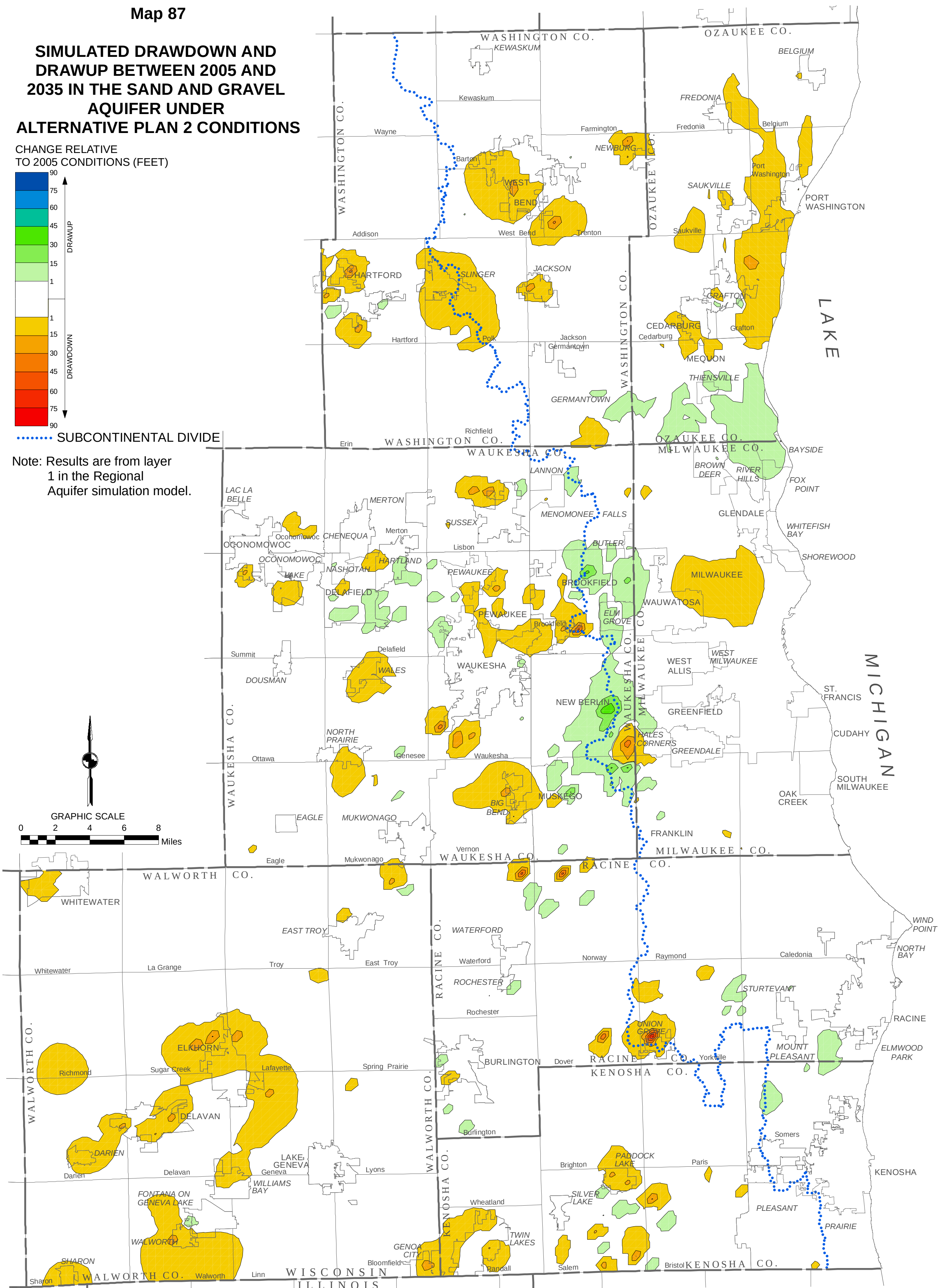
Model cells showing simulated drawdowns were distributed throughout the Region; however, there were areas that showed a high proportion of cells with drawdowns greater than one foot. These areas include western Kenosha County; eastern and central Ozaukee County; northern Milwaukee County; south-central Racine County; central and western Walworth County; and central Washington County. Areas with a high proportion of cells showing drawdowns greater than one foot were also scattered throughout Waukesha County as shown on Map 87.

Table 106 also summarizes simulated drawups in the glacial aquifer over the period 2005 to 2035. The percentage of cells in the model showing drawups over 2005 levels ranges from about 18 percent in Ozaukee County to about 63 percent in Racine County. Average drawups projected in this aquifer are relatively small, ranging from no drawups in Walworth County, to 1.4 feet for cells showing drawups in Ozaukee County. Maximum simulated drawups in this aquifer range from about four feet in Walworth and Washington Counties, to about 38 feet in Waukesha County. While model cells showing simulated drawups in the glacial aquifer were distributed throughout the Region, areas with a high proportion of cells showing drawups greater than one foot were found primarily along the Milwaukee-Ozaukee county line and in central and eastern Waukesha County as shown on Map 87.

Table 108 presents a summary of simulated drawdowns and drawups in the Silurian aquifer over the period 2005 to 2035. The percentage of cells in the model showing drawdowns over 2005 levels ranges from about 18 percent in Milwaukee County, to about 85 percent in Ozaukee County. With one exception, average drawdowns projected in this aquifer are relatively small, ranging from about 0.5 foot for cells showing drawdowns in Milwaukee County, to about 1.5 feet for cells showing drawdowns in Waukesha County. The model projects a higher average drawdown for cells showing drawdowns in Ozaukee County. In this County, the average drawdown projected by the model was about 13.6 feet. As already noted, the small average drawdown in this aquifer over most of the Region reflects, in part, the damping effect that surface waters have on changes in the shallow groundwater system.

Map 87

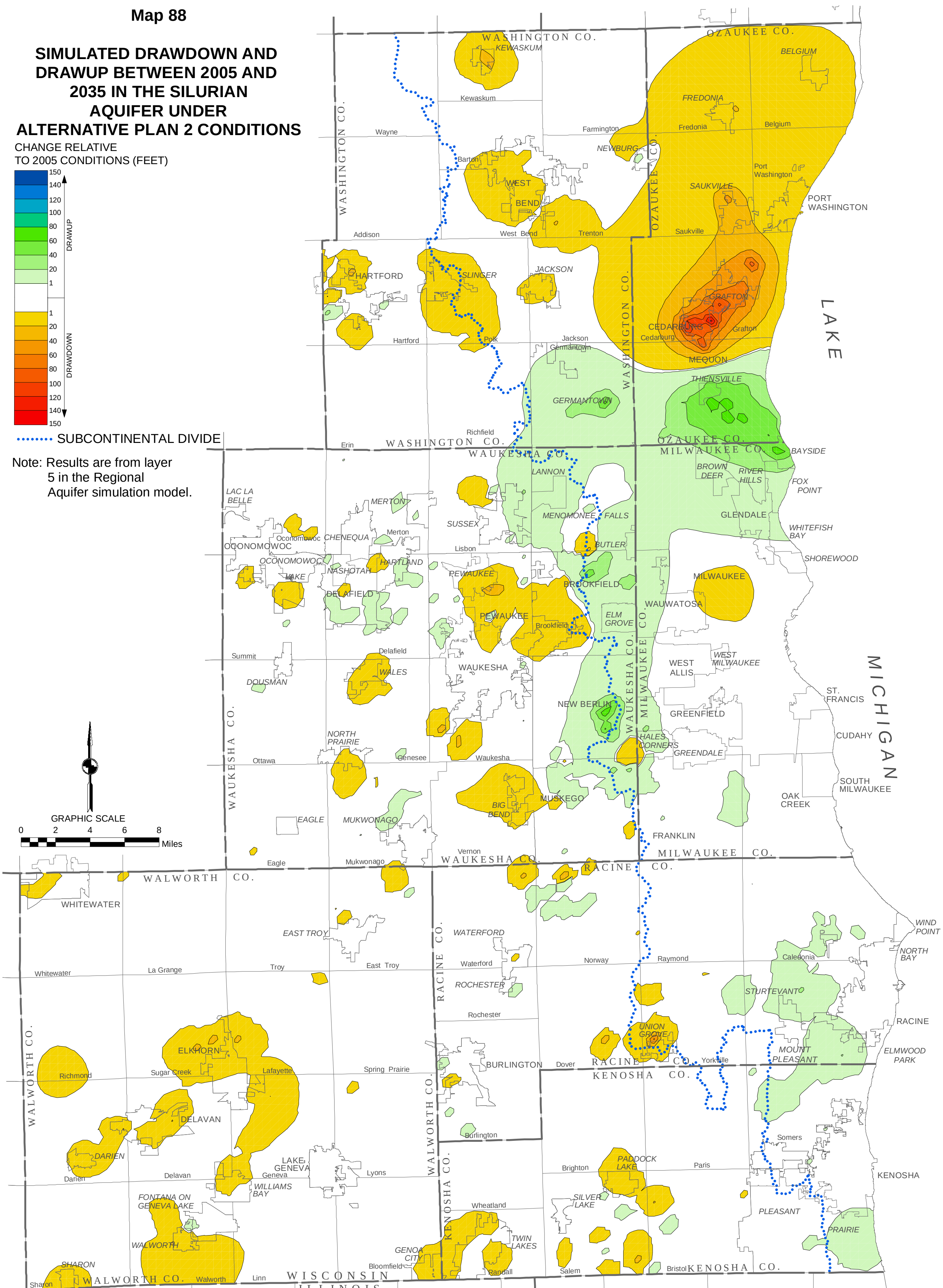
SIMULATED DRAWDOWN AND DRAWUP BETWEEN 2005 AND 2035 IN THE SAND AND GRAVEL AQUIFER UNDER ALTERNATIVE PLAN 2 CONDITIONS



Source: U.S. Geological Survey.

Map 88

SIMULATED DRAWDOWN AND DRAWUP BETWEEN 2005 AND 2035 IN THE SILURIAN AQUIFER UNDER ALTERNATIVE PLAN 2 CONDITIONS



Source: U.S. Geological Survey.

Table 106

AVERAGE AND MAXIMUM SIMULATED DRAWDOWN AND DRAWUP IN THE GLACIAL SAND AND GRAVEL AQUIFER UNDER ALTERNATIVE PLAN 2 CONDITIONS BY COUNTY: 2005-2035[a]

County	Drawdown			Drawup		
	Percent of Model Cells	Average (feet)	Maximum (feet)	Percent of Model Cells	Average (feet)	Maximum (feet)
Kenosha	53.6	0.7	31.5	46.4	0.2	8.2
Milwaukee	48.9	0.6	4.5	51.1	0.3	8.2
Ozaukee	82.0	1.0	28.3	18.0	1.4	9.4
Racine	36.8	0.9	75.7	63.2	0.1	9.0
Walworth	76.3	0.8	31.0	23.7	0.0	4.1
Washington	71.0	0.9	34.4	29.0	0.1	4.0
Waukesha	41.8	1.2	49.1	58.2	0.8	38.3

[a]*Results are from Layer 1 in the groundwater simulation model.*

Source: U.S. Geological Survey.

Table 107

SIMULATED DRAWDOWN IN THE GLACIAL SAND AND GRAVEL AQUIFER UNDER ALTERNATIVE PLAN 2 CONDITIONS BY COUNTY: 2005-2035[a]

County	Percent of Model Cells Showing Drawdown Beyond Greater than:				
	One Foot	Five Feet	10 Feet	50 Feet	100 Feet
Kenosha	6.8	1.7	0.9	0.0	0.0
Milwaukee	8.0	0.0	0.0	0.0	0.0
Ozaukee	17.6	4.6	0.9	0.0	0.0
Racine	3.4	1.2	0.5	0.2	0.0
Walworth	14.2	2.5	0.7	0.0	0.0
Washington	11.7	3.3	1.0	0.0	0.0
Waukesha	9.3	2.5	1.0	0.0	0.0

[a]*Results are from Layer 1 in the groundwater simulation model.*

Source: U.S. Geological Survey.

Maximum drawdowns projected for the Silurian aquifer are considerably higher than the average drawdowns, ranging from about two feet for cells showing drawdowns in Milwaukee County, to about 145 feet for cells showing drawdowns in Ozaukee County. Table 109 summarizes the variation among the model cells in terms of the percentage of the cells showing simulated drawdowns over the period 2005 to 2035 greater than the given thresholds. In much of the Region, drawdowns greater than 10 feet are relatively rare in the Silurian aquifer under Alternative Plan 2 conditions. Fewer than 2 percent of cells in Kenosha, Milwaukee, Racine, Walworth, Washington, and Waukesha Counties showed drawdowns in excess of 10 feet. Drawdowns in excess of 10 feet were more common in Ozaukee County, representing about 30 percent of the cells in this County. Model cells showing simulated drawdowns were distributed throughout the Region; however, there were areas that showed a high proportion of cells showing drawdowns greater than one foot. At the resolution of the model, these areas include western Kenosha County, northern and central portions of Ozaukee County, north-central Milwaukee County, southern Racine County, central and western Walworth County, and central and north-central Washington County. Areas with high proportions of cells showing drawdowns greater than one foot are also scattered throughout Waukesha County.

Table 108

AVERAGE AND MAXIMUM SIMULATED DRAWDOWN AND DRAWUP IN THE SILURIAN AQUIFER UNDER ALTERNATIVE PLAN 2 CONDITIONS: 2005-2035[a]

County	Drawdown			Drawup		
	Percent of Model Cells	Average (feet)	Maximum (feet)	Percent of Model Cells	Average (feet)	Maximum (feet)
Kenosha	51.2	0.8	31.2	48.8	0.6	19.7
Milwaukee	18.1	0.5	2.0	81.9	2.6	71.8
Ozaukee	84.8	13.6	144.9	15.2	29.8	69.8
Racine	26.7	1.2	62.6	73.2	0.6	26.7
Walworth	72.1	0.9	30.9	27.9	0.1	5.2
Washington	65.5	1.3	28.4	34.5	2.0	65.8
Waukesha	35.6	1.5	40.0	64.4	1.9	75.7

[a]*Results are from Layer 5 in the groundwater simulation model.*

Source: U.S. Geological Survey.

Table 109

SIMULATED DRAWDOWN IN THE SILURIAN AQUIFER UNDER ALTERNATIVE PLAN 2 CONDITIONS: 2005-2035[a]

County	Percent of Model Cells Showing Drawdown Beyond Greater than:				
	One Foot	Five Feet	10 Feet	50 Feet	100 Feet
Kenosha	7.9	1.7	0.6	0.0	0.0
Milwaukee	3.8	0.0	0.0	0.0	0.0
Ozaukee	79.6	49.1	30.1	5.5	0.6
Racine	4.1	1.2	0.6	0.1	0.0
Walworth	14.3	2.6	0.8	0.0	0.0
Washington	19.3	3.9	1.1	0.0	0.0
Waukesha	11.5	2.8	0.9	0.0	0.0

[a]*Results are from Layer 5 in the groundwater simulation model.*

Source: U.S. Geological Survey.

Table 108 also summarizes simulated drawups in the Silurian aquifer over the period 2005 to 2035. The percentage of cells in the model showing drawups over 2005 levels ranges from about 15 percent in Ozaukee County to about 82 percent in Milwaukee County. With one exception, average drawups projected in this aquifer are relatively small, ranging from less than 0.1 foot for cells showing drawups in Walworth County to about 2.6 feet for cells showing drawups in Milwaukee County. The model projects a higher average drawup for cells in Ozaukee County. In this County, the average drawup projected by the model was 29.8 feet. Maximum simulated drawups in this aquifer range from about five feet in Walworth County to about 76 feet in Waukesha County. While model cells showing simulated drawups in the Silurian aquifer were distributed throughout the Region, areas containing a high proportion of cells showing drawups greater than one foot were found in southern Ozaukee County, in northern Milwaukee County along the Milwaukee-Ozaukee county line, in southeastern Washington County, and in eastern Waukesha County. Much of the simulated drawup in southern Ozaukee and northern Milwaukee Counties may be attributed to shifting of the source of water supply in Mequon from private wells to Lake Michigan as envisioned under Alternative Plan 2. Smaller areas containing high proportions of cells showing drawups greater than one foot were found in northwestern Racine County and in eastern Racine and Kenosha Counties.

Water Budget Analysis

Table 110 shows results by County from a water budget analysis for the shallow groundwater system under Alternative Plan 2 conditions. This analysis derived the anticipated values of three groundwater performance indicators—the demand to supply ratio, the human influence ratio, and the baseflow reduction index—under Alternative Plan 2 conditions for the years 2005 and 2035. The analysis indicates that in 2005 the demand to supply ratio would range from about 0.04 in Walworth County to about 0.20 in Ozaukee County under Alternative Plan 2 conditions. The analysis projects that in 2035 this indicator would range from about 0.07 in Racine County to about 0.21 in Ozaukee County under Alternative Plan 2 conditions. While under these conditions increases in this indicator are projected to occur in Kenosha, Ozaukee, Racine, Walworth, Washington, and Waukesha Counties, all values of the demand to supply ratio for the shallow aquifer are projected to be well below 1.0, indicating little evidence of a water budget deficit in the shallow aquifer.

The analysis also indicates that in 2005 the human impact ratio would range from about minus 0.19 in Ozaukee County to about minus 0.04 in Walworth County under Alternative Plan 2 conditions, and projects that in 2035 this indicator would range from about minus 0.20 in Ozaukee County to about minus 0.07 in Racine County under Alternative Plan 2 conditions. These values suggest that the net effect of human activities under these conditions would be to remove water from the shallow groundwater system. In Kenosha, Ozaukee, Racine, Walworth, Washington, and Waukesha Counties, the projected values of this indicator for 2035 are lower than the 2005 values, indicating that the influence of human withdrawals on the water budget of the shallow groundwater system would be expected to increase in these Counties under Alternative Plan 2 conditions. In Milwaukee County, the projected value of this indicator for 2035 is higher than the 2005 value, indicating a reduction in the influence of human withdrawals on the water budget of the shallow groundwater system would be expected in this County under Alternative Plan 2 conditions. Despite this anticipated reduction, under these conditions the shallow groundwater system in Milwaukee County is anticipated to remain more heavily influenced by human activities in 2035 than those in several of the other counties in the Region.

Finally, the analysis indicates that in 2035 the baseflow reduction index would range from about minus 8.3 percent in Waukesha County to 2.4 percent in Milwaukee County. Under Alternative Plan 2 conditions, the value of the baseflow reduction index in Kenosha, Ozaukee, Racine, Walworth, Washington, and Waukesha Counties in 2035 is anticipated to be less than zero, indicating that reductions in average groundwater-derived baseflow to surface waters may be expected. The positive value of the indicator in Milwaukee County indicates that the average level of groundwater-derived baseflow to surface waters in this County may be expected to increase under Alternative Plan 2 conditions. It should be noted that, these are countywide averages developed for purposes of comparing alternative plans at the systems level of planning. Within any county, changes in baseflow may be expected to vary among waterbodies. It should be noted that, a change in baseflow does not indicate a change in total streamflow. The index only considers the groundwater component of streamflow. The impact on streamflow will typically be less in terms of percent reduction or increase. For those streams which receive discharges of sewage treatment plant effluent, the baseflow and streamflow amounts will be artificially increased and make surface water flows less sensitive to changes in groundwater-derived baseflow. Finally, it should be noted that, for all seven Counties, the 2035 magnitudes of average baseflow reduction under Alternative Plan 2 conditions are less than 10 percent, suggesting small average reductions relative to 2005 conditions.

Other Surface Water Impacts

Under Alternative Plan 2, the source of supply used by several utilities located east of the subcontinental divide that are served for sewage conveyance and treatment by the Milwaukee Metropolitan Sewerage District (MMSD) would be shifted from groundwater to Lake Michigan water. This would result in a reduction in the hardness of the water provided by these utilities and would eliminate the need for water softening by the customers of these utilities. This would result in reductions in the concentration of chloride in the sewage conveyed to the MMSD

Table 110

PROJECTED GROUNDWATER PERFORMANCE INDICATORS FOR THE GLACIAL SAND AND GRAVEL AND SILURIAN DOLOMITE AQUIFERS UNDER 2005 AND 2035 ALTERNATIVE PLAN 2 CONDITIONS

County	Demand to Supply Ratio[a]		Human Influence Ratio[b]		Baseflow Reduction[c] from 2005 Levels percent
	2005	2035	2005	2035	2035
Kenosha	0.047	0.094	-0.047	-0.091	-5.4
Milwaukee	0.159	0.131	-0.150	-0.127	2.4
Ozaukee	0.199	0.210	-0.188	-0.204	-0.1
Racine	0.061	0.069	-0.060	-0.068	-1.0
Walworth	0.045	0.085	-0.044	-0.084	-5.0
Washington	0.083	0.118	-0.081	-0.115	-4.5
Waukesha	0.089	0.158	-0.086	-0.149	-8.3

[a]*The demand to supply ratio is defined as the ratio of net pumping demand on an aquifer to the amount of water that is replenished at a given point in time. Generally, this indicator ranges from 0—representing no human impact—upward. Values over 1.0 indicate that more groundwater is being extracted than can be replaced in a long-term, sustainable fashion. The year 2005 and 2035 conditions for this indicator are compared to predevelopment conditions.*

[b]*The human impact ratio, is defined as the ratio of human-induced groundwater inflows to total inflows minus the ratio of human-induced groundwater outflows to total outflows. This indicator is an expression of the relative magnitude of human alteration of the groundwater system. Values range from minus 1.0 in areas where wells have become the only discharge from an aquifer by stopping all other groundwater discharges, through 0 representing no net human impact, to plus 1.0 representing situations where human additions are the only inputs to the aquifer. The year 2005 and 2035 conditions for this indicator are compared to predevelopment conditions.*

[c]*The base flow reduction index is defined as the ratio of the change in groundwater-derived baseflow discharge due to pumping to the groundwater-derived baseflow at a defined base time. The year 2035 conditions for this indicator are compared to 2005 conditions.*

Source: University of Wisconsin-Milwaukee.

treatment facilities and in the chloride loads discharged by these facilities to Lake Michigan. For example, a reduction in the average concentration of chloride in sewage conveyed to the MMSD treatment facilities from these communities of 100 milligrams per liter (mg/l) would result in an annual reduction in chloride discharge to Lake Michigan of about 3.8 million pounds. Given that the average concentrations of chloride in the effluent discharged by municipal wastewater treatment plants located west of the subcontinental divide that treat wastewater in communities using groundwater as a source of supply for which data were available ranged between 400 and 550 mg/l, it is likely that positive reductions in chloride loading to Lake Michigan on this order of magnitude could be expected under Alternative Plan 2 conditions.

For most other utilities, Alternative Plan 2 generally makes use of expanded sources of groundwater that are similar to the existing sources. Because of this, it is anticipated that this alternative will produce few changes in surface water quality within the Region, other than those described above, and those associated with changes in groundwater-derived baseflows that were previously noted.

Conclusions Concerning Groundwater and Surface Water Impacts of Alternative Plan 2

The results of the simulation modeling indicate that under Alternative Plan 2 conditions, drawups in the deep aquifer may be expected to occur in almost all model cells in the Region, except for cells in southern and western Walworth County, over the planning period. The magnitude of the average drawups over 2005 conditions in this aquifer may be expected to range between about eight and about 92 feet by county. The maximum drawup over 2005 conditions in this aquifer may be expected to be about 237 feet. In all Counties of the Region, except for Kenosha and Walworth Counties, drawups over 2005 conditions in excess of 50 feet may be expected to be common. These drawups reflect both the shift from the use of groundwater as a source of water supply to the use of Lake Michigan by some communities, and a shift by some communities from the deep groundwater system as a source of water supply to the shallow groundwater system as envisioned under Alternative Plan 2. Some drawdowns may be expected to occur in some model cells, primarily in Walworth County, over the planning period under this alternative plan. The magnitude of the average drawdowns over 2005 conditions in this aquifer may be expected to be relatively small, ranging between about 0.1 foot and about six feet by county for those counties experiencing drawdowns. The maximum drawdown over 2005 conditions in this aquifer may be expected to be about 10 feet. The drawdowns expected in Walworth County and the smaller drawups expected in Kenosha and Walworth Counties than in the other counties may be attributed, in part, to the influence of groundwater use in northeastern Illinois. In addition, these areas are also located a considerable distance from the communities whose source of water supply is envisioned to change from the deep aquifer to Lake Michigan under Alternative Plan 2. Water budget analyses indicate that the deep groundwater system is likely to be heavily influenced by human activities under Alternative Plan 2 conditions, with the net effect of human activities being to remove water from the deep groundwater system. This analysis also indicates that Racine and Waukesha Counties may experience water budget deficits in the deep aquifer under Alternative Plan 2 conditions.

On a Regional scale, pumpage under Alternative Plan 2 conditions may be expected to increase 15.7 mgd to about 92.5 mgd between 2005 and 2035. The model indicates that under Alternative Plan 2 conditions, a net amount of about 7.5 mgd of water from the Region would be contributed to accumulation in storage in the aquifers and to cross-boundary flow out of the planning area, requiring a mass balance analysis to account for 23.2 mgd of water. About 47 percent of this water to be accounted for will be derived from groundwater flow that, in the absence of pumping, would have discharged to surface water features; while about 53 percent would be derived directly from surface water features due to reversed hydraulic gradients at the groundwater-surface water interface. The impact of pumping on surface waters can be represented as groundwater-derived baseflow depletion. Groundwater-derived baseflow is the amount of flow in the waterbody from upgradient groundwater discharge. The overland component of total streamflow and any discharge of treated wastewater are not included in baseflow, and the simulation modeling results do not include, or account for, these components. Typically baseflow represents about 10 percent to 50 percent of streamflow on an annual basis. In aggregate, by 2035 surface waterbodies in the Region may be expected to experience a baseflow depletion relative to 2005 conditions of about 18.7 mgd, or slightly over 5 percent. On average, baseflow reduction under Alternative Plan 2 conditions are less than or slightly over 10 percent, suggesting small average reductions relative to 2005 conditions. These aggregate total and average values may, however, obscure site-specific differences in baseflow changes within each county. While the county totals project overall depletions within each county, individual waterbodies may experience either depletion or augmentation. The reductions in groundwater-derived baseflow at 23 of 100 surface water evaluation sites were in excess of 10 percent.

The results of the simulation indicate that under Alternative Plan 2 conditions, additional drawdowns over 2005 conditions may be expected to occur in the shallow aquifer over much of the Region. However, the magnitude of the drawdowns is estimated to be relatively small; in most Counties, the drawdown may be expected to average less than 1.5 feet. The relatively small magnitude of the drawdown may be attributed to the buffering effects of surface water baseflow interactions.

In the glacial sand and gravel aquifer, additional drawdowns may be expected to occur in 37 to 82 percent of the model cells by county over the period 2005 to 2035. The magnitude of average drawdowns over 2005 conditions in this aquifer was simulated to be small, less than 1.5 feet in all counties of the Region. While the maximum drawdown over 2005 conditions in this aquifer may be expected to be about 76 feet, only a small percentage of model cells were simulated to experience drawdowns over 2005 conditions in excess of 10 feet. With some exceptions, similar impacts were simulated to occur in the Silurian dolomitic aquifer. Additional drawdowns may be expected to occur in this aquifer in 18 to 85 percent of model cells by county over the planning period. While the maximum drawdown over 2005 conditions in this aquifer was simulated to be about 145 feet, only a small percentage of model cells in most counties were simulated to experience drawdowns over 2005 conditions in excess of 10 feet.

Water budget analyses indicate that in most counties of the Region, the influence of human activities on the shallow groundwater system will increase under Alternative Plan 2 conditions. In the county in which the influence of human activities is expected to decrease, the shallow groundwater system will remain heavily influenced by human activities. While the net effect of human activities in all counties of the Region will result in the removal of water from the shallow groundwater system, there is little evidence that a water budget deficit will occur where more groundwater will be extracted than can be replaced in a long-term sustainable fashion in the shallow groundwater system. This is likely due, in large part, to the buffering effects of surface waters.

Although the results of the simulation indicate that the changes in the shallow aquifer system are expected to be relatively small in much of the Region under Alternative Plan 2 conditions, some larger changes may be expected to occur in localized areas. Most of central and northern Ozaukee County may be expected to experience additional drawdowns in the Silurian dolomitic aquifer, in excess of 10 feet in much of the County and in excess of 50 feet in some locations. These drawdowns appear to result, at least in part, from both the continued reliance upon the shallow groundwater system as a major source of water supply in much of this County, and the addition of five shallow municipal wells that are envisioned in Alternative Plan 2. In contrast, the model results indicate that large drawups may be expected to occur in the Silurian dolomitic aquifer under Alternative Plan 2 conditions in southern Ozaukee and northern Milwaukee Counties, attributable to the shift in the source of water supply in areas served by the public sanitary sewer system in Mequon from private wells to Lake Michigan as envisioned under Alternative Plan 2. In addition, the model results indicate that drawups may be expected to occur in the Silurian dolomitic aquifer in southeastern Washington County and eastern Waukesha County, attributable to the shift in the source of water supply for several communities that are located east of the subcontinental divide or are located west of the divide, but where a return flow component currently exists from groundwater to Lake Michigan as envisioned under Alternative Plan 2.

Plan Description—Alternative Plan 3: Design Year 2035 Forecast Conditions with Groundwater Recharge Enhancement

Alternative Plan 3 is similar to Alternative Plan 2, but includes shallow groundwater aquifer recharge measures using local rainfall and sewage treatment plant effluent as the source of the recharge and deep aquifer groundwater recharge measures using treated Lake Michigan water as the source of the recharge. Alternative Plan 3 includes all of the components included under Alternative Plan 2, plus a set of aquifer recharge measures described in the following sections.

Rainfall Infiltration Systems

Alternative Plan 3 includes a component for the development of rainwater infiltration systems to provide enhanced recharge to the shallow aquifer system. This component is proposed to consist of 83 rainfall infiltration facilities located in selected areas throughout the Region. These facilities would occupy about 2,600 acres, or about four square miles, of land specifically modified through regrading and revegetation to enhance groundwater infiltration. The general locations of the facilities that were chosen for the purposes of simulation modeling are shown on Map 89. It should be noted that these sites were selected at a level of detail sufficient for identification of the model cells in which the sites concerned would fall. As shown in Table 111, the area of these facilities range from about 10 to 50 acres.

For the simulation modeling purposes, it was assumed that these facilities would, on average, contribute an additional 15 inches of recharge per unit area concerned to the shallow aquifer system over and above the recharge normally provided within the Region annually. The additional recharge contributed by these facilities would be derived from precipitation falling on the facilities themselves and on areas naturally tributary to the facilities. For the purpose of estimating the infiltration amounts, it was assumed that each facility would have a tributary area equal to twice the area of the facility itself. It is important to note that the actual tributary areas would be a function of the site-specific topography of the areas in which the facilities would be located, and that site-specific studies will be required to determine the location, area and configuration of each infiltration area, and of the size of the tributary areas associated with each facility. The sizes of the selected facilities and the additional recharge

Map 89

ALTERNATIVE PLAN 3
DESIGN YEAR 2035
GROUNDWATER RECHARGE FACILITIES

LEGEND

SHALLOW AQUIFER RECHARGE FACILITIES

RAINFALL INFILTRATION FACILITIES

MILLION GALLONS PER YEAR (MGY)

- 0.1 - 5.0
- 5.1 - 10.0
- 10.1 - 15.0
- 15.1 - 20.0
- 20.1 - 25.0

WASTEWATER TREATMENT PLANT
EFFLUENT INFILTRATION FACILITIES

MILLION GALLONS PER YEAR (MGY)

- ▲ 146
- ▲ 584
- ▲ 1,460
- ▲ 1,825

DEEP AQUIFER
RECHARGE FACILITIES

INJECTION WELLS

MILLION GALLONS PER YEAR (MGY)

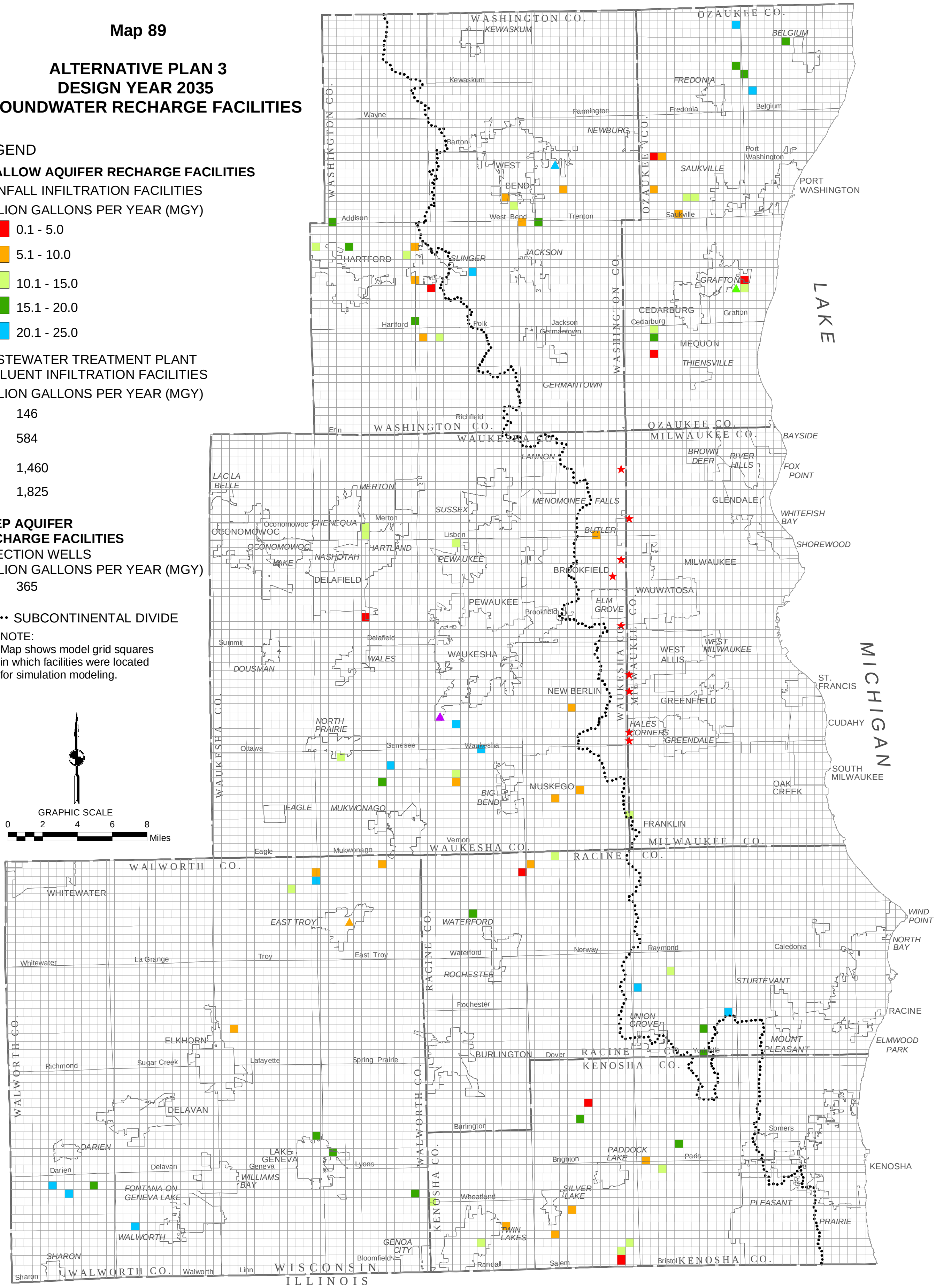
- ★ 365

•••••••• SUBCONTINENTAL DIVIDE

NOTE:
Map shows model grid squares
in which facilities were located
for simulation modeling.

GRAPHIC SCALE

0 2 4 6 8 Miles



Source: SEWRPC.

Table 111

RAINFALL INFILTRATION FACILITIES IN ALTERNATIVE PLAN 3

Identification Number	Facility Area (acres)	Additional Recharge (million gallons per year)[a]
Kenosha County		
43	30	12.3
44	10	4.2
45	20	8.1
46	35	14.4
47	15	6.0
48	35	14.4
49	50	20.4
50	45	18.3
51	35	14.4
52	10	4.2
78	15	6.0
79	20	8.1
80	30	12.3
81	40	16.2
Subtotal	390	159.3
Milwaukee County		
53	35	14.4
Subtotal	35	14.4
Ozaukee County		
28	25	10.2
29	35	14.4
30	10	4.2
31	30	12.3
32	45	18.3
33	50	20.4
34	50	20.4
35	20	8.1
36	45	18.3
37	45	18.3
38	35	14.4
39	40	16.2
40	10	4.2
41	15	6.0
42	15	6.0
82	10	4.2
Subtotal	480	195.9
Racine County		
12	10	4.2
13	20	8.1
14	40	16.2
15	40	16.5
16	30	12.3
17	40	16.2
75	50	20.4
76	50	20.4
77	25	10.2
Subtotal	305	124.5

Table 111 (continued)

Identification Number	Facility Area (acres)	Additional Recharge (million gallons per year)[a]
Walworth County		
18	50	20.4
19	30	12.3
20	50	20.4
21	20	8.1
22	50	20.4
23	40	16.2
24	50	20.4
25	45	18.3
26	15	6.0
27	40	16.2
67	20	8.1
83	40	16.2
Subtotal	450	183.0
Washington County		
1	35	14.4
2	20	8.1
3	45	18.3
4	25	10.2
5	50	20.4
6	25	10.2
7	35	14.4
8	10	4.2
9	40	16.2
10	25	10.2
11	35	14.4
70	20	8.1
71	45	18.3
72	20	8.1
73	15	6.0
74	45	16.2
Subtotal	485	197.7
Waukesha County		
54	45	18.3
55	50	20.4
56	50	20.4
57	50	20.4
58	25	10.2
59	25	10.2
60	35	14.4
61	20	8.1
62	35	14.4
63	30	12.3
64	20	8.1
65	15	6.0
66	15	6.0
68	20	8.1
69	10	4.2
Subtotal	445	181.5
Total	2,590	1,056.3

[a]*Estimates of additional recharge assumes that these facilities add 15 inches of additional recharge per year to the shallow groundwater system over the area of the facility. This water for this recharge is assumed to derive from precipitation falling over the facilities and over areas tributary to the facilities.*

Source: SEWRPC.

anticipated to be contributed by each facility are given in Table 111. It is estimated that these facilities would contribute an additional approximately 1.06 billion gallons of recharge to the shallow aquifer system on an average annual basis.

Several criteria were used in selecting sites for these facilities. First, facilities were sited on lands located in environmental corridors, on agricultural lands, or on other open lands. The siting of facilities on lands designated as primary or secondary environmental corridor would be limited to corridors with components considered compatible with the siting of such facilities based upon the guidelines set forth in the regional land use plan. Second, facilities were placed upgradient from surface water features which may be expected, by the year 2035, to experience reductions in baseflow greater than 10 percent over year 2000 conditions. The upgradient locations were identified using the available water table elevation map for the Region.[9] In some instances, because of a lack of other suitable sites, facilities were located upgradient from tributary streams discharging into surface water features which may be expected to experience by the design year 2035 reductions in baseflow greater than 10 percent over 2005 conditions. Third, facilities were sited in locations identified as having moderate to very high groundwater recharge potential as indicated by the soil-water balance model developed by the Wisconsin Geological and Natural History Survey for use in the regional water supply planning program.[10] This model accounts for various processes that divert precipitation from becoming groundwater recharge, including interception of precipitation by the plant canopy, runoff from the land surface, evapotranspiration of water from the soil, and storage of soil moisture within the root zone. In characterizing these processes, the model takes into account several factors, including topography, hydrologic soil group, soil water storage, and land use. Fourth, where multiple potential sites were available for the potential location of a facility, a number of other criteria were considered including vertical hydraulic conductivity, depth to water table, and depth to bedrock. It is important to note that while the siting criteria used were deemed adequate for the purposes of simulation modeling and systems level planning, actual siting of these facilities would require site-specific investigations to determine, in greater depth and detail, the suitability of the topography, soils, direction of shallow groundwater flow, and other factors associated with candidate sites for enhancing groundwater recharge, including, importantly, the cost and availability of land.

Construction of these facilities is typically expected to involve regrading and revegetation of the sites to reduce runoff and decrease removal of water that has infiltrated into the soil through evapotranspiration. Restoration of the sites to native prairie or woodland may be expected to increase recharge by reducing runoff. Studies indicate that the percentage of land that is in natural condition—woodlands, grasslands, and wetlands—is an important factor in the enhancement of groundwater recharge.[11] Runoff may be reduced by up to 25 percent by the conversion of cropland to woodland or native prairie with a net increase in groundwater recharge. For planning purposes and determination of costs, it was assumed that the facilities would be revegetated with native grassland species. It is important to note, that the plant community that would provide greatest enhancement of groundwater recharge at particular facilities will need to be determined on a site-specific basis.

The rainfall infiltration facilities could be developed in a manner which would serve multiple purposes over and above groundwater recharge. Such purposes could include reducing stormwater runoff rates and volumes; providing an aesthetic amenity; and improved wildlife habitat. Such sites may also potentially be used to provide buffer areas along streams and watercourses; preserve floodprone lands in natural open areas; and potentially expand environmental corridor lands. Sites would have to be specifically designed to serve the desired purposes.

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[9]*SEWRPC Technical Report No. 37,* Groundwater Resources of Southeastern Wisconsin, *June 2002.*

[10]*SEWRPC Technical Report No. 47,* Groundwater Recharge in Southeastern Wisconsin Estimated by a GIS-Based Water-Balance Model, *July 2008.*

[11]*Douglas S. Cherkauer and S. A. Ansari, "Estimating Groundwater Recharge from Topography, Hydrogeology, and Land Cover,* Ground Water, *Volume 43, January-February 2005."*

As part of this alternative plan, the recharge areas are envisioned to be open areas with grading and plantings to enhance recharge. Similar amounts of recharge could be developed by using a variety of other rainfall infiltration structures, such as rain gardens infiltrating water from roof surface and yard areas. The interpretation could also be related to more focused higher rate infiltration systems on smaller areas, but receiving and infiltrating similar amounts of rainfall from similar tributary areas. Selecting the best type of facility in each area will require a second-level analysis. Such evaluations would require recalculation of the areas collecting rainfall, infiltration areas, and costs pertaining to such facilities. In the design of Alternative Plan 3, the infiltration facilities envisioned were assumed to consist of relatively large, carefully sited and landscaped, infiltration areas.

As shown in Table 112, this component of Alternative Plan 3 has an estimated capital cost of about $40.4 million. About half of this cost may be attributed to land acquisition, with the remaining capital costs being roughly divided evenly between regrading and revegetation of the sites and engineering and contingencies.

Land acquisition costs were estimated using land sales data available from the U.S. Department of Agriculture National Agricultural Statistics Service (NASS). For sites in Kenosha, Ozaukee, Walworth, Washington, and Waukesha Counties the 2006 County average per acre sale price of land in agricultural use, without buildings and other improvements, was used as the per acre cost. Because there were no land sales of this sort in Racine County in 2006, the 2005 average per acre sales price was used to represent the per acre land cost for Racine County. These costs range from $5,900 to $10,800 per acre. Because the most recent sale in Milwaukee County occurred in 2001, the per acre land cost for Milwaukee County was estimated by adjusting the 2001 per acre cost by the average change in sales price between 2001 and 2006 for the Southeastern Wisconsin Region.

Several measures were used to estimate the costs of site preparation and revegetation. The cost of seed for revegetation were estimated by reviewing the prices of native species prairie seed mixtures from several nurseries in Wisconsin. The per acre prices of these seed mixtures ranged from about $500 to about $1,600. The cost of the measures necessary for the restoration of prairie conditions was estimated to be $4,000 per acre. To account for engineering and contingencies, 35 percent of the costs of land acquisition and site preparation and revegetation was added to the subtotal.

Estimated annual operation and maintenance costs for the rainfall infiltration facilities are given in Table 112. The estimated annual operations and maintenance costs range from a minimum of $129,800 to a maximum of $1,036,000. The lower cost assumes a minimal level of mowing. The higher cost assumes intensive active management, including periodic burning, mowing, brush reduction, and monitoring of vegetation and hydrology. Actual maintenance costs would be expected to fall within the range cited. For the purposes of estimating the costs for Alternative Plan 3, a total annual operation and maintenance cost of $150 per acre, or a total annual cost of about $400,000, was used.

Treated Wastewater Infiltration Systems

Alternative Plan 3 includes a component for the redirection from surface water to the shallow groundwater aquifer system of treated wastewater from four publicly owned wastewater treatment plants. The required facilities would occupy about 146 acres. Seepage cells would be constructed on these sites to receive the treated wastewater. The locations of the facilities selected for the purpose of simulation modeling are shown on Map 89. Implementation of this component would require the conduct of site-specific studies to determine the suitability of sites. The sizes of the facilities and the capacities of each facility are given in Table 113. The sizes of the facilities were determined by the capacity needed to infiltrate the average daily treated wastewater discharge during the period of maximum monthly flow reported by each wastewater treatment plant concerned to the Wisconsin Department of Natural Resources (WDNR) for 2006. In the case of the City of Waukesha wastewater treatment plant, it was determined to size the associated facility to accommodate about one-half of the average daily treated wastewater flow during the period of maximum monthly flow. It is important to note that these capacities are less than the design flows of the associated wastewater treatment plants, and that under this alternative plan these plants would continue to discharge treated wastewater to surface waters. It is estimated that these facilities would contribute an average of an additional 11 million gallons of recharge to the shallow aquifer system per day.

Table 112

CAPITAL COSTS AND OPERATIONS AND MAINTENANCE COSTS OF RAINFALL INFILTRATION SYSTEMS IN ALTERNATIVE PLAN 3

County	Sites	Area (acres)	Land Value ($ per acre)	Capital Cost ($ X 1,000)				Annual O & M Cost ($ X 1,000)	
				Total Land Acquisition	Regrading and Revegetation	Engineering and Contingencies	Total	Minimal Maintenance[a]	Intensive Active Management[b]
Kenosha	14	390	10,839	4,227	1,560	2,026	7,813	19.5	156
Milwaukee....................	1	35	8,465	296	140	153	589	1.8	14
Ozaukee	16	480	5,865	2,815	1,920	1,657	6,392	24.0	192
Racine	9	305	5,167	1,576	1,220	979	3,775	15.2	122
Walworth......................	12	450	6,449	2,902	1,800	1,646	6,348	22.5	180
Washington..................	16	485	6,840	3,317	1,940	1,840	7,097	24.5	194
Waukesha....................	15	445	9,900	4,406	1,780	2,165	8,351	22.3	178
Total	83	2,590	- -	19,539	10,360	10,466	40,365	129.8	1,036

[a]*Minimal maintenance consists of a minimal level of mowing of the facility.*

[b]*Intensive active management includes periodic burning, weed management, brush reduction, and monitoring of vegetation and hydrology.*

Source: SEWRPC.

Table 113

WASTEWATER INFILTRATION SYSTEMS IN ALTERNATIVE PLAN 3

Identification Number	Facility	Capacity (mgd)	Area (acres)	Capital Cost ($ X 1,000,000)[a]	Annual O&M Cost ($ X 1,000,000)[a]
1	Grafton	1.6	21	11.20	0.72
2	East Troy	0.4	5	2.80	0.18
3	West Bend	4.0	53	28.00	1.80
4	Waukesha	5.0	67	38.95[b]	2.24
	Total	11.0	146	80.95	4.94

[a] *Costs assume that recharge water receives secondary treatment, membrane filtration and reverse osmosis treatment, and ozonation. Adding carbon filtration to the tertiary treatment scheme in place of reverse osmosis in order to remove pharmaceutically active compounds, endocrine disruptors, emerging contaminants, and trace organic compounds would increase capital costs to about $12.6 million per million gallons capacity, giving this component an estimated capital cost of about $143 million. This would also increase operations and maintenance costs to about $1,630 per million gallons infiltrated, bringing annual operations and maintenance costs to about $6.53 million.*

[b] *Includes the cost of 3.6 miles of dedicated transmission main.*

Source: SEWRPC.

Current WDNR regulations and policies would preclude the use of secondary level wastewater treatment plant effluent for aquifer recharge based upon the nitrate, total dissolved solids, and chloride levels present in such effluent. Thus, a tertiary level of treatment designed to reduce the levels of these contaminants would have to be provided in conjunction with the infiltration facilities. This component, therefore, includes a provision that the wastewater used for aquifer recharge will be treated by membrane filtration and reverse osmosis to reduce chlorides, nitrates, and total dissolved solids with disinfection by ozonation. Tertiary treatment consisting of membrane filtration, reverse osmosis, and ozonation is likely to provide the minimum level of treatment necessary for use of the effluent for groundwater injection. It may be necessary to include carbon filtration in the treatment system if it is determined that removal of pharmaceutically active compounds and other nonconventional emerging pollutants is needed. Such an addition would significantly increase the cost of the treatment facilities.

As shown in Table 113, this component of Alternative Plan 3 has an estimated capital cost of $80.9 million. These costs are based on calculations made to approximate the cost of constructing a system similar to the infiltration basins operated by the City of Lake Geneva. For these estimates, it was assumed that a system of eight infiltration basins on a single 20-acre site with soils suitable for a surface infiltration system would have an infiltration capacity of about 1.5 mgd. The cost of land was assumed to be $100,000 per acre. The cost of the basins on a 20-acre site and one mile of dedicated 12-inch-diameter transmission main was estimated to be $1.77 million, or about 1.2 million gallons per day of capacity. Membrane treatment, reverse osmosis, and ozonation would add an additional $5.8 million per million gallons of capacity in construction costs. This represents a total capital cost of about $7.0 million per million gallons per day of recharge capacity. This total estimate includes 35 percent for engineering and contingencies.

Because no suitable site was available within one mile of the City of Waukesha’s wastewater treatment plant, the capital costs of building an additional 4.6 miles of dedicated transmission main were added to the capital costs concerned. It was assumed that peak flows would require a 24-inch transmission main to convey the secondary-level treated wastewater to the infiltration facility. Tertiary-level treatment would be provided at the infiltration facility site. This transmission main would require casing locations where it crossed three features: the Fox River, Pebble Creek, and STH 59. Based upon costs for constructing transmission mains given in the state-of the art report, the cost of this main was estimated as being $3.95 million.

The operation and maintenance costs of membrane treatment, reverse osmosis, and ozonation, as well as the infiltration systems, were estimated at $1,230 per million gallons treated. The total annual operation and maintenance cost associated with this component of Alternative Plan 3 was, therefore, estimated to be $4.94 million.

These capital and operating and maintenance costs assume tertiary treatment of infiltrated water consisting of membrane filtration, reverse osmosis, and ozonation. Adding carbon filtration to the tertiary treatment system to remove pharmaceutically active compounds, endocrine disruptors, emerging contaminants, and trace organic compounds would increase the capital costs to about $12.6 per million gallons of capacity, giving this component an estimated capital cost of about $143 million. This would also increase operations and maintenance costs to about $1,630 per million gallons infiltrated, bringing annual operations and maintenance costs to about $6.53 million.

It is recognized that the development of the wastewater treatment plant effluent as envisioned under Alternative Plan 3 may violate current State regulations and policies regarding groundwater management. This recognition is based upon the primary intent of the infiltration facilities to supplement groundwater recharge. It is recognized that wastewater treatment systems which discharge to the groundwater system currently may be approved as a means of disposing of treated effluent. However, such systems typically are not intended to supplement the groundwater aquifers and become a part of a source for water supply purposes. Thus, implementation of this plan component would require changes to, or variances from, those regulations and policies. Such considerations will be addressed in Chapters X and XI as appropriate, if this component is included in the recommended plan.

Injection Wells

Alternative Plan 3 includes a component for artificial recharge of the deep aquifer system through the use of injection wells. These wells would be similar to those used in an aquifer storage and recovery system utilizing treated Lake Michigan water as source water and the deep aquifer as a receptor. It is envisioned that the water would come from existing Lake Michigan water treatment facilities. For purposes of Alternative Plan 3, it was assumed that the injection wells would be located east of the subcontinental divide near the Milwaukee-Waukesha county line.

Map 89 shows the approximate locations selected for nine injection well facilities to be used for modeling purposes. Each facility would occupy about one-half acre of land and consist of one injection well and associated pumping facilities. For purposes of Alternative Plan 3, it was assumed that these wells would draw source water from connection points belonging to the City of Milwaukee Water Works, however, other options could be explored. The connection points are listed in Table 114. Each injection well would pump about 1.0 million gallons per day of treated water into the deep sandstone aquifer, with this component providing about 9.0 million gallons per day of recharge. It is estimated that these wells would need to be about 1,800 feet deep. Review of a geological cross-section of southeastern Wisconsin indicates that the top of the geological formation containing the sandstone aquifer is about 790 feet below the surface of the ground at the Milwaukee-Waukesha county line. The Precambrian crystalline basement at this location appears to be deeper than 1,400 feet below the surface. In addition, a review of well construction reports for eight high-capacity wells within one mile of the N. 124th Street and W. Bluemound Road connection point indicates that the top of the geological formation containing the sandstone aquifer is between 715 feet and 790 feet below the surface and that a few of these wells go deeper than 1,200 feet.

This component of Alternative Plan 3 has an estimated capital cost of $27.0 million. This cost estimate was based upon data developed by the Oak Creek Water Utility for the conversion of an existing municipal well in the deep sandstone aquifer for use as an aquifer storage and recovery well. This estimate includes costs for land acquisition, drilling of wells, conversion of wells to injection wells, pumping facilities, and additional required water transmission capacity over and above the capacity required for Alternative Plan 2.

The price of land for these facilities was assumed to be $100,000 per acre or $450,000 for the nine one-half-acre facilities. With the addition of a 35 percent allowance for engineering and contingencies, the cost of acquiring the land for the facilities were estimated at $608,000.

Table 114

INJECTION WELL FACILITIES INCLUDED IN ALTERNATIVE PLAN 3

Identification Number	Wells	Recharge Capacity per Well (mgd)	Total Recharge Capacity (mgd)	Estimated Cost of Wells and Associated Water Transmission Upgrades	
				Capital ($ X 1,000,000)	Annual O&M ($ X 1,000)
1	1	1.0	1.0	3.65	98.9
2	1	1.0	1.0	3.74	98.9
3	1	1.0	1.0	3.36	98.9
4	1	1.0	1.0	3.47	98.9
5	1	1.0	1.0	2.37	98.9
6	1	1.0	1.0	2.77	98.9
7	1	1.0	1.0	2.59	98.9
8	1	1.0	1.0	2.10	98.9
9	1	1.0	1.0	2.94	98.9
Total	9	9.0	9.0	26.99	890.1

Source: SEWRPC.

The Oak Creek Water Utility data indicated that the cost of construction of an aquifer storage and recovery system, including the well and pump house, may be expected to be between $830,000 and $1,750,000 for a single well. Because an injection well facility would not require the recovery capabilities of an aquifer storage and recovery system, it was determined to use a base cost near the lower limit of this range to estimate the cost of these facilities. An incremental cost of $216,000 was added to the cost of each well to account for the additional costs of drilling these wells to 1,800 feet. Based on these data, the cost of constructing a single facility with one injection well, including a 35 percent allowance for engineering and contingencies is estimated at $1.05 million. The total cost of constructing nine such facilities is estimated to be $9.41 million, as shown in Table 114.

This component of Alternative Plan 3 would also require upgrades to transmission main capacity over and above those required for Alternative Plan 2. To provide for 1.0 mgd of recharge at the facility proposed near N. 124th Street and W. Bradley Road, it was assumed the connection to the Milwaukee Water Works system would require the construction of about 10,400 lineal feet of 12-inch transmission water main along N. 107th Street from near STH 100 to W. Bradley Road and along W. Bradley Road from N. 107th Street to N. 124th Street, at an estimated cost of $1,446,000. To provide for 1.0 mgd recharge at the facility near N. 124th Street and W. Silver Spring Drive, it was assumed the connection to the Milwaukee Water Works system would require the construction of about 11,000 lineal feet of 12-inch transmission main along W. Silver Spring Drive from N. 91st Street to N. 124th Street, at an estimated cost of $1,529,000. The facilities near N. 124th Street and W. Burleigh Road would require the upgrading of about 16,250 lineal feet of 20-inch transmission water main from the Lisbon Avenue booster station along STH 181 to W. Burleigh Road and along W. Burleigh Road to N. 124th Street as proposed in Alternative Plan 2 to 24-inch transmission water main at an estimated incremental cost of $211,000. These facilities would also require the installation of about 3,000 linear feet of 12-inch transmission main along N. 124th Street, W. Townsend Street, and N. 127th Street from the connection point to Facility 3 at an estimated cost of $417,000 and the upgrading of about 3,000 linear feet of existing 16-inch transmission main along W. Burleigh Road from the connection point to Facility 4 to 20-inch transmission main at an estimated cost of $534,000. The facility near N. 124th Street and W. Bluemound Road would required the upgrading of about 1,800 lineal feet of 24-inch transmission main along Glenview Avenue proposed in Alternative 2 to 30-inch transmission main and about 14,000 lineal feet of 20-inch transmission main along W. Bluemound Road proposed in Alternative 2 to 24-inch transmission main at an estimated incremental cost of $288,000.

The proposed facilities near S. 124th Street and W. Morgan Oak Drive would require the upgrading of about 13,600 lineal feet of 16-inch transmission main from S. 92nd Street and W. Howard Avenue along W. Howard Avenue to the Root River Parkway and along W. Morgan Avenue to the connection point proposed in Alternative Plan 2 to 24-inch transmission main at an estimated incremental cost of $340,000. These facilities would also require the installation of about 3,800 lineal feet of 12-inch transmission main along S. 124th Street and CTH ES from the connection point to Facility 6 at an estimated cost of $528,000 and the installation of about 2,600 lineal feet of 12-inch transmission main along S. 124th Street from the connection point to Facility 7 at an estimated cost of $362,000.

The proposed facility near S. 124th Street and W. Grange Avenue would require the upgrading of about 3,500 lineal feet of 16-inch transmission main along W. Kurtz Road proposed in Alternative 2 to 20-inch transmission main at an estimated incremental cost of $42,000. The proposed facility near S. 124th Street and Janesville Road would require the upgrading of about 18,000 lineal feet of 30-inch transmission main along 92nd Street, Forest Home Avenue, and Janesville Road proposed in Alternative 2 to 36-inch transmission main and the upgrading of about 250 lineal feet of 24-inch transmission main along Janesville Road proposed in Alternative 2 to 30-inch transmission main at an estimated incremental cost of $804,000.

The proposed transmission facilities are shown on Map 90. These costs include 35 percent for engineering and contingencies. It is recognized that there would likely be additional internal improvements needed for the Milwaukee Water Works system. The costs for such improvements were assumed to be covered under a contingency item by adding 10 percent to the costs estimated.

This component of Alternative Plan 3 would also require upgrading the capacity of some pumping stations over and above the upgrades required for Alternative Plan 2. A pumping station with a capacity of 1.0 mgd would be required for the transmission main for the proposed facility near N. 124th Street and W. Bradley Road. The estimated capital cost of this station is $756,000. A pumping station with a capacity of 1.0 mgd would be required for the transmission main for the proposed facility near N. 124th Street and W. Silver Spring Drive. The estimated capital cost of this station is $756,000. Two pumping stations associated with the transmission mains serving the connection point at N. 124th Street and W. Burleigh Street would each require expansion to provide 2.0 mgd additional capacity over that proposed in Alternative Plan 2. The estimated incremental cost of this expansion is $2.84 million. The Bluemound Road pumping station would require expansion to provide 1.0 mgd additional capacity over that proposed in Alternative Plan 2. The estimated incremental cost of this expansion is $756,000. The pumping station associated with the transmission mains serving the connection point at S. 124th Street and W. Morgan Oak Drive would require expansion to provide 2.0 mgd additional capacity over that proposed in Alternative Plan 2. The estimated incremental cost of this expansion is $1.42 million. The pumping station associated with the transmission mains serving the connection point at S. 124th Street and W. Grange Avenue would require expansion to provide 1.0 mgd additional capacity over that proposed in Alternative Plan 2. The estimated incremental cost of this expansion is $756,000. The pumping station in Milwaukee County considered to serve the Muskego Water Utility under Alternative Plan 2 would require expansion to provide 1.0 mgd additional capacity over that proposed in Alternative Plan 2. These pumping stations are also shown on Map 90. The estimated incremental cost of this expansion is $756,000. These costs include 35 percent for engineering and contingencies.

Operation and maintenance costs for injection wells for groundwater are estimated to be similar to those for aquifer storage and recovery wells. It has been estimated that annual operations and maintenance costs for aquifer storage and recovery wells are about $15,000 per mgd.[12] This would suggest that the annual operations and maintenance costs associated with operating the injection wells would be about $135,000. For the purposes of this analysis, the cost of the water to be injected was computed by estimating the incremental cost of pumping and

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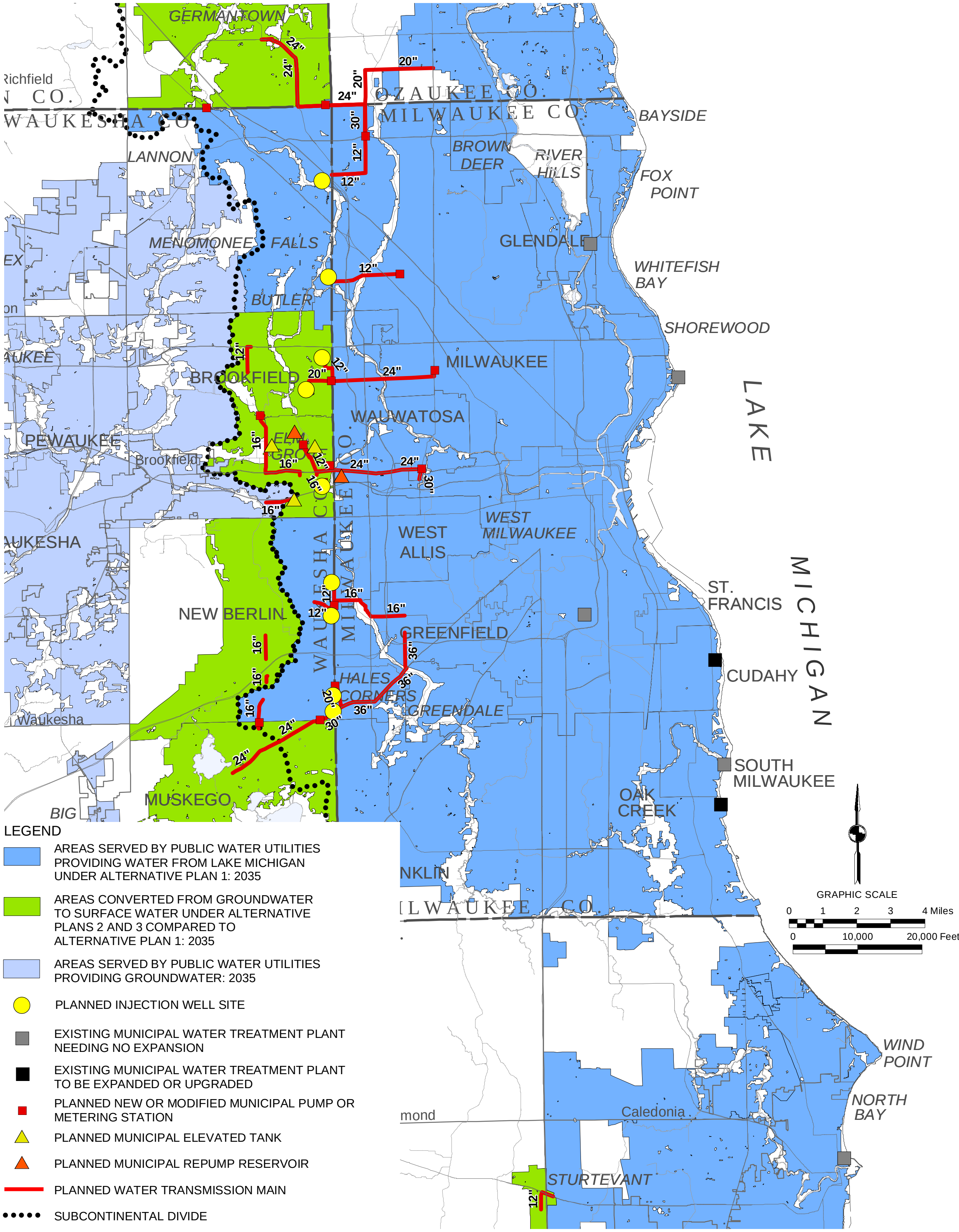
[12]*R. David G. Pyne, Philip C. Singer, and Cass T. Miller,* Aquifer Storage and Recovery of Treated Drinking Water, *American Water Works Association Research Foundation, 1996.*

Map 90

INJECTION WELL, WATER MAIN AND PUMPING STATION COMPONENT FOR ALTERNATIVE PLAN 3 DESIGN YEAR 2035 FORECAST CONDITIONS WITH RECHARGE ENHANCEMENT



Source: Ruekert & Mielke, Inc. and SEWRPC.

treating water by Lake Michigan water suppliers, based upon data submitted by this utility to the Public Service Commission. Based upon a review of the costs reported by the utilities operating Lake Michigan treatment facilities for power and chemicals, the incremental cost of providing water is about $230 per million gallons (MG). This would add about $755,000 to annual operations and maintenance costs, giving this component of Alternative Plan 3 a total annual operations and maintenance cost of $890,000.

It is recognized that the development of the injection wells envisioned under this alternative plan would violate current State regulations and policies regarding groundwater injection. Implementation of this component would require changes to, or variances from, those regulations and policies. In addition, implementation of this component would face issues of fiscal responsibility and groundwater user allocations for the injected water. Additionally, there are issues related to groundwater quality which will need to be addressed further. If this component is included in the recommended water supply plan, these issues will be addressed in Chapters X and XI.

Miscellaneous Recharge Enhancement Components

Alternative Plan 3 also includes a groundwater recharge area protection component and a stormwater management practices component. The groundwater recharge protection area component is directed toward the protection of the recharge of areas classified as having a high or very high recharge potential based upon analyses of the recharge potential of areas of the Region.[13] This component may be expected to be largely achieved through implementation of the design year 2035 regional land use plan since that plan recommends preservation of the environmental corridors, isolated natural resource areas, and prime and other agricultural areas, and rural residential areas of the Region—areas that facilitate recharge. As shown in Table 115, about 74 percent of the highly rated groundwater recharge areas and about 78 percent of the very highly rated recharge areas may be expected to be maintained by inclusion in the environmental corridors, isolated natural resource areas, and prime and other agricultural areas identified for preservation in the adopted regional land use plan and rural residential areas. An additional 10 percent of the highly rated areas and almost 1 percent of the very highly rated areas are included in areas of planned suburban and low-density residential use. Rural residential development has a density of no more than one dwelling unit per five acres. Suburban residential has a density of between 1.5 and 4.9 acres per dwelling unit. Low-density urban residential development has a density between 0.5 and 1.4 acres per dwelling unit. These areas—using cluster and conservation subdivision design—can be effectively developed to maintain most of the natural infiltration capabilities.

The stormwater management component of Alternative Plan 3 would provide for the inclusion of stormwater management practices, including treatment and infiltration systems, which, to the extent practicable, maintain the natural hydrology with regard to recharge on all new residential developments. This component is expected to be largely implemented through the provisions of Chapter NR 151 of the *Wisconsin Administrative Code* and through county and municipal and stormwater management ordinances adopted in accordance with Chapter 216 of the *Wisconsin Administrative Code*. These programs have as an objective the maintenance of the infiltration capacity of development sites under post-development conditions.

Since both of these components may be expected to be achieved through implementation of the regional land use plan and through State and local programs and regulations, no costs for those components were included in Alternative Plan 3. As described in Chapter VI, the amount of impervious surfaces in the Region is expected to increase by about 1 percent between the year 2000 and the year 2035. That increase assumes historic percentages of imperviousness associated with new development based upon the adopted 2035 regional land use plan. Given that the stormwater management regulations and policies noted above will largely offset the impact of the very modest expected increase in imperviousness, it may be assumed that on a regional basis, no significant change in recharge may be expected if the regional land use plan is implemented and the stormwater regulations and policies are followed. Accordingly, for regional water supply planning purposes, the simulation modeling assumed no change in the year 2005 infiltration conditions.

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[13]*SEWRPC Technical Report No. 47*, op. cit.

Table 115

AREAS OF HIGH AND VERY HIGH GROUNDWATER RECHARGE POTENTIAL TO REMAIN IN OPEN SPACE USES BASED UPON THE YEAR 2035 REGIONAL LAND USE PLAN FOR SOUTHEASTERN WISCONSIN

Land Use Plan Category[a]	High Groundwater Recharge Potential[b]		Very High Groundwater Recharge Potential[b]	
	Square Miles	Percent[c]	Square Miles	Percent[d]
Primary Environmental Corridor	28.7	20.1	210.8	57.9
Secondary Environmental Corridor	1.8	1.3	32.3	8.9
Isolated Natural Resource Area	2.1	1.5	19.7	5.4
Agricultural and Rural Residential	73.4	51.5	19.3	5.3
Subtotal	106.1	74.4	282.1	77.5
Sub-Urban-Density Residential	2.3	1.6	0.1	<0.1
Low-Density Residential	12.2	8.6	2.7	0.8
Total	120.6	84.6	284.9	78.3

[a]*Planned land use category in the 2035 regional land use plan.*

[b]*See Chapter X for water recharge potential areas.*

[c]*Percent of high water recharge potential areas located in each land use plan category.*

[d]*Percent of very high water recharge potential areas located in each land use plan category.*

Source: SEWRPC.

Summary of Alternative Plan 3: Groundwater Recharge Enhancement

Map 83 illustrates the areas served by municipal utilities and the sources of supply for those utilities under Alternative Plan 3. Maps 89 and 90 illustrate the location and types of aquifer recharge components considered. The new sources of supply and the recharge areas for each water utility in the Region under Alternative Plan 3 are listed in Table 116.

Under Alternative Plan 3, the sources of supply and the anticipated utilization of those sources may be summarized as follows:

- Design year 2035 total average annual groundwater pumpage is estimated to be about 93 mgd, with about 72 mgd, or about 77 percent, from the shallow aquifer and 21 mgd, or about 23 percent, from the deep aquifer. This represents a reduction of about 13 mgd, or about 12 percent, in total pumpage compared to Alternative Plan 1.

- Design year 2035 municipal water utility average annual groundwater pumpage is estimated to be about 76 mgd, a reduction of 13 mgd, or about 15 percent, compared to Alternative Plan 1. Of this amount, approximately 58 mgd, or about 76 percent, would be from the shallow aquifer and 18 mgd, or about 24 percent, from the deep aquifer, representing an increase of 5 mgd and a decrease of 18 mgd, or about 9 percent and about 50 percent, respectively, compared to the pumpages under Alternative Plan 1.

- Design year 2035 municipal water supply pumpage of Lake Michigan water is estimated to be 227 mgd, an increase of about 13 mgd, or about 6 percent, compared to Alternative Plan 1.

- In addition, under Alternative Plan 3, groundwater added artificial recharge to the shallow aquifer would approximate one million gallons per year from constructed rainfall filtration facilities and 11 mgd from wastewater treatment plant effluent recharge systems. Artificial infiltration into the deep aquifer would be about 9 mgd from injection well facilities. No artificial recharge was included in the other three alternative plans.

Table 116

PRINCIPAL FEATURES AND COSTS OF NEW, EXPANDED, AND UPGRADED WATER SUPPLY FACILITIES AND PROGRAMS UNDER ALTERNATIVE PLAN 3, DESIGN YEAR 2035 FORECAST CONDITIONS FOR GROUNDWATER RECHARGE ENHANCEMENT

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Kenosha County					
City of Kenosha Water Utility	No additions	- -	41.7	657	42
Village of Paddock Lake Municipal Water Utility	Addition of two 0.25 MG elevated tanks, three shallow aquifer wells with 0.20 MG reservoir each	4,032	54.0	3,135	199
Village of Pleasant Prairie Water Utility	Addition of 0.75 MG elevated tank	1,620	39.7[d]	2,104	134
Town of Bristol Utility District No. 1	Addition of three shallow aquifer wells to replace deep aquifer wells, 0.50 MG elevated tank, 0.40 MG reservoir	3,274	-57.0[e]	2,542[e]	161[e]
Town of Bristol Utility District No. 3	No additions	- -	0.1[d]	2	0
Town of Somers Water Utility	No additions	- -	3.5[d]	55	3
Village of Silver Lake Planned Utility	Addition of three shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank	3,437	93.4	1,694	107
Village of Twin Lakes Planned Utility	Addition of five shallow aquifer wells with 0.1 MG reservoir each, two 0.3 MG elevated tanks	5,317	158.7	3,782	240
Town of Salem Planned Utility	Addition of eight shallow aquifer wells, four with 0.15 MG reservoirs, two 0.3 MG elevated tanks	7,294	288.9	5,710	362
Powers-Benedict-Tombeau Lakes Area Planned Utility	Addition of two shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank	2,584	57.9	1,694	107
Land Acquisition for Wells and Storage Tanks	34 acres	2,380	- -	2,380	151
Countywide	14 rainfall infiltration sites[t]	7,813	58.5	4,765	302
Subtotal	24 Wells, 28 Storage Tanks, 14 Rainfall Infiltration Systems	37,751	739.4	28,520	1,808
Milwaukee County					
City of Cudahy Water Utility	Duplicate rapid mix facility	100	7.5	118	7
City of Franklin Water Utility	No additions	- -	13.4[d]	211	13
City of Glendale Water Utility	No additions	- -	6.1[d]	96	6
City of Milwaukee Water Works	No additions	- -	263.1	4,146	263
City of Oak Creek Water and Sewer Utility	Addition of 20 mgd coag-floc-sed, 14 mgd filtration, 17.5 mgd pumping	13,220	547.4[f]	21,169	1,343
City of South Milwaukee Water Utility	No additions	- -	8.6	136	9

Table 116 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Milwaukee County (continued)					
City of Wauwatosa Water Utility	No additions	- -	19.6[d]	309	20
City of West Allis Water Utility	No additions	- -	25.2[d]	397	25
Village of Brown Deer Public Water Utility	No additions	- -	4.8[d]	76	5
Village of Fox Point Water Utility	No additions	- -	2.6[d]	41	3
Village of Greendale Water Utility	No additions	- -	5.6[d]	88	6
Village of Shorewood Municipal Water Utility	No additions	- -	1.4[d]	22	1
Village of Whitefish Bay Water Utility	No additions	- -	5.8[d]	91	6
We Energies-Water Services	No additions	- -	1.0[d]	16	1
Countywide	One rainfall infiltration site[t]	589	5.9	371	24
Subtotal	0 Wells, 0 Storage Tanks, Two Treatment Plant Upgrades, One Rainfall Infiltration System	13,909	918.0	27,287	1,732
Ozaukee County					
City of Cedarburg Light & Water Commission	Addition of five shallow aquifer wells and replacing dolomite aquifer pumping	3,250	-35.0[e]	2,760[e]	175[e]
City of Port Washington Water Utility	Addition of 2.0 mgd coag-floc-sed, filtration, 1.8 mgd pumping	3,888	33.1	2,622	166
Village of Belgium Municipal Water Utility	Addition of 0.45 MG reservoir at Well 3, service pumps at Wells 1 and 2	586	2.0	298	19
Village of Fredonia Municipal Water Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.20 MG reservoir	1,417	23.5	886	56
Village of Grafton Water and Wastewater Commission	Addition of one shallow aquifer well with 0.70 MG reservoir	1,535	39.5	828	53
	Wastewater treatment plant effluent treatment and groundwater recharge system[u]	11,200	720.0	9,333	592
Village of Saukville Municipal Water Utility	Addition of one shallow aquifer well	650	29.9	575	36
We Energies-Water Services	5,300 feet of 30 inch main (shared with Village of Germantown) in N. 107th street, 16,100 feet of 20-inch main in Granville Road and Donges Bay Road	3,300	231.8[d,g]	5,153	327
Town of Fredonia-Waubeka Area Planned Utility	Addition of one shallow aquifer well with 0.10 MG reservoir, 0.25 MG elevated tank	1,460	24.3	899	57

Table 116 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Ozaukee County (continued) Land Acquisition for Wells and Storage Tanks	11 acres	770	- -	770	49
Countywide	16 rainfall infiltration sites[t]	6,392	72.0	4,100	260
Subtotal	Nine Wells, Six Storage Tanks, One Treatment Plant Upgrade, 16 Rainfall Infiltration Systems, One Wastewater Treatment Plant Effluent Groundwater Recharge System	34,448	1,141.1	28,224	1,790
Racine County City of Burlington Municipal Waterworks	No additions	- -	12.6	199	13
City of Racine Water and Wastewater Utility[h]	No additions	- -	45.9	724	46
Village of Caledonia West Utility District[i] (Oak Creek)	No additions	- -	0.4[d]	6	1
Village of Caledonia West Utility District[i] (Racine)	No additions	- -	3.1[d]	49	3
Village of Caledonia East Utility District[j] (Oak Creek)	No additions	- -	1.9[d]	30	2
Village of Caledonia East Utility District[j] (Racine)	No additions	- -	3.5[d]	55	4
Village of Union Grove Municipal Water Utility	Addition of two shallow aquifer wells, 0.40 MG reservoir, replacing one deep aquifer well	1,776	-31.4[e]	1,255[e]	80[e]
Village of Waterford Water and Sewer Utility	Addition of one shallow aquifer well with 0.40 MG reservoir	1,151	15.7	1,481	94
Village of Wind Point Municipal Water Utility	No additions	- -	0.8[d]	13	1
North Cape Sanitary District	Addition of one shallow aquifer well with 0.10 MG reservoir	155	2.1	194	12
Town of Yorkville Water Utility District 1	Lake Michigan supply connection	459[k]	-38.0[l]	-140[l]	-9[l]
Northwest Caledonia Area Planned Utility District	9,000 lineal feet of water transmission main	1,557	3.1[d,m]	726	46
Town of Burlington-Bohner Lake Area Planned Utility District	Addition of two shallow aquifer wells, 0.30 MG elevated tank	1,941	42.1	1,278	81
Town of Dover-Eagle Lake Area Planned Utility District	Addition of two shallow aquifer wells, 0.30 MG elevated tank	1,941	47.0	1,315	83
Town of Norway Area Planned Utility	Addition of four shallow aquifer wells, one with 0.15 MG reservoir, two 0.25 MG elevated tanks	4,024	112.9	2,825	179
Village of Rochester Area Planned Utility	Addition of two shallow aquifer wells, two 0.10 MG elevated tanks	1,844	27.6	1,125	71
Town of Rochester Area Planned Utility	Addition of two shallow aquifer wells, two 0.10 MG elevated tanks	1,844	30.7	1,148	73

Table 116 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Racine County (continued)					
Town of Waterford Area Planned Utility	Addition of three shallow aquifer wells, one with 0.15 MG reservoir, two 0.3 MG elevated tanks	3,485	114.4	2,571	163
Land Acquisition for Wells and Storage Tanks	29 acres	2,030	- -	2,030	129
Countywide	Nine rainfall infiltration sites[t]	3,775	45.8	2,449	155
Subtotal	19 Wells, 15 Storage Tanks, One Lake Michigan Supply Connection, Nine Rainfall Infiltration Systems	25,982	440.2	19,333	1,227
Walworth County					
City of Delavan Water and Sewerage Commission	Addition of five shallow aquifer wells with iron removal treatment, replacement of treated shallow pumping	5,125	59.2[e]	1,318[e]	84[e]
City of Elkhorn Light and Water	Addition of five shallow aquifer wells, 0.35 MG treated water reservoir	3,529	-178.5[e]	-1,705[e]	-108[e]
City of Lake Geneva Municipal Water Utility	No additions	- -	11.3	178	11
City of Whitewater Municipal Water Utility	No additions	- -	13.7	216	14
Village of Darien Water Works and Sewer System	Increase Well 1 output from 325 to 425 gpm	- -	15.2	35	2
Village of East Troy Municipal Water Utility	Addition of three shallow aquifer wells, two with 0.10 MG reservoir each	2,199	55.6	1,792	114
	Wastewater treatment plant effluent treatment and groundwater recharge system[u]	2,800	180.0	2,336	148
Village of Fontana Municipal Water Utility	No additions	- -	2.0	32	2
Village of Genoa City Municipal Water Utility	Addition of two shallow aquifer wells and 0.25 MG elevated tank	1,898	48.1	1,592	101
Village of Sharon Waterworks and Sewer System	Addition of one shallow aquifer well with 0.30 MG reservoir, 0.20 MG elevated tank	1,512	17.1	1,935	123
Village of Walworth Municipal Water and Sewer Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.15 MG reservoir	1,333	30.6	1,038	66
Village of Williams Bay Municipal Water Utility	No additions	- -	4.3	68	4
Town of Bloomfield Pell Lake Sanitary District No. 1	Addition of 0.2 MG elevated tank, one deep aquifer well with radium treatment and with 0.4 MG reservoir	1,891	39.6	2,416	153
Town of East Troy Sanitary District No. 3	Addition of one shallow aquifer well	130	0.1	136	8
Town of Geneva Lake Como Sanitary District No. 1	Addition of 0.20 MG elevated tank and 0.45 MG reservoir	1,066	12.4	1,206	77

Table 116 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Walworth County (continued)					
Town of Troy Sanitary District No. 1	Addition of one shallow aquifer well with 0.12 MG reservoir	80	0.2	87	6
Country Estates Sanitary District	Addition of two shallow aquifer wells, 0.20 MG elevated tank	1,730	-2.8[e]	1,793[e]	114[e]
Town of Lyons Area Planned Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.3 MG elevated tank	2,169	38.9	1,362	86
Town of East Troy-Potter Lake Area Planned Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.3 MG elevated tank	2,169	34.6	1,329	84
Land Acquisition for Wells and Storage Tanks	34 acres	2,380	- -	2,380	151
Countywide	12 rainfall infiltration sites[t]	6,348	67.5	4,083	256
Subtotal	26 Wells, 18 Storage Tanks, 12 Rainfall Infiltration Systems, One Wastewater Treatment Plant Effluent Groundwater Recharge System[u]	36,359	449.1	23,627	1,496
Washington County					
City of Hartford Utilities	Addition of one shallow aquifer well, treatment system, 0.75 MG elevated tank, and interconnecting piping	7,500	39.4[e]	6,979[e]	443[e]
City of West Bend Water Utility	Addition of one shallow aquifer well	625	58.4	1,443	92
	Wastewater treatment plant effluent treatment and groundwater recharge system[u]	28,000	1,790.0	23,272	1,477
Village of Germantown Water Utility	Lake Michigan supply connection[k]	8,404[k]	-1,724.0[n]	-18,400[n]	-1,167[n]
Village of Jackson Water Utility	No additions	- -	7.4	117	7
Village of Kewaskum Municipal Water Utility	Addition of 0.25 MG reservoir	351	4.4	420	27
Village of Slinger Utilities	Addition of two shallow aquifer wells with 0.20 MG reservoir each	1,824	31.9	1,730	110
Allenton Sanitary District No. 1	Addition of 0.20 MG elevated tank, one deep aquifer well with 0.30 MG reservoir	1,672	20.3	1,374	87
Village of Newburg Area Planned Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.30 MG elevated tank	2,169	39.9	1,938	123
Land Acquisition for Wells and Storage Tanks	12 acres	840	- -	840	53
Countywide	16 rainfall infiltration sites[t]	7,097	72.8	4,492	285
Subtotal	Seven Wells, Eight Storage Tanks, One Lake Michigan Supply Connection, 16 Rainfall Infiltration Systems, Wastewater Treatment Plant Groundwater Recharge System[u]	58,482	340.5	24,205	1,537

Table 116 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Waukesha County					
City of Brookfield Municipal Water Utility (east)	Lake Michigan supply connection[k]	19,682[k]	-1,919.0[o]	2,956[o]	187[o]
City of Brookfield Municipal Water Utility (west)	No additions, abandon one well with radium treatment	0	-111.0[e]	-255[e]	-16[e]
City of Delafield Municipal Water Utility	Addition of five shallow aquifer wells, 0.40 MG elevated tank	4,019	110.1	3,259	207
City of Muskego Public Water Utility	Lake Michigan supply connection	12,675[k]	-1,508.0[p]	-10,679[p]	-678[p]
City of New Berlin Water Utility (east)	Addition of 0.40 MG reservoir	526	8.5[d]	320	20
City of New Berlin Water Utility (central)	Lake Michigan supply connection	6,685[k]	-1,377.0[q]	-14,811[q]	-939[q]
City of Oconomowoc Utilities	No additions	- -	17.4	274	17
City of Pewaukee Water and Sewer Utility	Addition of two shallow aquifer wells, service pumps, abandon one well with radium treatment	1,410	12.3[e]	1,895[e]	120[e]
City of Waukesha Water Utility	Addition of 10 to 20 shallow aquifer wells,[r] abandon radium treatment wells	43,910	2,700.0	75,368[e]	4,782
	Wastewater treatment plant effluent treatment and groundwater recharge system[u]	38,950	2,240.0	30,623	1,943
Village of Butler Public Water Utility	Addition of 0.25 MG reservoir	351	0.8	307	19
Village of Dousman Water Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.40 MG reservoir	1,631	26.2	1,957	124
Village of Eagle Municipal Water Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.40 MG reservoir	1,631	17.8	1,850	117
Village of Hartland Municipal Water Utility	Addition of one shallow aquifer well	625	17.7	526	33
Village of Menomonee Falls Water Utility (east)	No additions	- -	12.2[d]	192	12
Village of Menomonee Falls Water Utility (west)	Addition of 0.20 MG elevated tank, two shallow aquifer wells	1,755	32.9	1,387	88
Village of Mukwonago Municipal Water Utility	Addition of three shallow aquifer wells	2,195	77.7	2,676	170
Village of Pewaukee Water Utility	Addition of one shallow aquifer well	625	36.2	989	63
Village of Sussex Public Water Utility	Addition of one shallow aquifer well	625	42.9	642	41
Town of Brookfield Sanitary District No. 4	Addition of 0.35 MG reservoir	467	6.0	562	36
Village of Big Bend Planned Utility	Addition of two shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank	2,584	76.1	1,822	116
Village of Elm Grove Planned Utility	Lake Michigan supply connection[k]	2,797[k]	-470.0[s]	-4,997[s]	-285[s]

Table 116 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Waukesha County (continued)					
Village of Lannon Planned Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.75 MG elevated tank	3,098	117.9	2,381	151
Village of North Prairie Planned Utility	Addition of 0.50 MG elevated tank	878	19.5	592	38
Village of Wales Planned Utility	Addition of two shallow aquifer wells, 0.30 MG elevated tank	1,941	41.8	1,277	81
Town of Eagle-Eagle Spring Lake Area Planned Utility	Addition of one shallow aquifer well with 0.15 MG reservoir	853	5.2	454	29
Town of Oconomowoc-Okauchee Lake Area Planned Utility	Addition of four shallow aquifer wells, one with 0.15 MG reservoir, two 0.30 MG elevated tanks	4,110	116.6	2,899	184
Town of Summit-Golden Lake Area Planned Utility	Addition of one shallow aquifer well with 0.10 MG reservoir	787	2.1	403	26
Town of Ottawa-Pretty Lake Area Planned Utility	Addition of one shallow aquifer well with 0.10 MG reservoir	787	3.1	409	26
Land Acquisition for Wells and Storage Tanks	60 acres	4,200	- -	4,200	266
Countywide	15 rainfall infiltration sites[t]	8,351	66.8	5,128	325
Subtotal	50 Wells, 22 Storage Tanks, Four Lake Michigan Supply Connections, 15 Rainfall Infiltration Systems, Wastewater Treatment Plant Effluent Groundwater Recharge System	168,148	422.8	14,606	7,303
Regionwide	Nine deep sandstone aquifer recharge injection wells[v]	27,000	890.1	14,177	900
Total	135 Wells, 97 Storage Tanks, Six Lake Michigan Supply Connections, Two Water Treatment Plant Expansions, 83 Rainfall Infiltration Systems, Four Wastewater Treatment Plant Effluent Groundwater Recharge Systems, Nine Deep Sandstone Aquifer Recharge Injection Wells	402,793	5,341.2	279,979	17,793

[a] *All utilities' programs include water conservation programs.*

[b] *Costs presented are those associated with the costs for new, expanded, or upgraded facilities. The operation and maintenance costs are for increased incremental costs associated with new, expanded, or upgraded facilities and for water conservation measures. Alternative Plan 1 is being considered as the base for alternative plans evaluation. The costs for Alternative Plans 2, 3, and 4 include an adjustment in the operation and maintenance costs to reflect existing facilities not used under these alternative plans compared to Alternative Plan 1.*

[c] *The estimated annual cost for water conservation is included as an operation and maintenance cost for all utilities.*

Footnotes to Table 116 (continued)

[d]*Water utilities which purchase water on a wholesale basis will have continued or increased costs for the purchase of water. For purposes of the cost-effectiveness analyses of the alternative water supply plans, only the incremental operation and maintenance cost associated with any increased water supply facility water production costs are considered. Alternative Plan 1 is being used as the base to which the other alternative plans will be compared. For this base alternative, only the operation and maintenance cost for new, expanded, or upgraded facilities are included since the cost for operation and maintenance of existing facilities which are common to all alternative are not included for any alternatives.*

[e]*The annual O&M cost includes a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 2.*

[f]*There is expected to be an estimated average reduction of $376,000 per year for savings associated with existing residences which would be able to discontinue their point-of-entry water treatment systems in the Cities of Oak Creek and Franklin. However, there is also an expected cost involved in developing local water distribution systems. The cost savings due to discontinuation of the point-of-entry water treatment systems and the costs of the local distribution systems are common to all alternative plans and are not specifically accounted for in this table.*

[g]*The annual O&M cost for the We Energies-Water Services Mequon and Thiensville service area includes an estimated average annual water production cost of $219,000 per year based upon the estimated incremental cost of $230 per million gallons for water production at the City of Milwaukee Water Works treatment process. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed cost and other costs. There is also expected to be an estimated average reduction of $1,520,000 per year for savings associated with existing residences which would be able to discontinue their point-of-entry water treatment systems. However, there are also expected costs involved in developing a local water distribution system. The cost savings due to discontinuation of the point-of-entry water treatment systems and the cost of the local distribution system are common to all alternative plans and are not specifically accounted for in this table.*

[h]*Includes the Village of Sturtevant Water Utility which was purchased by the City of Racine Water and Wastewater Utility in 2007 and is now served by the City Utility on a retail basis.*

[i]*Includes the former Crestview Sanitary District and the former North Park Sanitary Districts which were consolidated in 2007 to form the Caledonia East Utility District.*

[j]*Includes the former Caddy Vista Sanitary District and the former Caledonia Utility District No. 1 which were consolidated in 2006 to form the Caledonia West Utility District.*

[k]*See Table 98 for details.*

[l]*The annual O&M cost for the Town of Yorkville Utility District No. 1 includes an estimated annual water production cost of $17,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 2. The annual O&M costs also include an expected average reduction of $28,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.*

[m]*The annual O&M cost for the Northwest Caledonia Area does not include the incremental cost for water production, as that cost is included in the expanded City of Oak Creek Water Utility costs.*

[n]*The annual O&M cost for the Village of Germantown Water Utility includes an estimated annual water production cost of $215,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 2. The annual O&M costs also include an expected average reduction of $1,720,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.*

[o]*The annual O&M cost for the City of Brookfield Water Utility for the eastern portion of the City includes an estimated annual water production cost of $205,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 2. The annual O&M costs also include an expected average reduction of $1,440,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.*

Footnotes to Table 116 (continued)

[p]The annual O&M cost for the City of Muskego Water Utility includes an estimated annual water production cost of $133,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 2. The annual O&M costs also include an expected average reduction of $1,519,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.

[q]The annual O&M cost for the City of New Berlin Water Utility for the central portion of the City includes an estimated annual water production cost of $185,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 2. The annual O&M costs also include an expected average reduction of $1,260,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.

[r]Number of wells needed varies with expected well capacity, with the range based upon wells of 0.5 mgd to 1.0 mgd.

[s]The annual O&M cost for the Village of Elm Grove includes an estimated annual water production cost of $62,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs also include an expected average reduction of $596,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.

[t]See Tables 111 and 112.

[u]See Table 113.

[v]See Table 114.

Source: Ruekert & Mielke, Inc., and SEWRPC.

Alternative Plan 3 has an estimated capital cost of $402.8 million and an annual operation and maintenance cost of $5.3 million. Based upon an analysis period of 50 years and an annual interest rate of 6 percent, the estimated present worth cost of this alternative is $280.0 million, and the equivalent annual cost is $17.8 million. The operation and maintenance cost used for purposes of comparison with Alternative Plan 1 is the net amount arrived at by combining the new facility costs; the expected savings due to the elimination of individual residential point-of-entry treatment devices—household water softening facilities; and reductions in costs due to the elimination of existing facilities which were operated under Alternative Plan 1, but are not included in Alternative Plan 3.

Groundwater and Surface Water Impacts of Alternative Plan 3

The potential impacts of Alternative Plan 3 on the groundwater and surface water systems of the Region under the attendant pumping conditions to the design year were estimated using the regional aquifer simulation model under the groundwater pumping conditions for Alternative Plan 3, and a parallel water budget analysis.

Groundwater Impacts in the Deep Aquifer

Simulated Water Levels in the Deep Aquifer

Results of the groundwater simulation modeling suggest that under Alternative Plan 3 conditions, drawups relative to 2005 conditions may be expected to occur in the deep aquifer over most of the Region. These impacts are shown on Map 91 and are most evident along the Milwaukee-Waukesha county line where the impacts were found to exceed 300 feet of drawup, in central and eastern Waukesha County, most of Milwaukee County, southern Ozaukee County, central and northern Racine County, and in southeastern Washington County where the impacts were found to exceed 100 feet of drawup. It should be noted that deep aquifer pumping in areas to the south of the Region in northeastern Illinois may be expected to continue to impact the deep aquifer underlying the Region. The smaller drawups shown in Kenosha and Walworth Counties on Map 91 may be attributed to such out-of-Region pumpage. For analytical purposes, the pumping in northeastern Illinois has been held at the year 2000 level for the planning period of 2000 through 2035. At the time that these analyses were conducted, no comprehensive areawide water supply plan was in place for the northeastern Illinois area. Therefore, no basis existed for forecasting potential changes in the pumpage concerned, and the impacts under future conditions may be somewhat different than developed under this planning program. However, the relative differences between the alternative plans considered may be expected to be valid.

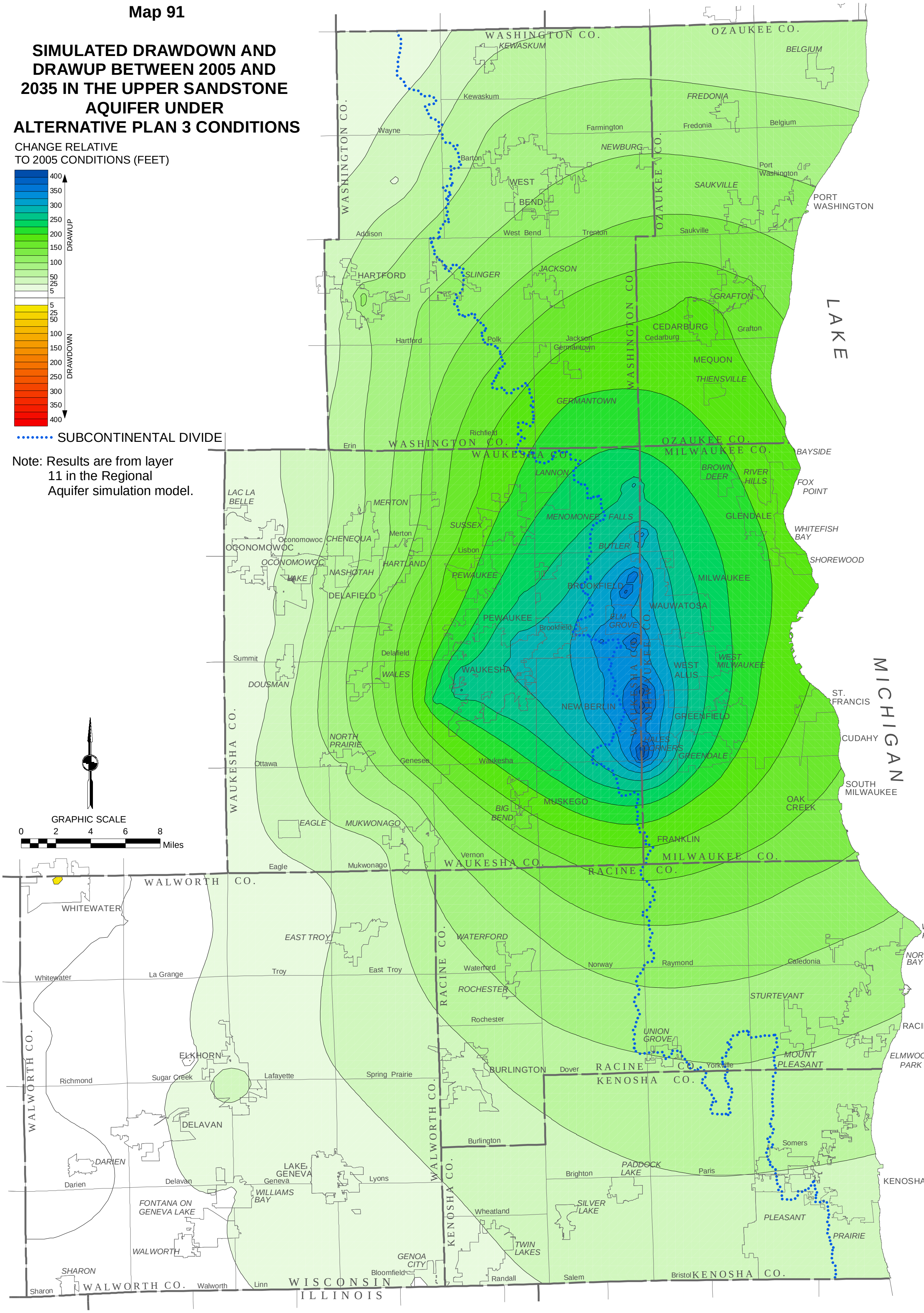
As shown by Table 117, no drawdowns over 2005 levels are expected to occur in the upper sandstone aquifer under Alternative Plan 3 conditions. An exception occurs in Walworth County where about 12 percent of model cells exhibit drawdowns over 2005 levels in the upper sandstone aquifer under Alternative Plan 3 conditions. For cells showing drawdowns in Walworth County, average drawdowns projected in this aquifer were less than one foot, and maximum drawdowns projected for this aquifer were about seven feet.

Under Alternative Plan 3 conditions, relatively little variation in drawdown was found in terms of the percentage of cells showing simulated drawdowns over the period 2005 to 2035 greater than the given thresholds. As noted above, drawdowns may be expected to occur only in Walworth County. No drawdowns in the deep aquifer greater than 10 feet were found to occur in this County. About 0.1 percent of model cells showing drawdowns in Walworth County had drawdowns greater than five feet.

Table 117 also summarizes simulated drawups in the upper sandstone aquifer over the period 2005 to 2035 under Alternative Plan 3 conditions. The percentage of cells in the model showing drawups over 2005 levels ranges from about 88 percent in Walworth County to 100 percent in Kenosha, Milwaukee, Ozaukee, Racine, Washington, and Waukesha Counties. Average drawups in this aquifer are projected to range from about 14 feet for cells showing drawups in Walworth County, to about 212 feet for cells showing drawups in Milwaukee County. Maximum simulated drawups in this aquifer range from about 74 feet in Kenosha County to about 414 feet in Waukesha County. Model cells in most of the Region showed simulated drawups in the upper sandstone aquifer under Alternative Plan 3 conditions greater than five feet as shown on Map 91. Exceptions were located in southern and western Walworth County.

Map 91

SIMULATED DRAWDOWN AND DRAWUP BETWEEN 2005 AND 2035 IN THE UPPER SANDSTONE AQUIFER UNDER ALTERNATIVE PLAN 3 CONDITIONS



Note: Results are from layer 11 in the Regional Aquifer simulation model.

Source: U.S. Geological Survey.

Table 117

AVERAGE AND MAXIMUM SIMULATED DRAWDOWN AND DRAWUP IN THE UPPER SANDSTONE AQUIFER UNDER ALTERNATIVE PLAN 3 CONDITIONS: 2005-2035[a]

County	Drawdown			Drawup		
	Percent of Model Cells	Average (feet)	Maximum (feet)	Percent of Model Cells	Average (feet)	Maximum (feet)
Kenosha	0.0	0.0	0.0	100.0	45.4	73.7
Milwaukee	0.0	0.0	0.0	100.0	211.8	367.8
Ozaukee	0.0	0.0	0.0	100.0	122.5	221.1
Racine	0.0	0.0	0.0	100.0	91.9	156.2
Walworth	12.2	0.6	6.8	87.8	14.3	76.2
Washington	0.0	0.0	0.0	100.0	96.6	263.0
Waukesha	0.0	0.0	0.0	100.0	149.9	414.5

[a]*Results are from Layer 11 in the groundwater simulation model.*

Source: U.S. Geological Survey.

Table 118

SIMULATED DRAWUP IN THE UPPER SANDSTONE AQUIFER UNDER ALTERNATIVE PLAN 3 CONDITIONS: 2005-2035[a]

County	Percent of Model Cells Showing Drawup Beyond Greater than:						
	One Foot	Five Feet	10 Feet	50 Feet	100 Feet	150 Feet	200 Feet
Kenosha	100.0	100.0	36.8	0.0	0.0	0.0	0.0
Milwaukee	100.0	100.0	100.0	100.0	100.0	93.5	54.1
Ozaukee	100.0	100.0	100.0	100.0	57.7	33.4	3.8
Racine	100.0	100.0	100.0	91.9	37.5	1.2	0.0
Walworth	73.2	57.3	45.4	2.6	0.0	0.0	0.0
Washington	100.0	100.0	100.0	81.0	41.5	17.2	3.6
Waukesha	100.0	100.0	99.5	78.1	62.4	49.0	34.5

[a]*Results are from Layer 11 in the groundwater simulation model.*

Source: U.S. Geological Survey.

Table 118 summarizes the variation in drawup in terms of the percentage of cells showing simulated drawups over the period 2005 to 2035 greater than the given thresholds. In much of the Region, drawups in excess of 10 feet are common in the upper sandstone aquifer under Alternative Plan 3 conditions, representing over 99 percent of model cells in all counties except Kenosha and Walworth Counties. In much of the Region, drawups in excess of 50 feet were common in the upper sandstone aquifer under Alternative Plan 3 conditions. No model cells in Kenosha County and relatively few cells in Walworth County showed drawups in excess of 50 feet. Drawups in excess of 50 feet were more common in Milwaukee, Ozaukee, Racine, Washington, and Waukesha Counties, ranging from about 78 percent of cells in Waukesha County to 100 percent of cells in Milwaukee and Ozaukee Counties. Drawups in excess of 200 feet were found in four counties under Alternative Plan 3 conditions. In Milwaukee and Waukesha Counties, such drawups represented about 54 percent, and 35 percent of cells, respectively. Drawups in excess of 200 feet were less common in Ozaukee and Washington Counties, accounting for less than 4 percent of model cells in each of these Counties.

Much of the simulated drawup shown on Map 91 may be attributed to the effects of two components of Alternative Plan 3. Some of the simulated drawup projected by the model may be attributed to the shift in pumping from the deep aquifer to the shallow aquifer under this alternative plan. In addition, the enhanced recharge to the deep aquifer provided by the injection well component of Alternative Plan 3 accounts for some of the additional drawup over Alternative Plan 2 conditions. This is indicated by the correspondence between the locations of the injection wells simulated in the model and of the areas of highest drawup under Alternative Plan 3 conditions—both occurring along the Milwaukee-Waukesha county line.

Previous model results suggest that the top of the Sinnipee Group dolomite below the Maquoketa shale has become unsaturated in central Waukesha County.[14] The simulation modeling results suggest that under Alternative Plan 3 conditions, such unsaturated conditions would not occur under Alternative Plan 3 conditions. An unsaturated condition at this depth, depending on how it spreads, could influence well yields and groundwater geochemistry around deep wells open to the Sinnipee Group, the St. Peter Formation, and below. Because of the model resolution and because the model does not explicitly simulate unsaturated flow, however, the potential for this condition would require further more-detailed evaluation if such conditions are expected under the recommended plan.

Water Budget Analyses

Table 119 shows results by County from a water budget analysis for the deep groundwater system under Alternative Plan 3 conditions. This analysis derived the anticipated values of two groundwater performance indicators—the demand to supply ratio and the human influence ratio—under Alternative Plan 3 conditions for the years 2005 and 2035. The analysis indicates that in 2005 the demand to supply ratio would range from about 0.10 in Kenosha County to about 5.77 in Waukesha County under Alternative Plan 3 conditions. Under these conditions, the values of the demand to supply ratio for Ozaukee, Racine, and Waukesha Counties in 2005 are expected to exceed one, indicating water budget deficits in the deep aquifer underlying these counties. The analysis also projects that under Alternative Plan 3 conditions the demand to supply ratio would range from about 0.02 in Ozaukee County to about 2.29 in Racine County in 2035. Under these conditions, the values of this indicator are anticipated to increase in Racine and Walworth Counties between 2005 and 2035. For 2035, the values of the demand to supply ratio for Racine County exceeds one, indicating a water budget deficit in the deep aquifer underlying this County.

The analysis also indicates that in 2005 the human impact ratio would range from about minus 0.88 in Waukesha County to about minus 0.04 in Kenosha County under Alternative Plan 3 conditions and projects that in 2035 this indicator would range from about minus 0.44 in Racine County to about 0.01 in Ozaukee County under Alternative Plan 3 conditions. These values suggest that the net effect of human activities under these conditions would be to remove water from the deep groundwater system in all Counties of the Region. In all Counties of the Region except Walworth County, the projected changes in the values of this indicator between 2005 and 2035 indicate that the influence of human withdrawals on the water budget of the deep groundwater would be expected to decrease in these Counties under Alternative Plan 3 conditions. Despite the anticipated reduction in the influence of human withdrawals, under these conditions the deep groundwater systems in Racine and Walworth Counties are anticipated to remain heavily influenced by human activities in 2035.

Groundwater Impacts in the Shallow Aquifer

Impacts to Groundwater-Derived Baseflow to Surface Waters

Alternative Plan 3 provides approximately 13.9 mgd of enhanced recharge to the shallow groundwater system. This additional water can be intercepted by wells, discharge to surface water features, be added to storage, or flow from inside the planning area to outside its borders. On a Regional scale, simulated pumpage under Alternative Plan 3 conditions increased from 76.8 mgd in 2005, to 93.7 mgd in 2035, representing a total increase in pumping

[14]*SEWRPC Technical Report No. 41*, op. cit.

Table 119

PROJECTED GROUNDWATER PERFORMANCE INDICATORS FOR THE SANDSTONE AQUIFERS UNDER ALTERNATIVE PLAN 3 CONDITIONS: 2005 AND 2035

County	Demand to Supply Ratio[a]		Human Influence Ratio[b]	
	2005	2035	2005	2035
Kenosha	0.101	0.057	-0.041	-0.016
Milwaukee	0.567	0.369	-0.197	-0.087
Ozaukee	1.040	0.017	-0.317	-0.010
Racine	1.963	2.293	-0.500	-0.437
Walworth	0.745	0.883	-0.326	-0.407
Washington	0.453	0.294	-0.191	-0.181
Waukesha	5.773	0.496	-0.881	-0.088

[a]*The demand to supply ratio is defined as the ratio of net pumping demand on an aquifer to the amount of water that is replenished at a given point in time. Generally, this indicator ranges from 0—representing no human impact—upward. Values over 1.0 indicate that more groundwater is being extracted than can be replaced in a long-term, sustainable fashion. The year 2005 and 2035 conditions for this indicator are compared to predevelopment conditions.*

[b]*The human impact ratio, is defined as the ratio of human-induced groundwater inflows to total inflows minus the ratio of human-induced groundwater outflows to total outflows. This indicator is an expression of the relative magnitude of human alteration of the groundwater system. Values range from minus 1.0 in areas where wells have become the only discharge from an aquifer by stopping all other groundwater discharges, through 0 representing no net human impact, to plus 1.0 representing situations where human additions are the only inputs to the aquifer. The year 2005 and 2035 conditions for this indicator are compared to predevelopment conditions.*

Source: University of Wisconsin-Milwaukee.

of 16.9 mgd. The model indicates that 12.3 mgd, or about 73 percent, of this additional extracted water was derived directly from surface water features due to reversed hydraulic gradients at the groundwater-surface water interface. The model also indicates that the amount of baseflow to surface water features under Alternative Plan 3 conditions increased by 4.4 mgd, resulting in a net extraction from surface waters of about 7.4 mgd or about 47 percent of the increase in pumping. The remaining 9.0 mgd, or 53 percent, was derived from other sources with enhanced recharge being the dominant source. This mass balance analysis for sources of water to wells suggests that under Alternative Plan 3 conditions, enhanced recharge is approximately as important a source of water to wells as baseflow depletion to surface water features.

Major streams, rivers, and lakes in the surface water system in the Southeastern Wisconsin Region are represented in the model by 3,756 cells designated as stream nodes. The simulation model results indicated that under 2005 pumping conditions, about 92 percent of these nodes were receiving baseflow from groundwater, while about 5 percent are losing baseflow to groundwater. By 2035, these percentages would change slightly under Alternative Plan 3 conditions, with about 91 percent of these nodes expected to receive baseflow from groundwater, and about 6 percent as losing baseflow to groundwater. As previously noted, the analyses conducted consider only the impacts on the groundwater-derived baseflow of the streamflow. Groundwater-derived baseflow typically comprises from 10 to 50 percent of total streamflow.

Table 120 summarizes simulated changes in baseflow to surface waters in the Southeastern Wisconsin Region under Alternative Plan 3 conditions over the period 2005 to 2035. In aggregate, by 2035 surface waterbodies in the Region may be expected to experience a baseflow depletion of about 6.1 mgd. The amounts of depletion will vary among the Counties, ranging from an augmentation of baseflow of about 0.1 mgd in Ozaukee County, to a depletion of baseflow of about 3.3 mgd in Walworth County. This baseflow depletion is the net result of 9.9 mgd of outflow depletion, reduced by 3.7 mgd of inflow augmentation. It is important to note that these aggregate

Table 120

SIMULATED BASEFLOW DEPLETION TO SURFACE WATERS UNDER ALTERNATIVE PLAN 3 CONDITIONS: 2005-2035

Baseflow to Surface Water	2000 Baseflow (million gallons per day)	2035 Baseflow (million gallons per day)	Difference (million gallons per day)[a]	Percent Change[a]
Kenosha County				
Inflow to Surface Water	41.63	40.72	-0.91	-2.2
Outflow from Surface Water	0.40	1.12	-0.72	-178.4
Subtotal	41.23	39.60	-1.63	-3.9
Milwaukee County				
Inflow to Surface Water	11.45	11.69	0.24	2.0
Outflow from Surface Water	2.98	2.96	0.02	0.8
Subtotal	8.47	8.73	0.26	3.1
Ozaukee County				
Inflow to Surface Water	17.34	17.49	0.15	0.8
Outflow from Surface Water	0.46	0.53	-0.07	-14.5
Subtotal	16.88	16.96	0.08	0.7
Racine County				
Inflow to Surface Water	41.70	41.85	0.15	0.4
Outflow from Surface Water	0.07	0.45	-0.38	-565.4
Subtotal	41.63	41.40	-0.23	-0.6
Walworth County				
Inflow to Surface Water	104.00	102.13	-1.87	-1.8
Outflow from Surface Water	8.99	10.43	-1.44	-16.0
Subtotal	95.01	91.70	-3.31	-3.5
Washington County				
Inflow to Surface Water	63.52	65.72	2.20	3.5
Outflow from Surface Water	2.52	3.29	-0.77	-30.7
Subtotal	61.00	62.43	1.43	2.3
Waukesha County				
Inflow to Surface Water	89.55	93.32	3.77	4.2
Outflow from Surface Water	1.28	7.81	-6.53	-509.9
Subtotal	88.27	85.51	-2.76	-3.1
Southeastern Wisconsin Region				
Inflow to Surface Water	369.19	372.92	3.73	1.0
Outflow from Surface Water	16.70	26.59	-9.89	-59.2
Total	352.49	346.33	-6.16	-1.7

[a]*A positive difference or change represents augmentation of baseflow to surface waters, a negative difference or change represents depletion of baseflow to surface waters.*

Source: U.S. Geological Survey.

totals may obscure differences in site-specific baseflow changes within each County. While the County totals project overall depletions within each County, some individual waterbodies may experience either depletion or augmentation on a site-specific basis.

Model nodes showing greater than 10 percent and greater than 25 percent baseflow depletion under Alternative Plan 3 conditions are shown on Maps 92 and 93, respectively. As previously noted, these data are considered to be valid for the purpose of comparing alternative plans. Model refinement would be needed for consideration of

Map 92

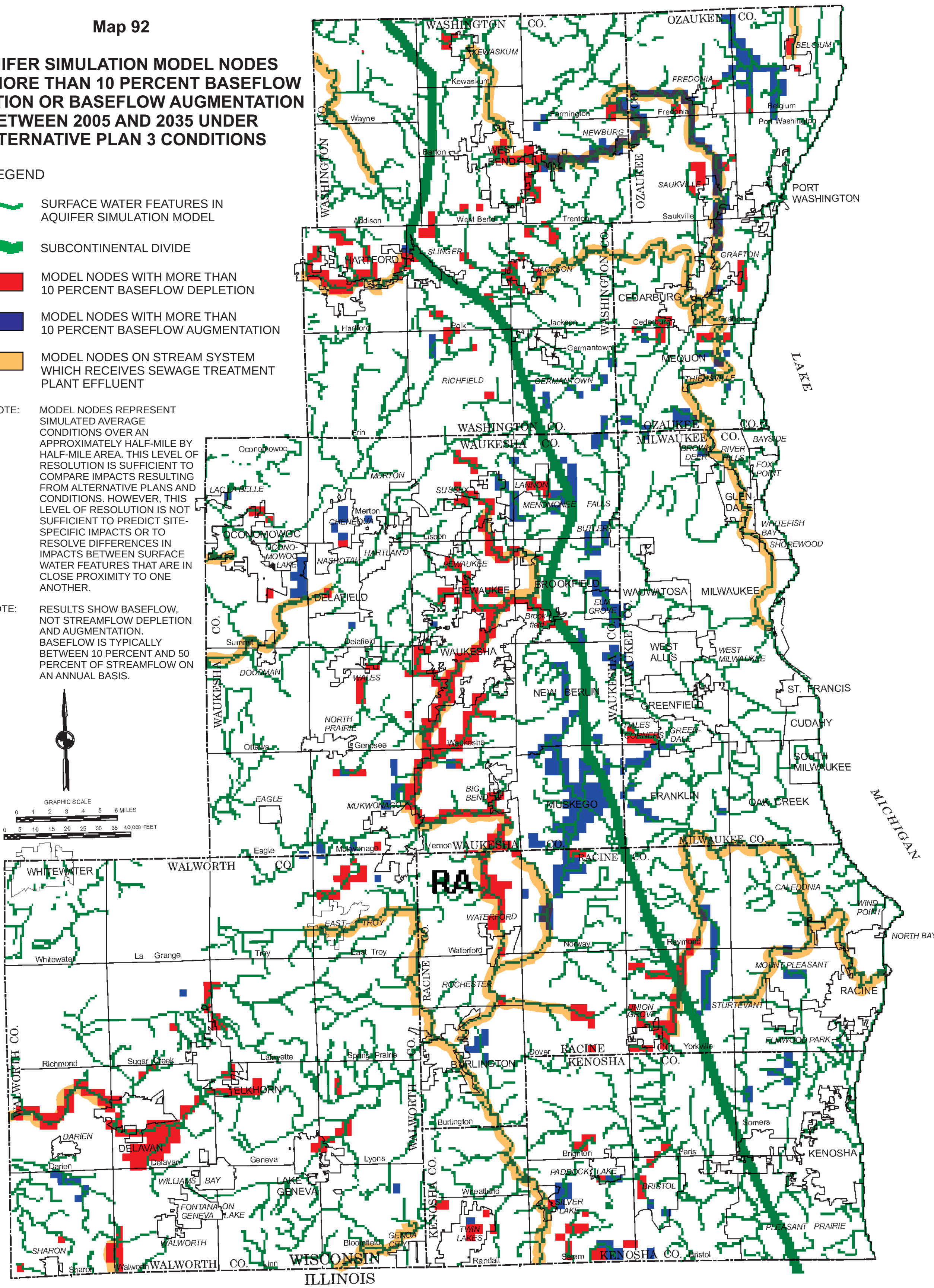
AQUIFER SIMULATION MODEL NODES WITH MORE THAN 10 PERCENT BASEFLOW DEPLETION OR BASEFLOW AUGMENTATION BETWEEN 2005 AND 2035 UNDER ALTERNATIVE PLAN 3 CONDITIONS

LEGEND

- SURFACE WATER FEATURES IN AQUIFER SIMULATION MODEL
- SUBCONTINENTAL DIVIDE
- MODEL NODES WITH MORE THAN 10 PERCENT BASEFLOW DEPLETION
- MODEL NODES WITH MORE THAN 10 PERCENT BASEFLOW AUGMENTATION
- MODEL NODES ON STREAM SYSTEM WHICH RECEIVES SEWAGE TREATMENT PLANT EFFLUENT

NOTE: MODEL NODES REPRESENT SIMULATED AVERAGE CONDITIONS OVER AN APPROXIMATELY HALF-MILE BY HALF-MILE AREA. THIS LEVEL OF RESOLUTION IS SUFFICIENT TO COMPARE IMPACTS RESULTING FROM ALTERNATIVE PLANS AND CONDITIONS. HOWEVER, THIS LEVEL OF RESOLUTION IS NOT SUFFICIENT TO PREDICT SITE-SPECIFIC IMPACTS OR TO RESOLVE DIFFERENCES IN IMPACTS BETWEEN SURFACE WATER FEATURES THAT ARE IN CLOSE PROXIMITY TO ONE ANOTHER.

NOTE: RESULTS SHOW BASEFLOW, NOT STREAMFLOW DEPLETION AND AUGMENTATION. BASEFLOW IS TYPICALLY BETWEEN 10 PERCENT AND 50 PERCENT OF STREAMFLOW ON AN ANNUAL BASIS.



Source: U.S. Geological Survey.

Map 93

AQUIFER SIMULATION MODEL NODES WITH MORE THAN 25 PERCENT BASEFLOW DEPLETION OR BASEFLOW AUGMENTATION BETWEEN 2005 AND 2035 UNDER ALTERNATIVE PLAN 3 CONDITIONS

LEGEND

SURFACE WATER FEATURES IN AQUIFER SIMULATION MODEL

SUBCONTINENTAL DIVIDE

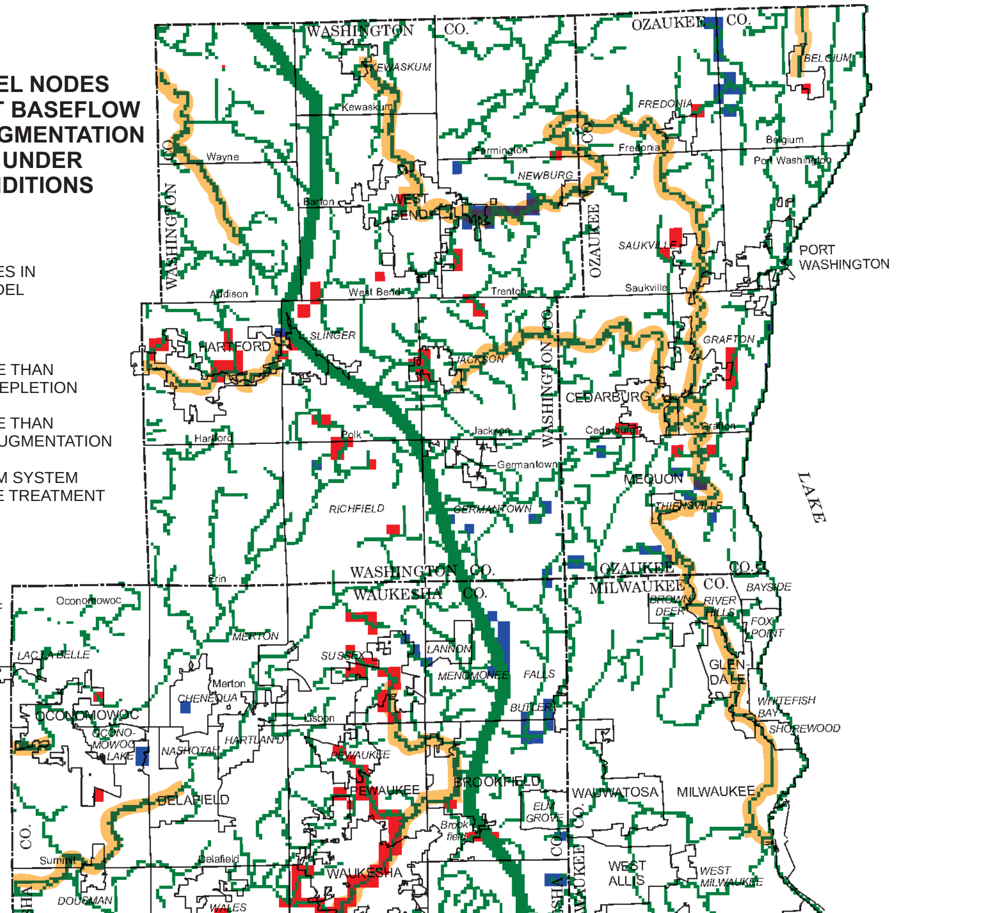
MODEL NODES WITH MORE THAN 25 PERCENT BASEFLOW DEPLETION

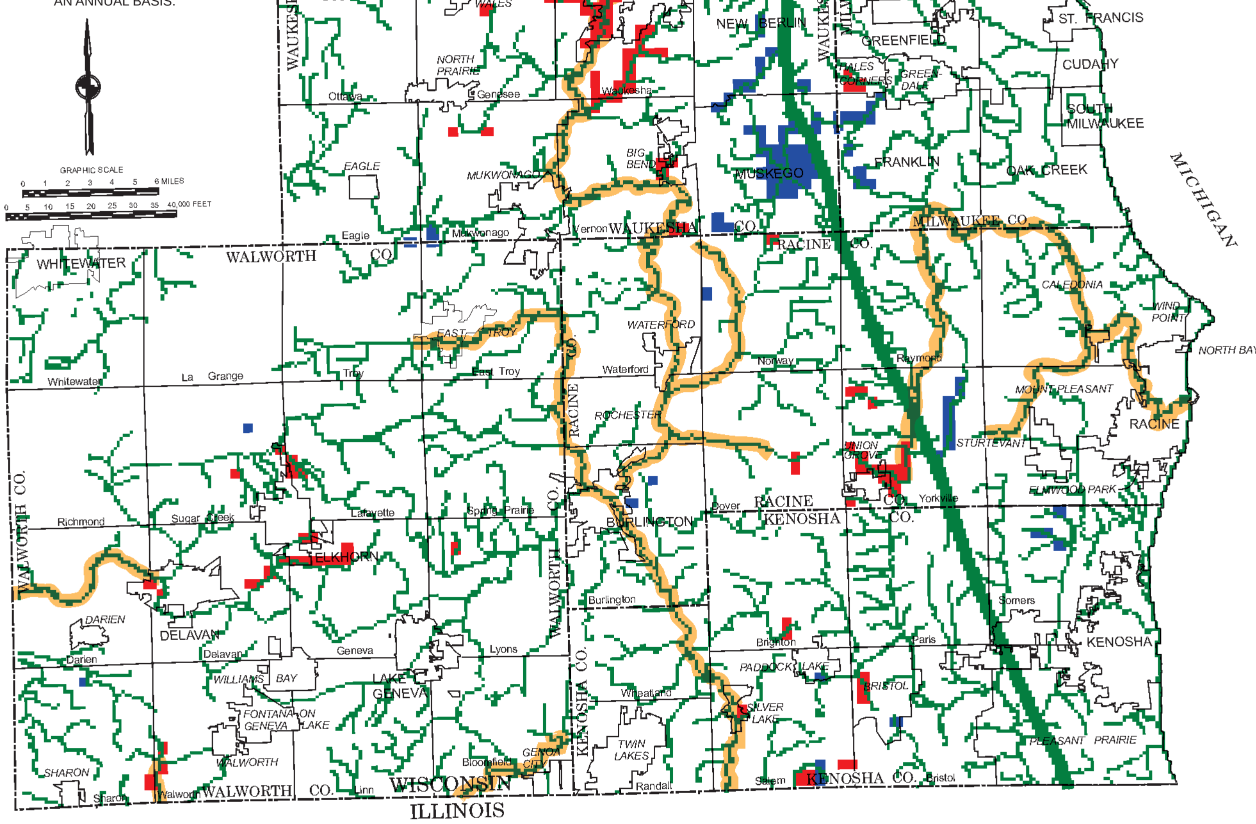
MODEL NODES WITH MORE THAN 25 PERCENT BASEFLOW AUGMENTATION

MODEL NODES ON STREAM SYSTEM WHICH RECEIVES SEWAGE TREATMENT PLANT EFFLUENT

NOTE: MODEL NODES REPRESENT SIMULATED AVERAGE CONDITIONS OVER AN APPROXIMATELY HALF-MILE BY HALF-MILE AREA. THIS LEVEL OF RESOLUTION IS SUFFICIENT TO COMPARE IMPACTS RESULTING FROM ALTERNATIVE PLANS AND CONDITIONS. HOWEVER, THIS LEVEL OF RESOLUTION IS NOT SUFFICIENT TO PREDICT SITE-SPECIFIC IMPACTS OR TO RESOLVE DIFFERENCES IN IMPACTS BETWEEN SURFACE WATER FEATURES THAT ARE IN CLOSE PROXIMITY TO ONE ANOTHER.

NOTE: RESULTS SHOW BASEFLOW, NOT STREAMFLOW DEPLETION AND AUGMENTATION. BASEFLOW IS TYPICALLY BETWEEN 10 PERCENT AND 50 PERCENT OF STREAMFLOW ON AN ANNUAL BASIS.





Source: U.S. Geological Survey.

site-specific impacts. Several notable areas of baseflow depletion are indicated in the model results. Nodes for which the simulation analyses indicated greater than 10 percent baseflow reduction include those representing portions of Mole Creek, Pigeon Creek, and Sauk Creek in Ozaukee County; the mainstem of the Milwaukee River near West Bend in Washington County; portions of Quaas Creek in Washington County; the Rubicon River and the East Branch of the Rubicon River in Washington County; the Fox River between the City of Pewaukee in Waukesha County and the Village of Waterford in Racine County including some portions of Vernon Marsh; portions of several tributaries to the Fox River in Waukesha County including Pebble Brook, Pebble Creek, the Pewaukee River, and Sussex Creek; Lake Beulah in Walworth County; a portion of the White River in Walworth County; Turtle Creek in Walworth County; Delavan Lake in Walworth County; Jackson Creek In Walworth County; a portion of the West Branch of the Root River Canal in Racine County; and the Des Plaines River near Union Grove in Racine County. Maps 92 and 93 also highlight those streams which receive a significant amount of wastewater treatment plant effluent, and are, thus, somewhat less sensitive to reductions in baseflows. It is important to note that several of the streams simulated to show baseflow reductions in excess of 10 percent under Alternative Plan 3 conditions receive wastewater treatment plant effluent.

Model nodes simulated to show greater than 25 percent baseflow reduction include those representing a small portion of Pigeon Creek in Ozaukee County; portions of the Rubicon River and the East Branch of the Rubicon River in Washington County; the Fox River between the City of Pewaukee and a point downstream from the confluence with Pebble Creek in Waukesha County, some portions of the Vernon Marsh; portions of several tributaries to the Fox River in Waukesha County including portions of Pebble Brook, Pebble Creek, the Pewaukee River, and Sussex Creek; Jackson Creek in Walworth County; and a portion of the Des Plaines River near Union Grove in Racine County. Some of the streams simulated to show baseflow reductions in excess of 25 percent under Alternative Plan 3 conditions receive wastewater treatment plant effluent (see Map 93).

Maps 92 and 93 also depict model nodes which show potential augmentation of baseflow under Alternative Plan 3 conditions greater than 10 percent and greater than 25 percent, respectively. As previously noted, these results are considered to be valid for the purpose of comparing alternative plans; however, additional analyses would be needed for consideration of site-specific impacts. Several notable areas of baseflow augmentation are indicated by the model results. Nodes for which simulation analyses indicated greater than 10 percent baseflow augmentation include those representing the mainstem of the Milwaukee River between West Bend and Grafton in Washington and Ozaukee Counties; Trinity Creek and upstream portions of Sauk Creek in Ozaukee County; Butler Ditch, Hale Creek, Underwood Creek, Upper Nashotah Lake, Lower Nashotah Lake, Upper Nemahbin Lake, Lake Denoon, and portions of Deer Creek in Waukesha County; the Wind Lake subwatershed of the Fox River watershed in Waukesha and Racine Counties, including Big Muskego, Little Muskego, and Wind Lakes and the Muskego and Wind Lake Drainage Canals; Ryan and Tess Corners Creeks in Milwaukee County; portions of Darien Creek in Walworth County; Browns Lake and the East Branch of the Root River Canal in Racine County; and Silver Lake in Kenosha County.

Model nodes simulated to show greater than 25 percent baseflow potential augmentation include those representing a portion of the mainstem of the Milwaukee River near West Bend in Washington County; Trinity Creek and some of the headwaters of Sauk Creek in Ozaukee County; Butler Ditch, Hale Creek, Lake Denoon, Upper Nashotah Lake, and upper portions of the Wind Lake subwatershed of the Fox River watershed in Waukesha County; and the upstream portions of the East Branch of the Root River Canal in Racine County.

As may be seen by review of Maps 92 and 93, most of the surface water features potentially impacted by baseflow augmentations do not receive wastewater treatment plant effluent. The major exception to this observation is the section of the Milwaukee River between West Bend and Grafton which receives contributions of treated effluent from wastewater treatment plants located in Campbellsport, Kewaskum, West Bend, Newburg, Cascade, Random Lake, Fredonia, and Saukville.

These simulated baseflow reductions and augmentations need to be carefully interpreted. As noted above, the groundwater model simulates changes in baseflow, not changes in total streamflow. A change in baseflow does not necessarily indicate a change in total streamflow. For example, in some streams much of a reduction in baseflow may be returned to the surface water system through discharge from wastewater treatment plants. This is the case for the Fox River where 15 municipal wastewater treatment plants discharge treated effluent into the River or its tributaries. Increase in runoff due to changes in land use may also serve to augment streamflow in streams experiencing baseflow reductions. Increases in streamflow due to increases in runoff may be associated with potential negative water quality and quantity considerations, including increases in nonpoint source pollution loadings and increases in peak period flows. In addition, because of the resolution provided by the model grid, any simulated change in baseflow represents an average change over an area of one-quarter square mile. Because variations can occur within the area represented by a model cell, this average may not be totally representative of individual surface water features within the cell, particularly small surface water features in cells containing multiple surface water features.

Simulated baseflow changes between 2005 and 2035 were evaluated at 100 model nodes containing surface water evaluation sites. Decreases in baseflow under Alternative Plan 3 conditions were found to occur at 54 evaluation sites, or 54 percent of evaluation sites; with decreases in excess of 10 percent of 2005 baseflow found at 16, or 16 percent, of these sites; and decreases in excess of 25 percent of 2005 baseflow found at seven, or 7 percent, of these sites. Increases in baseflow were found to occur at 35 evaluation sites, or 35 percent of evaluation sites, with simulated increases in excess of 10 percent of 2005 baseflow found at nine, or 9 percent, of these sites, and simulated increases in excess of 25 percent of 2005 baseflow found at four, or 4 percent, of these sites. The remaining 11 evaluation sites, or 11 percent of evaluation sites, were found to either experienced no change in baseflow or were not simulated as having streamflow in 2005.

Simulated Water Levels in the Shallow Aquifers

The results of the simulation indicate that under Alternative Plan 3 conditions, additional drawdowns may be expected to occur in the shallow aquifer over much of the Region. These impacts are shown on Maps 94 and 95. Table 121 provides a summary of the simulated drawdowns and drawups in the glacial sand and gravel aquifer over the period 2005 to 2035. The percentage of cells in the model showing drawdowns over 2005 levels ranges from about 27 percent in Racine County to about 74 percent in Ozaukee County. Average drawdowns projected in this aquifer are relatively small, ranging from about 0.6 foot for cells showing drawdowns in Milwaukee County, to about 1.4 feet for cells showing drawdowns in Waukesha County. This reflects, in part, the damping effect that surface waters have on changes in the shallow groundwater system. Often the major effect of pumping from shallow wells is to reduce groundwater discharge to local surface water features. In addition, these relatively small drawdowns reflect the effects of the enhanced recharge to the shallow groundwater system provided by components of Alternative Plan 3. The maximum drawdowns projected for this aquifer range from about 4.5 feet for cells showing drawdowns in Milwaukee County, to about 77 feet for cells showing drawdowns in Racine County.

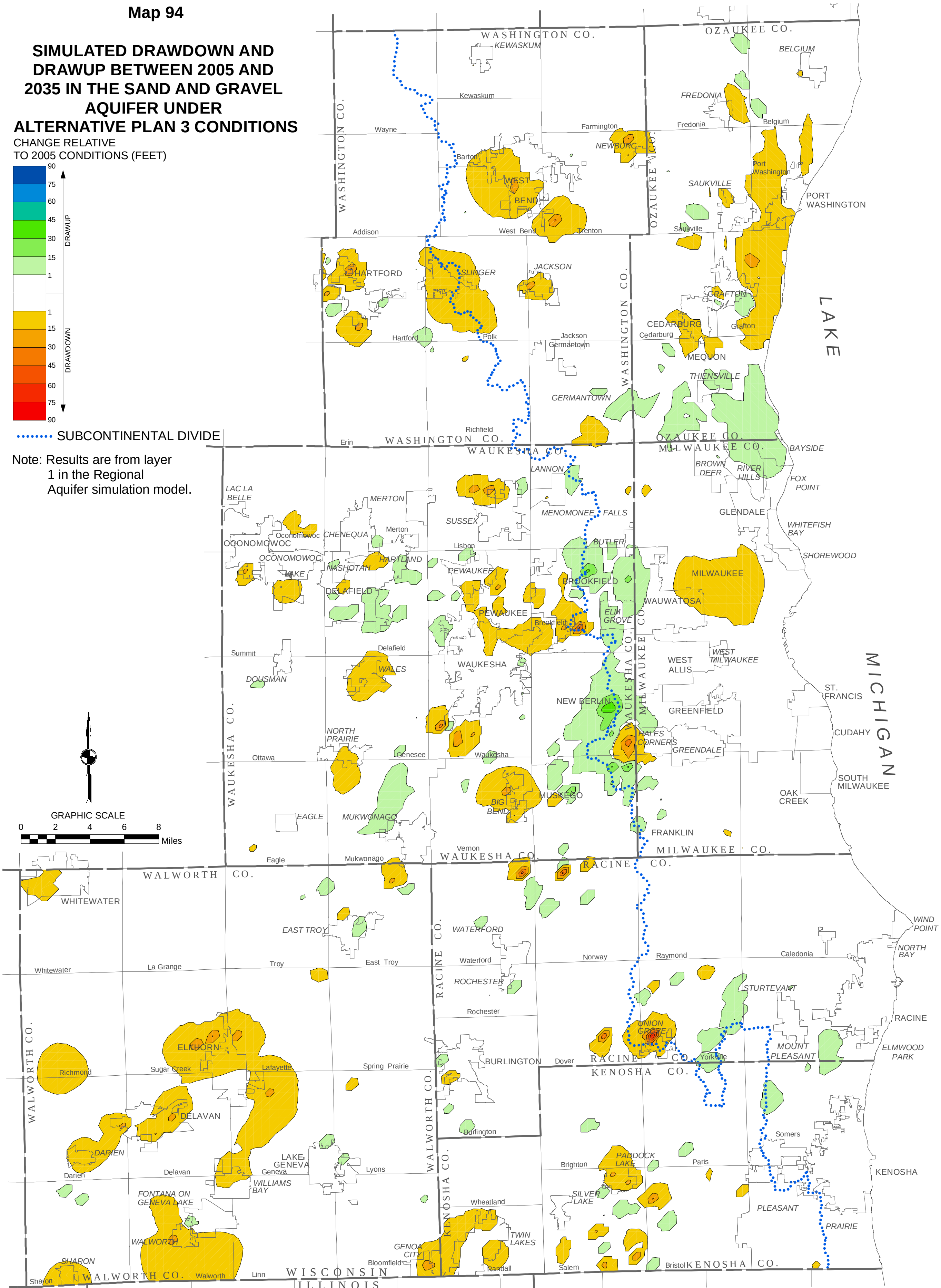
Table 122 summarizes the variation among model cells in terms of the percentage of the cells showing simulated drawdowns over the period 2005 to 2035 greater than the given thresholds. In most of the Region, drawdowns greater than 10 feet are relatively rare in the glacial aquifer under Alternative Plan 3 conditions. None of the model cells in Milwaukee County and fewer than 1 percent of the model cells in Kenosha, Ozaukee, Racine, and Walworth Counties indicate drawdowns in excess of 10 feet. Drawdowns in excess of 10 feet were more common in Washington and Waukesha Counties, representing about 1 percent of cells in each of these Counties.

Model cells showing simulated drawdowns were distributed throughout the Region; however, there were areas showing a high proportion of cells with drawdowns greater than one foot as shown on Map 94. These areas include western Kenosha County; eastern and central Ozaukee County; northern Milwaukee County; south-central Racine County; central and western Walworth County; and central Washington County. Areas with high proportions of cells showing drawdowns greater than one foot were also scattered throughout Waukesha County.

Table 121 also summarizes simulated drawups in the glacial aquifer over the period 2005 to 2035. The percentage of cells in the model showing drawups over 2005 levels ranges from about 26 percent in Ozaukee County to about 73 percent in Racine County. Average drawups projected in this aquifer are relatively small, ranging from about

Map 94

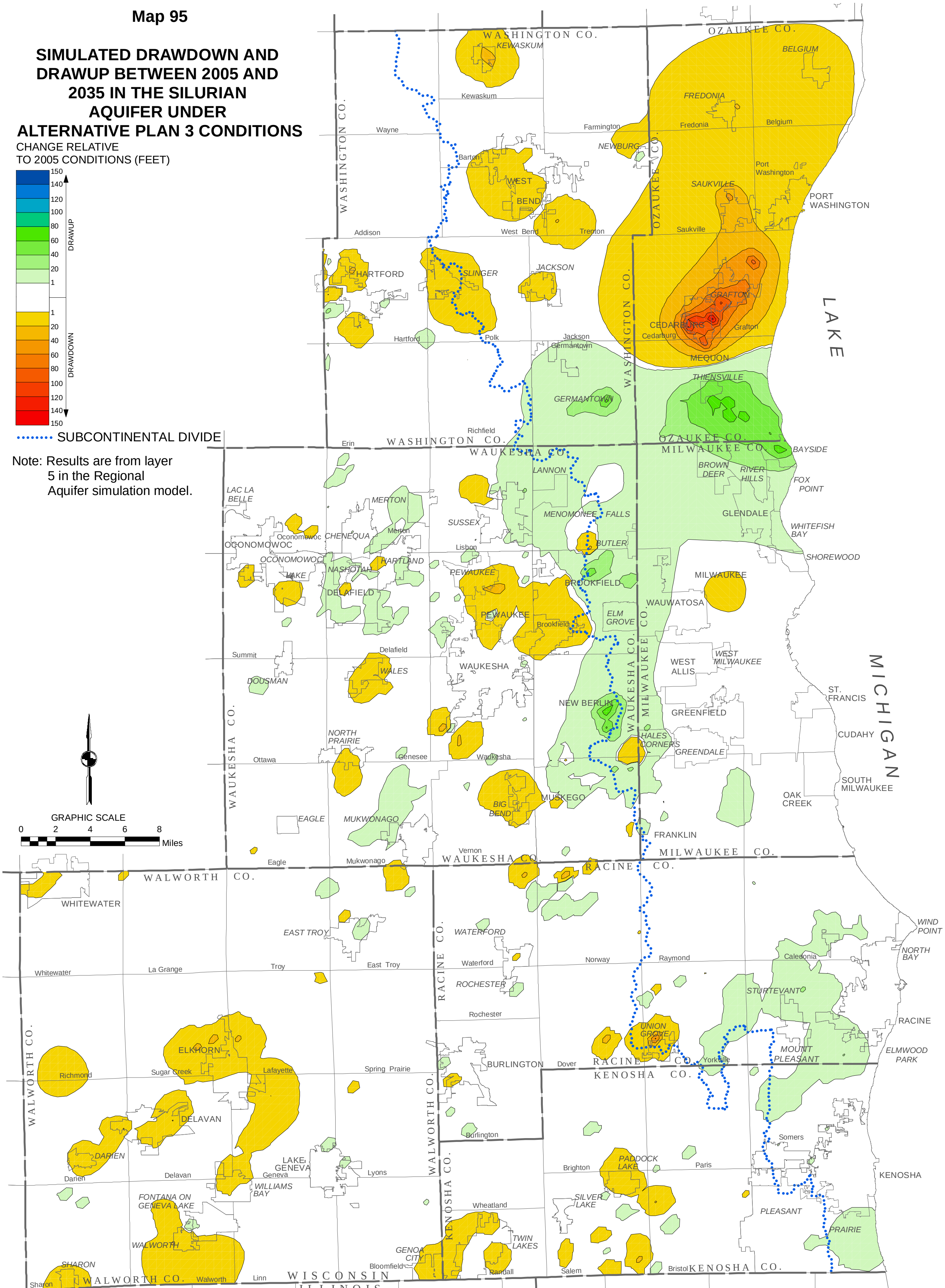
SIMULATED DRAWDOWN AND DRAWUP BETWEEN 2005 AND 2035 IN THE SAND AND GRAVEL AQUIFER UNDER ALTERNATIVE PLAN 3 CONDITIONS



Source: U.S. Geological Survey.

Map 95

SIMULATED DRAWDOWN AND DRAWUP BETWEEN 2005 AND 2035 IN THE SILURIAN AQUIFER UNDER ALTERNATIVE PLAN 3 CONDITIONS



Note: Results are from layer 5 in the Regional Aquifer simulation model.

Source: U.S. Geological Survey.

Table 121

AVERAGE AND MAXIMUM SIMULATED DRAWDOWN AND DRAWUP IN THE GLACIAL SAND AND GRAVEL AQUIFER UNDER ALTERNATIVE PLAN 3 CONDITIONS BY COUNTY: 2005-2035[a]

County	Drawdown			Drawup		
	Percent of Model Cells	Average (feet)	Maximum (feet)	Percent of Model Cells	Average (feet)	Maximum (feet)
Kenosha	43.0	0.8	31.5	57.0	0.2	8.2
Milwaukee	42.6	0.6	4.5	57.4	0.3	8.4
Ozaukee	74.2	1.0	28.3	25.8	1.4	13.0
Racine	27.4	1.1	76.6	72.6	0.2	15.4
Walworth	66.6	0.9	31.0	33.4	0.1	6.0
Washington	61.2	1.0	33.1	38.8	0.1	4.1
Waukesha	33.2	1.4	49.0	66.8	0.8	38.4

[a]*Results are from Layer 1 in the groundwater simulation model.*

Source: U.S. Geological Survey.

Table 122

SIMULATED DRAWDOWN IN THE GLACIAL SAND AND GRAVEL AQUIFER UNDER ALTERNATIVE PLAN 3 CONDITIONS BY COUNTY: 2005-2035[a]

County	Percent of Model Cells Showing Drawdown Beyond Greater than:				
	One Foot	Five Feet	10 Feet	50 Feet	100 Feet
Kenosha	6.4	1.6	0.8	0.0	0.0
Milwaukee	7.6	0.0	0.0	0.0	0.0
Ozaukee	14.8	4.1	0.8	0.0	0.0
Racine	2.7	1.2	0.5	0.1	0.0
Walworth	13.9	2.4	0.7	0.0	0.0
Washington	10.2	3.2	1.0	0.0	0.0
Waukesha	8.2	2.3	1.0	0.0	0.0

[a]*Results are from Layer 1 in the groundwater simulation model.*

Source: U.S. Geological Survey.

0.1 foot for cells showing drawups in Walworth and Washington County, to 1.4 foot for cells showing drawups in Ozaukee County. Maximum simulated drawups in this aquifer range from about four feet in Washington County to about 38 feet in Waukesha County. While model cells showing simulated drawups in the glacial aquifer were distributed throughout the Region, areas that contain a high proportion of cells showing drawups greater than one foot were found primarily along the Milwaukee-Ozaukee county line and in central and eastern Waukesha County as shown on Map 94.

Table 123 presents a summary of simulated drawdowns and drawups in the Silurian aquifer over the period 2005 to 2035. The percentage of cells in the model showing drawdowns over 2005 levels ranges from about 9 percent in Milwaukee County, to about 85 percent in Ozaukee County. With one exception—Ozaukee County—average drawdowns projected in this aquifer are relatively small, ranging from about 0.6 foot for cells showing drawdowns in Milwaukee County, to about 1.7 feet for cells showing drawdowns in Waukesha County. As already

Table 123

AVERAGE AND MAXIMUM SIMULATED DRAWDOWN AND DRAWUP IN THE SILURIAN AQUIFER UNDER ALTERNATIVE PLAN 3 CONDITIONS: 2005-2035[a]

County	Drawdown			Drawup		
	Percent of Model Cells	Average (feet)	Maximum (feet)	Percent of Model Cells	Average (feet)	Maximum (feet)
Kenosha	39.3	0.9	29.6	60.7	0.6	19.8
Milwaukee	8.9	0.6	1.6	91.1	2.6	72.2
Ozaukee	84.6	13.3	144.4	15.4	29.8	70.2
Racine	17.3	1.6	62.5	82.8	0.6	26.8
Walworth	62.7	1.0	30.8	37.3	0.2	5.2
Washington	56.2	1.4	27.6	43.8	1.7	66.2
Waukesha	27.5	1.7	38.4	72.5	1.9	76.1

[a]*Results are from Layer 5 in the groundwater simulation model.*

Source: U.S. Geological Survey.

Table 124

SIMULATED DRAWDOWN IN THE SILURIAN AQUIFER UNDER ALTERNATIVE PLAN 3 CONDITIONS: 2005-2035[a]

County	Percent of Model Cells Showing Drawdown Beyond Greater than:				
	One Foot	Five Feet	10 Feet	50 Feet	100 Feet
Kenosha	7.6	1.6	0.6	0.0	0.0
Milwaukee	1.9	0.0	0.0	0.0	0.0
Ozaukee	77.8	47.0	29.0	5.4	0.5
Racine	3.5	1.2	0.6	0.1	0.0
Walworth	14.0	2.4	0.8	0.0	0.0
Washington	16.6	3.7	1.1	0.0	0.0
Waukesha	10.0	2.4	0.8	0.0	0.0

[a]*Results are from Layer 5 in the groundwater simulation model.*

Source: U.S. Geological Survey.

noted, the small average drawdown in this aquifer over most of the Region reflects, in part, the damping effect that surface waters have on changes in the shallow groundwater system and the effects of enhanced recharge to the shallow groundwater system.

Maximum drawdowns projected for the Silurian aquifer are considerably higher than the average drawdowns, ranging from about 1.6 feet for cells showing drawdowns in Milwaukee County, to about 144 feet for cells showing drawdowns in Ozaukee County. Table 124 summarizes the variation among the model cells in terms of the percentage of cells showing simulated drawdowns over the period 2005 to 2035 greater than the given thresholds. In most of the Region, drawdowns greater than 10 feet are relatively rare in the Silurian aquifer under Alternative Plan 3 conditions. Fewer than 2 percent of cells in Kenosha, Milwaukee, Racine, Walworth, Washington, and Waukesha Counties indicated drawdowns in excess of 10 feet. Drawdowns in excess of 10 feet were more common in Ozaukee County, representing about 29 percent of cells in this County. Model cells showing simulated drawdowns were distributed throughout the Region; however, there were areas showing a high proportion of cells with drawdowns greater than one foot. These areas include western Kenosha County, northern and central portions of Ozaukee County, north-central Milwaukee County, southern Racine County, central and western Walworth County, and central and north-central Washington County. Areas with high proportions of cells showing drawdowns greater than one foot were also scattered throughout Waukesha County.

Table 123 also summarizes simulated drawups in the Silurian aquifer over the period 2005 to 2035. The percentage of cells in the model showing drawups over 2005 levels ranges from about 15 percent in Ozaukee County to about 91 percent in Milwaukee County. With one exception—Ozaukee County—average drawups projected in this aquifer are relatively small, ranging from about 0.2 foot for cells showing drawups in Walworth County to about 2.6 feet for cells showing drawups in Milwaukee County. Maximum simulated drawups in this aquifer range from about five feet in Walworth County to about 76 feet in Waukesha County. In most of the Region, drawups greater than 10 feet are relatively rare in the Silurian aquifer under Alternative Plan 3 conditions. Fewer than 5 percent of cells in Kenosha, Racine, Walworth, Washington, and Waukesha Counties showed drawups in excess of 10 feet. Drawups in excess of 10 feet were more common in Milwaukee and Ozaukee Counties, representing about 6 percent and 29 percent respectively of cells in these Counties. While model cells showing simulated drawups in the Silurian aquifer were distributed throughout the Region, areas showing a high proportion of cells with drawups greater than one foot were found in southern Ozaukee County, in northern Milwaukee County along the Milwaukee-Ozaukee county line, in southeastern Washington County, and in eastern Waukesha County. Much of the simulated drawup in southern Ozaukee and northern Milwaukee Counties may be attributable to the shift of the source of water supply in Mequon in areas served by a public sanitary sewer system from private wells to Lake Michigan under Alternative Plan 3. Smaller areas showing a high proportion of cells with drawups greater than one foot were found in northwestern Racine County and in eastern Racine and Kenosha Counties.

Water Budget Analysis

Table 125 shows results by County from a water budget analysis for the shallow groundwater system under Alternative Plan 3 conditions. This analysis derived the anticipated values of three groundwater performance indicators—the demand to supply ratio, the human influence ratio, and the baseflow reduction index—under Alternative Plan 3 conditions for the years 2005 and 2035. The analysis indicates that in 2005 the demand to supply ratio would range from about 0.05 in Walworth County to about 0.20 in Ozaukee County under Alternative Plan 3 conditions. The analysis projects that in 2035 this indicator would range from about 0.06 in Racine County to about 0.15 in Ozaukee County under Alternative Plan 3 conditions. While under these conditions increases in this indicator are projected to occur in Kenosha, Racine, Walworth, and Waukesha Counties, all values of the demand to supply ratio for the shallow aquifer are projected to be well below 1.0, indicating little evidence of a water budget deficit in the shallow aquifer.

The analysis also indicates that in 2005 the human impact ratio would range from about minus 0.19 in Ozaukee County to about minus 0.04 in Walworth County under Alternative Plan 3 conditions, and projects that in 2035 this indicator would range from about minus 0.14 in Ozaukee County to about minus 0.06 in Racine County under Alternative Plan 3 conditions. These values suggest that the net effect of human activities under these conditions would be to remove water from the shallow groundwater system. In Kenosha, Racine, Walworth, and Waukesha Counties, the projected values of this indicator for 2035 are lower than the 2005 values, indicating that the influence of human withdrawals on the water budget of the shallow groundwater would be expected to increase in these Counties under Alternative Plan 3 conditions. In Milwaukee, Ozaukee, and Washington Counties, the projected values of this indicator for 2035 are higher than the 2005 values, indicating a reduction in the influence of human withdrawals on the water budget of the shallow groundwater system would be expected in these Counties under Alternative Plan 2 conditions. Despite this anticipated reduction, under these conditions the shallow groundwater systems in Milwaukee and Ozaukee Counties are anticipated to remain more heavily influenced by human activities in 2035 than those in most of the other counties in the Region.

Table 125

PROJECTED GROUNDWATER PERFORMANCE INDICATORS FOR THE GLACIAL SAND AND GRAVEL AND SILURIAN DOLOMITE AQUIFERS UNDER 2005 AND 2035 ALTERNATIVE PLAN 3 CONDITIONS

County	Demand to Supply Ratio[a]		Human Influence Ratio[b]		Baseflow Reduction[c] from 2000 Levels (percent)
	2005	2035	2005	2035	2035
Kenosha	0.047	0.087	-0.047	-0.084	-4.6
Milwaukee	0.159	0.131	-0.150	-0.127	3.0
Ozaukee	0.199	0.154	-0.188	-0.142	6.8
Racine	0.061	0.064	-0.060	-0.063	-0.5
Walworth	0.045	0.079	-0.044	-0.077	-4.1
Washington	0.083	0.073	-0.081	-0.068	1.2
Waukesha	0.089	0.123	-0.086	-0.114	-3.0

[a]*The demand to supply ratio is defined as the ratio of net pumping demand on an aquifer to the amount of water that is replenished at a given point in time. Generally, this indicator ranges from 0—representing no human impact—upward. Values over 1.0 indicate that more groundwater is being extracted than can be replaced in a long-term, sustainable fashion. The year 2005 and 2035 conditions for this indicator are compared to predevelopment conditions.*

[b]*The human impact ratio, is defined as the ratio of human-induced groundwater inflows to total inflows minus the ratio of human-induced groundwater outflows to total outflows. This indicator is an expression of the relative magnitude of human alteration of the groundwater system. Values range from minus 1.0 in areas where wells have become the only discharge from an aquifer by stopping all other groundwater discharges, through 0 representing no net human impact, to plus 1.0 representing situations where human additions are the only inputs to the aquifer. The year 2005 and 2035 conditions for this indicator are compared to predevelopment conditions.*

[c]*The base flow reduction index is defined as the ratio of the change in groundwater-derived baseflow discharge due to pumping to the groundwater-derived baseflow at a defined base time. The year 2005 and 2035 conditions for this indicator are compared to predevelopment conditions.*

Source: University of Wisconsin-Milwaukee.

Finally, the analysis indicates that in 2035 the baseflow reduction index would range from about minus 4.6 percent in Kenosha County to 6.8 percent in Ozaukee County. Under Alternative Plan 3 conditions, the value of the baseflow reduction indices in Kenosha, Racine, Walworth, and Waukesha Counties in 2035 are all anticipated to be less than zero, indicating that reductions in average groundwater-derived baseflow to surface waters may be expected. The positive value of the indicator in Milwaukee, Ozaukee, and Washington Counties indicates that the average level of groundwater-derived baseflow to surface waters in these Counties may be expected to increase under Alternative Plan 3 conditions. It should be noted that these are countywide averages developed for purposes of comparing alternative plans at the systems level of planning. Within any county, changes in baseflow may be expected to vary among waterbodies. It should be noted that a change in baseflow does not indicate a change in total streamflow. The index only considers the groundwater component of streamflow. The impact on streamflow will typically be less in terms of percent reduction or increase. For those streams which receive discharges of sewage treatment plant effluent, the baseflow and streamflow amounts will be artificially increased and make surface water flows less sensitive to changes in groundwater-derived baseflow. Finally, it should be noted that for all seven Counties, the 2005 and 2035 magnitudes of average baseflow reduction under Alternative Plan 3 conditions are less than 10 percent, suggesting small average reductions relative to 2005 conditions.

Other Surface Water Impacts

In Alternative Plan 3, the source of supply used by several utilities located east of the subcontinental divide that have sewage treatment and conveyance services provided by the MMSD would be shifted from groundwater as a source to Lake Michigan water. This would result in a reduction in the hardness of the water provided by these utilities and would eliminate the need for water softening by these utilities’ customers. This would also result in reductions in the concentration of chloride in the sewage conveyed to the MMSD treatment facilities and in the chloride loads discharged by these facilities to Lake Michigan. For example, a reduction in the average concentration of chloride in sewage conveyed to the MMSD treatment facilities from these communities of 100 mg/l would result in an annual reduction in chloride discharge to Lake Michigan of about 3.8 million pounds. Given that the average concentrations of chloride in the effluent discharged by municipal wastewater treatment plants located west of the subcontinental divide that treat wastewater from communities using groundwater as a source of supply for which data were available ranged between 400 and 550 mg/l, it is likely that reductions in chloride loading to Lake Michigan on this order of magnitude may be expected under Alternative Plan 3 conditions.

Under Alternative Plan 3, about 11 mgd of wastewater treatment plant effluent from four facilities that currently discharge to surface waters would be infiltrated into the shallow groundwater system. This may be expected to reduce loadings of some pollutants on the streams currently receiving treated wastewater from these facilities. For example, average concentrations of total phosphorus, ammonia-nitrogen, and chloride in treated effluent discharged by the City of Waukesha sewage treatment plant are almost twice the ambient concentrations reported in the Fox River at CTH I, a sampling station located downstream from the Waukesha treatment plant. On an annual basis, infiltration of five million gallons per day of treated effluent from this facility, as envisioned under Alternative Plan 3, would reduce direct loadings of these pollutants to the Fox River by about 3,000 pounds, 1,500 pounds, and 6,400,000 pounds per year, respectively. While some of this pollutant load may ultimately reach the Fox River indirectly through groundwater flow and discharge to the River in baseflow, a reduction in the pollutant contribution to the River is likely to occur both because under Alternative Plan 3 the infiltrated effluent would be subject to a higher level of treatment than the effluent currently being discharged to the River, and because some of this load is likely to be contributed to groundwater.

For most other utilities, Alternative Plan 3 generally makes use of expanded sources of groundwater that are similar to the existing sources. Because of this, it is anticipated that this alternative will produce few changes in surface water quality within the Region, other than those described above and those associated with changes in groundwater-derived baseflows previously noted.

Conclusions of Groundwater and Surface Water Impacts of Alternative Plan 3

The results of the simulation modeling indicate that under Alternative Plan 3 conditions, drawups in the deep aquifer may be expected to occur in almost all model cells in the Region, except for cells in western Walworth County. The magnitude of the average drawups over 2005 conditions in this aquifer may be expected to range between 14 feet and 212 feet by county. The maximum drawup over 2005 conditions in this aquifer may be expected to be about 415 feet in the vicinity of the center of the Waukesha-Milwaukee county line. In all Counties of the Region, except for Kenosha and Walworth Counties, drawups over 2005 conditions in excess of 100 feet may be expected to be common. In addition, in Milwaukee and Waukesha Counties, drawups over 2005 conditions in excess of 200 feet may be expected to be common. While some of these drawups reflect the shift from the use of groundwater as a source of water supply to the use of Lake Michigan by some communities and a shift by some communities from the deep groundwater system as a source of water supply to the shallow groundwater system as envisioned under Alternative Plan 3, the locations of the greatest drawups suggest that enhanced recharge provided to the deep aquifer by the injection wells envisioned in Alternative Plan 3 is also a major factor in producing these drawups. Some additional drawdowns may be expected to occur in some model cells in Walworth County over the planning period under Alternative Plan 3 conditions. The magnitude of the average drawdown over 2005 conditions in this aquifer may be expected to be less than one foot and the maximum drawdown over 2005 conditions in this aquifer may be expected to be about seven feet. The drawdowns expected in Walworth County and the smaller drawups expected in Kenosha and Walworth Counties are due, in part, to the influence of groundwater use in northeastern Illinois. In addition, these areas are also located a considerable distance from the communities whose source of water supply is envisioned to change from the deep aquifer to Lake Michigan under Alternative Plan 3. Water budget analyses indicate that the deep groundwater system is likely to be heavily influenced by human activities under Alternative Plan 3 conditions. In most of the Region, the net effect of human activities is likely to be removal of water from the deep groundwater system. This analysis also indicates that Racine County may experience a water budget deficit in the deep aquifer under Alternative Plan 3 conditions.

On a Regional scale, simulated pumpage under Alternative Plan 3 conditions may be expected to increase 15.7 mgd to about 92.5 mgd between 2005 and 2035. The model indicates that under Alternative Plan 3 conditions that a net percentage of about 47 percent of this extracted water was derived directly from surface water features due to reversed hydraulic gradients at the groundwater-surface water interface. The remaining 53 percent of this extracted water was derived from other sources with the enhanced recharge envisioned in Alternative Plan 3 being the dominant source. The impact of pumping on surface waters can be represented as groundwater-derived baseflow depletion. Groundwater-derived baseflow is the amount of flow in the waterbody from upgradient groundwater discharge. The overland component of total streamflow and any discharge of treated wastewater are not included in baseflow, and the simulation modeling results do not include, or account for, these components. Typically baseflow represents about 10 percent to 50 percent of streamflow on an annual basis. In aggregate, by 2035 surface waterbodies in the Region may be expected to experience a baseflow depletion relative to 2005 conditions of about 6.2 mgd, or slightly less than 2 percent. On average, baseflow reductions under Alternative Plan 3 conditions are less than or slightly over 4 percent, suggesting small average reductions relative to 2005 conditions. On average, some Counties experience augmentations in baseflow. This aggregate total and average, however, obscure differences in baseflow changes among sites within each county. While the county totals project overall depletions or augmentations within each county, individual waterbodies may experience either depletion or augmentation. The reductions in groundwater-derived baseflow at 16 of 100 surface water evaluation sites were in excess of 10 percent.

The results of the simulation indicate that under Alternative Plan 3 conditions, additional drawdowns over 2005 conditions may be expected to occur in the shallow aquifer over much of the Region. The magnitude of the drawdowns is estimated to be relatively small; in most Counties, the drawdown may be expected to average less than 1.7 feet. The relatively small magnitude of the drawdown may be attributed, in part, to the buffering effects of surface water baseflow interactions.

In the glacial sand and gravel aquifer, additional drawdowns may be expected to occur in 27 percent to 67 percent of model cells by county over the period 2005 to 2035. The magnitude of average drawdowns over 2005 conditions in this aquifer may be expected to be small, less than 1.5 feet in all counties of the Region. While the maximum drawdown over 2005 conditions in this aquifer may be expected to be about 77 feet, only a small percentage of model cells were simulated to experience drawdowns over 2005 conditions in excess of 10 feet. With some exceptions, similar impacts were simulated to occur in the Silurian dolomitic aquifer. Additional drawdowns may be expected to occur in this aquifer in 9 percent to 85 percent of model cells by county over the planning period. While the maximum drawdown over 2005 conditions in this aquifer was simulated to be about 144 feet, only a small percentage of model cells in most counties were simulated to experience drawdowns over 2005 conditions in excess of 10 feet. Water budget analyses indicate that in most counties of the Region, the influence of human activities on the shallow groundwater system will increase under Alternative Plan 3 conditions. In those counties in which the influence of human activities are expected to decrease, the shallow groundwater system will remain heavily influenced by human activities. While the net effect of human activities in all counties of the Region will result in the removal of water from the shallow groundwater system, there is little evidence that a water budget deficit will occur where more groundwater will be extracted than can be replaced in a long-term sustainable fashion in the shallow groundwater system. This is likely due, in large part, to the buffering effects of surface waters. In addition, some buffering effects are provided by the enhanced groundwater recharge component envisioned in this alternative.

Although the results of the simulation indicate that the changes in the shallow aquifer system are expected to be relatively small in much of the Region under Alternative Plan 3 conditions, some larger changes may be expected to occur. Most of central and northern Ozaukee County may be expected to experience additional drawdowns in the Silurian dolomitic aquifer, in excess of 10 feet in much of the County and in excess of 50 feet in other locations. These drawdowns appear to result, at least in part, from both the continued reliance upon the shallow groundwater system as a major source of water supply in much of this County, and the addition of five shallow municipal wells that are envisioned in Alternative Plan 3. By contrast, the model results indicate that large drawups may be expected to occur in the Silurian dolomitic aquifer under Alternative Plan 3 conditions in southern Ozaukee and northern Milwaukee Counties. These drawups may be attributed to the shift in the source of water supply to Lake Michigan as envisioned under Alternative Plan 3. In addition, the model results indicate that drawups may be expected to occur in the Silurian dolomitic aquifer in southeastern Washington County and eastern Waukesha County. These drawups may be attributed to the shift in source of water supply to Lake Michigan.

Plan Description—Alternative Plan 4: Further Expansion of Lake Michigan Supply
Alternative Plan 4 is similar to Alternative Plan 2, but includes an expanded use of Lake Michigan as a source of supply. This alternative assumes that additional utilities within the Region lying east of the subcontinental divide, consisting of the City of Cedarburg Light & Water Commission; the Village of Fredonia Municipal Water Utility; the Village of Grafton Water and Wastewater Commission; and the Village of Saukville Municipal Water Utility; and selected utilities either straddling or located west of the subcontinental divide, including the western portion of the City of Brookfield Water Utility service area; the western portion of the Village of Menomonee Falls Water Utility service area; the Town of Brookfield Sanitary District No. 4; and the Village of Union Grove Water Utility—all of which are classified under the Great Lakes-St. Lawrence River Water Resource Compact as being part or all of a “straddling community”—would be provided with Lake Michigan water. In addition, the City of Waukesha Water Utility, the City of Pewaukee Water Utility, the Village of Pewaukee Water Utility, the Village of Sussex Water Utility, and the Village of Lannon, all of which are classified under the Compact as communities within a straddling county, would be provided with Lake Michigan water. The additional utility service areas assumed to be served by Lake Michigan as a source of supply under Alternative Plan 4 were delineated based upon consideration of a number of factors, including existing infrastructure capacity, aquifer characteristics, and location in relation to potential Lake Michigan sources of supply. The selected additional areas would be provided with Lake Michigan supply in a manner consistent with the proposed Great Lakes-St. Lawrence River Basin Water Resources Compact. Alternative Plan 4 will includes the following components:

- All of the components included under Alternative Plan 2, except as noted in the following component;

- Provision of Lake Michigan water supply to selected utilities or portions of utility service areas located both east and west of the subcontinental divide in a manner consistent with the Great Lakes-St. Lawrence River Water Resources Compact. This alternative envisions that the following additional utilities would be provided with Lake Michigan water:

  — Utilities lying east of the subcontinental divide:

    – City of Cedarburg Light & Water Commission,

    – Village of Fredonia Municipal Water Utility,

    – Village of Grafton Water and Wastewater Commission, and

    – Village of Saukville Municipal Water Utility.

  — Utilities or communities lying west of, or straddling, the subcontinental divide:

    – Western portion of the City of Brookfield Water Utility,

    – Western portion of the Village of Menomonee Falls Water Utility,

    – Town of Brookfield Sanitary District No. 4,

– Village of Union Grove Water Utility,

– City of Waukesha Water Utility,

– City of Pewaukee Water Utility,

– Village of Pewaukee Water Utility,

– Village of Sussex Water Utility, and

– Village of Lannon.

Two subalternatives were developed for this alternative plan that address the return flow requirements for communities which do not currently have, or are not projected to have, a return flow component via a sanitary sewerage connection to a system discharging treated wastewater to Lake Michigan or its tributaries. These include the City of Pewaukee Utility; the City of Waukesha Water Utility; the western portion of the City of Brookfield Water Utility; the Village of Pewaukee Water Utility; the Village of Sussex Water Utility; and the Town of Brookfield Sanitary District No. 4. Under the first subalternative, wastewater treatment plant effluent from these utility service areas equal in volume to at least the amount of water to be provided from Lake Michigan would be conveyed back to Lake Michigan via a pipeline, or pipelines, discharging directly to the Lake. Under the second subalternative, wastewater treatment plant effluent from these utility service areas would be conveyed by a pipeline, or pipelines, discharging to streams tributary to Lake Michigan. It is recognized that there may be other options for providing the needed return flow, such as through the diversion to the Lake Michigan basin of stormwater runoff generated in the Mississippi River basin and increases in stormwater runoff generated within the Lake Michigan basin itself, which could be considered under subsequent second-level planning.

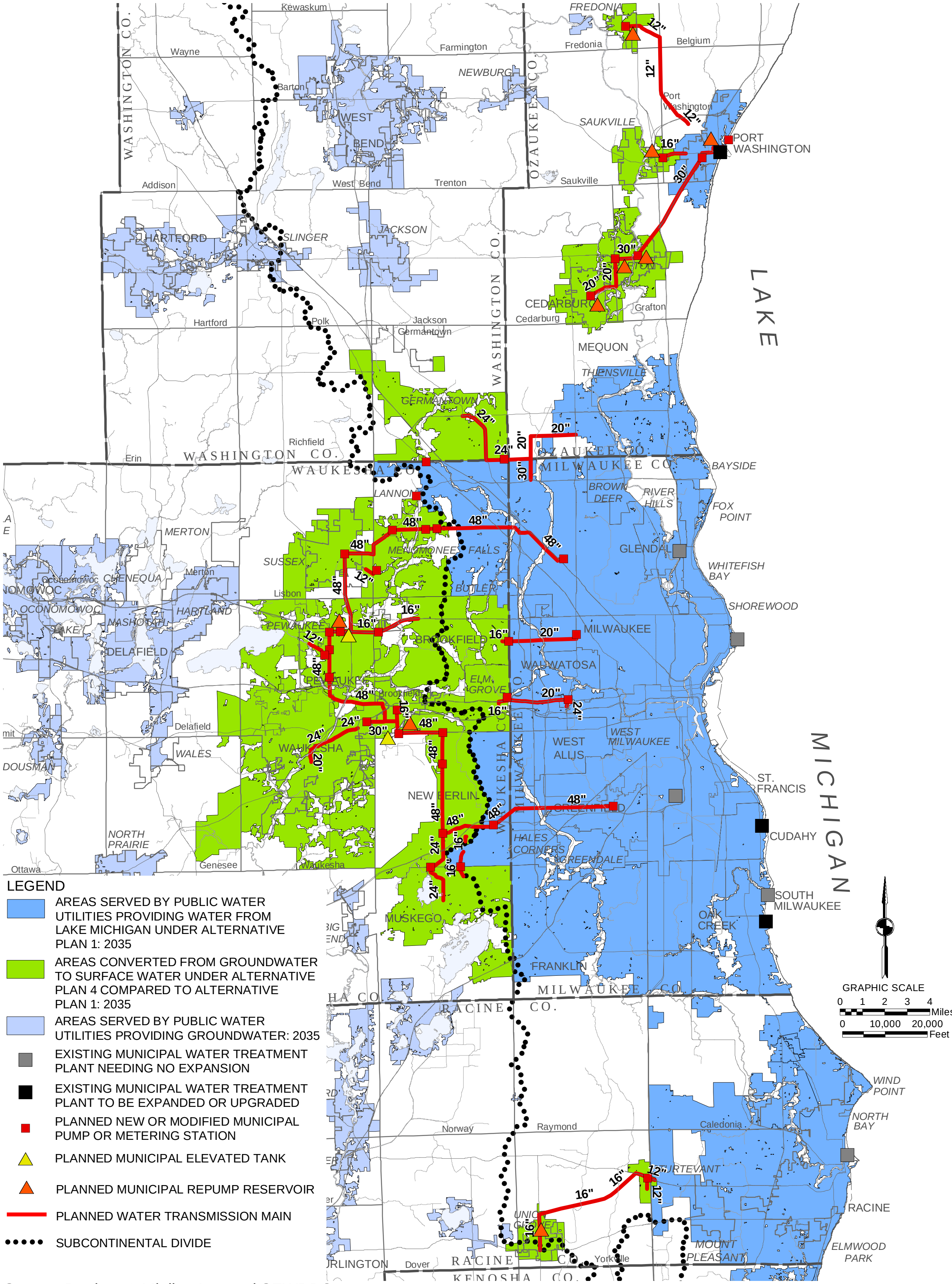
With regard to the alternative plan element providing for Lake Michigan as a source of supply for the selected additional utilities noted above, four subalternatives were considered in order to describe a range of potential means and costs to carry out that element. The four subalternatives are depicted on Maps 96, 97, 98, and 99, and the components and costs of each subalternative are summarized in Tables 126, 127, 128, and 129.

Subalternative 1 for the provision of Lake Michigan water supplies to additional areas under Alternative Plan 4 provides for a direct water supply from the Milwaukee Water Works to the Village of Germantown Water Utility, the City of Brookfield Municipal Water Utility, the City of New Berlin Water Utility, the City of Muskego Public Water Utility, the City of Pewaukee Water Utility, the City of Waukesha Water Utility, the Village of Pewaukee Water Utility, the Village of Elm Grove, and the Town of Brookfield Sanitary District No. 4. The City of Port Washington would, by direct connection, provide the water supply to the City of Cedarburg Light & Water Commission, the Village of Grafton Water and Wastewater Commission, the Village of Fredonia Municipal Water Utility, and the Village of Saukville Municipal Water Utility. The City of Racine Water and Wastewater Utility would, also by direct connection, provide the water supply to the Town of Yorkville Utility District No. 1 and the Village of Union Grove Municipal Water Utility. Subalternative 1 for the provision of Lake Michigan water is shown on Map 96 and the components and costs are summarized in Table 126. Subalternative 1 has an estimated capital cost of about $263.1 million and an annual operation and maintenance cost of about $3.2 million. Based upon an analysis period of 50 years and an annual interest rate of 6 percent, the estimated present worth cost of this option is about $325.6 million and the equivalent annual cost is $20.7 million.

Subalternative 2 for the provision of Lake Michigan water supplies to additional areas under Alternative Plan 4 provides for a direct connection from the Milwaukee Water Works to the same utilities as under Subalternative 1, except for the City of Muskego Public Water Utility. That utility would be provided with water supply from the City of Oak Creek Water Utility through the City of Franklin water supply system. The City of Cedarburg Light & Water Commission and the Village of Grafton Water and Wastewater Commission would develop a new Lake Michigan water treatment plant to serve both utilities. The City of Port Washington Water Utility would, by direct connection, serve the Village of Fredonia Municipal Water Utility and the Village of Saukville Municipal Water Utility. The City of Racine Water and Wastewater Utility would, by direct connection, provide the water supply

Map 96

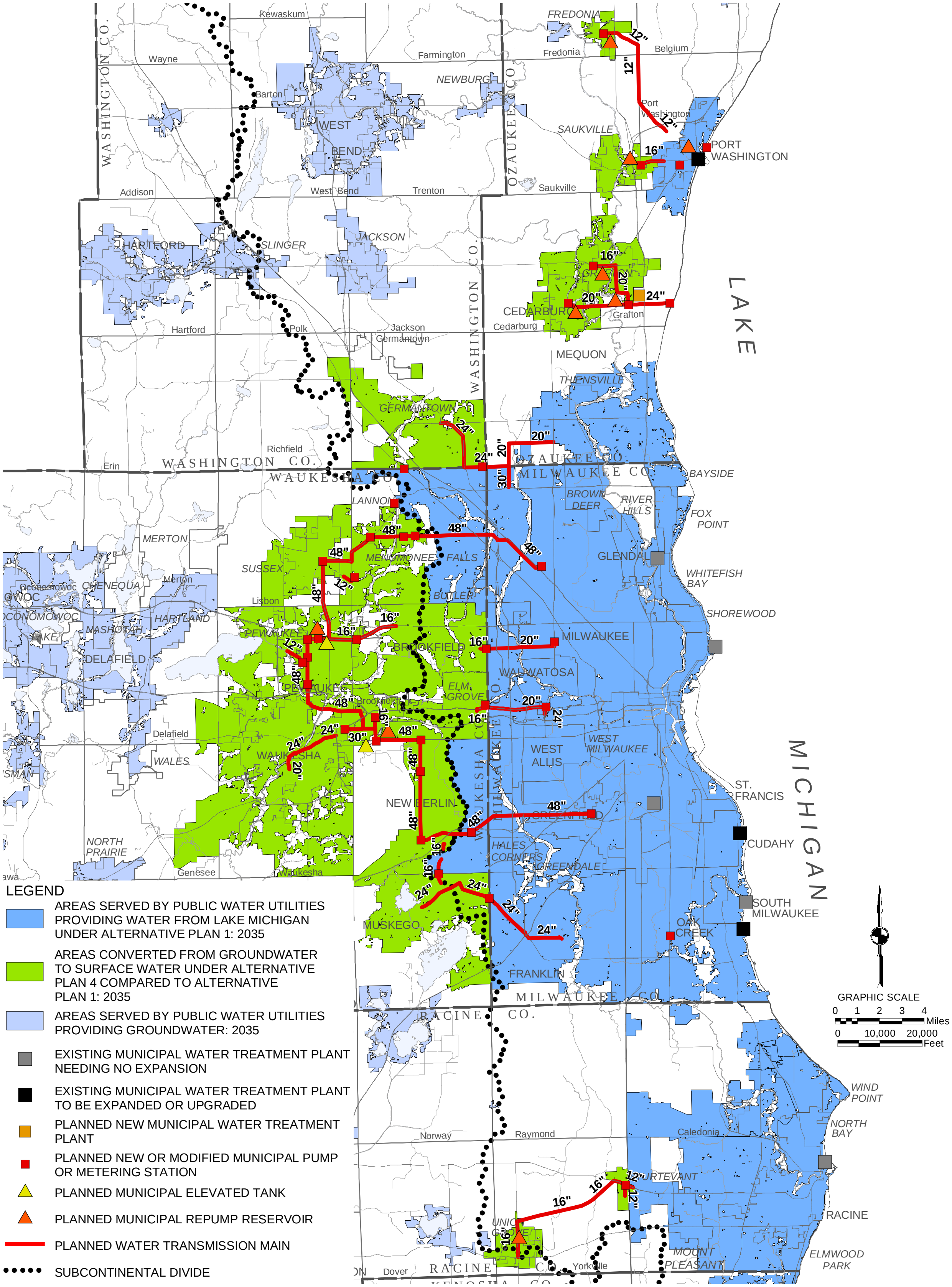
SUBALTERNATIVE 1 FOR NEW LAKE MICHIGAN SUPPLY COMPONENT FOR ALTERNATIVE PLAN 4 FURTHER EXPANSION OF LAKE MICHIGAN SUPPLY



Source: Ruekert & Mielke, Inc. and SEWRPC.

Map 97

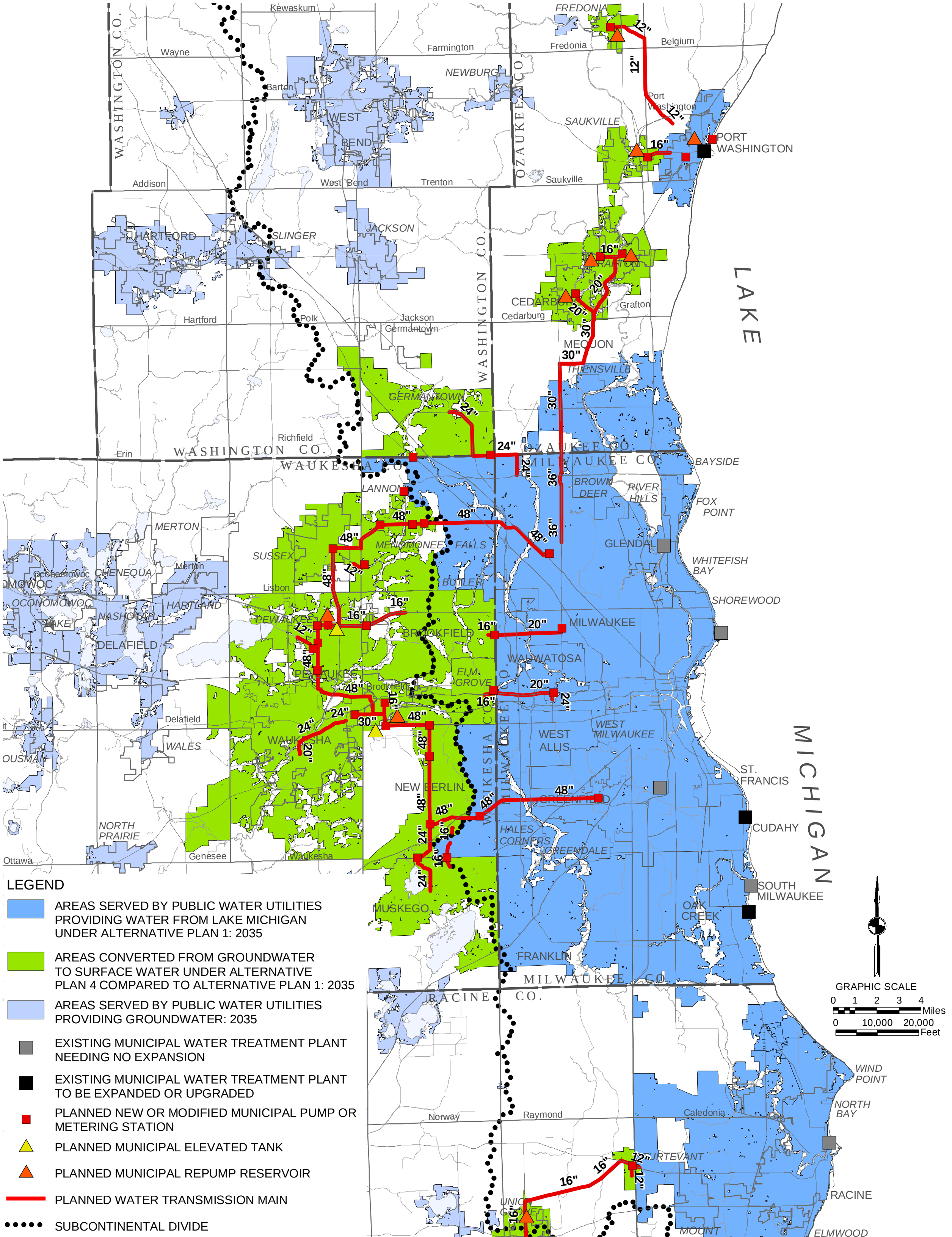
SUBALTERNATIVE 2 FOR NEW LAKE MICHIGAN SUPPLY COMPONENT FOR ALTERNATIVE PLAN 4 FURTHER EXPANSION OF LAKE MICHIGAN SUPPLY



Source: Ruekert & Mielke, Inc. and SEWRPC.

Map 98

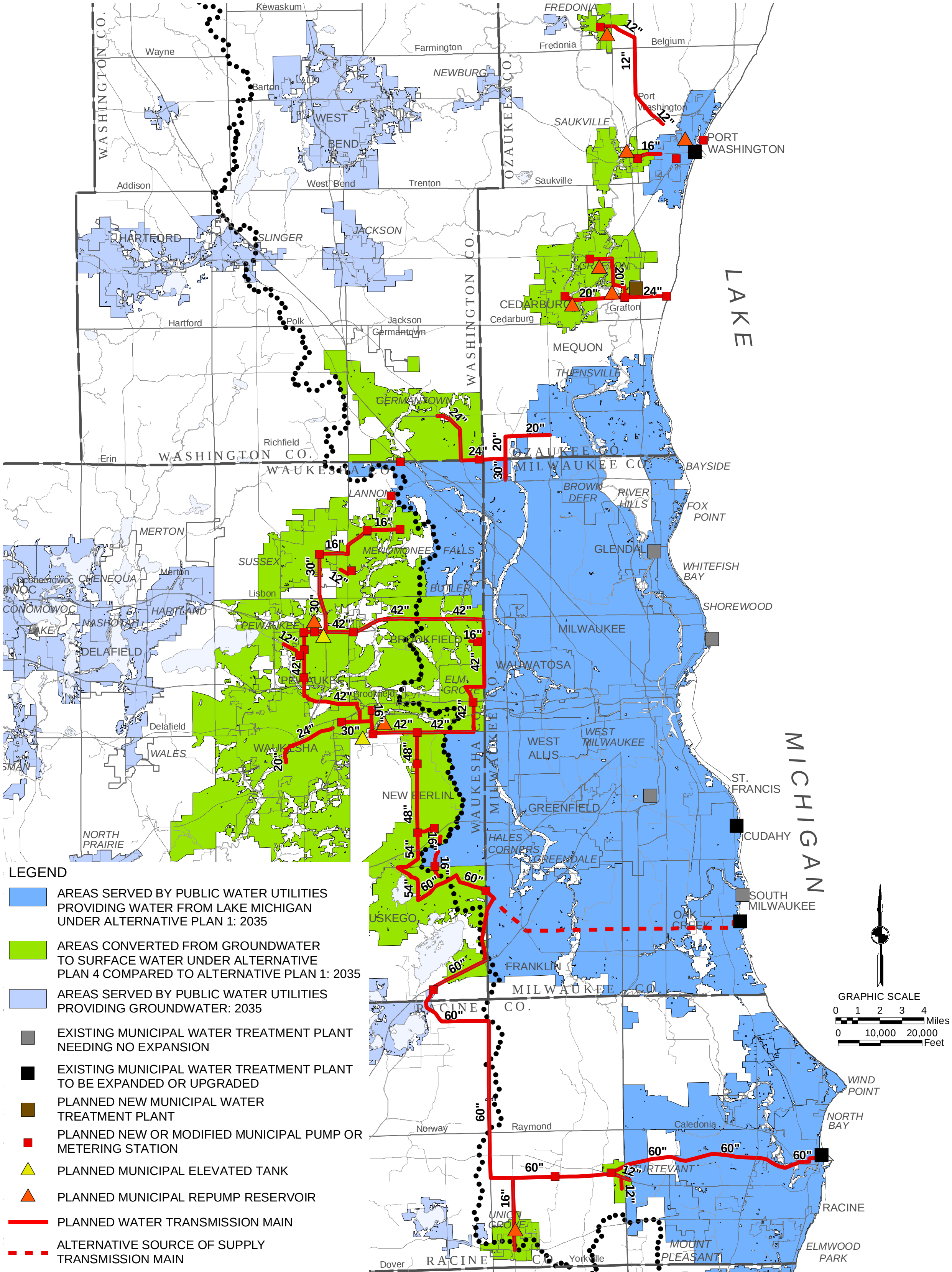
SUBALTERNATIVE 3 FOR NEW LAKE MICHIGAN SUPPLY COMPONENT FOR ALTERNATIVE PLAN 4 FURTHER EXPANSION OF LAKE MICHIGAN SUPPLY



Source: Ruekert & Mielke, Inc. and SEWRPC.

Map 99

SUBALTERNATIVE 4 FOR NEW LAKE MICHIGAN SUPPLY COMPONENT FOR ALTERNATIVE PLAN 4 FURTHER EXPANSION OF LAKE MICHIGAN SUPPLY



Source: Ruekert & Mielke, Inc. and SEWRPC.

Table 126

PRINCIPAL FEATURES AND COSTS OF NEW, EXPANDED, AND UPGRADED WATER SUPPLY FACILITIES AND PROGRAMS UNDER SUBALTERNATIVE 1 FOR THE NEW LAKE MICHIGAN SUPPLY COMPONENT OF ALTERNATIVE PLAN 4: DESIGN YEAR 2035 FORECAST CONDITIONS WITH FURTHER EXPANSION OF LAKE MICHIGAN SUPPLY

Utility	Project Description	Project Location	Capacity	Units	Unit Cost	Number of Units	Capital Cost	Total Capital Cost
Germantown	Pumping station-Milwaukee	Germantown	6.00	mgd	$ 1,535,718	1	$ 1,535,718	
	24-inch mains	Germantown	- -	Lineal feet	198	19,100	3,781,800	
	Pumping station-Menomonee Falls	Germantown	3.65	mgd	936,405	1	936,405	- -
	24-inch mains	Milwaukee County	- -	Lineal feet	198	4,200	831,600	
	30-inch mains (shared with Mequon)	Milwaukee County	- -	Lineal feet	168	5,300	890,400	
	Miscellaneous internal system upgrades	Milwaukee County	- -	- -	- -	- -	430,000[a]	
- -	- -	- -	- -	- -	- -	- -	$ 8,403,923	$ 8,403,923
Waukesha County Transmission Main Loop Facilities	Florist pumping station expansion	Milwaukee County	30.00	mgd	$ 3,169,988	1	$ 3,169,988	
	New SW zone pumping station	Milwaukee County	30.00	mgd	3,169,988	1	3,169,988	
	48-inch transmission main loop	Milwaukee and Waukesha Counties	- -	Lineal feet	428	197,300	84,444,400	
	Waukesha County pumping stations	Waukesha County	30.00	mgd	3,169,988	2	6,339,976	- -
	Elevated tanks	Waukesha County	2.00	MG	3,100,000	2	6,200,000	
	Repump storage facilities	Waukesha County	10.00	MG	5,640,000	2	11,280,000	
	Repump pumping stations	Waukesha County	15.00	mgd	2,320,084	2	4,640,168	
	Miscellaneous internal system upgrades	Milwaukee County	- -	- -	- -	- -	22,696,000[a]	
- -	- -	- -	- -	- -	- -	- -	$141,940,520	$141,940,520
City of Brookfield and Village of Elm Grove	Pumping station-Burleigh Road	City of Brookfield	3.50	mgd	$ 1,204,769	1	$ 1,204,769	
	Pumping station-Bluemound Road	City of Brookfield	2.50	mgd	1,035,386	1	1,035,386	
	Metering station-Capitol Drive	City of Brookfield	2.50	mgd	517,693	1	517,693	
	Metering station-Calhoun Road	City of Brookfield	2.20	mgd	488,734	1	488,734	
	Pumping station-Burleigh Road	Milwaukee County	3.50	mgd	1,204,769	1	1,204,769	- -
	Pumping station-Bluemound Road	Milwaukee County	3.50	mgd	1,035,386	1	1,035,386	
	16-inch mains	Waukesha County	- -	Lineal feet	173	21,100	3,650,300	
	24-inch mains	Milwaukee County	- -	Lineal feet	198	3,500	693,000	
	20-inch mains	Milwaukee County	- -		184	28,600	5,262,400	
	Miscellaneous internal system upgrades	Milwaukee County	- -	- -	- -	- -	2,048,000[a]	
- -	- -	- -	- -	- -	- -	- -	$17,140,437	$ 17,140,437
Town of Brookfield	Pumping station	Town of Brookfield	1.70	mgd	$ 870,324	1	$ 870,324	- -
	16-inch mains	Town of Brookfield	- -	Lineal feet	173	2,600	449,800	
- -	- -	- -	- -	- -	- -	- -	$ 1,320,124	$ 1,320,124
Waukesha	Metering station	Waukesha	13.50	mgd	$ 1,106,290	1	$ 1,106,290	
	24-inch mains	Waukesha	- -	Lineal feet	198	11,600	2,296,800	- -
	20-inch mains	Waukesha	- -	Lineal feet	184	6,800	1,251,200	
	30-inch mains	Waukesha	- -	Lineal feet	257	4,400	1,130,800	
- -	- -	- -	- -	- -	- -	- -	$ 5,785,090	$ 5,785,090

Table 126 (continued)

Utility	Project Description	Project Location	Capacity	Units	Unit Cost	Number of Units	Capital Cost	Total Capital Cost
New Berlin-Central	Pumping station-Glendale Drive Pumping station-Beloit Road 16-inch mains	New Berlin New Berlin New Berlin	2.35 2.35 - -	mgd mgd Lineal feet	$ 1,006,936 1,006,936 173	1 1 4,600	$ 1,006,936 1,006,936 795,800[a]	- -
- -	- -	- -	- -	- -	- -	- -	$ 2,809,672	$ 2,809,672
Muskego	Metering station-Small Road Pumping station-Moorland Road 24-inch mains 24-inch mains 16-inch mains	Muskego Muskego-New Berlin Muskego New Berlin Muskego	5.40 3.50 - - - - - -	mgd mgd Lineal feet Lineal feet Lineal feet	$ 732,279 1,204,769 198 198 173	1 1 10,000 9,300 2,400	$ 732,279 1,204,769 1,980,000 1,841,400 415,200[a]	- -
- -	- -	- -	- -	- -	- -	- -	$ 6,173,648	$ 6,173,648
Menomonee Falls-West	Pumping station-Town Hall Drive Pumping station-Silver Spring Drive	Menomonee Falls Menomonee Falls-Sussex	1.60 2.50	mgd mgd	$ 846,886 1,035,386	1 1	$ 846,886 1,035,386[a]	- -
- -	- -	- -	- -	- -	- -	- -	$ 1,882,272	$ 1,882,272
Lannon	Pumping station Pumping station	Lannon Lannon-Menomonee Falls	0.60 - -	mgd mgd	$ 544,517 453,646	1 1	$ 544,517 453,646[a]	- -
- -	- -	- -	- -	- -	- -	- -	$ 998,163	$ 998,163
Sussex	Pumping station	Sussex	3.70	mgd	$ 1,235,296	1	$ 1,235,296	$ 1,235,296
City of Pewaukee	Pumping station-Green Road Pumping station-Riverwood Drive	City of Pewaukee City of Pewaukee	2.50 2.50	mgd mgd	$ 1,035,386 1,035,386	1 1	$ 1,035,386 1,035,386[a]	- -
- -	- -	- -	- -	- -	- -	- -	$ 2,070,772	$ 2,070,772
Village of Pewaukee	Pumping station-Sunnyridge Road Pumping station-Wisconsin Avenue	Village of Pewaukee City and Village of Pewaukee	2.00 1.40	mgd mgd	$ 936,405 797,464	1 1	$ 936,405 797,464[a]	- -
- -	- -	- -	- -	- -	- -	- -	$ 1,733,869	$ 1,733,869
Yorkville U.D.1	20-inch mains	Racine County	- -	Lineal feet	$ 184	3,300	$ 607,200	$ 607,200
Union Grove	20-inch mains 16-inch mains Pumping station Repump reservoir	Racine to Yorkville Yorkville to Union Grove Union Grove Union Grove	- - - - 1.85 3.20	Lineal feet Lineal feet mgd MG	$ 184 173 904,102 3,156,000	3,600 33,800 1 1	$ 662,400 5,847,400 904,102 3,156,000	- -
- -	- -	- -	- -	- -	- -	- -	$10,569,902	$ 10,569,902

Table 126 (continued)

Utility	Project Description	Project Location	Capacity	Units	Unit Cost	Number of Units	Capital Cost	Total Capital Cost
Port Washington	Treatment plant expansion	Port Washington	12.00	mgd	$16,640,576	1	$16,640,576	
	Repump reservoir (clearwell)	Port Washington	2.00	MG	2,439,000	1	2,439,000	- -
	Pumping station	Port Washington	12.00	mgd	2,098,288	1	2,098,288	
- -	- -	- -	- -	- -	- -	- -	$21,177,864	$ 21,177,864
Fredonia	12-inch mains	Port Washington to Fredonia	- -	Lineal feet	$ 146	31,700	$ 4,628,200	
	Pumping station	Fredonia	0.85	mgd	636,982	1	636,982	- -
	Repump reservoir	Fredonia	1.20	MG	1,483,000	1	1,483,000	
- -	- -	- -	- -	- -	- -	- -	$ 6,748,182	$ 6,748,182
Saukville	16-inch mains	Port Washington to Saukville	- -	Lineal feet	$ 173	5,500	$ 951,500	
	Pumping station	Saukville	2.10	mgd	957,206	1	957,206	- -
	Repump reservoir	Saukville	1.60	MG	1,961,000	1	1,961,000	
- -	- -	- -	- -	- -	- -	- -	$ 3,869,706	$ 3,869,706
Grafton/ Cedarburg	30-inch mains	Port Washington to Grafton		Lineal feet	$ 257	40,600	$10,434,200	
	20-inch mains	Grafton to Cedarburg		Lineal feet	184	13,200	2,428,800	
	Pumping station	Grafton-East	2.00	mgd	936,405	1	936,405	
	Repump reservoir	Grafton-East	3.50	MG	3,448,000	1	3,448,000	- -
	Pumping station	Grafton-West	2.00	mgd	936,405	1	936,405	
	Repump reservoir	Grafton-West	3.50	MG	3,448,000	1	3,448,000	
	Pumping station	Cedarburg	3.00	mgd	1,123,977	1	3,371,932	
	Repump reservoir	Cedarburg	5.80	MG	3,650,000	1	3,650,000	
- -	- -	- -	- -	- -	- -	- -	$28,653,742	$ 28,653,742
- -	- -	- -	- -	- -	- -	- -	- -	$263,122,382

Present Worth of Capital Cost	$274,891,000
Total O&M Cost	$ 3,220,000
Present Worth of Total O&M Cost	$ 50,747,000
Total Present Worth Cost	$325,638,000
Equivalent Annual Cost	$ 20,662,000

[a]*Allowance of 25 percent to cover internal system improvements for the Milwaukee Water Works water supply system.*

Source: Ruekert & Mielke, Inc., and SEWRPC.

Table 127

PRINCIPAL FEATURES AND COSTS OF NEW, EXPANDED, AND UPGRADED WATER SUPPLY FACILITIES AND PROGRAMS UNDER SUBALTERNATIVE 2 FOR THE NEW LAKE MICHIGAN SUPPLY COMPONENT OF ALTERNATIVE PLAN 4: DESIGN YEAR 2035 FORECAST CONDITIONS WITH FURTHER EXPANSION OF LAKE MICHIGAN SUPPLY

Utility	Project Description	Project Location	Capacity	Units	Unit Cost	Number of Units	Capital Cost	Total Capital Cost
Germantown	Pumping station-Milwaukee	Germantown	6.00	mgd	$ 1,535,718	1	$ 1,535,718	
	24-inch mains	Germantown	- -	Lineal feet	198	19,100	3,781,800	
	Pumping station-Menomonee Falls	Germantown	2.00	mgd	936,405	1	936,405	- -
	24-inch mains	Milwaukee County	- -	Lineal feet	198	4,200	831,600	
	30-inch mains (shared with Mequon)	Milwaukee County	- -	Lineal feet	168	5,300	890,400	
	Miscellaneous internal system upgrades	Milwaukee County	- -	- -	- -	- -	430,000[a]	
- -	- -	- -	- -	- -	- -	- -	$ 8,403,923	$ 8,403,923
Waukesha County Transmission Main Loop Facilities	Florist pumping station expansion	Milwaukee County	30.00	mgd	$ 3,169,988	1	$ 3,169,988	
	New SW zone pumping station	Milwaukee County	30.00	mgd	3,169,988	1	3,169,988	
	48-inch transmission main loop	Milwaukee and Waukesha Counties	- -	Lineal feet	428	197,300	84,444,400	
	Waukesha County pumping stations	Waukesha County	30.00	mgd	3,169,988	2	6,339,976	- -
	Elevated tanks	Waukesha County	2.00	MG	3,100,000	2	6,200,000	
	Repump storage facilities	Waukesha County	10.00	MG	5,640,000	2	11,280,000	
	Repump pumping stations	Waukesha County	15.00	mgd	2,320,084	2	4,640,168	
	Miscellaneous internal system upgrades	Milwaukee County	- -	- -	- -	- -	22,696,000[a]	
- -	- -	- -	- -	- -	- -	- -	$141,940,520	$141,940,520
City of Brookfield and Village of Elm Grove	Pumping station-Burleigh Road	City of Brookfield	3.50	mgd	$ 1,204,769	1	$ 1,204,769	
	Pumping station-Bluemound Road	City of Brookfield	2.50	mgd	1,035,386	1	1,035,386	
	Metering station-Capitol Drive	City of Brookfield	2.50	mgd	517,693	1	517,693	
	Metering station-Calhoun Road	City of Brookfield	2.20	mgd	488,734	1	488,734	
	Pumping station-Burleigh Road	Milwaukee County	3.50	mgd	1,204,769	1	1,204,769	- -
	Pumping station-Bluemound Road	Milwaukee County	3.50	mgd	1,035,386	1	1,035,386	
	16-inch mains	Waukesha County	- -	Lineal feet	173	21,100	3,650,300	
	24-inch mains	Milwaukee County	- -	Lineal feet	198	3,500	693,000	
	20-inch mains	Milwaukee County	- -	- -	184	28,600	5,262,400	
	Miscellaneous internal system upgrades	Milwaukee County	- -	- -	- -	- -	2,048,000[a]	
- -	- -	- -	- -	- -	- -	- -	$17,140,437	$ 17,140,437
Town of Brookfield	Pumping station	Town of Brookfield	1.70	mgd	$ 870,324	1	$ 870,324	- -
	16-inch mains	Town of Brookfield	- -	Lineal feet	173	2,600	449,800	
- -	- -	- -	- -	- -	- -	- -	$ 1,320,124	$ 1,320,124
Waukesha	Metering station	Waukesha	13.50	mgd	$ 1,106,290	1	$ 1,106,290	
	24-inch mains	Waukesha	- -	Lineal feet	198	11,600	2,296,800	- -
	20-inch mains	Waukesha	- -	Lineal feet	184	6,800	1,251,200	
	30-inch mains	Waukesha	- -	Lineal feet	257	4,400	1,130,800	
- -	- -	- -	- -	- -	- -	- -	$ 5,785,090	$ 5,785,090

Table 127 (continued)

Utility	Project Description	Project Location	Capacity	Units	Unit Cost	Number of Units	Capital Cost	Total Capital Cost
New Berlin-Central	Pumping station-Glendale Drive	New Berlin	2.35	mgd	$ 1,006,936	1	$ 1,006,936	
	Pumping station-Beloit Road	New Berlin	2.35	mgd	1,006,936	1	1,006,936	- -
	16-inch mains	New Berlin	- -	Lineal feet	173	4,600	795,800	
- -	- -	- -	- -	- -	- -	- -	$ 2,809,672	$ 2,809,672
Muskego	Oak Creek Plant Expansion	Oak Creek	5.40	mgd	$ 4,617,000	1	$ 4,617,000	
	Pumping station-County Line	Muskego	5.40	mgd	1,464,559	1	1,464,559	
	Pumping station-Oak Creek	Oak Creek	5.40	Mgd	1,464,559	1	1,464,559	
	Pumping station-Moorland Road	Muskego-New Berlin	3.50	mgd	1,204,769	1	1,204,769	- -
	24-inch mains	Franklin	- -	Lineal feet	198	21,200	4,197,600	
	24-inch mains	Muskego	- -	Lineal feet	198	19,100	3,781,800	
	16-inch mains	Muskego	- -	Lineal feet	173	2,400	415,200	
- -	- -	- -	- -	- -	- -	- -	$ 17,145,487	$ 17,145,487
Menomonee Falls-West	Pumping station-Town Hall Drive	Menomonee Falls	1.60	mgd	$ 846,886	1	$ 846,886	- -
	Pumping station-Silver Spring Drive	Menomonee Falls-Sussex	2.50	mgd	1,035,386	1	1,035,386	
- -	- -	- -	- -	- -	- -	- -	$ 1,882,272	$ 1,882,272
Lannon	Pumping station	Lannon	0.60	mgd	$ 544,517	1	$ 544,517	- -
	Pumping station	Lannon-Menomonee Falls	0.40	mgd	453,646	1	453,646	
- -	- -	- -	- -	- -	- -	- -	$ 998,163	$ 998,163
Sussex	Pumping station	Sussex	3.70	mgd	$ 1,235,296	1	$ 1,235,296	- -
	12-inch mains	Sussex	- -	Lineal feet	146	1,400	204,400	
- -	- -	- -	- -	- -	- -	- -	$ 1,439,696	$ 1,439,696
City of Pewaukee	Pumping station-Green Road	City of Pewaukee	2.50	mgd	$ 1,035,386	1	$ 1,035,386	- -
	Pumping station-Riverwood Drive	City of Pewaukee	2.50	mgd	1,035,386	1	1,035,386	
- -	- -	- -	- -	- -	- -	- -	$ 2,070,772	$ 2,070,772
Village of Pewaukee	Pumping station-Sunnyridge Road	Village of Pewaukee	2.00	mgd	$ 936,405	1	$ 936,405	
	Pumping station-Wisconsin Avenue	City and Village of Pewaukee	1.40	mgd	797,464	1	797,464	- -
	12-inch mains	Village of Pewaukee	- -	Lineal feet	146	2,700	394,200	
- -	- -	- -	- -	- -	- -	- -	$ 2,128,069	$ 2,128,069
Yorkville U.D.1	12-inch mains	Racine County	- -	Lineal feet	139	3,300	$ 458,700	$ 458,700
Union Grove	20-inch mains	Racine to Yorkville	- -	Lineal feet	$ 184	3,600	$ 662,400	
	16-inch mains	Yorkville to Union Grove	- -	Lineal feet	173	33,800	5,847,400	- -
	Pumping station	Yorkville	1.85	mgd	904,102	1	904,102	
	Repump reservoir	Union Grove	3.20	MG	3,156,000	1	3,156,000	
- -	- -	- -	- -	- -	- -	- -	$10,569,902	$ 10,569,902

Table 127 (continued)

Utility	Project Description	Project Location	Capacity	Units	Unit Cost	Number of Units	Capital Cost	Total Capital Cost
Port Washington	Treatment plant expansion	Port Washington	4.00	mgd	$3,491,000	1	$3,491,000	
	Repump reservoir (clearwell)	Port Washington	1.00	MG	1,244,000	1	1,244,000	- -
	Pumping station	Port Washington	4.00	mgd	1,279,000	1	1,279,000	
- -	- -	- -	- -	- -	- -	- -	$6,014,000	$ 6,014,000
Fredonia	12-inch mains	Port Washington to Fredonia	- -	Lineal feet	$ 146	31,700	$ 4,628,200	
	Pumping station	Fredonia	0.85	mgd	636,982	1	636,982	- -
	Repump reservoir	Fredonia	1.20	MG	1,483,000	1	1,483,000	
- -	- -	- -	- -	- -	- -	- -	$ 6,748,182	$ 6,748,182
Saukville	16-inch mains	Port Washington to Saukville	- -	Lineal feet	$ 173	5,500	$ 951,500	
	Pumping station	Saukville	2.10	mgd	$957,206	1	957,206	
	Repump reservoir	Saukville	1.60	MG	$1,961,000	1	1,961,000	
- -	- -	- -	- -	- -	- -	- -	$ 3,869,706	$ 3,869,706
Grafton/ Cedarburg	24-inch raw water main	Lake Michigan to Grafton (east)	- -	Lineal feet	$ 198	10,000	1,980,000	
	20-inch mains	Grafton east to Cedarburg and Grafton	- -	Lineal feet	184	25,700	4,728,800	
	16-inch mains	Grafton to Cedarburg	- -	Lineal feet	173	5,300	$ 916,900	
	Intake	- -	9.00	mgd	2,250,000	1	2,250,000	
	Pumping station-raw water	- -	9.00	mgd	2,150,000	1	2,150,000	
	Treatment plant	Grafton (east)	9.00	mgd	23,292,000	1	23,292,000	- -
	Pumping station-distribution	Grafton (east)	9.00	mgd	1,843,339	1	1,843,339	
	Clear well	Grafton (east)	2.00	MG	2,439,122	1	2,439,122	
	Pumping station-Grafton	Grafton	2.50	mgd	1,035,386	1	1,035,386	
	Repump reservoir-Grafton	Grafton	2.50	mgd	3,036,822	1	3,036,822	
	Pumping station	Cedarburg	2.00	Mgd	936,405	1	936,405	
	Repump reservoir	Cedarburg	2.00	mgd	2,439,122	1	2,439,122	
- -	- -	- -	- -	- -	- -	- -	$47,047,986	$ 47,047,986
- -	- -	- -	- -	- -	- -	- -	- -	$277,774,611

Present Worth of Capital Cost	$291,095,000
Total O&M Cost	$ 3,613,000
Present Worth of Total O&M Cost	$ 56,941,000
Total Present Worth Cost	$348,036,000
Equivalent Annual Cost	$ 22,084,000

[a] *Allowance of 25 percent to cover internal system improvements for the Milwaukee Water Works water supply system.*

Source: Ruekert & Mielke, Inc., and SEWRPC.

Table 128

PRINCIPAL FEATURES AND COSTS OF NEW, EXPANDED, AND UPGRADED WATER SUPPLY FACILITIES AND PROGRAMS UNDER SUBALTERNATIVE 3 FOR THE NEW LAKE MICHIGAN SUPPLY COMPONENT OF ALTERNATIVE PLAN 4: DESIGN YEAR 2035 FORECAST CONDITIONS WITH FURTHER EXPANSION OF LAKE MICHIGAN SUPPLY

Utility	Project Description	Project Location	Capacity	Units	Unit Cost	Number of Units	Capital Cost	Total Capital Cost
Germantown	Pumping station-Milwaukee	Germantown	6.00	mgd	$ 1,535,718	1	$ 1,535,718	
	24-inch mains	Germantown	- -	Lineal feet	198	19,100	3,781,800	
	Pumping station-Menomonee Falls	Germantown	2.00	mgd	936,405	1	936,405	- -
	24-inch mains	Milwaukee County	- -	Lineal feet	198	4,200	831,600	
	30-inch mains (shared with Mequon)	Milwaukee County	- -	Lineal feet	168	5,300	890,400	
	Miscellaneous internal system upgrades	Milwaukee County	- -	- -	- -	- -	430,000[a]	
- -	- -	- -	- -	- -	- -	- -	$ 8,403,923	$ 8,403,923
Waukesha County Transmission Main Loop Facilities	Florist pumping station expansion	Milwaukee County	30.00	mgd	$ 3,169,988	1	$ 3,169,988	
	New SW zone pumping station	Milwaukee County	30.00	mgd	3,169,988	1	3,169,988	
	48-inch transmission main loop	Milwaukee and Waukesha Counties	- -	Lineal feet	428	197,300	84,444,400	
	Waukesha County pumping stations	Waukesha County	30.00	mgd	3,169,988	2	6,339,976	- -
	Elevated tanks	Waukesha County	2.00	MG	3,100,000	2	6,200,000	
	Repump storage facilities	Waukesha County	10.00	MG	5,640,000	2	11,280,000	
	Repump pumping stations	Waukesha County	15.00	mgd	2,320,084	2	4,640,168	
	Miscellaneous internal system upgrades	Milwaukee County	- -	- -	- -	- -	22,696,000[a]	
- -	- -	- -	- -	- -	- -	- -	$141,940,520	$141,940,520
City of Brookfield and Village of Elm Grove	Pumping station-Burleigh Road	City of Brookfield	3.50	mgd	$ 1,204,769	1	$ 1,204,769	
	Pumping station-Bluemound Road	City of Brookfield	2.50	mgd	1,035,386	1	1,035,386	
	Metering station-Capitol Drive	City of Brookfield	2.50	mgd	517,693	1	517,693	
	Metering station-Calhoun Road	City of Brookfield	2.20	mgd	488,734	1	488,734	
	Pumping station-Burleigh Road	Milwaukee County	3.50	mgd	1,204,769	1	1,204,769	- -
	Pumping station-Bluemound Road	Milwaukee County	3.50	mgd	1,035,386	1	1,035,386	
	16-inch mains	Waukesha County	- -	Lineal feet	173	21,100	3,650,300	
	24-inch mains	Milwaukee County	- -	Lineal feet	198	3,500	693,000	
	20-inch mains	Milwaukee County	- -	- -	184	28,600	5,262,400	
	Miscellaneous internal system upgrades	Milwaukee County	- -	- -	- -	- -	2,048,000[a]	
- -	- -	- -	- -	- -	- -	- -	$17,140,437	$ 17,140,437
Town of Brookfield	Pumping station	Town of Brookfield	1.70	mgd	$ 870,324	1	$ 870,324	- -
	16-inch mains	Town of Brookfield	- -	Lineal feet	173	2,600	449,800	
- -	- -	- -	- -	- -	- -	- -	$ 1,320,124	$ 1,320,124
Waukesha	Metering station	Waukesha	13.50	mgd	$ 1,106,290	1	$ 1,106,290	
	24-inch mains	Waukesha	- -	Lineal feet	198	11,600	2,296,800	- -
	20-inch mains	Waukesha	- -	Lineal feet	184	6,800	1,251,200	
	30-inch mains	Waukesha	- -	Lineal feet	257	4,400	1,130,800	
- -	- -	- -	- -	- -	- -	- -	$ 5,785,090	$ 5,785,090

Table 128 (continued)

Utility	Project Description	Project Location	Capacity	Units	Unit Cost	Number of Units	Capital Cost	Total Capital Cost
New Berlin-Central	Pumping station-Glendale Drive	New Berlin	2.35	mgd	$ 1,006,936	1	$ 1,006,936	- -
	Pumping station-Beloit Road	New Berlin	2.35	mgd	1,006,936	1	1,006,936	
	16-inch mains	New Berlin	- -	Lineal feet	173	4,600	795,800	
- -	- -	- -	- -	- -	- -	- -	$ 2,809,671	$ 2,809,671
Muskego	Metering station-Small Road	Muskego	5.40	mgd	$ 732,279	1	$ 732,279	- -
	Pumping station-Moorland Road	Muskego-New Berlin	3.50	mgd	1,204,769	1	1,204,769	
	24-inch mains	Muskego	- -	Lineal feet	198	10,000	1,980,000	
	24-inch mains	New Berlin	- -	Lineal feet	198	9,300	1,841,400	
	16-inch mains	Muskego	- -	Lineal feet	173	2,400	415,200	
- -	- -	- -	- -	- -	- -	- -	$ 6,173,648	$ 6,173,648
Menomonee Falls-West	Pumping station-Town Hall Drive	Menomonee Falls	1.60	mgd	$ 846,886	1	$ 846,886	- -
	Pumping station-Silver Spring Drive	Menomonee Falls-Sussex	2.50	mgd	1,035,386	1	1,035,386	
- -	- -	- -	- -	- -	- -	- -	$ 1,882,272	$ 1,882,272
Lannon	Pumping station	Lannon	0.60	mgd	$ 544,517	1	$ 544,517	- -
	Pumping station	Lannon-Menomonee Falls	0.40	mgd	453,646	1	453,646	
- -	- -	- -	- -	- -	- -	- -	$ 998,163	$ 998,163
Sussex	Pumping station	Sussex	3.70	mgd	$ 1,235,296	1	$ 1,235,296	- -
	12-inch mains	Sussex	- -	Lineal feet	146	1,400	204,400	
- -	- -	- -	- -	- -	- -	- -	$ 1,439,696	$ 1,439,696
City of Pewaukee	Pumping station-Green Road	City of Pewaukee	2.50	mgd	$ 1,035,386	1	$ 1,035,386	- -
	Pumping station-Riverwood Drive	City of Pewaukee	2.50	mgd	1,035,386	1	1,035,386	
- -	- -	- -	- -	- -	- -	- -	$ 2,070,772	$ 2,070,772
Village of Pewaukee	Pumping station-Sunnyridge Road	Village of Pewaukee	2.00	mgd	$ 936,405	1	$ 936,405	- -
	Pumping station-Wisconsin Avenue	City and Village of Pewaukee	1.40	mgd	797,464	1	797,464	
	12-inch mains	Village of Pewaukee	- -	Lineal feet	146	2,700	394,200	
- -	- -	- -	- -	- -	- -	- -	$ 2,128,069	$ 2,128,069
Yorkville U.D.1	12-inch mains	Racine County	- -	Lineal feet	139	3,300	$ 458,700	$ 458,700
Union Grove	20-inch mains	Racine to Yorkville	- -	Lineal feet	$ 184	3,600	$ 662,400	- -
	16-inch mains	Yorkville to Union Grove	- -	Lineal feet	173	33,800	5,847,400	
	Pumping station	Yorkville	1.85	mgd	904,102	1	904,102	
	Repump reservoir	Union Grove	3.20	MG	3,156,000	1	3,156,000	
- -	- -	- -	- -	- -	- -	- -	$10,569,902	$ 10,569,902

Table 128 (continued)

Utility	Project Description	Project Location	Capacity	Units	Unit Cost	Number of Units	Capital Cost	Total Capital Cost
Port Washington	Treatment plant expansion	Port Washington	2.00	mgd	$3,491,000	1	$ 3,491,000	
	Repump reservoir (clearwell)	Port Washington	1.00	MG	1,244,000	1	1,244,000	- -
	Pumping station	Port Washington	4.00	mgd	1,279,000	1	1,279,000	
- -	- -	- -	- -	- -	- -	- -	$ 6,014,000	$ 6,014,000
Fredonia	12-inch mains	Port Washington to Fredonia	- -	Lineal feet	$ 146	31,700	$ 4,628,200	
	Pumping station	Fredonia	0.85	mgd	636,982	1	636,982	- -
	Repump reservoir	Fredonia	1.20	MG	1,483,000	1	1,483,000	
- -	- -	- -	- -	- -	- -	- -	$ 6,748,182	$ 6,748,182
Saukville	16-inch mains	Port Washington to Saukville	- -	Lineal feet	$ 173	5,500	$ 951,500	
	Pumping station	Saukville	2.10	mgd	$957,206	1	957,206	- -
	Repump reservoir	Saukville	1.60	MG	$1,961,000	1	1,961,000	
- -	- -	- -	- -	- -	- -	- -	$ 3,869,706	$ 3,869,706
Grafton/ Cedarburg	36-inch mains (incremental cost component)	Milwaukee to Mequon	- -	Lineal feet	$ 157	26,600	$ 4,176,200	
	30-inch mains	Mequon to Cedarburg	- -	Lineal feet	257	34,200	$ 8,789,400	
	20-inch mains	Grafton to Cedarburg	- -	Lineal feet	184	22,000	4,048,000	
	Pumping station	Grafton-East	2.00	mgd	936,405	1	936,405	
	Repump reservoir	Grafton-East	3.50	MG	3,448,000	1	3,448,000	- -
	Pumping station	Grafton-West	2.00	mgd	936,405	1	936,405	
	Repump reservoir	Grafton-West	3.50	MG	3,448,000	1	3,448,000	
	Pumping station	Cedarburg	3.00	mgd	1,123,977	1	3,371,932	
	Repump reservoir	Cedarburg	5.80	MG	3,650,000	1	3,650,000	
- -	- -	- -	- -	- -	- -	- -	$32,804,342	$ 32,804,342
- -	- -	- -	- -	- -	- -	- -	- -	$252,559,218

Present Worth of Capital Cost	$266,840,000
Total O&M Cost	$ 3,212,000
Present Worth of Total O&M Cost	$ 50,621,000
Total Present Worth Cost	$317,761,000
Equivalent Annual Cost	$ 20,163,000

[a]*Allowance of 25 percent to cover internal system improvements for the Milwaukee Water Works water supply system.*

Source: Ruekert & Mielke, Inc., and SEWRPC.

Table 129

PRINCIPAL FEATURES AND COSTS OF NEW, EXPANDED, AND UPGRADED WATER SUPPLY FACILITIES AND PROGRAMS UNDER SUBALTERNATIVE 4 FOR THE NEW LAKE MICHIGAN SUPPLY COMPONENT OF ALTERNATIVE PLAN 4: DESIGN YEAR 2035 FORECAST CONDITIONS WITH FURTHER EXPANSION OF LAKE MICHIGAN SUPPLY

Utility	Project Description	Project Location	Capacity	Units	Unit Cost	Number of Units	Capital Cost	Total Capital Cost
Germantown	Pumping station-Milwaukee	Germantown	6.00	mgd	$ 1,535,718	1	$ 1,535,718	
	24-inch mains	Germantown	- -	Lineal feet	198	19,100	3,781,800	
	Pumping station-Menomonee Falls	Germantown	2.00	mgd	936,405	1	936,405	- -
	24-inch mains	Milwaukee County	- -	Lineal feet	198	4,200	831,600	
	30-inch mains (shared with Mequon)	Milwaukee County	- -	Lineal feet	168	5,300	890,400	
	Miscellaneous internal system upgrades	Milwaukee County	- -	- -	- -	- -	430,000[a]	
- -	- -	- -	- -	- -	- -	- -	$ 8,405,923	$ 8,405,923
Racine	Water Intake	Lake Michigan	48.00	mgd	$11,040,000	1	$11,040,000	
	Pumping station-raw water	Racine	30.00	mgd	3,200,000	1	3,200,000	- -
	Treatment plant	Racine	48.00	mgd	40,300,000	1	40,300,000	
- -	- -	- -	- -	- -	- -	- -	$ 54,540,000	$ 54,540,000
Racine County-Waukesha County Transmission Facilities	60-inch transmission main	Racine and Waukesha Counties	- -	Lineal feet	$ 586	190,200	$111,457,200	
	54-inch transmission main	Waukesha County	- -	Lineal feet	427	22,100	9,436,700	
	48-inch transmission main	Waukesha County	- -	Lineal feet	349	23,700	8,271,300	
	42-inch transmission main	Waukesha County	- -	Lineal feet	310	136,500	42,315,000	
	Elevated tanks	Waukesha County	2.00	MG	3,100,000	2	6,200,000	- -
	Repump storage facilities	Waukesha County	10.00	MG	5,640,000	2	11,280,000	
	Pumping stations	Racine County	49.70	mgd	3,979,048	2	7,958,096	
	Pumping station	Waukesha County	47.80	mgd	3,909,816	1	3,909,816	
	Pumping station	Waukesha County	42.40	mgd	3,704,356	1	3,704,356	
	Pumping station	Waukesha County	44.00	mgd	3,766,662	1	3,766,662	
- -	- -	- -	- -	- -	- -	- -	$208,299,130	$208,299,130
City of Brookfield and Village of Elm Grove	Metering station-Capitol Drive	City of Brookfield	2.50	mgd	$ 517,693	1	$ 517,693	
	Pumping station-Bluemound Road	City of Brookfield	2.50	mgd	1,035,386	1	1,035,386	
	Pumping station-Burleigh Road	City of Brookfield	3.50	mgd	1,204,769	1	1,204,769	- -
	Metering station-Calhoun Road	City of Brookfield	2.20	mgd	488,734	1	488,734	
	16-inch mains	City of Brookfield	- -	Lineal feet	173	1,700	294,100	
- -	- -	- -	- -	- -	- -	- -	$ 3,540,682	$ 3,540,682
Town of Brookfield	Pumping station	Town of Brookfield	1.70	mgd	$ 870,324	1	$ 870,324	- -
	16-inch mains	Town of Brookfield	- -	Lineal feet	173	2,600	449,800	
- -	- -	- -	- -	- -	- -	- -	$ 1,320,124	$ 1,320,124

Table 129 (continued)

Utility	Project Description	Project Location	Capacity	Units	Unit Cost	Number of Units	Capital Cost	Total Capital Cost
Waukesha	Metering station 24-inch mains 20-inch mains 30-inch mains	Waukesha Waukesha Waukesha Waukesha	13.50 - - - - - -	mgd Lineal feet Lineal feet Lineal feet	$ 1,106,290 198 184 257	1 11,600 6,800 4,400	$ 1,106,290 2,296,800 1,251,200 1,130,800	- -
- -	- -	- -	- -	- -	- -	- -	$ 5,785,090	$ 5,785,090
New Berlin-Central	Pumping station-Glendale Drive Pumping station-Beloit Road 16-inch mains	New Berlin New Berlin New Berlin	2.35 2.35 - -	mgd mgd Lineal feet	$ 1,006,936 1,006,936 173	1 1 4,600	$ 1,006,936 1,006,936 795,800	- -
- -	- -	- -	- -	- -	- -	- -	$ 2,809,672	$ 2,809,672
Muskego	Metering station 16-inch mains	Muskego Muskego	5.40 - -	mgd Lineal feet	$ 732,279 173	1 2,400	$ 732,279 415,200	- -
- -	- -	- -	- -	- -	- -	- -	$ 1,147,479	$ 1,147,479
Menomonee Falls-West	Pumping station-Town Hall Drive Pumping station-Silver Spring Drive	Menomonee Falls Menomonee Falls-Sussex	1.60 2.50	mgd mgd	$ 846,886 1,035,386	1 1	$ 846,886 1,035,386	- -
- -	- -	- -	- -	- -	- -	- -	$ 1,882,272	$ 1,882,272
Lannon	Pumping station Pumping station	Lannon Lannon-Menomonee Falls	0.60 0.40	mgd mgd	$ 544,517 453,646	1 1	$ 544,517 453,646	- -
- -	- -	- -	- -	- -	- -	- -	$ 998,163	$ 998,163
Sussex	Pumping station 12-inch mains	Sussex Sussex	3.70 - -	mgd Lineal feet	$ 1,235,296 146	1 1,400	$ 1,235,296 204,400	- -
- -	- -	- -	- -	- -	- -	- -	$ 1,439,696	$ 1,439,696
City of Pewaukee	Pumping station-Green Road Pumping station-Riverwood Drive	City of Pewaukee City of Pewaukee	2.50 2.50	mgd mgd	$ 1,035,386 1,035,386	1 1	$ 1,035,386 1,035,386	- -
- -	- -	- -	- -	- -	- -	- -	$ 2,070,772	$ 2,070,772
Village of Pewaukee	Pumping station-Sunnyridge Road Pumping station-Wisconsin Avenue 12-inch main	Village of Pewaukee City and Village of Pewaukee City and Village of Pewaukee	2.00 1.40 - -	mgd mgd Lineal feet	$ 936,405 797,464 146	1 1 3,300	$ 936,405 797,464 481,800	- -
- -	- -	- -	- -	- -	- -	- -	$ 2,215,669	$ 2,215,669
Yorkville U.D.1	12-inch mains	Yorkville	- -	Lineal feet	$ 146	3,300	$ 481,800	$ 481,800
Union Grove	16-inch mains Repump Reservoir	Racine County Union Grove	- - 3.20	Lineal feet MG	$ 173 3,156,000	17,000 1	$ 2,941,000 3,156,000	- -
- -	- -	- -	- -	- -	- -	- -	$ 6,097,000	$ 6,097,000

Table 129 (continued)

Utility	Project Description	Project Location	Capacity	Units	Unit Cost	Number of Units	Capital Cost	Total Capital Cost
Port Washington	Treatment plant expansion	Port Washington	2.00	mgd	$3,491,000	1	$ 3,491,000	
	Repump reservoir (clearwell)	Port Washington	1.00	MG	1,244,000	1	1,244,000	- -
	Pumping station	Port Washington	4.00	mgd	1,279,000	1	1,279,000	
- -	- -	- -	- -	- -	- -	- -	$ 6,014,000	$ 6,014,000
Fredonia	12-inch mains	Port Washington to Fredonia	- -	Lineal feet	$ 146	31,700	$ 4,628,200	
	Pumping station	Fredonia	0.85	mgd	636,982	1	636,982	- -
	Repump reservoir	Fredonia	1.20	MG	1,483,000	1	1,483,000	
- -	- -	- -	- -	- -	- -	- -	$ 6,748,182	$ 6,748,182
Saukville	16-inch mains	Port Washington to Saukville	- -	Lineal feet	$ 173	5,500	$ 951,500	
	Pumping station	Saukville	2.10	mgd	$957,206	1	957,206	- -
	Repump reservoir	Saukville	1.60	MG	$1,961,000	1	1,961,000	
- -	- -	- -	- -	- -	- -	- -	$ 3,869,706	$ 3,869,706
Grafton/ Cedarburg	24-inch raw main	Lake Michigan to Grafton (east)	- -	Lineal feet	$ 198	10,000	$ 1,980,000	
	20-inch main	Lake Michigan to Grafton/Cedarburg	- -	Lineal feet	184	25,700	4,728,800	
	16-inch main	Grafton to Cedarburg	- -	Lineal feet	173	5,300	916,900	
	Water intake	Lake Michigan	9.00	mgd	2,250,000	1	2,250,000	
	Pumping station-raw water	- -	9.00	mgd	2,150,000	1	2,150,000	
	Treatment plant	Grafton (east)	9.00	mgd	23,292,000	1	23,292,000	- -
	Pumping station-distribution	Grafton (east)	9.00	mgd	1,843,339	1	1,843,339	
	Clearwell	Grafton (east)	2.00	MG	2,439,122	1	2,439,122	
	Pumping station	Grafton	2.50	mgd	1,035,386	1	1,035,386	
	Repump reservoir	Grafton	2.50	MG	3,036,822	1	3,036,822	
	Pumping station	Cedarburg	2.00	mgd	936,405	1	936,405	
	Repump reservoir	Cedarburg	2.00	MG	2,439,122	1	2,439,122	
- -	- -	- -	- -	- -	- -	- -	$47,047,896	$ 47,047,896
- -	- -	- -	- -	- -	- -	- -	- -	$364,713,256

Present Worth of Capital Cost	$387,416,000
Total O&M Cost	$ 6,505,000
Present Worth of Total O&M Cost	$109,204,000
Total Present Worth Cost	$496,620,000
Equivalent Annual Cost	$ 31,511,000

[a]*Allowance of 25 percent to cover internal system improvements for the Milwaukee Water Works water supply system.*

Source: Ruekert & Mielke, Inc., and SEWRPC.

to the Town of Yorkville Utility District No. 1 and the Village of Union Grove Municipal Water Utility. Subalternative 2 for the provision of Lake Michigan water is shown on Map 97 and the components and costs are summarized in Table 127. Subalternative 2 has an estimated capital cost of about $277.8 million and an annual operation and maintenance cost of about $3.6 million. Based upon an analysis period of 50 years and an annual interest rate of 6 percent, the estimated present worth cost of this option is about $348.0 million and the equivalent annual cost is $22.1 million.

Subalternative 3 for the provision of Lake Michigan water supplies to additional areas under Alternative Plan 4 provides for a direct connection from the Milwaukee Water Works to the same utilities as under Subalternative 1, plus the City of Cedarburg Light & Water Commission and the Village of Grafton Water and Wastewater Commission. The City of Racine Water and Wastewater Utility would, by direct connection, provide the water supply to the Town of Yorkville Utility District No. 1 and the Village of Union Grove Municipal Water Utility. The City of Port Washington would, by direct connection, serve the Village of Fredonia Municipal Water Utility and the Village of Saukville Municipal Water Utility. Subalternative 3 is shown on Map 98 and the components and costs are summarized in Table 128. Subalternative 3 has an estimated capital cost of about $252.6 million and an annual operation and maintenance cost of about $3.2 million. Based upon an analysis period of 50 years and an annual interest rate of 6 percent, the estimated present worth cost of this option is about $317.8 million and the equivalent annual cost is $20.2 million.

Subalternative 4 for the provision of Lake Michigan water supplies to additional areas under Alternative Plan 4 provides for a direct water supply from the Milwaukee Water Works to the Village of Germantown Water Utility. The City of Racine Water and Wastewater Utility or, optionally, the City of Oak Creek Water Utility would provide water supply to the City of Brookfield Municipal Water Utility, the City of New Berlin Water Utility, the City of Muskego Public Water Utility, the City of Pewaukee Water Utility, the City of Waukesha Water Utility, the Village of Pewaukee Water Utility, the Village of Elm Grove, and the Town of Brookfield Sanitary District No. 4. For purposes of cost estimation, the City of Racine Water and Wastewater Utility water supply connection was assumed to supply these Waukesha County communities. However, the connection could also be made from the City of Oak Creek Water Utility. The City of Cedarburg Light & Water Commission and the Village of Grafton Water and Wastewater Commission would develop a new Lake Michigan water treatment plant to serve both utilities. The City of Port Washington would, by direct connection, provide the water supply to the Village of Fredonia Municipal Water Utility, and the Village of Saukville Municipal Water Utility. The City of Racine Water and Wastewater Utility would, also by direct connection, provide the water supply to the Town of Yorkville Utility District No. 1 and the Village of Union Grove Municipal Water Utility. Subalternative 4 for the provision of Lake Michigan water is shown on Map 99 and the components and costs are summarized in Table 129. Subalternative 4 has an estimated capital cost of about $364.7 million and an annual operation and maintenance cost of about $6.5 million. Based upon an analysis period of 50 years and an annual interest rate of 6 percent, the estimated present worth cost of this option is about $496.6 million and the equivalent annual cost is $31.5 million.

Tables 126, 127, 128, and 129, indicate that the present worth and equivalent annual costs of Subalternatives 1, 2, and 3 for provision of Lake Michigan water under Alternative Plan 4 are all within 10 percent of each other. The limited differences were interpreted as indicating the costs entailed, as estimated at the systems planning level, would be essentially equal. The cost of Subalternative 4 for the provision of Lake Michigan water may be expected to be about 40 percent higher than that of either Subalternative 1, 2, or 3. Accordingly, the costs associated with Subalternative 1 for the provision of Lake Michigan water were included in Alternative Plan 4 as a valid approximation of the costs of any viable subalternatives for the provision of Lake Michigan water.

Under Alternative Plan 4, consideration was given to two subalternatives for the return of Lake Michigan water used in areas west of the subcontinental divide that were not currently provided with, or projected to have, a return flow component via a connection to a sewerage system discharging treated effluent to Lake Michigan or its tributaries. Under the first subalternative, wastewater treatment plant effluent from these utility service areas equal in volume to at least the amount of water to be withdrawn would be conveyed back to Lake Michigan via a pipeline, or pipelines, discharging directly to the Lake. Under the second subalternative, wastewater treatment plant effluent from these utility service areas would be conveyed by a pipeline, or pipelines, discharging to streams tributary to Lake Michigan. It is recognized that implementation of either subalternative would require subsequent more-detailed second-level evaluations of costs, environmental impacts, and pipe routing. The subalternatives were developed to illustrate the range of options available and to identify and provide information on the costs and impacts of the subalternatives at a systems planning level.

Subalternative 1 for the return of Lake Michigan water would provide for treated wastewater from the wastewater treatment plants operated by the Cities of Brookfield and Waukesha and the Village of Sussex to be conveyed to Lake Michigan via a series of pumping stations and pipelines. It was assumed that there would be active management of the return flow in order to minimize the need to return wastewater treatment plant flows during periods of high streamflows and to minimize the impacts on the Fox River during periods of low streamflows. Since wastewater volumes typically are about 15 percent or more greater than the water used, such an active management scheme could be used while meeting the return flow requirements. Subalternative 1 for providing a return flow component under Alternative Plan 4 is shown on Map 100 and the estimated costs entailed are summarized in Table 130. Subalternative 1 has an estimated capital cost of about $72.8 million and an annual operation and maintenance cost of about $2.2 million.

Under the second return flow subalternative of Alternative Plan 4, return flow from the communities served by the Village of Sussex wastewater treatment plant—the Villages of Lannon and Sussex and the western portion of the Village of Menomonee Falls—and from the communities served by the City of Brookfield wastewater treatment plant—the western portion of the City of Brookfield, the City of Pewaukee, the Village of Pewaukee, and the Town of Brookfield Sanitary District No. 4—would be provided by conveying treated effluent from these service areas through a system of pumping stations and pipelines discharging to Underwood Creek, a stream tributary to the Menomonee River which flows into Lake Michigan. In addition, return flow from the City of Waukesha would be effected by conveying treated effluent from the City of Waukesha wastewater treatment plant through a series of pumping stations and pipelines discharging into the Root River, a stream tributary to Lake Michigan. As noted above for Subalternative 1, Subalternative 2 would use an active management scheme to ensure no return flow during potential flood-flow periods on the tributaries to which the treated wastewater is discharged, and to minimize impacts on the Fox River during low-flow periods. Subalternative 2 for providing a return flow component under Alternative Plan 4 is shown on Map 101 and the components and costs are summarized in Table 131. Subalternative 2 has an estimated capital cost of about $50.9 million and an annual operation and maintenance cost of about $1.6 million.

Tables 130 and 131 indicate that the cost of Subalternative 1 for the return of water to Lake Michigan under Alternative Plan 4 is considerably higher than the cost of Subalternative 2. This is to be expected, given the longer pipeline requirement under Subalternative 1. In order to provide a conservatively high cost estimate for Alternative Plan 4, Subalternative 1 was included in that alternative for use in the initial comparative evaluation of the alternative plans concerned.

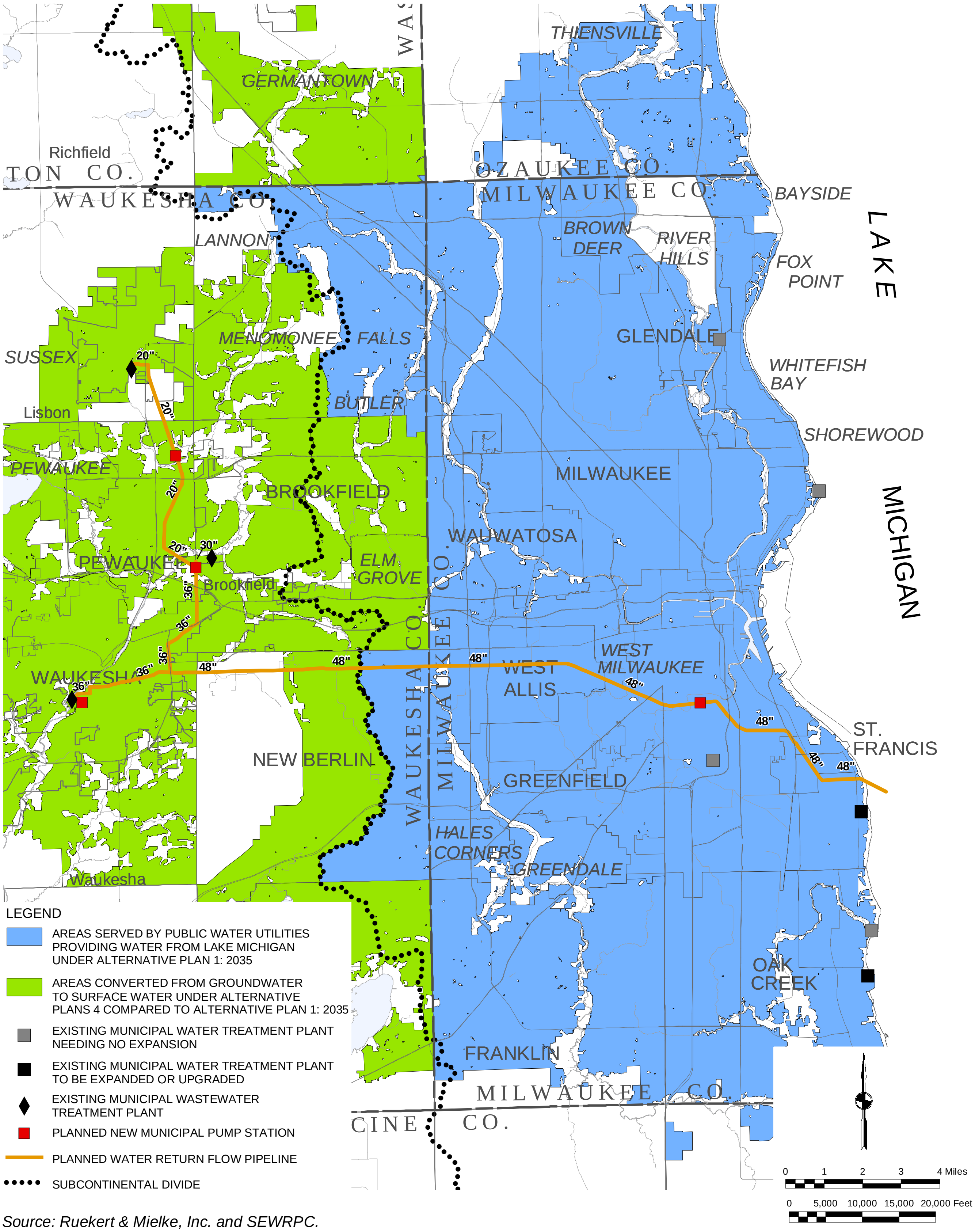
Map 102 illustrates the areas served by municipal utilities and the sources of supply for those utilities under Alternative Plan 4. The sources of supply for each water utility in the Region under Alternative Plan 4 are listed in Table 132. Those sources of supply and the anticipated utilization of those sources may be summarized as follows:

- Design year 2035 total average annual groundwater pumpage is estimated to be 65 mgd, with about 50 mgd, or about 78 percent, from the shallow aquifer and about 15 mgd, or about 22 percent, from the deep aquifer. This represents a reduction of about 41 mgd, or about 39 percent, in total pumpage compared to Alternative Plan 1.

- Design year 2035 municipal water utility average annual groundwater pumpage is estimated to be 48 mgd, a reduction of 41 mgd, or about 46 percent, compared to Alternative Plan 1. Of this amount,

Map 100

SUBALTERNATIVE 1 FOR RETURN FLOW FOR ALTERNATIVE PLAN 4
RETURN FLOW PIPELINE TO LAKE MICHIGAN



Source: Ruekert & Mielke, Inc. and SEWRPC.

Table 130

PRINCIPAL FEATURES AND COSTS OF FACILITIES UNDER SUBALTERNATIVE 1 FOR THE RETURN FLOW COMPONENT OF ALTERNATIVE PLAN 4: DESIGN YEAR 2035 FORECAST CONDITIONS WITH FURTHER EXPANSION OF LAKE MICHIGAN SUPPLY

Component	Capital Cost ($ X 1,000)	Annual O&M Cost ($ X 1,000)
20-Inch Pipe Sussex to Brookfield (34,020 L.F.)	$ 6,050	$ 10
30-Inch Pipe from Brookfield-Sussex Connection to Waukesha Pipe (1,000 L.F.)	250	1
36-Inch Pipe from Brookfield-Sussex Connection to Waukesha Pipe (16,740 L.F.)	4,920	5
36-Inch Pipe from Waukesha WWTP to Brookfield-Sussex Pipe (15,000 L.F.)	4,422	5
48-Inch Pipe from Waukesha-Brookfield-Sussex Connection to Lake Michigan (101,500 L.F.)	41,171	29
48-Inch Outfall	6,650	2
Pumping Station between Sussex and Brookfield	1,448[a]	82
Pumping Station at Brookfield WWTP	2,467[b]	471
Pumping Station at Waukesha WWTP	2,408[c]	482
Pumping Station between Connection of Waukesha, Brookfield, and Sussex and Lake Michigan	3,003	1,084
Total	$72,789	$2,171

[a]*Includes an allowance of $132,000 for control system to support active flow management strategy.*

[b]*Includes an allowance of $194,000 for control system to support active flow management strategy.*

[c]*Includes an allowance of $288,000 for control system to support active flow management strategy.*

Source: SEWRPC.

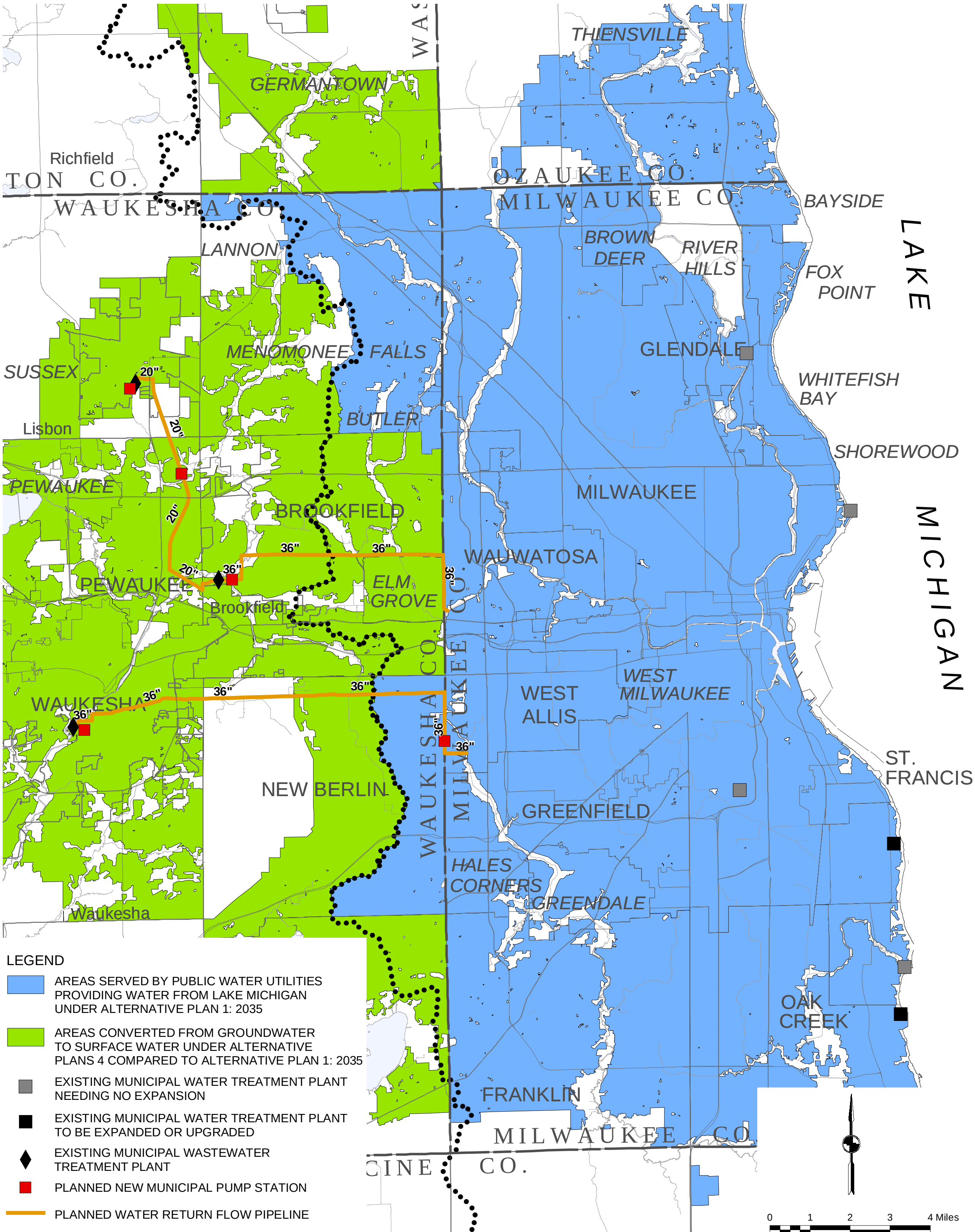
approximately 37 mgd, or about 77 percent, would be from the shallow aquifer and 11 mgd, or about 23 percent, would be from the deep aquifer, representing decreases of 16 mgd and 25 mgd, or about 30 percent and 69 percent, respectively, compared to the pumpages under Alternative Plan 1.

- Design year 2035 municipal water supply pumpage of Lake Michigan water is estimated to be 255 mgd, an increase of 41 mgd, or about 19 percent, compared to Alternative Plan 1.

Alternative Plan 4 has an estimated capital cost of $472.0 million and annual savings in operation and maintenance cost of $14.5 million compared to Alternative Plan 1. Based upon an analysis period of 50 years and an annual interest rate of 6 percent, the estimated present worth cost of this alternative is $228.4 million, and the equivalent annual cost is $14.5 million. The operation and maintenance cost used for purposes of comparison with Alternative Plan 1 is the net amount arrived at by combining the operation and maintenance costs of the proposed new facilities; the expected savings due to the elimination of individual residential point-of-entry treatment devices—water softeners—and the reductions in costs due to the elimination of existing facilities which were required under Alternative Plan 1, but are not required under Alternative Plan 4. The costs of Alternative Plan 4 would be lower if Subalternative Plan 2, providing for indirect return flow to Lake Michigan via two stream systems, was included in Alternative Plan 4 in lieu of Subalternative Plan 1 which provides for direct return flow to Lake Michigan.

Map 101

SUBALTERNATIVE 2 FOR RETURN FLOW FOR ALTERNATIVE PLAN 4
RETURN FLOW PIPELINES TO STREAMS TRIBUTARY TO LAKE MICHIGAN



LEGEND

AREAS SERVED BY PUBLIC WATER UTILITIES PROVIDING WATER FROM LAKE MICHIGAN UNDER ALTERNATIVE PLAN 1: 2035

AREAS CONVERTED FROM GROUNDWATER TO SURFACE WATER UNDER ALTERNATIVE PLANS 4 COMPARED TO ALTERNATIVE PLAN 1: 2035

EXISTING MUNICIPAL WATER TREATMENT PLANT NEEDING NO EXPANSION

EXISTING MUNICIPAL WATER TREATMENT PLANT TO BE EXPANDED OR UPGRADED

EXISTING MUNICIPAL WASTEWATER TREATMENT PLANT

PLANNED NEW MUNICIPAL PUMP STATION

PLANNED WATER RETURN FLOW PIPELINE

SUBCONTINENTAL DIVIDE

0 1 2 3 4 Miles

0 5,000 10,000 15,000 20,000 Feet

Source: Ruekert & Mielke, Inc. and SEWRPC.

Table 131

PRINCIPAL FEATURES AND COSTS OF FACILITIES UNDER SUBALTERNATIVE 2 FOR THE RETURN FLOW COMPONENT OF ALTERNATIVE PLAN 4: DESIGN YEAR 2035 FORECAST CONDITIONS WITH FURTHER EXPANSION OF LAKE MICHIGAN SUPPLY

Component	Capital Cost ($ X 1,000)	O&M Cost ($ X 1,000)
Sussex-Brookfield to Underwood Creek		
20-Inch Pipe Sussex to Brookfield (39,800 L.F.)	$ 7,090	$ 11
36-Inch Pipe from Brookfield-Sussex Connection to Underwood Creek (37,700 L.F.)	7,420	11
Pumping Station between Sussex and Brookfield	1,448[a]	82
Pumping Station at Brookfield WWTP	2,467[b]	471
Subtotal	$18,425	$ 575
Waukesha to Root River		
36-Inch Pipe from Waukesha WWTP to Root River (85,900 L.F.)	$27,900	$ 24
Pumping Station at Waukesha WWTP	2,408[c]	482
Pumping Station between Waukesha and Root River	2,120	482
Subtotal	$32,428	$ 988
Total	$50,853	$1,563

[a]*Includes an allowance of $132,000 for control system to support active flow management strategy.*

[b]*Includes an allowance of $194,000 for control system to support active flow management strategy.*

[c]*Includes an allowance of $288,000 for control system to support active flow management strategy.*

Source: SEWRPC.

Groundwater and Surface Water Impacts of Alternative Plan 4

The potential impacts of Alternative Plan 4 on the groundwater and surface water systems of the Region under the attendant pumping conditions to the design year 2035 were estimated by simulation modeling and by a parallel water budget analysis. In addition, surface water quantity and quality analyses were conducted utilizing stream gaging records developed under the stream gaging program operated cooperatively by the Commission and the U.S. Geological Survey, wastewater treatment plant loading and performance data available through the WDNR Compliance Maintenance Annual Reports (CMAR), and water supply system data reported to the Public Service Commission of Wisconsin.

Groundwater Impacts in the Deep Aquifer

Simulated Water Levels in the Deep Aquifer

Results of the groundwater simulation indicate that under Alternative Plan 4 conditions, drawups relative to 2005 conditions may be expected to occur in the deep aquifer over most of the Region. These impacts are shown on Map 103 and are most evident in portions of central Waukesha County where those impacts appear to exceed 250 feet of drawup in central and eastern Waukesha County and exceed 100 feet in most of Milwaukee and Waukesha Counties, in much of southern Ozaukee County, and in southeastern Washington County. It should be noted that there will remain impacts on the deep aquifer from pumping in areas to the south of the Region in northeastern Illinois. The smaller drawups shown in Kenosha and Walworth Counties on Map 103 may be attributed to the out-of-Region pumpage. For analysis purposes, the pumping in northeastern Illinois has been held at the year 2000

Map 102

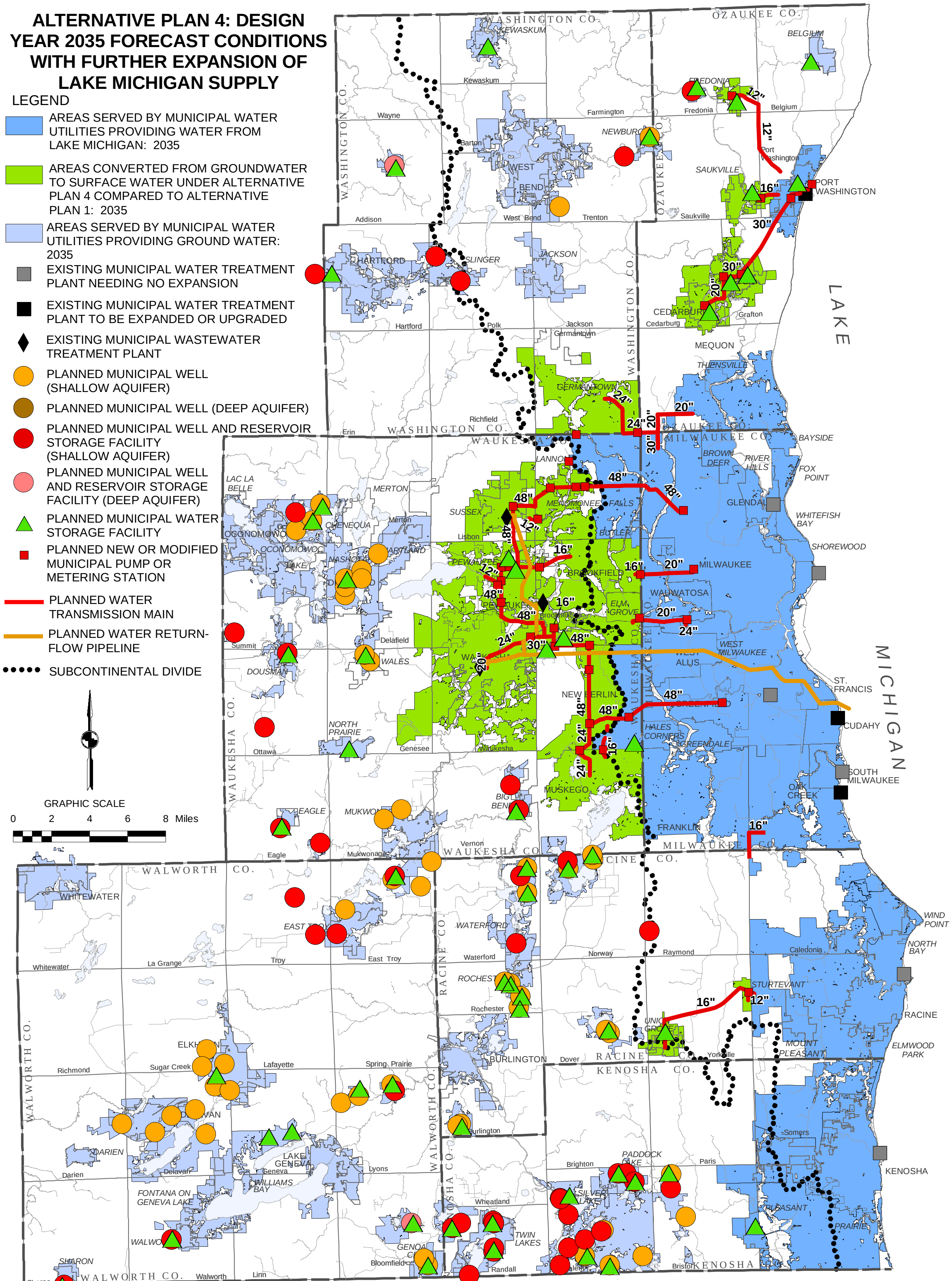
ALTERNATIVE PLAN 4: DESIGN YEAR 2035 FORECAST CONDITIONS WITH FURTHER EXPANSION OF LAKE MICHIGAN SUPPLY

LEGEND

- AREAS SERVED BY MUNICIPAL WATER UTILITIES PROVIDING WATER FROM LAKE MICHIGAN: 2035
- AREAS CONVERTED FROM GROUNDWATER TO SURFACE WATER UNDER ALTERNATIVE PLAN 4 COMPARED TO ALTERNATIVE PLAN 1: 2035
- AREAS SERVED BY MUNICIPAL WATER UTILITIES PROVIDING GROUND WATER: 2035
- EXISTING MUNICIPAL WATER TREATMENT PLANT NEEDING NO EXPANSION
- EXISTING MUNICIPAL WATER TREATMENT PLANT TO BE EXPANDED OR UPGRADED
- EXISTING MUNICIPAL WASTEWATER TREATMENT PLANT
- PLANNED MUNICIPAL WELL (SHALLOW AQUIFER)
- PLANNED MUNICIPAL WELL (DEEP AQUIFER)
- PLANNED MUNICIPAL WELL AND RESERVOIR STORAGE FACILITY (SHALLOW AQUIFER)
- PLANNED MUNICIPAL WELL AND RESERVOIR STORAGE FACILITY (DEEP AQUIFER)
- PLANNED MUNICIPAL WATER STORAGE FACILITY
- PLANNED NEW OR MODIFIED MUNICIPAL PUMP OR METERING STATION
- PLANNED WATER TRANSMISSION MAIN
- PLANNED WATER RETURN-FLOW PIPELINE
- SUBCONTINENTAL DIVIDE

GRAPHIC SCALE

0 2 4 6 8 Miles



Source: Ruekert & Mielke, Inc. and SEWRPC.

Table 132

PRINCIPAL FEATURES AND COSTS OF NEW, EXPANDED, AND UPGRADED WATER SUPPLY FACILITIES AND PROGRAMS UNDER ALTERNATIVE PLAN 4, DESIGN YEAR 2035 FORECAST CONDITIONS WITH FURTHER EXPANSION OF LAKE MICHIGAN SUPPLY

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Kenosha County					
City of Kenosha Water Utility	No additions	- -	41.7	657	00,042w
Village of Paddock Lake Municipal Water Utility	Addition of two 0.25 MG elevated tanks, three shallow aquifer wells with 0.20 MG reservoir each	4,03x	54.0	3,135	199
Village of Pleasant Prairie Water Utility	Addition of 0.75 MG elevated tank	1,620	39.7[d]	2,104	134
Town of Bristol Utility District No. 1	Addition of three shallow aquifer wells to replace deep aquifer wells, 0.50 MG elevated tank, 0.40 MG reservoir	3,274	-57.0[e]	2,542[e]	161[e]
Town of Bristol Utility District No. 3	No additions	- -	0.1[d]	2	0
Town of Somers Water Utility	No additions	- -	3.5[d]	55	3
Village of Silver Lake Planned Utility	Addition of three shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank	3,437	93.4	1,694	107
Village of Twin Lakes Planned Utility	Addition of five shallow aquifer wells with 0.1 MG reservoir each, two 0.3 MG elevated tanks	5,317	158.7	3,782	240
Town of Salem Planned Utility	Addition of eight shallow aquifer wells, four with 0.15 MG reservoirs, two 0.3 MG elevated tanks	7,294	288.9	5,710	362
Powers-Benedict-Tombeau Lakes Area Planned Utility	Addition of two shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank	2,584	57.9	1,694	107
Land Acquisition for Wells and Storage Tanks	34 acres	2,380	- -	2,380	151
Subtotal	24 Wells, 28 Storage Tanks	29,938	680.9	23,755	1,506
Milwaukee County					
City of Cudahy Water Utility	Duplicate rapid mix facility	100	7.5	118	7
City of Franklin Water Utility	No additions	- -	13.4[d]	211	13
City of Glendale Water Utility	No additions	- -	6.1[d]	96	6
City of Milwaukee Water Works	No additions	- -	263.1	4,146	263
City of Oak Creek Water and Sewer Utility	Addition of 20 mgd coag-floc-sed, 14 mgd filtration, 17.5 mgd pumping	13,220	547.4[f]	21,169	1,343
City of South Milwaukee Water Utility	No additions	- -	8.6	136	9
City of Wauwatosa Water Utility	No additions	- -	19.6[d]	309	20

Table 132 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Milwaukee County (continued) City of West Allis Water Utility	No additions	- -	25.2[d]	397	25
Village of Brown Deer Public Water Utility	No additions	- -	4.8[d]	76	5
Village of Fox Point Water Utility	No additions	- -	2.6[d]	41	3
Village of Greendale Water Utility	No additions	- -	5.6[d]	88	6
Village of Shorewood Municipal Water Utility	No additions	- -	1.4[d]	22	1
Village of Whitefish Bay Water Utility	No additions	- -	5.8[d]	91	6
We Energies-Water Services	No additions	- -	1.0[d]	16	1
Subtotal	0 Wells, 0 Storage Tanks, Two Treatment Plant Upgrades	13,320	912.1	26,916	1,708
Ozaukee County City of Cedarburg Light & Water Commission/Village of Grafton Water and Wastewater Commission	Lake Michigan supply connections	28,654[k]	-2,213.0[cc]	-5,461[cc]	-346[cc]
City of Port Washington Water Utility	Addition of 12 MGD intake, coag-floc-sed, filtration, pumping, 2.0 MG repump reservoir	21,178[k]	367.1[dd]	29,717	1,886
Village of Belgium Municipal Water Utility	Addition of 0.45 MG reservoir at Well 3, service pumps at Wells 1 and 2	586	2.0	298	19
Village of Fredonia Municipal Water Utility	Lake Michigan supply connection	6,748[k]	-168.5[aa]	4,186[aa]	266[aa]
Village of Saukville Municipal Water Utility	Lake Michigan supply connection	3,870[k]	-287.8[dd]	-526[dd]	-33[dd]
We Energies-Water Services	5,300 feet of 30 inch main (shared with Village of Germantown) in N. 107th street, 16,100 feet of 20-inch main in Granville Road and Donges Bay Road	3,300	231.8[d,g]	5,153	327
Town of Fredonia-Waubeka Area Planned Utility	Addition of one shallow aquifer well with 0.10 MG reservoir, 0.25 MG elevated tank	1,460	24.3	899	57
Land Acquisition for Wells and Storage Tanks	Two acres	140	- -	140	9
Subtotal	One Well, Three Storage Tanks, Four Lake Michigan Supply Connections, One Treatment Plant Upgrade	65,936	-2,044.1	34,406	2,185
Racine County City of Burlington Municipal Waterworks	No additions	- -	12.6	199	13
City of Racine Water and Wastewater Utility[h]	No additions	- -	45.9	724	46
Village of Caledonia West Utility District[i] (Oak Creek)	No additions	- -	0.4[d]	6	1

Table 132 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Racine County (continued)					
Village of Caledonia West Utility District[i] (Racine)	No additions	- -	3.1[d]	49	3
Village of Caledonia East Utility District[j] (Oak Creek)	No additions	- -	1.9[d]	30	2
Village of Caledonia East Utility District[j] (Racine)	No additions	- -	3.5[d]	55	4
Village of Union Grove Municipal Water Utility	Lake Michigan supply connection	10,570[k]	-447.2[bb]	3,654[bb]	232[bb]
Village of Waterford Water and Sewer Utility	Addition of one shallow aquifer well with 0.40 MG reservoir	1,151	15.7	1,481	94
Village of Wind Point Municipal Water Utility	No additions	- -	0.8[d]	13	1
North Cape Sanitary District	Addition of one shallow aquifer well with 0.10 MG reservoir	155	2.1	194	12
Town of Yorkville Water Utility District 1	Lake Michigan supply connection	459[k]	-38.0[l]	-140[l]	-9[l]
Northwest Caledonia Area Planned Utility District	9,000 lineal feet of water transmission main	1,557	3.1[d,m]	726	46
Town of Burlington-Bohner Lake Area Planned Utility District	Addition of two shallow aquifer wells, 0.30 MG elevated tank	1,941	42.1	1,278	81
Town of Dover-Eagle Lake Area Planned Utility District	Addition of two shallow aquifer wells, 0.30 MG elevated tank	1,941	47.0	1,315	83
Town of Norway Area Planned Utility	Addition of four shallow aquifer wells, one with 0.15 MG reservoir, two 0.25 MG elevated tanks	4,024	112.9	2,825	179
Village of Rochester Area Planned Utility	Addition of two shallow aquifer wells, two 0.10 MG elevated tanks	1,844	27.6	1,125	71
Town of Rochester Area Planned Utility	Addition of two shallow aquifer wells, two 0.10 MG elevated tanks	1,844	30.7	1,148	73
Town of Waterford Area Planned Utility	Addition of three shallow aquifer wells, one with 0.15 MG reservoir, two 0.3 MG elevated tanks	3,485	114.4	2,571	163
Land Acquisition for Wells and Storage Tanks	27 acres	1,890	- -	1,890	120
Subtotal	17 Wells, 14 Storage Tanks, Two Lake Michigan Supply Connections	30,861	-21.4	19,143	1,215
Walworth County					
City of Delavan Water and Sewerage Commission	Addition of five shallow aquifer wells with iron removal treatment, replacement of treated shallow pumping	5,125	59.2[e]	1,318[e]	84[e]
City of Elkhorn Light and Water	Addition of five shallow aquifer wells, 0.35 MG treated water reservoir	3,529	-178.5[e]	-1,705[e]	-108[e]
City of Lake Geneva Municipal Water Utility	No additions	- -	11.3	178	11

Table 132 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Walworth County (continued) City of Whitewater Municipal Water Utility	No additions	- -	13.7	216	14
Village of Darien Water Works and Sewer System	Increase Well 1 output from 325 to 425 gpm	- -	15.2	35	2
Village of East Troy Municipal Water Utility	Addition of three shallow aquifer wells, two with 0.10 MG reservoir each	2,199	55.6	1,792	114
Village of Fontana Municipal Water Utility	No additions	- -	2.0	32	2
Village of Genoa City Municipal Water Utility	Addition of two shallow aquifer wells and 0.25 MG elevated tank	1,898	48.1	1,592	101
Village of Sharon Waterworks and Sewer System	Addition of one shallow aquifer well with 0.30 MG reservoir, 0.20 MG elevated tank	1,512	17.1	1,935	123
Village of Walworth Municipal Water and Sewer Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.15 MG reservoir	1,333	30.6	1,038	66
Village of Williams Bay Municipal Water Utility	No additions	- -	4.3	68	4
Town of Bloomfield Pell Lake Sanitary District No. 1	Addition of 0.2 MG elevated tank, one deep aquifer well with radium treatment and with 0.4 MG reservoir	1,891	39.6	2,416	153
Town of East Troy Sanitary District No. 3	Addition of one shallow aquifer well	130	0.1	136	8
Town of Geneva-Lake Como Sanitary District No. 1	Addition of 0.20 MG elevated tank and 0.45 MG reservoir	1,066	12.4	1,206	77
Town of Troy Sanitary District No. 1	Addition of one shallow aquifer well with 0.12 MG reservoir	80	0.2	87	6
Country Estates Sanitary District	Addition of two shallow aquifer wells, 0.20 MG elevated tank	1,730	-2.8[e]	1,793[e]	114[e]
Town of Lyons Area Planned Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.3 MG elevated tank	2,169	38.9	1,362	86
Town of East Troy-Potter Lake Area Planned Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.3 MG elevated tank	2,169	34.6	1,329	84
Land Acquisition for Wells and Storage Tanks	34 acres	2,380	- -	2,380	151
Subtotal	26 Wells, 17 Storage Tanks	27,211	201.6	17,208	1,092
Washington County City of Hartford Utilities	Addition of one shallow aquifer well, treatment system, 0.75 MG elevated tank, and interconnecting piping	7,500	39.4[e]	6,979[e]	443[e]
City of West Bend Water Utility	Addition of one shallow aquifer well	625	58.4	1,443	92

Table 132 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Washington County (continued)					
Village of Germantown Water Utility	Lake Michigan supply connection[k]	8,404[k]	-1,724.0[n]	-18,400[n]	-1,167[n]
Village of Jackson Water Utility	No additions	- -	7.4	117	7
Village of Kewaskum Municipal Water Utility	Addition of 0.25 MG reservoir	351	4.4	420	27
Village of Slinger Utilities	Addition of two shallow aquifer wells with 0.20 MG reservoir each	1,824	31.9	1,730	110
Allenton Sanitary District No. 1	Addition of 0.20 MG elevated tank, one deep aquifer well with 0.30 MG reservoir	1,672	20.3	1,374	87
Village of Newburg Area Planned Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.30 MG elevated tank	2,169	39.9	1,938	123
Land Acquisition for Wells and Storage Tanks	10 acres	700	- -	700	44
Subtotal	Seven Wells, Eight Storage Tanks, One Lake Michigan Supply Connection	23,245	-1,522.3	-3,699	-234
Waukesha County					
Waukesha County Transmission Main Loop Facilities	Pumping stations, transmission main loop, elevated tanks and repump facilities	141,941[k]	1,277.0	166,486	10,564
City of Brookfield Municipal Water Utility/Village of Elm Grove	Lake Michigan supply connection	17,140[k]	-2,563.0[o]	-22,365[o]	-1,483[o]
City of Delafield Municipal Water Utility	Addition of five shallow aquifer wells, 0.40 MG elevated tank	4,019	110.1	3,259	207
City of Muskego Public Water Utility	Lake Michigan supply connection	6,174[k]	-1,579.0[p]	-16,854[p]	-1,020[p]
City of New Berlin Water Utility (east)	Addition of 0.40 MG reservoir	526	8.5[d]	320	20
City of New Berlin Water Utility (central)	Lake Michigan supply connection	2,810[k]	-1,384.6[q]	-18,716[q]	-1,187[q]
City of Oconomowoc Utilities	No additions	- -	17.4	274	17
City of Pewaukee Water and Sewer Utility	Lake Michigan supply connection	2,071[k]	-1,190.0[u]	16,379[u]	1,039[u]
City of Waukesha Water Utility	Lake Michigan supply connection	5,785[k]	-7,010.0[x]	-104,411[x]	-6,635[x]
Village of Butler Public Water Utility	Addition of 0.25 MG reservoir	351	0.8	307	19
Village of Dousman Water Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.40 MG reservoir	1,631	26.2	1,957	124
Village of Eagle Municipal Water Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.40 MG reservoir	1,631	17.8	1,850	117
Village of Hartland Municipal Water Utility	Addition of one shallow aquifer well	625	17.7	526	33
Village of Menomonee Falls Water Utility (east)	No additions	- -	12.2[d]	192	12

Table 132 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Waukesha County (continued)					
Village of Menomonee Falls Water Utility (west)	Lake Michigan supply connection	1,883[k]	-382.1[s]	-3,863[s]	-245[s]
Village of Mukwonago Municipal Water Utility	Addition of three shallow aquifer wells	2,195	77.7	2,676	170
Village of Pewaukee Water Utility	Lake Michigan supply connection	2,128[k]	-1,044.0[v]	-14,070[v]	-893[v]
Village of Sussex Public Water Utility	Lake Michigan supply connection	1,440[k]	-1,057.9[y]	-15,051[y]	-955[y]
Town of Brookfield Sanitary District No. 4	Lake Michigan supply connection	1,320[k]	-519.0[w]	-6,731[w]	-427[w]
Village of Big Bend Planned Utility	Addition of two shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank	2,584	76.1	1,822	116
Village of Lannon Planned Utility	Lake Michigan Supply Connection	998[k]	41.5[t]	491[t]	31[t]
Village of North Prairie Planned Utility	Addition of 0.50 MG elevated tank	878	19.5	592	38
Village of Wales Planned Utility	Addition of two shallow aquifer wells, 0.30 MG elevated tank	1,941	41.8	1,277	81
Town of Eagle-Eagle Spring Lake Area Planned Utility	Addition of one shallow aquifer well with 0.15 MG reservoir	853	5.2	454	29
Town of Oconomowoc-Okauchee Lake Area Planned Utility	Addition of four shallow aquifer wells, one with 0.15 MG reservoir, two 0.30 MG elevated tanks	4,110	116.6	2,899	184
Town of Summit-Golden Lake Area Planned Utility	Addition of one shallow aquifer well with 0.10 MG reservoir	787	2.1	403	26
Town of Ottawa-Pretty Lake Area Planned Utility	Addition of one shallow aquifer well with 0.10 MG reservoir	787	3.1	409	26
Land Acquisition for Wells and Storage Tanks	30 acres	2,100	- -	2,100	133
Subtotal	22 Wells, 18 Storage Tanks, 10 Lake Michigan Supply Connections	208,708	-14,858.3	2,612	141
Return Flow System-Subalternative 1	Piping and pumping stations from Brookfield and Waukesha wastewater treatment plants	72,789	2,171.0	108,088	6,858
Total	99 Wells, 90 Storage Tanks, 17 Lake Michigan Supply Connections, Two Water Treatment Plant Expansions	472,008	-14,480.5	228,429	14,471

[a]*All utilities' programs include water conservation programs.*

[b]*Costs presented are those associated with the costs for new, expanded, or upgraded facilities. The operation and maintenance costs are for increased incremental costs associated with new, expanded, or upgraded facilities and for water conservation measures. Alternative Plan 1 is being considered as the base for alternative plans evaluation. The costs for Alternative Plans 2, 3, and 4 include an adjustment in the operation and maintenance costs to reflect existing facilities not used under these alternative plans compared to Alternative Plan 1.*

Footnotes to Table 132 (continued)

[c]*The estimated annual cost for water conservation is included as an operation and maintenance cost for all utilities.*

[d]*Water utilities which purchase water on a wholesale basis will have continued or increased costs for the purchase of water. For purposes of the cost-effectiveness analyses of the alternative water supply plans, only the incremental operation and maintenance cost associated with any increased water supply facility water production costs are considered. Alternative Plan 1 is being used as the base to which the other alternative plans will be compared. For this base alternative, only the operation and maintenance cost for new, expanded, or upgraded facilities are included since the cost for operation and maintenance of existing facilities which are common to all alternatives are not included for any alternatives.*

[e]*The annual O&M cost includes a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 2.*

[f]*There is expected to be an estimated average reduction of $376,000 per year for savings associated with existing residences which would be able to discontinue their point-of-entry water treatment systems in the Cities of Oak Creek and Franklin. However, there is also an expected cost involved in developing local water distribution systems. The cost savings due to discontinuation of the point-of-entry water treatment systems and the costs of the local distribution systems are common to all alternative plans and are not specifically accounted for in this table.*

[g]*The annual O&M cost for the We Energies-Water Services Mequon and Thiensville service area includes an estimated average annual water production cost of $219,000 per year based upon the estimated incremental cost of $230 per million gallons for water production at the City of Milwaukee Water Works treatment process. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed cost and other costs. There is also expected to be an estimated average reduction of $1,520,000 per year for savings associated with existing residences which would be able to discontinue their point-of-entry water treatment systems. However, there are also expected costs involved in developing a local water distribution system. The cost savings due to discontinuation of the point-of-entry water treatment systems and the cost of the local distribution system are common to all alternative plans and are not specifically accounted for in this table.*

[h]*Includes the Village of Sturtevant Water Utility which was purchased by the City of Racine Water and Wastewater Utility in 2007 and is now served by the City Utility on a retail basis.*

[i]*Includes the former Crestview Sanitary District and the former North Park Sanitary Districts which were consolidated in 2007 to form the Caledonia East Utility District.*

[j]*Includes the former Caddy Vista Sanitary District and the former Caledonia Utility District No. 1 which were consolidated in 2006 to form the Caledonia West Utility District.*

[k]*See Table 126 for details.*

[l]*The annual O&M cost for the Town of Yorkville Utility District No. 1 includes an estimated annual water production cost of $17,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 2. The annual O&M costs also include an expected average reduction of $28,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.*

[m]*The annual O&M cost for the Northwest Caledonia Area does not include the incremental cost for water production, as that cost is included in the expanded City of Oak Creek Water Utility costs.*

[n]*The annual O&M cost for the Village of Germantown Water Utility includes an estimated annual water production cost of $215,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 4. The annual O&M costs also include an expected average reduction of $1,720,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.*

[o]*The annual O&M cost for the City of Brookfield Water Utility and for the Village of Elm Grove includes an estimated annual water production cost of $618,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 4. The annual O&M costs also include an expected average reduction of $3,240,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.*

Footnotes to Table 132 (continued)

[p]The annual O&M cost for the City of Muskego Water Utility includes an estimated annual water production cost of $133,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 4. The annual O&M costs also include an expected average reduction of $1,519,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.

[q]The annual O&M cost for the City of New Berlin Water Utility for the central portion of the City includes an estimated annual water production cost of $185,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 2. The annual O&M costs also include an expected average reduction of $1,260,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.

[r]Number of wells needed varies with expected well capacity, with the range based upon wells of 0.5 mg to 1.0 mg.

[s]The annual O&M cost for the Village of Menomonee Falls for the west portion of the Village includes an estimated annual water production cost of $51,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 4. The annual O&M costs also include an expected average reduction of $452,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.

[t]The annual O&M cost for the Village of Lannon includes an estimated annual water production cost of $32,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs also include an expected average reduction of $84,400 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.

[u]The annual O&M cost for the City of Pewaukee Water Utility includes an estimated annual water production cost of $155,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 4. The annual O&M costs also include an expected average reduction of $1,125,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.

[v]The annual O&M cost for the Village of Pewaukee Water Utility includes an estimated annual water production cost of $91,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 4. The annual O&M costs also include an expected average reduction of $1,023,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.

[w]The annual O&M cost for the Town of Brookfield Sanitary District No. 4 includes an estimated annual water production cost of $95,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 4. The annual O&M costs also include an expected average reduction of $605,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.

[x]The annual O&M cost for the City of Waukesha Water Utility includes an estimated annual water production cost of $739,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 4. The annual O&M costs also include an expected average reduction of $7,268,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.

Footnotes to Table 132 (continued)

[y]The annual O&M cost for the Village of Sussex Water Utility includes an estimated annual water production cost of $128,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 4. The annual O&M costs also include an expected average reduction of $1,117,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.

[z]The annual O&M cost for the Village of Union Grove Water Utility includes an estimated annual water production cost of $75,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 4. The annual O&M costs also include an expected average reduction of $427,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.

[aa]The annual O&M cost for the Village of Fredonia Water Utility includes an estimated annual water production cost of $24,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 4. The annual O&M costs also include an expected average reduction of $208,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.

[bb]The annual O&M cost for the Village of Saukville Water Utility includes an estimated annual water production cost of $120,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 4. The annual O&M costs also include an expected average reduction of $445,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.

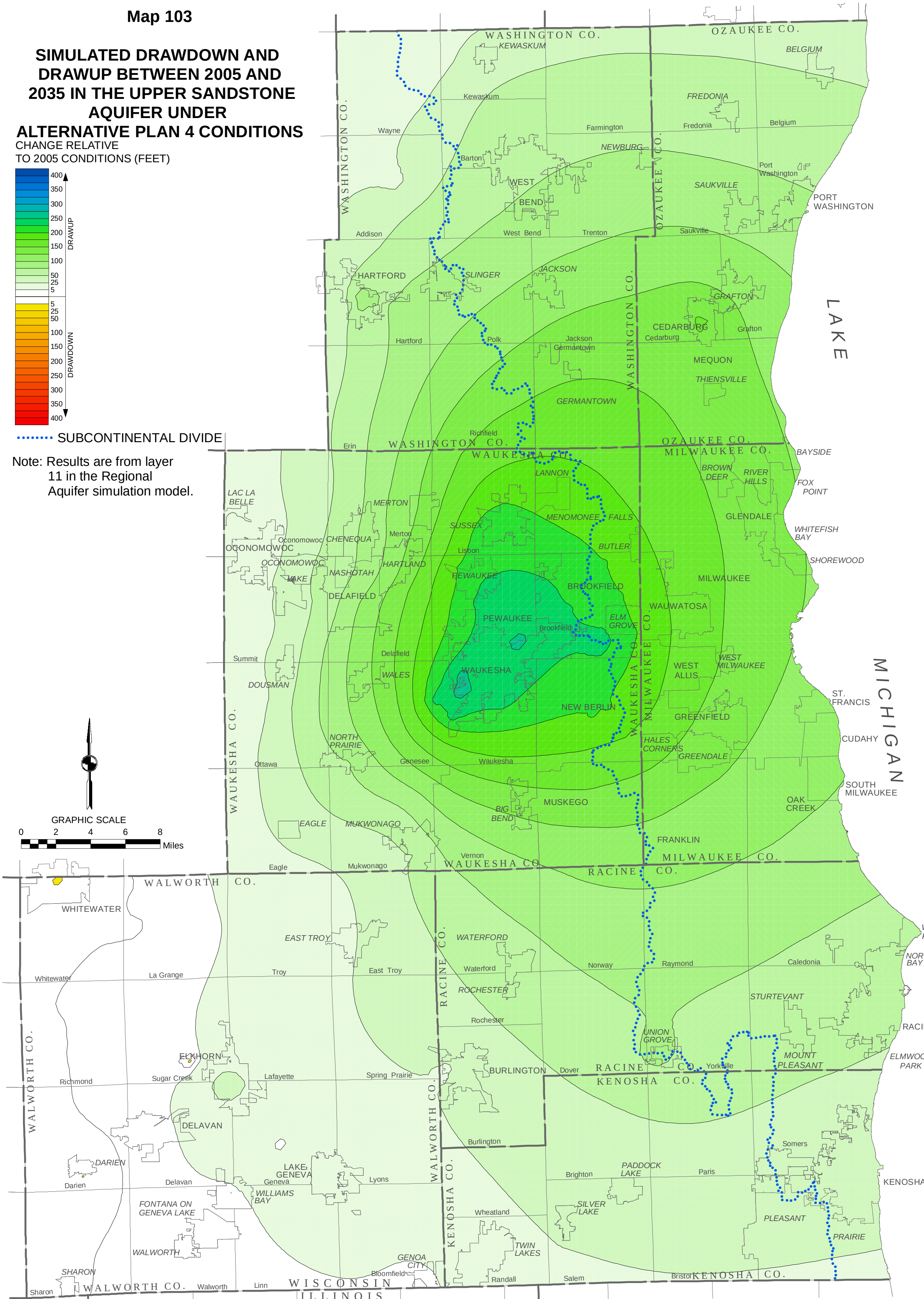
[cc]The annual O&M cost for the City of Cedarburg Light & Water Commission and the Village of Grafton Water and Wastewater Utility includes an estimated annual water production cost of $299,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 4. The annual O&M costs also include an expected average reduction of $2,483,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.

[dd]The City of Port Washington Water Utility costs do not include $443,000 of operation and maintenance costs included as the incremental cost for water production at the new customer utilities including the City of Cedarburg Light & Water Commission, the Village of Grafton Water and Wastewater Utility, the Village of Fredonia Water Utility and the Village of Saukville Water Utility. These costs are included in the specific customer utility costs.

Source: Ruekert & Mielke, Inc., and SEWRPC.

Map 103

SIMULATED DRAWDOWN AND DRAWUP BETWEEN 2005 AND 2035 IN THE UPPER SANDSTONE AQUIFER UNDER ALTERNATIVE PLAN 4 CONDITIONS



Note: Results are from layer 11 in the Regional Aquifer simulation model.

Source: U.S. Geological Survey.

level for the planning period of 2000 through 2035. At the time that these analyses were conducted, no comprehensive areawide water supply plans were in place for the northeastern Illinois area. Therefore, no basis existed for forecasting potential changes in the pumpage concerned, and, the impacts under future conditions may be somewhat different than developed under this planning program. However, the relative differences between the alternative plans considered may be expected to be valid for comparative purposes.

An exception to the general potential drawups in the deep aquifer under this alternative occurs in Walworth County where about 18 percent of model cells exhibit drawdowns over 2005 levels in the upper sandstone aquifer under Alternative Plan 4 conditions. For cells showing drawdowns in Walworth County, the average drawdown projected in this aquifer was less than one foot and the maximum drawdown projected for this aquifer was about seven feet. There was relatively little variation in drawdown in terms of the percentage of cells showing simulated drawdowns over the period 2005 to 2035 greater than the given thresholds under Alternative Plan 4 conditions. No drawdowns greater than 10 feet in the upper sandstone aquifer were simulated to occur in this County. Only about 0.1 percent of model cells showing drawdowns in Walworth County had drawdowns greater than five feet.

Table 133 also summarizes simulated drawups in the upper sandstone aquifer over the period 2005 to 2035 under Alternative Plan 4 conditions. The percentage of cells in the model showing drawups over 2005 levels ranges from about 82 percent in Walworth County to 100 percent in Kenosha, Milwaukee, Ozaukee, Racine, Washington, and Waukesha Counties. Average drawups in this aquifer are projected to range from less than about 12 feet for cells showing drawups in Walworth County to about 136 feet for cells showing drawups in Milwaukee County. Maximum simulated drawups in this aquifer range from about 61 feet in Walworth County to about 270 feet in Waukesha County. Model cells in most of the Region showed simulated drawups in the upper sandstone aquifer under Alternative Plan 4 conditions greater than five feet as shown on Map 103. Exceptions were located in southern and western Walworth County.

Table 134 summarizes the variation in drawup in terms of the percentage of cells showing simulated drawups over the period 2005 to 2035 greater than the given thresholds. In much of the Region, drawups in excess of 10 feet were common in the upper sandstone aquifer under Alternative Plan 4 conditions, representing all of the model cells in all of the Counties, except for Walworth County. In much of the Region, drawups in excess of 100 feet were common in the upper sandstone aquifer under Alternative Plan 4 conditions. While no model cells in Kenosha or Walworth Counties show drawups in excess of 50 feet, drawups in excess of 50 feet were found in Milwaukee, Ozaukee, Racine, Washington, and Waukesha Counties, ranging from about 2 percent of cells in Racine County to 95 percent of cells in Milwaukee County. Drawups in excess of 200 feet were detected in two Counties under Alternative Plan 4 conditions. In Waukesha County, they represented about 20 percent of model cells. Drawups in excess of 200 feet were less common in Washington County, accounting for less than 1 percent of model cells in this County.

Previous model results suggest that the top of the Sinnipee Group dolomite below the Maquoketa shale had become unsaturated by the year 2000 in central Waukesha County.[15] The simulation results suggest that under Alternative Plan 4 conditions, such unsaturated conditions would not continue to exist. An unsaturated condition at this depth, depending on how it might spread, could influence well yields and groundwater geochemistry around deep wells open to the Sinnipee Group, the St. Peter Formation, and below.

Water Budget Analyses

Table 134 shows the findings by County of a water budget analysis for the deep groundwater system under Alternative Plan 4 conditions. This analysis derived the anticipated values of two groundwater performance indicators—the demand to supply ratio and the human influence ratio—under Alternative Plan 4 conditions for the years 2005 and 2035. The analysis indicates that in 2005 the demand to supply ratio would range from about

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[15]*SEWRPC Technical Report No. 41*, op. cit.

Table 133

AVERAGE AND MAXIMUM SIMULATED DRAWDOWN AND DRAWUP IN THE UPPER SANDSTONE AQUIFER UNDER ALTERNATIVE PLAN 4 CONDITIONS: 2005-2035[a]

County	Drawdown			Drawup		
	Percent of Model Cells	Average (feet)	Maximum (feet)	Percent of Model Cells	Average (feet)	Maximum (feet)
Kenosha..................	0.0	0.0	0.0	100.0	35.2	66.5
Milwaukee................	0.0	0.0	0.0	100.0	135.9	187.7
Ozaukee	0.0	0.0	0.0	100.0	91.4	159.7
Racine.....................	0.0	0.0	0.0	100.0	68.6	105.6
Walworth.................	17.9	0.6	6.9	82.1	11.9	61.4
Washington.............	0.0	0.0	0.0	100.0	77.9	254.9
Waukesha................	0.0	0.0	0.0	100.0	125.0	270.2

[a]*Results are from Layer 11 in the groundwater simulation model.*

Source: U.S. Geological Survey.

Table 134

SIMULATED DRAWUP IN THE UPPER SANDSTONE AQUIFER UNDER ALTERNATIVE PLAN 4 CONDITIONS: 2005-2035[a]

County	Percent of Model Cells Showing Drawup Beyond Greater than:						
	One Foot	Five Feet	10 Feet	50 Feet	100 Feet	150 Feet	200 Feet
Kenosha..................	100.0	100.0	36.8	11.3	0.0	0.0	0.0
Milwaukee................	100.0	100.0	100.0	100.0	94.8	29.1	0.0
Ozaukee	100.0	100.0	100.0	86.8	41.5	2.4	0.0
Racine.....................	100.0	100.0	100.0	85.7	2.4	0.0	0.0
Walworth.................	69.5	52.3	37.4	0.7	0.0	0.0	0.0
Washington.............	100.0	100.0	99.9	72.8	27.7	6.5	0.1
Waukesha................	100.0	100.0	99.5	77.2	60.7	42.2	19.8

[a]*Results are from Layer 11 in the groundwater simulation model.*

Source: U.S. Geological Survey.

0.10 in Kenosha County to about 5.77 in Waukesha County under Alternative Plan 4 conditions. Under these conditions, the values of the demand to supply ratio for Ozaukee, Racine, and Waukesha Counties in 2005 are expected to exceed one, indicating water budget deficits in the deep aquifer underlying these counties. The analysis also projects that under Alternative Plan 4 conditions the demand to supply ratio would range from about 0.02 in Ozaukee County to about 1.93 in Racine County in 2035. Under these conditions, the values of this indicator are anticipated to decrease in every County of the Region except Walworth County between 2005 and 2035. For 2035, the values of the demand to supply ratio for Racine and Waukesha Counties exceed one, indicating water budget deficits in the deep aquifer underlying these Counties.

The analysis also indicates, as shown in Table 135, that in 2005 the human impact ratio would range from about minus 0.88 in Waukesha County to about minus 0.04 in Kenosha County under Alternative Plan 4 conditions and projects that in 2035 this indicator would range from about minus 0.49 in Waukesha County to about minus 0.08 in Ozaukee County under Alternative Plan 4 conditions. These values suggest that the net effect of human

Table 135

PROJECTED GROUNDWATER PERFORMANCE INDICATORS FOR THE SANDSTONE AQUIFERS UNDER ALTERNATIVE PLAN 4 CONDITIONS: 2005 AND 2035

County	Demand to Supply Ratio[a]		Human Influence Ratio[b]	
	2005	2035	2005	2035
Kenosha	0.101	0.057	-0.041	-0.018
Milwaukee	0.567	0.369	-0.197	-0.142
Ozaukee	1.040	0.017	-0.317	-0.008
Racine	1.963	1.932	-0.500	-0.441
Walworth	0.745	0.883	-0.326	-0.400
Washington	0.453	0.294	-0.191	-0.174
Waukesha	5.773	1.626	-0.881	-0.494

[a]*The demand to supply ratio is defined as the ratio of net pumping demand on an aquifer to the amount of water that is replenished at a given point in time. Generally, this indicator ranges from 0—representing no human impact—upward. Values over 1.0 indicate that more groundwater is being extracted than can be replaced in a long-term, sustainable fashion. The year 2005 and 2035 conditions for this indicator are compared to predevelopment conditions.*

[b]*The human impact ratio, is defined as the ratio of human-induced groundwater inflows to total inflows minus the ratio of human-induced groundwater outflows to total outflows. This indicator is an expression of the relative magnitude of human alteration of the groundwater system. Values range from minus 1.0 in areas where wells have become the only discharge from an aquifer by stopping all other groundwater discharges, through 0 representing no net human impact, to plus 1.0 representing situations where human additions are the only inputs to the aquifer. The year 2005 and 2035 conditions for this indicator are compared to predevelopment conditions.*

Source: University of Wisconsin-Milwaukee.

activities under these conditions would be to remove water from the deep groundwater system. The values for Racine, Walworth and Waukesha Counties suggest that pumping is a major component of the outflows from the deep aquifer in these Counties under Alternative Plan 4 conditions. In Walworth County, the projected values of this indicator for 2035 are lower than the 2005 values, indicating that the influence of human withdrawals on the water budget of the deep groundwater would be expected to increase in these Counties under Alternative Plan 4 conditions. In the other counties of the Region, the projected values of this indicator for 2035 are higher than the 2005 values, indicating a reduction in the influence of human withdrawals on the water budget of the deep groundwater system would be expected in these Counties under Alternative Plan 4 conditions. Despite this anticipated reduction, under these conditions the deep groundwater systems in Racine, Walworth and Waukesha Counties are anticipated to remain heavily influenced by human activities in 2035.

Groundwater Impacts in the Shallow Aquifer

As previously noted, except in those portions of the Region where the shallow aquifers are confined by overlying clay-rich glacial tills, the effects of alternative plans upon baseflow to surface water features will generally be more informative of the impacts upon the shallow groundwater system than the associated changes in water levels in the sand and gravel and Silurian dolomite aquifers.

Impacts to Groundwater-Derived Baseflow to Surface Waters

On a Regional scale, pumpage under Alternative Plan 4 conditions decreased from 76.8 mgd in 2005, to 65.6 mgd in 2035, representing a total decrease in pumping of 11.2 mgd, or about 15 percent. In addition, the model indicates that under Alternative Plan 4 conditions a net amount of about 1.7 mgd of water is induced to flow out from surface waters in the Region. Thus, about 12.9 mgd consisting of water previously going to wells or drawn from surface waters are contributed under Alternative Plan 4 conditions to other sinks such as accumulation in storage in the confined and unconfined aquifers and to a reduction of net cross-boundary flow into and out of the planning area.

As already noted, major streams, rivers, and lakes in the surface water system in the Southeastern Wisconsin Region are represented in the model by 3,756 cells designated as stream nodes. The simulation results indicated that under 2005 pumping conditions, about 92 percent of these nodes were receiving baseflow from groundwater, while about 5 percent were losing baseflow to groundwater. These percentages may be expected to remain unchanged in the plan design year 2035 under Alternative Plan 4 conditions. As previously noted, the analyses conducted consider only the impacts on the groundwater-derived baseflow of the streamflow. Groundwater-derived baseflow typically comprises from 10 to 50 percent of total streamflow.

Table 136 summarizes simulated changes in baseflow to surface waters in the Southeastern Wisconsin Region under Alternative Plan 4 conditions over the period 2005 to 2035. In aggregate, by 2035 surface waterbodies in the Region may be expected to experience a net baseflow depletion of about 2.6 mgd. The amounts of depletion will vary among the Counties, ranging from an augmentation of baseflow of about 3.4 mgd in Waukesha County, to a depletion of about 4.0 mgd in Walworth County. This is the result of about 3.5 mgd of outflow depletion which is partially offset by about 0.9 mgd augmented baseflow to surface water features. These aggregate totals, however, obscure differences in site-specific baseflow changes within each County. While the County totals project overall depletions or augmentations within each County, individual waterbodies may experience either depletion or augmentation on a site-specific basis.

Model nodes showing greater than 10 percent and greater than 25 percent potential baseflow depletion under Alternative Plan 4 conditions are shown on Maps 104 and 105, respectively. As previously noted, these data are considered valid for the purpose of comparing alternative plans. Model refinement would be needed for consideration of site-specific impacts. Several notable areas of baseflow depletion are indicated by the model results. Nodes for which the simulation analyses indicated greater than 10 percent baseflow reduction include those representing the mainstem of the Milwaukee River between West Bend and Newburg in Washington County; Quaas Creek in Washington County; the Rubicon River and the East Branch of the Rubicon River in Washington County; portions of Pebble Brook in Waukesha County; Lake Beulah in Walworth County; a portion of the White River in Walworth County; Turtle Creek in Walworth County; Delavan Lake in Walworth County; Jackson Creek in Walworth County; and a portion of Darien Creek in Walworth County. Maps 104 and 105 also highlight those streams which receive a significant amount of wastewater treatment plant effluent, and are, thus, less sensitive to reductions in baseflows. It is important to note that several of the streams expected to show baseflow reductions in excess of 10 percent under Alternative Plan 4 conditions receive wastewater treatment plant effluent. In those streams, the impacts of a reduced groundwater-derived baseflow are generally mitigated from a streamflow perspective. Some impacts may remain from a water quality perspective. Model nodes showing greater than 25 percent baseflow reductions include those representing portions of the Rubicon River and the East Branch of the Rubicon River in Washington County and Jackson Creek in Walworth County.

Maps 103 and 104 also depict model nodes which show augmentation of baseflow under Alternative Plan 4 conditions greater than 10 percent and greater than 25 percent, respectively. Several notable areas of baseflow augmentation are indicated by the model results. Nodes for which simulation analyses indicated greater than 10 percent baseflow augmentation include those representing some of the headwaters of the Menomonee River in Washington and Ozaukee Counties; portions of the Nor-X-Way Channel in Washington and Waukesha Counties; Mole, Pigeon, and Trinity Creeks and portions of Ulao Creek in Ozaukee County; the Little Menomonee River in Ozaukee and Milwaukee Counties; the mainstem of the Fox River between the confluences with Poplar Creek and Mill Brook, Butler Ditch, Hale Creek, Underwood Creek, Upper Nashotah Lake, Lower Nashotah Lake, Upper Nemahbin Lake, Lake Denoon, and portions of Deer Creek in Waukesha County; the Wind Lake subwatershed of the Fox River watershed in Waukesha and Racine Counties, including Big Muskego, Little Muskego, and Wind Lakes and the Muskego and Wind Lake Drainage Canals; the mainstem of the Menomonee River between the confluences with the Little Menomonee River and Honey Creek and Tess Corners Creeks in Milwaukee County; Browns Lake and a portion of the East Branch of the Root River Canal in Racine County; and Silver Lake in Kenosha County.

Table 136

SIMULATED BASEFLOW DEPLETION TO SURFACE WATERS UNDER ALTERNATIVE PLAN 4 CONDITIONS: 2005-2035

Baseflow to Surface Water	2000 Baseflow (million gallons per day)	2035 Baseflow (million gallons per day)	Difference (million gallons per day)[a]	Percent Change[a]
Kenosha County				
Inflow to Surface Water	41.63	40.50	-1.13	-2.7
Outflow from Surface Water	0.40	1.12	-0.72	-180.3
Subtotal	41.23	39.38	-1.85	-4.5
Milwaukee County				
Inflow to Surface Water	11.45	11.65	0.20	1.7
Outflow from Surface Water	2.98	2.96	0.02	0.7
Subtotal	8.47	8.69	0.22	2.7
Ozaukee County				
Inflow to Surface Water	17.34	19.87	2.53	14.6
Outflow from Surface Water	0.46	0.47	-0.01	-2.0
Subtotal	16.88	19.40	2.52	14.9
Racine County				
Inflow to Surface Water	41.70	41.95	0.25	0.6
Outflow from Surface Water	0.07	0.45	-0.38	-563.1
Subtotal	41.63	41.50	-0.13	-0.3
Walworth County				
Inflow to Surface Water	104.00	101.54	-2.46	-2.4
Outflow from Surface Water	8.99	10.52	-1.53	-17.0
Subtotal	95.01	91.02	-3.99	-4.2
Washington County				
Inflow to Surface Water	63.52	61.55	-1.97	-3.1
Outflow from Surface Water	2.52	3.31	-0.79	-31.5
Subtotal	61.00	58.24	-2.76	-4.5
Waukesha County				
Inflow to Surface Water	89.55	92.99	3.44	3.8
Outflow from Surface Water	1.28	1.35	-0.07	- 31.5
Subtotal	88.27	91.64	3.37	3.8
Southeastern Wisconsin Region				
Inflow to Surface Water	369.19	370.05	0.86	0.2
Outflow from Surface Water	16.70	20.18	-3.48	-20.8
Total	352.49	349.87	-2.62	-0.7

[a] *A positive difference or change represents augmentation of baseflow to surface waters, a negative difference or change represents depletion of baseflow to surface waters.*

Source: U.S. Geological Survey.

Model nodes simulated to show greater than 25 percent baseflow augmentation include those representing Trinity and Pigeon Creeks and portions of Mole, Ulao, and Sauk Creeks in Ozaukee County; Butler Ditch, portions of Poplar Creek, Lake Denoon, and upper portions of the Wind Lake subwatershed of the Fox River watershed in Waukesha County; and Tess Corners Creek in Milwaukee County.

Maps 103 and 104, indicate that most of the surface water features impacted by baseflow augmentations do not receive wastewater treatment plant effluent. The major exception to this generalization is the section of the Fox

Map 104

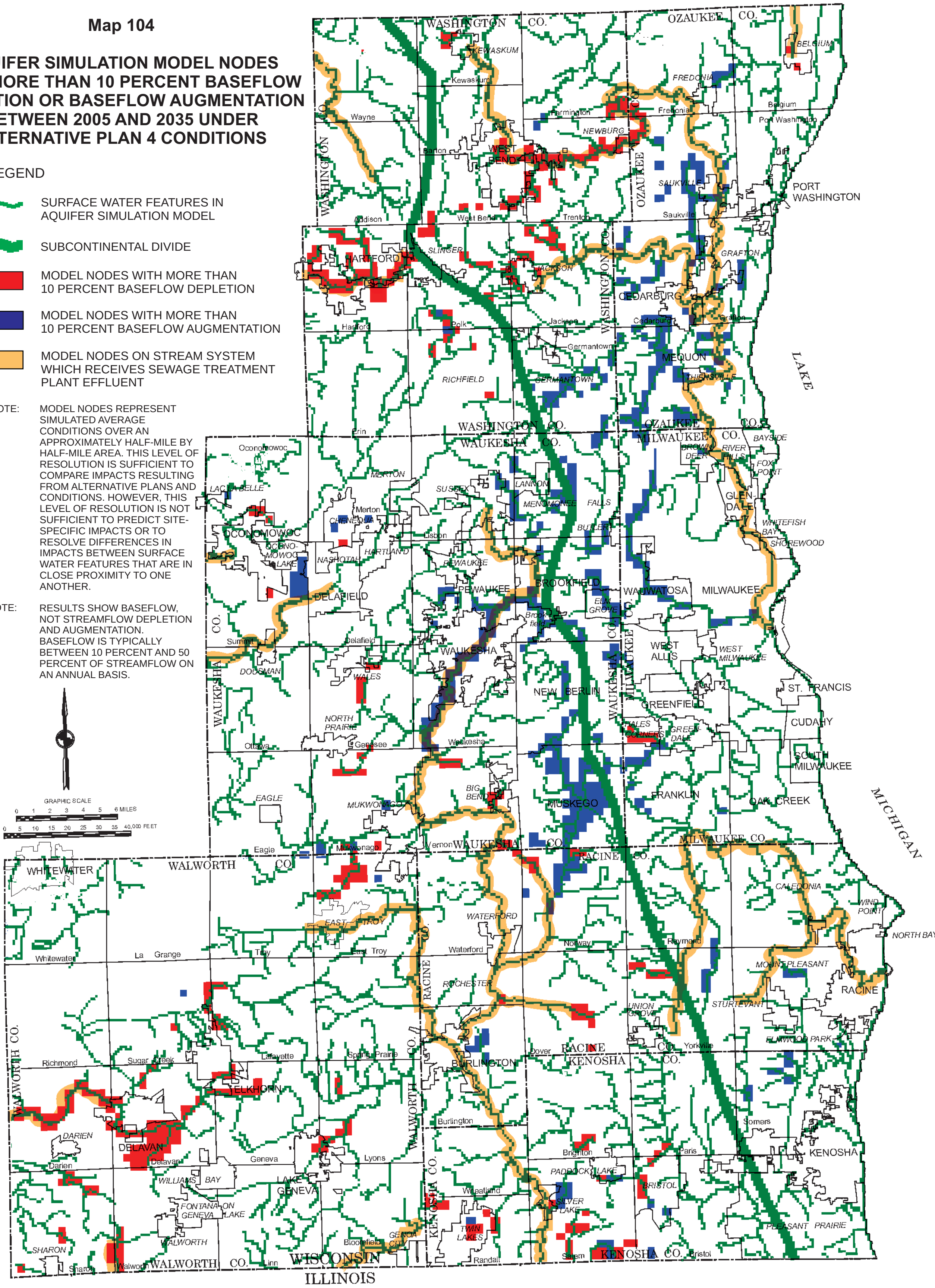
AQUIFER SIMULATION MODEL NODES WITH MORE THAN 10 PERCENT BASEFLOW DEPLETION OR BASEFLOW AUGMENTATION BETWEEN 2005 AND 2035 UNDER ALTERNATIVE PLAN 4 CONDITIONS

LEGEND

- SURFACE WATER FEATURES IN AQUIFER SIMULATION MODEL
- SUBCONTINENTAL DIVIDE
- MODEL NODES WITH MORE THAN 10 PERCENT BASEFLOW DEPLETION
- MODEL NODES WITH MORE THAN 10 PERCENT BASEFLOW AUGMENTATION
- MODEL NODES ON STREAM SYSTEM WHICH RECEIVES SEWAGE TREATMENT PLANT EFFLUENT

NOTE: MODEL NODES REPRESENT SIMULATED AVERAGE CONDITIONS OVER AN APPROXIMATELY HALF-MILE BY HALF-MILE AREA. THIS LEVEL OF RESOLUTION IS SUFFICIENT TO COMPARE IMPACTS RESULTING FROM ALTERNATIVE PLANS AND CONDITIONS. HOWEVER, THIS LEVEL OF RESOLUTION IS NOT SUFFICIENT TO PREDICT SITE-SPECIFIC IMPACTS OR TO RESOLVE DIFFERENCES IN IMPACTS BETWEEN SURFACE WATER FEATURES THAT ARE IN CLOSE PROXIMITY TO ONE ANOTHER.

NOTE: RESULTS SHOW BASEFLOW, NOT STREAMFLOW DEPLETION AND AUGMENTATION. BASEFLOW IS TYPICALLY BETWEEN 10 PERCENT AND 50 PERCENT OF STREAMFLOW ON AN ANNUAL BASIS.



Source: U.S. Geological Survey.

Map 105

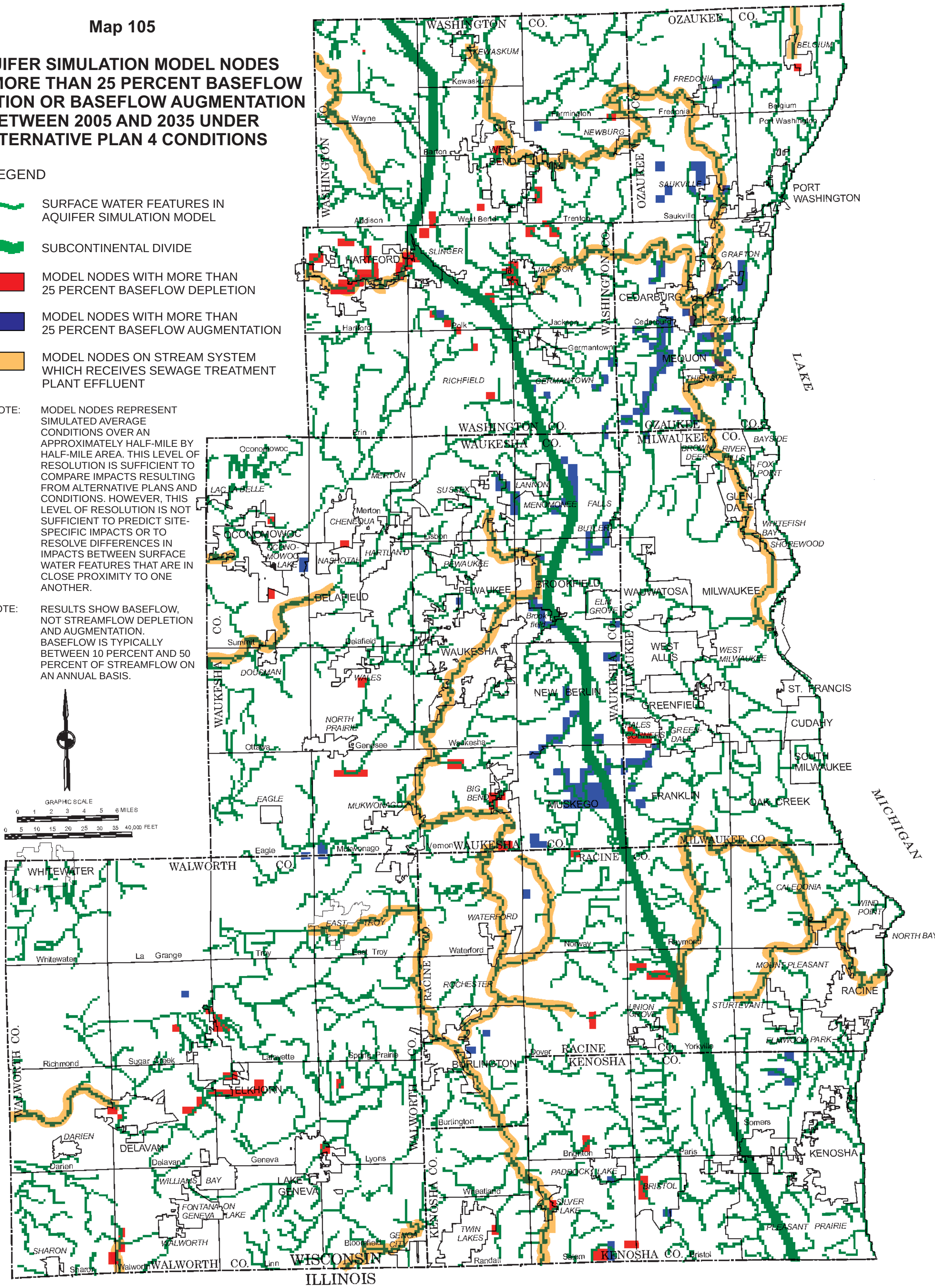
AQUIFER SIMULATION MODEL NODES WITH MORE THAN 25 PERCENT BASEFLOW DEPLETION OR BASEFLOW AUGMENTATION BETWEEN 2005 AND 2035 UNDER ALTERNATIVE PLAN 4 CONDITIONS

LEGEND

- SURFACE WATER FEATURES IN AQUIFER SIMULATION MODEL
- SUBCONTINENTAL DIVIDE
- MODEL NODES WITH MORE THAN 25 PERCENT BASEFLOW DEPLETION
- MODEL NODES WITH MORE THAN 25 PERCENT BASEFLOW AUGMENTATION
- MODEL NODES ON STREAM SYSTEM WHICH RECEIVES SEWAGE TREATMENT PLANT EFFLUENT

NOTE: MODEL NODES REPRESENT SIMULATED AVERAGE CONDITIONS OVER AN APPROXIMATELY HALF-MILE BY HALF-MILE AREA. THIS LEVEL OF RESOLUTION IS SUFFICIENT TO COMPARE IMPACTS RESULTING FROM ALTERNATIVE PLANS AND CONDITIONS. HOWEVER, THIS LEVEL OF RESOLUTION IS NOT SUFFICIENT TO PREDICT SITE-SPECIFIC IMPACTS OR TO RESOLVE DIFFERENCES IN IMPACTS BETWEEN SURFACE WATER FEATURES THAT ARE IN CLOSE PROXIMITY TO ONE ANOTHER.

NOTE: RESULTS SHOW BASEFLOW, NOT STREAMFLOW DEPLETION AND AUGMENTATION. BASEFLOW IS TYPICALLY BETWEEN 10 PERCENT AND 50 PERCENT OF STREAMFLOW ON AN ANNUAL BASIS.



Source: U.S. Geological Survey.

River between the confluences with Poplar Creek and Mill Brook which currently receives contributions of treated effluent from wastewater treatment plants located in Sussex, Brookfield, and Waukesha. It is important to note that Alternative Plan 4 envisions that most of the discharges from these plants would be directed to the Lake Michigan watershed to provide return flow of water diverted from Lake Michigan. The baseflow augmentation in this section of the Fox River would provide some mitigation resultant reduction in flow from these facilities.

These simulated baseflow reductions need to be carefully interpreted. As noted above, the groundwater model simulates changes in baseflow, not changes in total streamflow. A change in baseflow does not necessarily indicate a change in total streamflow. For example, in some streams much of a reduction in baseflow may be returned to the surface water system through discharge from wastewater treatment plants. This is certainly the case for the mainstem of the Milwaukee River in Washington County where four municipal wastewater treatment plants discharge treated effluent into the River or its tributaries in or upstream of the portion of the River projected to experience baseflow reductions greater than 10 percent. Increase in runoff due to changes in land use may also serve to augment streamflow in streams experiencing baseflow reductions. In addition, because of the resolution provided by the model grid, any simulated change in baseflow represents an average change over the approximately 160-acre area of a model cell. Because variations may occur within the area represented by a model cell, this average may not be totally representative of individual surface water features within the cell, particularly small surface water features in cells containing multiple surface water features.

Simulated baseflow changes between 2005 and 2035 were evaluated at 100 model nodes representing surface water evaluation sites. Decreases in baseflow under Alternative Plan 4 conditions were found to occur at 45 evaluation sites, or 45 percent of evaluation sites, with decreases in excess of 10 percent of 2005 baseflow found at 13, or 13 percent, of these sites, and simulated decreases in excess of 25 percent of 2005 baseflow found at five, or 5 percent, of these sites. Increases in baseflow were found to occur at 42 evaluation sites, or 42 percent of evaluation sites, with increases in excess of 10 percent of 2005 baseflow found at 10, or 10 percent, of these sites and increases in excess of 25 percent of 2005 baseflow found at seven, or 7 percent, of these sites. The remaining 13 evaluation sites, or 13 percent of evaluation sites, either experienced no change in baseflow or were not simulated as having streamflow in 2005.

Simulated Water Levels in the Shallow Aquifers

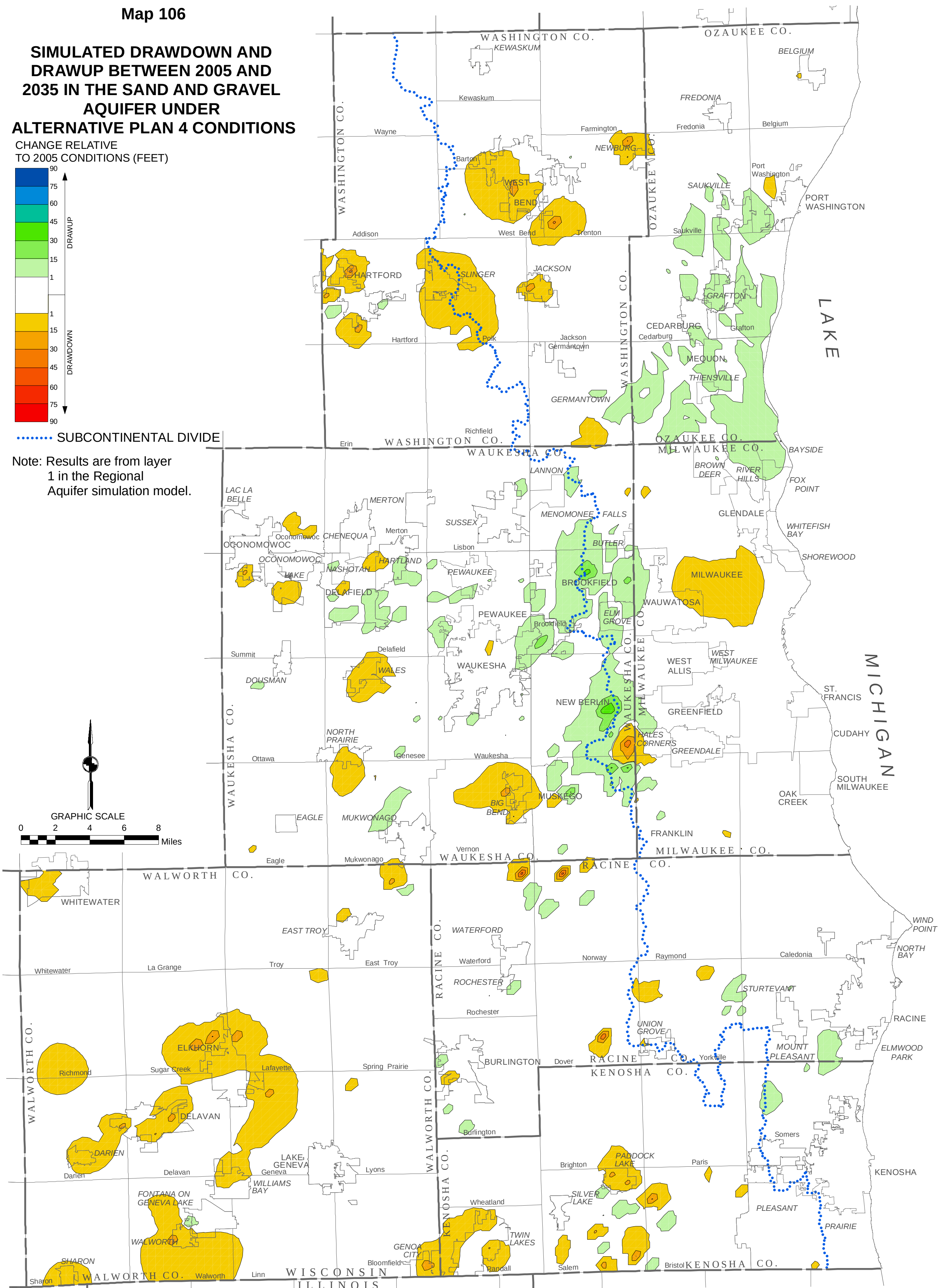
The results of the simulation indicate that under Alternative Plan 4 conditions, additional drawdowns may be expected to occur in the shallow aquifer over much of the Region. These impacts are shown on Maps 106 and 107. Table 137 provides a summary of the simulated drawdowns and drawups in the glacial sand and gravel aquifer over the period 2005 to 2035. The percentage of cells in the model showing drawdowns over 2005 levels ranges from about 25 percent in Waukesha County to about 72 percent in Walworth County. Average drawdowns projected in this aquifer are relatively small, ranging from about 0.2 foot for cells showing drawdowns in Ozaukee County, to about 1.1 feet for cells showing drawdowns in Washington and Waukesha Counties. This reflects the damping effect that surface waters have on changes in the shallow groundwater system. Often the major effect of pumping from shallow wells is to reduce groundwater discharge to local surface water features. The maximum drawdowns projected for this aquifer are considerably higher, ranging from about 1.4 feet for cells showing drawdowns in Ozaukee County, to about 51 feet for cells showing drawdowns in Racine County.

Table 138 summarizes the variation among model cells in terms of the percentage of the cells showing simulated drawdowns over the period 2005 to 2035 greater than the given thresholds. In most of the Region, drawdowns greater than 10 feet are relatively rare in the glacial aquifer under Alternative Plan 4 conditions. None of the model cells in Milwaukee and Ozaukee Counties and fewer than 1 percent of the model cells in Kenosha, Racine, Walworth, and Waukesha Counties indicate drawdowns in excess of 10 feet. Drawdowns in excess of 10 feet may be expected to be slightly more common in Washington County, representing about 1 percent of cells in this County.

Model cells showing simulated drawdowns were distributed throughout the Region; however, there were areas that showed a high proportion of cells showing drawdowns greater than one foot. These areas include western

Map 106

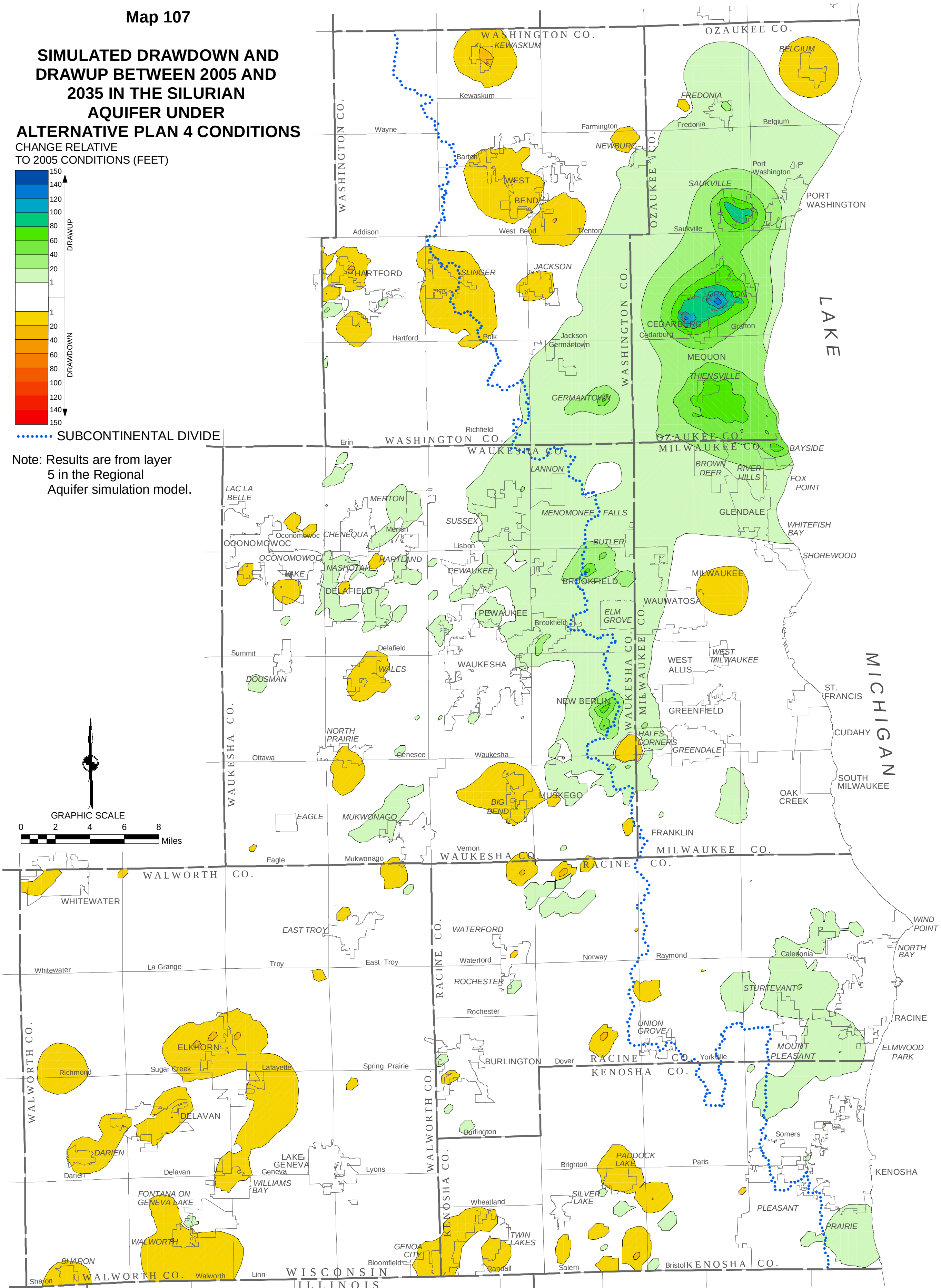
SIMULATED DRAWDOWN AND DRAWUP BETWEEN 2005 AND 2035 IN THE SAND AND GRAVEL AQUIFER UNDER ALTERNATIVE PLAN 4 CONDITIONS



Source: U.S. Geological Survey.

Map 107

SIMULATED DRAWDOWN AND DRAWUP BETWEEN 2005 AND 2035 IN THE SILURIAN AQUIFER UNDER ALTERNATIVE PLAN 4 CONDITIONS



Note: Results are from layer 5 in the Regional Aquifer simulation model.

Source: U.S. Geological Survey.

Table 137

AVERAGE AND MAXIMUM SIMULATED DRAWDOWN AND DRAWUP IN THE GLACIAL SAND AND GRAVEL AQUIFER UNDER ALTERNATIVE PLAN 4 CONDITIONS BY COUNTY: 2005-2035[a]

County	Drawdown			Drawup		
	Percent of Model Cells	Average (feet)	Maximum (feet)	Percent of Model Cells	Average (feet)	Maximum (feet)
Kenosha	50.8	0.8	31.5	49.2	0.2	8.2
Milwaukee	46.6	0.6	4.5	53.4	0.3	8.5
Ozaukee	26.3	0.2	1.4	73.7	1.0	12.3
Racine	32.2	0.6	50.8	67.8	0.1	9.0
Walworth	72.1	0.9	31.0	27.9	0.1	4.1
Washington	58.8	1.1	34.4	41.2	0.1	4.1
Waukesha	24.9	1.1	41.2	75.1	0.1	38.3

[a]Results are from Layer 1 in the groundwater simulation model.

Source: U.S. Geological Survey.

Table 138

SIMULATED DRAWDOWN IN THE GLACIAL SAND AND GRAVEL AQUIFER UNDER ALTERNATIVE PLAN 4 CONDITIONS BY COUNTY: 2005-2035[a]

County	Percent of Model Cells Showing Drawdown Beyond Greater than:				
	One Foot	Five Feet	10 Feet	50 Feet	100 Feet
Kenosha	6.8	1.7	0.9	0.0	0.0
Milwaukee	7.6	0.0	0.0	0.0	0.0
Ozaukee	0.6	0.0	0.0	0.0	0.0
Racine	1.8	0.5	0.2	0.1	0.0
Walworth	14.2	2.5	0.7	0.0	0.0
Washington	11.5	3.3	1.0	0.0	0.0
Waukesha	5.1	1.3	0.6	0.0	0.0

[a]Results are from Layer 1 in the groundwater simulation model.

Source: U.S. Geological Survey.

Kenosha County; central Milwaukee County; south-central Racine County; central and western Walworth County; and central Washington County. Areas with a high proportion of cells showing drawdowns greater than one foot are also scattered through western and southern Waukesha County, as shown on Map 105.

Table 137 also summarizes simulated drawups in the glacial aquifer over the period 2005 to 2035. The percentage of cells in the model showing drawups over 2005 levels ranges from about 28 percent in Walworth County to about 75 percent in Waukesha County. Average drawups projected in this aquifer are relatively small, ranging from less than 0.1 foot for cells showing drawups in Racine County, Walworth County, Washington County, and Waukesha County to about one foot for cells showing drawups in Ozaukee County. Maximum simulated drawups in this aquifer range from about four feet in Walworth County and Washington County to about 38 feet in Waukesha County. While model cells showing simulated drawups in the glacial aquifer were distributed throughout the Region, areas with a high proportion of cells showing drawups greater than one foot were found primarily in southern and central Ozaukee County and in central and eastern Waukesha County, as shown on Map 105.

Table 139 presents a summary of simulated drawdowns and drawups in the Silurian aquifer over the period 2005 to 2035. The percentage of cells in the model showing drawdowns over 2005 levels ranges from about 10 percent in Ozaukee County, to about 67 percent in Walworth County. Average drawdowns projected in this aquifer are relatively small, ranging from about 0.6 foot for cells showing drawdowns in Milwaukee County, to about 1.4 feet for cells showing drawdowns in Washington County. As already noted, the small average drawdown in this aquifer over most of the Region reflects the damping effect that surface waters have on changes in the shallow groundwater system.

Maximum drawdowns projected for the Silurian aquifer are considerably higher than the average drawdowns, ranging from about 1.8 feet for cells showing drawdowns in Milwaukee County, to about 39 feet for cells showing drawdowns in Racine County. Table 140 summarizes the variation among the model cells in terms of the percentage of the cells showing simulated drawdowns over the period 2005 to 2035 greater than the given thresholds. In most of the Region, drawdowns greater than 10 feet are relatively rare in the Silurian aquifer under Alternative Plan 4 conditions. None of the model cells in Milwaukee and Ozaukee Counties and fewer than 1 percent of the model cells in Kenosha, Racine, Walworth, and Waukesha Counties indicate drawdowns in excess of 10 feet. Drawdowns in excess of 10 feet may be expected to be slightly more common in Washington County, representing about 1 percent of cells in this County. Model cells showing simulated drawdowns were distributed throughout the Region; however, there were areas that indicated a high proportion of cells showing drawdowns greater than one foot. At the resolution of the model, these areas include western Kenosha County, northeastern Ozaukee County, north-central Milwaukee County, southern Racine County, central and western Walworth County, and central and north-central Washington County. Areas with high proportions of cells showing drawdowns greater than one foot are also scattered throughout western and southern Waukesha County.

Table 139 also summarizes simulated drawups in the Silurian aquifer over the period 2005 to 2035. The percentage of cells in the model showing drawups over 2005 levels ranges from about 33 percent in Walworth County to about 90 percent in Ozaukee County. With one exception—Ozaukee County—average drawups projected in this aquifer are relatively small, ranging from about 0.1 foot for cells showing drawups in Walworth County to about 2.7 feet for cells showing drawups in Milwaukee County. Maximum simulated drawups in this aquifer range from about five feet in Walworth County to about 133 feet in Ozaukee County. While model cells showing simulated drawups in the Silurian aquifer were distributed throughout the Region, areas containing a high proportion of cells showing drawups greater than one foot were found in most of Ozaukee County, in northern Milwaukee County along the Milwaukee-Ozaukee county line, in southeastern Washington County, and in eastern Waukesha County. Much of the simulated drawup in these areas may be attributed to shifting of the source of water supply from shallow wells to a Lake Michigan supply as envisioned under Alternative Plan 4. Smaller areas containing high proportions of cells showing drawups greater than one foot were found in northwestern Racine County and in eastern Racine and Kenosha Counties.

Water Budget Analysis

Table 141 shows results by County from a water budget analysis for the shallow groundwater system under Alternative Plan 4 conditions. This analysis derived the anticipated values of three groundwater performance indicators—the demand to supply ratio, the human influence ratio, and the baseflow reduction index—under Alternative Plan 4 conditions for the years 2005 and 2035. The analysis indicates that in 2005 the demand to supply ratio would range from about 0.04 in Walworth County to about 0.20 in Ozaukee County under Alternative Plan 4 conditions. The analysis projects that in 2035 this indicator would range from about 0.06 in Racine County and Waukesha County to about 0.13 in Milwaukee County under Alternative Plan 4 conditions. While under these conditions, increases in this indicator are projected to occur in Kenosha, Racine, Walworth, and Washington Counties, with all values of the demand to supply ratio for the shallow aquifer projected to be below 1.0, indicating little evidence of a water budget deficit in the shallow aquifer.

The analysis also indicates that in 2005 the human impact ratio would range from about minus 0.19 in Ozaukee County to about minus 0.04 in Walworth County under Alternative Plan 4 conditions, and projects that in 2035 this indicator would range from about minus 0.13 in Milwaukee County to about minus 0.05 in Ozaukee County

Table 139

AVERAGE AND MAXIMUM SIMULATED DRAWDOWN AND DRAWUP IN THE SILURIAN AQUIFER UNDER ALTERNATIVE PLAN 4 CONDITIONS: 2005-2035[a]

County	Drawdown			Drawup		
	Percent of Model Cells	Average (feet)	Maximum (feet)	Percent of Model Cells	Average (feet)	Maximum (feet)
Kenosha	47.3	0.8	31.2	52.7	0.6	19.8
Milwaukee	13.3	0.6	1.8	86.7	2.7	72.6
Ozaukee	10.4	1.3	9.8	89.6	24.3	133.1
Racine	21.7	0.8	38.7	78.3	0.6	26.7
Walworth	67.3	0.9	30.9	32.7	0.1	5.2
Washington	51.3	1.4	28.4	48.7	2.2	67.0
Waukesha	18.9	1.1	18.6	81.1	2.4	75.8

[a]*Results are from Layer 5 in the groundwater simulation model.*

Source: U.S. Geological Survey.

Table 140

SIMULATED DRAWDOWN IN THE SILURIAN AQUIFER UNDER ALTERNATIVE PLAN 4 CONDITIONS: 2005-2035[a]

County	Percent of Model Cells Showing Drawdown Beyond Greater than:				
	One Foot	Five Feet	10 Feet	50 Feet	100 Feet
Kenosha	7.9	1.7	0.6	0.0	0.0
Milwaukee	2.9	0.0	0.0	0.0	0.0
Ozaukee	4.0	0.3	0.0	5.4	0.5
Racine	2.4	0.5	0.2	0.0	0.0
Walworth	14.2	2.6	0.8	0.0	0.0
Washington	13.8	3.6	1.1	0.0	0.0
Waukesha	4.8	1.0	0.3	0.0	0.0

[a]*Results are from Layer 5 in the groundwater simulation model.*

Source: U.S. Geological Survey.

under Alternative Plan 4 conditions. These values suggest that the net effect of human activities under these conditions would be to remove water from the shallow groundwater system. In Kenosha, Racine, Walworth, and Washington Counties, the projected values of this indicator for 2035 are lower than the 2005 values, indicating that the influence of human withdrawals on the water budget of the shallow groundwater would be expected to increase in these Counties under Alternative Plan 4 conditions. In Milwaukee, Ozaukee, and Waukesha Counties, the projected values of this indicator for 2035 are higher than the 2005 values, indicating a reduction in the influence of human withdrawals on the water budget of the shallow groundwater system would be expected in these Counties under Alternative Plan 4 conditions. Despite this anticipated reduction, under these conditions the shallow groundwater system in Milwaukee County is anticipated to remain more heavily influenced by human activities in 2035 than those in the other counties in the Region.

Finally, the analysis indicates that in 2035 the baseflow reduction index would range from about minus 5.3 percent in Kenosha County to 15.6 percent in Ozaukee County. Under Alternative Plan 4 conditions, the value of the

Table 141

PROJECTED GROUNDWATER PERFORMANCE INDICATORS FOR THE GLACIAL SAND AND GRAVEL AND SILURIAN DOLOMITE AQUIFERS UNDER 2005 AND 2035 ALTERNATIVE PLAN 4 CONDITIONS

County	Demand to Supply Ratio[a]		Human Influence Ratio[b]		Baseflow Reduction[c] from 2005 Levels (percent)
	2005	2035	2005	2035	2035
Kenosha	0.047	0.094	-0.047	-0.091	-5.3
Milwaukee	0.159	0.131	-0.150	-0.127	2.8
Ozaukee	0.199	0.047	-0.188	-0.046	15.6
Racine	0.061	0.063	-0.060	-0.062	-0.5
Walworth	0.045	0.085	-0.044	-0.084	-4.9
Washington	0.083	0.118	-0.081	-0.115	-3.9
Waukesha	0.089	0.063	-0.086	-0.063	3.8

[a]The demand to supply ratio is defined as the ratio of net pumping demand on an aquifer to the amount of water that is replenished at a given point in time. Generally, this indicator ranges from 0—representing no human impact—upward. Values over 1.0 indicate that more groundwater is being extracted than can be replaced in a long-term, sustainable fashion. The year 2005 and 2035 conditions for this indicator are compared to predevelopment conditions.

[b]The human impact ratio, is defined as the ratio of human-induced groundwater inflows to total inflows minus the ratio of human-induced groundwater outflows to total outflows. This indicator is an expression of the relative magnitude of human alteration of the groundwater system. Values range from minus 1.0 in areas where wells have become the only discharge from an aquifer by stopping all other groundwater discharges, through 0 representing no net human impact, to plus 1.0 representing situations where human additions are the only inputs to the aquifer. The year 2005 and 2035 conditions for this indicator are compared to predevelopment conditions.

[c]The base flow reduction index is defined as the ratio of the change in groundwater-derived baseflow discharge due to pumping to the groundwater-derived baseflow at a defined base time. The year 2035 conditions for this indicator are compared to 2005 conditions.

Source: University of Wisconsin-Milwaukee.

baseflow reduction index in Kenosha, Racine, Walworth, and Washington Counties in 2035 is anticipated to be less than zero, indicating that reductions in average groundwater-derived baseflow to surface waters could be expected. The positive value of the indicator in Milwaukee, Ozaukee, and Waukesha Counties indicates that the average level of groundwater-derived baseflow to surface waters in these Counties may be expected to increase under Alternative Plan 4 conditions. Three caveats should be kept in mind when interpreting the changes in the baseflow reduction index. It should be noted that these are countywide averages developed for purposes of comparing alternative plans at the systems level of planning. Within any county, changes in baseflow may be expected to vary among waterbodies. It should also be noted that a change in baseflow does not indicate a change in total streamflow. The index only considers the groundwater component of streamflow. The impact on streamflow will typically be less in terms of percent reduction or increase. For those streams which receive discharges of sewage treatment plant effluent, the baseflow and streamflow amounts will be artificially increased and make surface water flows less sensitive to changes in groundwater-derived baseflow. Finally, it should be noted that for all seven Counties, the 2005 and 2035 magnitudes of average baseflow reduction under Alternative Plan 4 conditions are less than 10 percent, suggesting a small average reduction relative to 2005 conditions.

Other Surface Water Impacts

Impacts to Water Quantity in the Fox River

Several communities that would be provided with Lake Michigan water as a source of supply under Alternative Plan 4 currently utilize groundwater as a source of supply and subsequently discharge it as treated wastewater to the Fox River or its tributary streams which are located in the Mississippi River basin. To the extent that discharges by wastewater treatment plants currently constitute a major source of water in the Fox River, reductions in discharges to the Fox River associated with return flow of water to the Great Lakes basin, as envisioned in Alternative Plan 4 and as required by the Great Lakes-St. Lawrence River Basin Water Resources Compact, could potentially produce adverse environmental impacts. These impacts would be in the form of reduced flows in streams of this watershed that currently receive discharges from wastewater treatment plants. To assess the potential for such impacts, the role of wastewater treatment plant discharges in the overall quantity of water in the Fox River was examined.

Currently, 16 publicly owned wastewater treatment plants are located within the watershed. All but one of these plants currently discharge treated wastewater to surface waters of the watershed. The Lake Geneva plant discharges to the groundwater system. In addition, five privately owned wastewater treatment plants are located within the watershed. All of these plants discharge treated wastewater to surface waters of the watershed. The wastewater treatment plants in the Fox River watershed are listed in Table 142. Under Alternative Plan 4 it is envisioned that treated effluent from three public wastewater treatment plants—the plants serving the Cities of Brookfield and Waukesha and the Village of Sussex—would be returned to the Lake Michigan basin.

Flow data for the wastewater treatment plants were obtained from the CMAR submitted by the plant operators to the WDNR for the years 2003 through 2006. The data so obtained are summarized in Table 143. These data were compared to stream discharge data provided by two streamflow gages located on the Fox River: one at Waukesha (USGS Gage 05543830) and one at New Munster (USGS Gage 05545750).[16]

For each of the two stream gages, the data were disaggregated into months and the locations of the 10th percentile, 25th percentile, 50th percentile, 75th percentile, and 90th percentile ranks were determined for each month's data.[17] At each gage, these percentile ranks were plotted by month as shown in Figure 36. These monthly flow percentiles were compared to the average monthly flow from the WWTPs upstream from the gage. Mean daily streamflows at the Waukesha and New Munster stream gages over their periods of record were about 68 mgd and 366 mgd, respectively.

The 50th percentile lines shown in Figure 36 represent monthly median daily flows and describe average discharges at the two gages located on the Fox River. The lowest monthly median daily flows at the gages at Waukesha and New Munster are 25 mgd and 144 mgd, respectively, and occur during the months of August and September, respectively. The highest monthly median daily flows at these two gages are 97 mgd and 552 mgd, respectively, and occur during the month of April. Annual variation in flow follows a similar pattern at both gages. The lowest flows typically occur during the late summer or early fall. Discharge increases relatively slowly over the fall and winter. In early spring, discharge increases rapidly as a result of snowmelt and spring rains, with the highest flows typically occurring during April. Following this, flow decreases over late spring and summer until late summer or early fall.

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[16]*These stream gages are operated under the long-standing SEWRPC-U.S. Geological Survey (USGS) cooperative stream gaging program. They were chosen because of their locations in the watershed and because they have long periods of record—44 years and 67 years at the Waukesha and New Munster gages, respectively.*

[17]*A percentile rank is a percentage of values which are lower than a given value. For example, the 10th percentile represents the upper boundary of the lowest 10 percent of the data. The interpretation of this statistic is that on 10 percent of the dates in this month during the period of record, average daily discharge at this gage was less than or equal to this value. Similarly, the 90th percentile represents the upper boundary of the lowest 90 percent of the data and is interpreted in a similar manner.*

Table 142

WASTEWATER TREATMENT FACILITIES IN THE FOX RIVER WATERSHED: 2008

Facility Name	Receiving Water	Ownership
Brookfield	Fox River	Public
Burlington Water Pollution Control Center	Fox River	Public
Eagle Lake Sewer Utility	Eagle Creek	Public
Village of East Troy	Honey Creek	Public
Village of Genoa City	Nippersink Creek	Public
Grand Geneva Resort and Spa	White River	Private
Lake Geneva Wastewater Treatment Plant	Groundwater	Public
Lakeview Neurological Rehabilitation Center	Tributary to Wind Lake Drainage Canal	Private
Lyons Sanitary District No. 2	White River	Public
Village of Mukwonago	Fox River	Public
New Berlin Public Schools	Tributary to Poplar Creek	Private
Town of Norway Sanitary District No. 1	Wind Lake Drainage Canal	Public
Pell Lake Sanitary District	Nippersink Creek	Public
Salem Utility District	Fox River	Public
Village of Silver Lake	Fox River	Public
Village of Sussex	Sussex Creek	Public
Village of Twin Lakes	Bassett Creek	Public
Wisconsin Department of Transportation Rest Area No. 36	Tributary to Sugar Creek	Private
City of Waukesha	Fox River	Public
Western Racine County Sewerage District	Fox River	Public
Wheatland Estates Mobile Home Park	Tributary to Fox River	Private

Source: SEWRPC.

Two publicly owned wastewater treatment plants, the Brookfield and Sussex plants, and one privately owned wastewater treatment plant, the New Berlin West High School plant, discharge to the Fox River or its tributaries upstream from the gage at Waukesha. On average, these facilities contributed 10.1 mgd of treated effluent to the Fox River during the period 2003 through 2006. When computed on a monthly basis, the highest daily average discharge was 13.8 mgd and occurred during May. The lowest daily average discharge was 8.6 mgd and occurred during September.

Upstream from the gage at New Munster, 10 publicly owned facilities and four privately owned facilities discharge to the Fox River or its tributaries. On average, these facilities contributed 28.1 mgd of treated effluent to the Fox River during the period 2003-2006. When computed on a monthly basis, the highest daily average discharge was 35.3 mgd and occurred during May. The lowest daily average discharge was 25.0 mgd and occurred during September.

Figure 36 compares percentile ranks of flows at the gages at Waukesha and New Munster to the average daily discharges from the wastewater treatment plants upstream from each gage on a monthly basis. At lower percentile rank discharges, treated wastewater treatment plant effluent comprises a higher percentage of flow at each of these gage sites. This is especially the case during summer and fall when flows in the River tend to be lower than during other times of the year.

At the Waukesha gage, treated effluent represents a substantial portion of discharge during the summer and fall at times when flow in the River is less than the monthly median average daily flow shown in Figure 36. At the 50th percentile, discharges of treated effluent from the wastewater treatment plants upstream from the gage represent about one third of the flow at the gage during July through September. This indicates that during these months, treated effluent represents more than one third of the flow about half of the time. At the 25th percentile, discharges of treated effluent from the wastewater treatment plants upstream from the gage represent about

Table 143

AVERAGE DAILY DISCHARGES FROM WASTEWATER TREATMENT FACILITIES IN THE FOX RIVER WATERSHED: 2003-2006

Facility Name	Monthly Average Daily Discharge (million gallons per day)		
	Minimum[a]	Maximum[a]	Mean
Brookfield	7.01 (September)	10.88 (May)	8.05
Burlington Water Pollution Control Center	2.66 (November)	3.39 (June)	2.92
Eagle Lake Sewer Utility	0.19 (August)	0.44 (May)	0.27
Village of East Troy	0.32 (November)	0.39 (May)	0.34
Village of Genoa City	0.20 (October)	0.23 (February)	0.21
Grand Geneva Resort and Spa	0.07 (January)	0.13 (August)	0.09
Lakeview Neurological Rehabilitation Center	0.01 (August)	0.02 (June)	0.02
Lyons Sanitary District No. 2	0.08 (August)	0.11 (May)	0.09
Village of Mukwonago	0.72 (October)	0.92 (May)	0.79
New Berlin Public Schools	0.01 (October)	0.02 (August)	0.01
Town of Norway Sanitary District No. 1	0.01 (October)	0.01 (February)	0.01
Pell Lake Sanitary District	0.17 (March)	0.19 (December)	0.18
Salem Utility District	0.72 (September)	1.23 (May)	0.92
Village of Silver Lake	0.24 (August)	0.38 (May)	0.30
Village of Sussex	1.54 (September)	2.92 (May)	2.03
Village of Twin Lakes	0.56 (October)	0.68 (March)	0.61
Wisconsin Department of Transportation Rest Area No. 36	<0.01 (February)	<0.01 (August)	<0.01
City of Waukesha	8.32 (October)	10.92 (May)	9.24
Western Racine County Sewerage District	1.04 (January)	1.32 (May)	1.13
Wheatland Estates Mobile Home Park	0.03 (October)	0.05 (May)	0.03

[a]*Month in parentheses indicates the month of occurrence.*

Source: Wisconsin Department of Natural Resources.

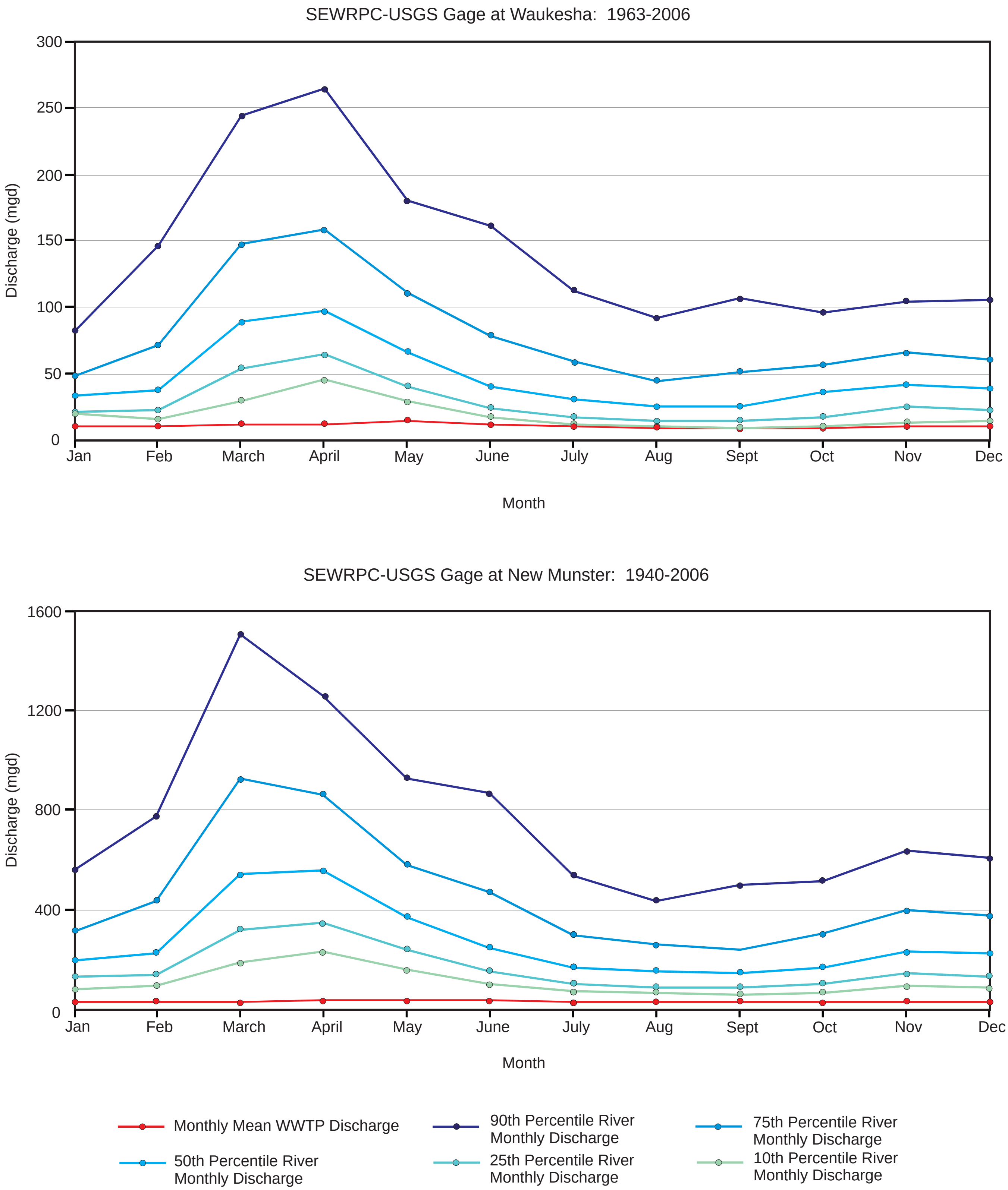
one-half of the flow at the gage during June through September. This indicates that during these months, treated effluent represents more than half of the flow about 25 percent of the time. At the 10th percentile, discharges of treated effluent from the wastewater treatment plants upstream from the gage represent 80 percent or more of the flow during July through October and nearly 100 percent of flow during September. This indicates that during these months, treated effluent represents more than 80 percent of the flow at the gage about 10 percent of the time. The values indicated above concerning the amount of wastewater treatment plant effluent discharge as a percent of streamflow are conservatively high as they assume the treated effluent additions are cumulative and conservative in the River. This is not the case, in part, because of flow interaction between the River and inflow to, and pumped discharge from, large stone quarries located in the Waukesha and Sussex-Lannon-Lisbon areas.

At the New Munster gage, treated effluent represents a smaller portion of discharge than it represents at the Waukesha gage shown in Figure 36. This is the case even during those times in summer and fall when flow in the River is less than the monthly median average daily flow. For example, at the 10th percentile, discharges of treated effluent from the wastewater treatment plants upstream from the gage represent at least one third of the flow at the gage during July through October. This indicates that during these months, treated effluent represents more than one third of the flow at the gage about 10 percent of the time.

The comparisons provided in Figure 36 suggest that treated wastewater treatment plant effluent constitutes a major component of baseflow to the Fox River in the Southeastern Wisconsin Region, especially in upstream reaches. In the summer and fall during periods when flow is at or below the 10th percentile, treated effluent from the wastewater treatment plants upstream from the Waukesha gage accounts for almost all of the flow reported at

Figure 36

COMPARISON OF DISCHARGE IN THE FOX RIVER TO DISCHARGE AT WASTEWATER TREATMENT PLANTS UPSTREAM FROM THE STREAM GAGES



Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, and SEWRPC.

the gage. This suggests that actions that would eliminate discharges from the wastewater treatment plants upstream from the Waukesha gage could result in substantial reductions in flow in the Fox River at and upstream from this gage in dry periods during the summer and fall. These periods may be expected to occur annually about 10 percent of the time. In addition, reductions in flow in the Fox River might also occur if discharges from the upstream wastewater treatment plants were reduced substantially rather than eliminated, although the magnitude of the reductions in flow in the River and how often the reduced flows would be likely to occur would depend upon the magnitude of the reductions in the discharges from the wastewater treatment plants. Given that the average daily discharge from the Waukesha wastewater treatment plant, which is located downstream from the Waukesha gage, is slightly less than the total of the average daily discharges from the three wastewater treatment plants located upstream from the gage, the portion of the Fox River likely to be impacted if discharges from the Waukesha plant were also eliminated or reduced may be expected to extend some distance downstream from the Waukesha plant.

Under Alternative Plan 4 conditions, the reductions in flow in the Fox River at the New Munster gage would be small. On average, treated effluent from the three facilities whose contributions to the River would be eliminated or reduced under this alternative represents about 5 percent of the flow at the New Munster gage. At the 10th percentile treated effluent from these three facilities represents about 30 percent of flow at this gage during the month of September. In all other months, treated effluent from these three facilities represents a smaller portion of flow at this percentile rank. As noted above, these estimates are likely to be conservatively high because of the assumption that effluent additions are conservative and additive in the stream.

The provision of Lake Michigan water as a source of supply to communities located west of the subcontinental divide within Waukesha County that do not currently have a return flow component in place would be unlikely to require completely eliminating discharges to the Fox River from the wastewater treatment plants serving these communities. Comparisons of the average daily pumpage of the utilities that would be affected by this change in supply to the average daily discharges reported by the wastewater treatment plants in the CMAR reports for 2003 through 2007 indicate that the pumpage accounts for about 85 percent of the water treated and discharged by the wastewater treatment plants.[18] The remaining 15 percent is derived from clearwater infiltration and inflow into the sanitary sewerage systems and originates west of the subcontinental divide. Assuming that these proportions are typical of these sewerage systems, would indicate that, on average, about 85 percent of the treated effluent discharged by these treatment plants would need to be returned to the Lake Michigan watershed. The remaining 15 percent of the treated effluent would be available for discharge into receiving waters in the Fox River watershed.

This suggests that the impacts of the return flow required under Alternative Plan 4 on water quantity in the Fox River could be reduced through active management of return flow to the Lake Michigan watershed and discharges to the Fox River watershed. Under this scheme, during periods of low flow a major portion of the effluent treated by the wastewater treatment plants could be discharged to the Fox River watershed in order to preserve flows in the Fox River. During periods of more typical flows, most or all of the treated effluent could be returned to the Lake Michigan watershed. As long as the amount of water returned annually to the Lake Michigan watershed is equal to the amount withdrawn less the allowance for consumptive use, the return flow requirement should be satisfied.

It is important to note the limitations of this analysis. First, as noted above, the analysis assumes that effluent additions to streamflow are conservative and additive in the stream. This is not the case, in part, because of flow interactions between the River and the flow of groundwater into the existing large stone quarries in the area, and

[18]*In 2005, average daily pumpage for the City of Brookfield Water Utility, the City of Pewaukee Water and Sewer Utility, the City of Waukesha Water Utility, the Village of Pewaukee Water Utility, the Sussex Village Hall and Water Utility, and the Town of Brookfield Sanitary District No. 4 totaled 16.36 mgd. The average daily discharge reported by the Brookfield, Sussex, and Waukesha WWTPs in the 2003-2006 CMAR reports totaled 19.32 mgd.*

pumped outflow from those quarries to the stream system. In addition, the analysis does not take into account other potential interactions between groundwater and the River. Second, the analysis does not examine the response of the shallow groundwater system to a conversion to Lake Michigan water as a source of supply. Alternative Plan 4 would result in reduced pumpage from the shallow groundwater system, as well as from the deep aquifer, in the affected communities. A likely result of this would be increases in baseflow in streams in the vicinity of these communities. These increases in baseflow are likely to offset some of the reductions in flow in the Fox River resulting from the reductions in discharge of treated effluent that would result from the return flow requirement. Therefore, the estimates made of the impacts of Alternative Plan 4 on water quantity in the Fox River may be considered to be worst case rather than most likely case. More detailed studies of the potential impacts of the return flow component of Alternative Plan 4 on water quantity in the Fox River would be necessary if implementation of Alternative Plan 4 were to be pursued.

Impacts to Water Quantity in Underwood Creek, the Menomonee River, and the Root River of Return Flow Subalternative 2

Under the second return flow subalternative of Alternative Plan 4, return flow from the communities served by the Village of Sussex wastewater treatment plant—the Villages of Lannon and Sussex and the western portion of the Village of Menomonee Falls—and from the communities served by the City of Brookfield wastewater treatment plant—the western portion of the City of Brookfield, the City of Pewaukee, the Village of Pewaukee, and the Town of Brookfield Sanitary District No. 4—would be accomplished by conveying treated effluent from these facilities through a series of pumping stations and pipelines discharging to Underwood Creek, a tributary to the Menomonee River which flows into Lake Michigan. In addition, return flow from the City of Waukesha would be accomplished by conveying treated effluent from the City of Waukesha wastewater treatment plant through a series of pumping stations and pipelines discharging to the Root River, a tributary of Lake Michigan. The return flow to these tributaries could have beneficial impacts during low periods of flow in the receiving streams. The flow in Underwood Creek and the upper reaches of the Root River at the 10th percentile are relatively small, being 3.0 and 0.9 cubic feet per second, respectively. The return flows could, however, also have adverse impacts on flood flows and stages, streambank erosion, and on recreational uses of the stream system as a result of the reintroduction of wastewater treatment plant effluent to the streams involved.

The impacts of the return flow envisioned under this subalternative on the water quantity in Underwood Creek could be reduced through active management of return flow to the Creek and discharges to the Fox River watershed. During periods of high flow, treated effluent from the Brookfield and Sussex wastewater treatment plants could be discharged to the streams in the Fox River watershed that currently act as receiving waters for the treatment plant effluents concerned. During periods of more typical flows, the treated effluent from these plants could be discharged to Underwood Creek as return flow. For the purposes of the systems level analysis, it was assumed that this would provide conservative protection against flooding. This would allow, for example, discontinuing discharges to the receiving streams whenever the flow in those streams reached a selected recurrence interval under which there would be a potential for impact. Such a recurrence interval could be selected to be conservatively safe, such as a four-month recurrence interval, which would have a probability of occurrence of three times each year. It was assumed for the purposes of the analysis that the impacts of return flow on water quantity in the Root River would be similar to those in Underwood Creek and that a similar active management strategy could be pursued to reduce the impacts during periods of high flow. As noted above, only about 85 percent of the treated effluent would need to be returned to the Lake Michigan basin. Such return would constitute an amount greater than the amount of water provided from Lake Michigan. The remaining amount would be available for discharge to the surface waters of the Fox River basin. It appears that this amount would be adequate both to supplement flow in the Fox River during low flow periods in this River, as described in the previous subsection, and to discharge to the Fox River during periods of high flow in Underwood Creek and the Root River. Should this subalternative be selected and pursued, more detailed studies of the impacts of providing return flow through discharge of treated effluent into the streams tributary to Lake Michigan will be necessary. Such studies would address the issues of water quality, baseflow enhancement, streambank erosion, and recreational use impacts, as well as any other identified issues.

Surface Water Quality Impacts

Under Alternative Plan 4, the source of supply used by several utilities located east of the subcontinental divide would be shifted from groundwater to Lake Michigan water. This would result in a reduction in the hardness of the water provided by the customers of these utilities and would eliminate the need for water softening by these utilities. This would also result in reductions in the concentration of chlorides in the sewage conveyed to the wastewater treatment plants serving these customers and in the chloride loads discharged by these plants to receiving waters, such as Cedar Creek, the Milwaukee River, and Lake Michigan. A reduction in the average concentrations of chloride in sewage conveyed to wastewater treatment facilities serving these communities of 100 mg/l would result in annual reductions of chloride discharged to Cedar Creek, the Milwaukee River, and Lake Michigan of about 0.5 million pounds, 1.1 million pounds and 3.1 million pounds, respectively. Given that the average concentrations of chloride in effluent discharged by municipal wastewater treatment plants that treat wastewater in communities using groundwater as a source of supply may be expected to range from 400 to 550 mg/l, it is likely that reductions in chloride loadings to Cedar Creek, the Milwaukee River, and Lake Michigan on this order of magnitude may be expected under Alternative Plan 4 conditions.

Potential surface water quality impacts are associated with the second return flow subalternative of Alternative Plan 4. Potential impacts could occur in Underwood Creek and the Menomonee and Root Rivers, because, as noted above, under this Subalternative, treated effluent from the City of Brookfield and Village of Sussex wastewater treatment plants would be discharged to Underwood Creek and treated effluent from the City of Waukesha wastewater treatment plant would be discharged into the Root River. The potential impacts were assessed by comparing the concentrations of key pollutants in the treated effluent of the Brookfield, Sussex, and Waukesha wastewater treatment plants, as reported in recent CMAR reports, to ambient concentrations of these pollutants in the streams that would be impacted. The ambient concentrations were taken from average amounts in SEWRPC Technical Report No. 39, *Water Quality and Sources of Pollution in the Greater Milwaukee Watersheds,* November 2007. It is important to note that these comparisons are based upon a summary statistical analysis of actual conditions and not upon simulation results. More detailed studies of the impacts of providing return flow through tributary streams upon surface water quality would be necessary, if this return flow subalternative were to be implemented.

In 2007, average concentrations of ammonia-nitrogen, biochemical oxygen demand, and total suspended solids were lower in the treated effluent discharged by the Brookfield and Sussex plants than the average ambient concentrations in Underwood Creek and the Menomonee River. The water use objectives for Underwood Creek and the Menomonee River are specified in the adopted regional water quality management plan. Underwood Creek and the Menomonee River downstream from the confluence with Honey Creek are subject to a special variance set forth in Section NR 104.06(2)(a) of the *Wisconsin Administrative Code* under which these waters shall meet the standards for fish and aquatic life except that dissolved oxygen shall not be lowered to less than 2 mg/l at any time, nor shall the membrane filter fecal coliform bacteria count exceed 1,000 per 100 ml as a monthly geometric mean based on not less than five samples per month nor exceed 2,000 per 100 ml in more than 10 percent of all samples in any month. The Creek and River concentrations generally approach meeting the standards supporting the water use objectives for constituents other than bacteria. The ambient concentrations of dissolved oxygen and ammonia nitrogen in the Creek and River generally met or nearly met the water quality criteria attendant to these objectives. The ambient concentrations of bacteria, however, did not. Similarly, average concentrations of ammonia-nitrogen, biochemical oxygen demand, and total suspended solids were lower in treated effluent discharged from the Waukesha plant than the average ambient concentrations of these pollutants in the Root River. The specified water use objective for the Root River is fish and aquatic life. Ambient concentrations of dissolved oxygen and ammonia-nitrogen generally met or nearly met the standards supporting the water use objectives. Ambient concentrations of bacteria, however, did not. The differences between the concentrations of the pollutants concerned in the treatment plant effluents and the ambient water quality conditions indicate that it is unlikely that water quality problems associated with the pollutants concerned would occur as a result of providing return flow through these tributaries. However, more detailed analyses, including water quality modeling would be needed to determine if the water use objectives and supporting standards, as set forth in the regional water quality management plan could be achieved following use of these streams for return flow.

Average concentrations of total phosphorus in the treated effluent discharged by the Brookfield and Sussex plants were higher than average ambient concentrations in Underwood Creek and the Menomonee River. These differences suggest that providing return flow through discharging treated effluent into Underwood Creek, as envisioned in the second return flow subalternative of Alternative Plan 4, has the potential to increase the concentrations of total phosphorus in the Creek and in the Menomonee River downstream from the confluence with Underwood Creek. The average concentration of total phosphorus in the treated effluent discharged by the Waukesha plant was slightly higher than the average ambient concentration in the Root River. While the potential exists for the provision of return flow through discharging treated effluent into the Root River to increase total phosphorus concentrations in the Root River, the increases are likely to be relatively small based upon systems level analyses. More detailed studies of these impacts would be necessary if this return flow subalternative were to be selected and pursued.

Average concentrations of chloride were higher in treated effluent discharged by the Brookfield and Sussex plants than the average ambient concentration in Underwood Creek and the Menomonee River and the average concentration of chloride was higher in treated effluent discharged from the Waukesha plant than the average ambient concentration in the Root River; however, the use of Lake Michigan as a source of water supply by the communities served by these facilities, as envisioned under Alternative Plan 4, would result in a reduction in the hardness of the water provided by these utilities and would eliminate the need for water softening by the customers of these utilities. This would also result in reductions in the concentration of chlorides in the sewage conveyed to the wastewater treatment facilities serving these customers and in the chloride loads discharged by these facilities into receiving waters. Because the magnitudes of these reductions are uncertain, the potential impacts upon Underwood Creek and the Menomonee and Root Rivers are not clear; however, if reduced use of water softening resulted in a 50 percent reduction in the average concentration of chloride in the treated effluent, the average chloride concentration in the effluent would be close to the average ambient concentrations in these streams.

In any consideration of the use of the Menomonee River or Root River systems for return flow, it should be recognized that the introduction of wastewater treatment plant effluent to the streams of these systems would mark a reversal of historic efforts by the Commission and others to eliminate the discharge of such effluent to these stream systems. The regional water quality management plan adopted in 1979 recommended abandonment of six then-existing wastewater treatment plants discharging effluent to the Menomonee and Root Rivers: the Germantown, Menomonee Falls (two plants), Hales Corners, Franklin, and Caddy Vista plants, with the connection of the sewerage systems served by these plants to the Milwaukee Metropolitan Sewerage District System for conveyance and treatment. All of the plants concerned were indeed abandoned as recommended in the regional plan. One of the reasons advanced for the abandonment of these plants was related to water quality of the receiving streams concerned which flow through Milwaukee County parks and parkways and are widely used for recreational purposes. Other reasons included the nonproliferation policy of the Wisconsin Department of Natural Resources which favored having fewer consolidated treatment plants and the potential for sewage bypassing. These later two reasons are not a current consideration, as the number of treatment facilities will not be impacted by the return flow options and any bypassing which might occur would occur at or before the treatment plant involved in the Fox River watershed. Furthermore, the water quality of the wastewater treatment plant effluent involved is currently of a much higher quality than expected when the regional water quality management plan was developed. Thus, the water quality considerations are now different.

Given the issues raised regarding water quality in the streams being considered, a more-detailed evaluation of the planned conditions with the return flow would be needed to determine what water quality measures may be needed to achieve the water use objectives and supporting standards. Such analyses would typically require water quality modeling and would be carried out under more-detailed facility planning if the return flow component discharging to streams were to proceed to a more-detailed planning level.

For most other utilities, Alternative Plan 4 generally makes use of expanded sources of groundwater that are similar to existing sources. Because of this, it is anticipated that this alternative will produce few changes in surface water quality within the Region, other than those described above.

Conclusions Concerning Groundwater-Surface Water Impacts of Alternative Plan 4

The results of the simulation indicate that under Alternative Plan 4 conditions, drawups may be expected to occur in the deep aquifer over most of the Region. The magnitude of the average drawups over 2005 conditions in this aquifer may be expected to range between 12 and 136 feet by County. The maximum drawup over 2005 conditions in this aquifer may be expected to be about 270 feet. In all Counties of the Region, except for Kenosha and Walworth Counties, drawups over 2005 conditions in excess of 50 feet may be expected to be common. These drawups reflect both the shift from the use of groundwater as a source of water supply to the use of Lake Michigan by some communities, and a shift by some communities from the deep groundwater system as a source of water supply to the shallow groundwater system as envisioned under Alternative Plan 4. Some drawdowns may be expected to occur in some areas of Walworth County over the planning period under this alternative plan. The magnitude of the drawdowns over 2005 conditions in this aquifer may be expected to be relatively small with average drawdowns for this County being about 0.6 foot, and the maximum drawdown as being about seven feet. The drawdowns and the smaller drawups expected in Walworth County may be attributed, in part, to the influence of groundwater use in northeastern Illinois. In addition, the areas concerned are also located a considerable distance from the communities whose source of water supply is envisioned to change from the deep aquifer to Lake Michigan under Alternative Plan 4. Water budget analyses indicate that the deep groundwater system is likely to be heavily influenced by human activities under Alternative Plan 4 conditions, with the net effect of human activities being to remove water from the deep groundwater system. This analysis also indicates that Racine and Waukesha Counties may experience water budget deficits in the deep aquifer under Alternative Plan 4 conditions. However, the deficits are reduced under planned 2035 conditions compared to 2005 conditions and drawup or partial recovery of the historic drawdown is expected throughout these two counties.

On a Regional scale, groundwater pumpage under Alternative Plan 4 conditions may be expected to decrease by 9.4 mgd, to about 67.3 mgd between 2005 and 2035, or by about 12 percent. In addition, the simulation modeling indicates that under Alternative Plan 4 conditions a net amount of about 1.7 mgd of water would be induced to flow out of surface waters in the Region. Thus, about 11.1 mgd consisting of water previously going to wells and water drawn from surface waters would be contributed under Alternative Plan 4 conditions to other sinks such as accumulation in storage in the confined and unconfined aquifers and to a net reduction of cross-boundary flow and from the planning area.

The impact of pumping on surface waters can be represented as groundwater-derived baseflow depletion. Groundwater-derived baseflow is the amount of flow in the waterbody from upgradient groundwater discharge. The overland component of total streamflow and any discharge of treated wastewater are not included in baseflow, and the simulation modeling results do not include, or account for, these components. Typically baseflow represents about 10 percent to 50 percent of streamflow on an annual basis. In aggregate, by 2035 surface waterbodies in the Region may be expected to experience a baseflow depletion relative to 2005 conditions of about 2.6 mgd, or less than 1 percent. On average, changes in groundwater-derived baseflow to surface waters relative to 2005 conditions under Alternative Plan 4 conditions are less than 10 percent within each County, except in Ozaukee County which would have an average augmentation of groundwater-derived baseflow of slightly less than 15 percent. These aggregate total and average values may, however, obscure site-specific differences in baseflow changes within each county. While the county totals project overall depletions within each county, individual waterbodies may experience either depletion or augmentation. The reductions in groundwater-derived baseflow at 13 of 100 surface water evaluation sites were in excess of 10 percent.

The results of the simulation indicate that under Alternative Plan 4 conditions, additional drawdowns over 2005 conditions may be expected to occur in the shallow aquifer over much of the Region. However, the magnitude of the drawdowns is estimated to be relatively small; in most counties, the drawdowns may be expected to average less than 1.5 feet. The relatively small magnitude of the drawdowns may be attributed to the buffering effects of surface water baseflow interactions and to the increases in baseflow that occur in some parts of the Region under Alternative Plan 4 conditions.

In the glacial sand and gravel aquifer, additional drawdowns may be expected to occur in 25 to 72 percent of the model cells by county over the period 2005 to 2035. The magnitude of average drawdowns over 2005 conditions in this aquifer was simulated to be small, less than 1.5 feet in all counties of the Region. While the maximum drawdown over 2005 conditions in this aquifer may be expected to be about 51 feet, only a small percentage of model cells were found to experience drawdowns over 2005 conditions in excess of 10 feet. In other parts of the Region, especially southern Ozaukee County and eastern Waukesha County, it is expected that drawups over 2005 conditions will occur in the sand and gravel aquifer under Alternative Plan 4 conditions. In most of the areas found to experience drawups, only a small percentage of model cells were found to experience drawups over 2005 conditions in excess of 10 feet. With some exceptions, similar impacts were found to occur in the Silurian dolomitic aquifer. Additional drawdowns may be expected to occur in this aquifer in 10 to 67 percent of model cells by county over the planning period. While the maximum drawdown over 2005 conditions in this aquifer was found to be about 38 feet, only a small percentage of model cells in most counties were simulated to experience drawdowns over 2005 conditions in excess of 10 feet. In other parts of the Region, especially southern Ozaukee County, southeastern Washington County, and eastern Waukesha County, drawups over 2005 conditions may be expected to occur in the Silurian dolomitic aquifer under Alternative Plan 4 conditions. In most of the areas found to experience drawups, only a small percentage of model cells were found to experience drawups over 2005 conditions in excess of 10 feet. Ozaukee County is an exception to this generalization. In this County, more than half of the model cells were found to experience drawups over 2005 conditions in excess of 10 feet in this aquifer under Alternative Plan 4 conditions.

Water budget analyses indicate that in most counties of the Region, the influence of human activities on the shallow groundwater system will decrease under Alternative Plan 4 conditions. In those counties in which the influence of human activities are expected to decrease, the shallow groundwater system will remain heavily influenced by human activities. While the net effect of human activities in all counties of the Region will result in the removal of water from the shallow groundwater system, there is little evidence that a water budget deficit will occur where more groundwater will be extracted than can be replaced in a long-term sustainable fashion in the shallow groundwater system. This is likely due, in large part, to the buffering effects of surface waters and to the shift from the use of groundwater as a source of water supply to Lake Michigan water in some portions of the Region as envisioned under Alternative Plan 4.

Although the results of the simulation modeling indicate that the changes in the shallow aquifer system may be expected to be relatively small over much of the Region under Alternative Plan 4 conditions, larger changes may be expected to occur in some areas. Most of Ozaukee County and portions of southeastern Washington and eastern Waukesha Counties may be expected to experience drawups in the Silurian dolomitic aquifer, in excess of 10 feet in many locations, especially in Ozaukee County, and in excess of 50 feet in some locations. These drawups are attributable to several factors envisioned under Alternative Plan 4 including the shift in the source of water supply in areas served by the public sanitary sewer system in Mequon from private wells to Lake Michigan, and the shift in the source of water supply for several communities that are located on either side of the subcontinental divide from groundwater to Lake Michigan as the source of supply. The relatively large magnitude of these changes also results from the fact that overlying clay-rich glacial tills act to confine this aquifer.

During low flow periods, there is the potential for the return flow component of Alternative Plan 4 to produce adverse impacts upon water quantity in the upper reaches of the Fox River; however, this could be mitigated through a strategy of active management of the location of discharge of the fraction of wastewater treatment plant effluent that exceeds the amount of Lake Michigan water provided to the communities west of the subcontinental divide. The impacts on water quantity of providing return flow through discharge of treated effluent to streams tributary are likely to be small. There is the potential for positive impacts to occur during low flow periods and for negative impacts to occur during high flow periods. At periods of high flow, negative impacts could also be mitigated through a strategy of active management of the location of discharge of the fraction of wastewater treatment plant effluent that exceeds the amount of Lake Michigan water provided to the communities west of the subcontinental divide. Water quality impacts are also expected to be modest based upon systems level analyses; however, both the water quantity and water quality impacts would have to be studied in more detail if this alternative plan were selected and pursued.

SUMMARY

Four alternative water supply plans were developed and are described in this chapter, along with the planning criteria and analytic procedures used in the plan development. This chapter also presents costs and the groundwater and surface water impacts of each alternative plan. The salient characteristics of each of the alternative water supply plans are summarized as shown in Table 144.

Table 144

SELECTED CHARACTERISTICS OF ALTERNATIVE REGIONAL WATER SUPPLY PLANS

Alternative Plan	Components	Costs				2035 Groundwater Pumpage Amounts	2035 Lake Michigan Municipal Supply Amount	Groundwater Level Impacts		Surface Water Baseflow Impacts
		Capital ($ X 1,000)	O&M ($ X 1,000)	Present Worth Costs ($ X 1,000)	Equivalent Annual ($ X 1,000)			Deep Aquifer	Shallow Aquifer	
Alternative Plan 1: Design Year 2035 Forecast Conditions Under Existing Trends and Committed Actions	108 wells (eight deep, 102 shallow) 105 storage tanks 17 radium treatment systems 2 water treatment plant expansions	172,011	5,365.0	182,862	11,605	106 mgd, an increase from 77 mgd in 2005 67 mgd from shallow aquifer 39 mgd from deep aquifer	214 mgd, an increase from 209 mgd in 2005	County averages of 10 to 22 feet drawdown, with a maximum of 64 feet. No drawup	County averages of one foot or less of drawdown, with a maximum of 76 feet County averages of one foot or less of drawup, with a maximum of 31 feet	Net reduction (2005-2035) of 16 mgd or 4.5 percent 19 of 100 sensitive sites have reduction of 10 percent or more
Alternative Plan 2: Design Year 2035 Forecast Conditions With Limited Expansions of Lake Michigan and Shallow Groundwater Aquifer Supplies	135 wells (all shallow) 97 storage tanks 2 water treatment plant expansions 6 Lake Michigan supply connections	253,624	-68.2	175,210	11,117	93 mgd, of which 72 mgd is from the shallow aquifer and 21 mgd is from the deep aquifer	227 mgd	County averages of from 0 to six feet of drawdown, with a maximum of 10 feet County averages of eight to 92 feet of drawup, with a maximum of 237 feet	County averages of one foot or less of drawdown, with a maximum of 76 feet County averages of one foot or less of drawup, with a maximum of 38 feet	Net reduction (2005-2035) of 19 mgd or 5.3 percent 23 of 100 sensitive sites have reduction of 10 percent or more
Alternative Plan 3: Design Year 2035 Forecast Conditions with Groundwater Recharge Enhancement	135 wells (all shallow) 97 storage tanks 2 water treatment plant expansions 6 Lake Michigan supply connections 83 rainfall infiltration sites 4 wastewater treatment infiltration systems 9 deep aquifer injection wells	402,793	5,341.0	279,979	17,793	93 mgd, of which 72 mgd is from the shallow aquifer and 21 mgd is from the deep aquifer	227 mgd, plus 9 mgd used for deep aquifer recharge	County averages of from 14 to 212 feet of drawup, with a maximum of 368 feet No significant drawdown	County averages of one foot or less of drawdown, with a maximum of 76 feet County averages of one foot or less of drawup, with a maximum of 38 feet	Net reduction (2005-2035) of 6 mgd or 1.7 percent 16 of 100 sensitive sites have reduction of 10 percent or more
Alternative Plan 4: Further Expansion of Lake Michigan Supply	99 wells (all shallow) 90 storage tanks 2 to 4 water treatment plant expansions, depending upon the subalternative selected 17 Lake Michigan supply connections Lake Michigan return flow component	474,008	-14,480.0	228,429	14,471	65 mgd, of which 50 mgd is from the shallow aquifer and 15 mgd is from the deep aquifer	255 mgd	County averages of from 35 to 136 feet of drawup, with a maximum of 270 feet	County averages of one foot or less of drawdown, with a maximum of 51 feet County averages of less than one foot of drawup, with a maximum of 38 feet	Net reduction (2005-2035) of 2.6 mgd or 0.7 percent 13 of 100 sensitive sites have reduction of 10 percent or more

Source: SEWRPC.

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Chapter IX

ALTERNATIVE PLAN COMPARATIVE EVALUATION AND SELECTION OF A COMPOSITE PLAN FOR FURTHER CONSIDERATION

INTRODUCTION

As noted in Chapter I, the primary purpose of the regional water supply planning program was to develop a water supply plan for the Southeastern Wisconsin Region that best meets the objectives set forth in Chapter V. The planning program was thus intended to develop a plan for the provision of water supply within the Region that identifies measures needed to abate existing and probable future water supply problems and to preserve and protect the sources of supply. Chapter VII of this report identified the water supply problems and issues which needed to be addressed in the planning process. Chapter VIII of this report described a set of four alternative water supply plans that were developed as candidates for adoption as a regional water supply plan for southeastern Wisconsin. In order to resolve the identified water supply problems and issues in a manner which best meets the plan objectives, it was necessary to comparatively evaluate those plans in order to determine the extent to which each of the plans may be expected to achieve the agreed-upon objectives.

This chapter presents the findings of the required comparative evaluation of the alternative plans considered. The evaluation identifies the extent to which each of the plans may be expected to achieve the agreed-upon water supply objectives, and thereby identifies the technical, economic, and environmental performance of the plans. Based upon this comparative evaluation, this chapter also sets forth a composite regional water supply plan developed for further consideration. This composite plan was presented for public review and reaction, and based upon that review and reaction, was refined to produce a final recommended plan. In development of the composite plan, consideration was given to the inclusion of desirable elements drawn from the four alternative plans considered, together with other elements developed on the basis of a review of the findings of the comparative evaluation of the four alternative plans.

In considering the objectives and supporting standards utilized in the evaluation of alternative plans, it should be recognized that those objectives and standards are intended to be applied at the systems level of planning, as opposed to the more-detailed level of local facility planning. It should also be recognized that it is unlikely that any one plan proposal will fully meet all of the objectives and supporting standards, and the extent to which each objective and the supporting standards are met, exceeded, or violated is intended to serve as a measure of the overall performance of the plan. It should be further recognized that certain of the agreed-upon objectives and standards may be inherently conflicting, requiring resolution through compromise; and that meaningful alternative plan evaluation can only take place through comprehensive assessment of each alternative plan considered against all the extent to which conflicting objectives and supporting standards are met.

METHOD OF EVALUATION

A rank-based method was used to compare the anticipated performance of the alternative plans with respect to the agreed-upon water supply development and management objectives utilizing the standards supporting each objective. In this method, the alternative plans were evaluated and ranked on the basis of the ability to achieve the water supply objectives. In instances where two or more alternative plans were found to have similar performance levels relative to an objective concerned, the rankings were averaged. For example, if Alternative Plan 1 was expected to best achieve a given objective; Alternative Plan 4 was expected to most poorly achieve the objective; and Alternative Plans 2 and 3 were expected to achieve the objective moderately and equally well, the ratings for Alternative Plans 1 through 4 would be 1.0, 2.5, 2.5, and 4, respectively. The rankings of each alternative plan under each of the five objectives were then totaled to establish the rank order of the plans.

For each objective, the ranks of the alternative plans were derived by ranking their expected performance relative to the standards supporting the objective. For some standards, additional analyses were performed in order to establish ranks for the alternative plans. These analyses are presented in Appendix M. A similar procedure to the one described above with respect to the objectives was used to address standards where two or more alternative plans were expected to have similar performance levels. For each alternative plan, the rankings derived by application of the standards supporting the objective were totaled to yield a numerical value for the objective. These values were then converted to ranks. This procedure was followed in order to give each objective equal weight in the evaluation.

Some of the alternative plans included one or more subalternatives. These subalternatives differed from one another in such details as to which water treatment plants were to be utilized to provide water supply to communities to be provided with Lake Michigan water; the number and routes of water transmission mains; and, in the case of Alternative Plan 4, the means of providing return flow to Lake Michigan from communities located west of the subcontinental divide. For the purposes of the comparative evaluation the best of the subalternatives considered under each alternative plan concerned was used in the ranking based upon consideration of costs, environmental impacts, and implementability of the subalternatives.

EVALUATION BASED UPON STANDARDS

The rank-based evaluation of the alternative plans with respect to the standards supporting the agreed-upon water supply development and management objectives is presented in Table 145. The following text describes the findings of the comparisons made for each standard, and presents the basis for the rank orders given in the table.

Objective No. 1—Support Existing Land Use Patterns and Support and Direction of Planned Land Use Patterns

Standard 1—Public Water Supply Systems Should Be Designed to Serve Lands Planned to Be Developed for Urban Uses, in Accordance with the Adopted Regional Land Use Plan

The planned municipal water supply service areas in the design year 2035 are presented in Chapter IV of this report. These service areas are based upon a reevaluation and refinement of the areas proposed to be served by municipal water supply facilities in the adopted design year 2035 regional land use plan.[1] Because these service areas are identical under all four alternative water supply plans, the expected abilities of the alternative plans to achieve this standard are equal and the plans were given identical ranks.

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[1]*SEWRPC Planning Report No. 48,* A Regional Land Use Plan for Southeastern Wisconsin: 2035, *June 2006.*

Table 145

RANK ORDER RATINGS OF ALTERNATIVE WATER SUPPLY PLANS RELATIVE TO THE STANDARDS SUPPORTING EACH OF THE WATER SUPPLY SYSTEM DEVELOPMENT AND MANAGEMENT OBJECTIVES[a]

Standard	Alternative Plan[b]			
	1	2	3	4
Objective No. 1—Support of Existing Land Use Patterns and Support and Direction of Planned Land Use Patterns	- -	- -	- -	- -
1. Public water supply systems should be designed to serve lands planned to be developed for urban uses, in accordance with the adopted regional land use plan	2.5	2.5	2.5	2.5
2. Areas of high potential for groundwater contamination should be excluded for the siting of potentially contaminating land uses or facilities	2.5	2.5	2.5	2.5
3. Important groundwater recharge and discharge areas should be identified for preservation or application of land development plans and practices which maintain the natural surface and groundwater hydrology, while protecting the groundwater quality	3.0	3.0	1.0	3.0
4. Sources of water supply should be specifically allocated to adequately serve lands planned to be maintained in agricultural uses	4.0	3.0	2.0	1.0
5. Primary environmental corridors should be preserved in essentially natural, open uses, and the extension of urban services, including public water supply services, into such corridors should be avoided, except for corridor-dependent uses, such as recreational facilities and water transmission main, sewage conveyance facilities, and other utility crossings	3.0	3.0	1.0	3.0
6. Secondary environmental corridors and isolated natural resource areas should be preserved in essentially natural, open uses to the extent practicable, as determined in county and local plans	2.5	2.5	2.5	2.5
7. The most productive soils, those designated by the U.S. Natural Resources Conservation Service as comprising agricultural soil capability Classes I and II, should be preserved for agricultural use, to the extent practicable, recognizing that certain Class I and Class II farmland will have to be converted to urban use in order to accommodate the orderly expansion of urban service areas within the Region. The extension of urban services, including public water supply services, into such areas should be avoided, except as these lands are converted to urban uses	2.0	2.0	4.0	2.0
8. Development of water sources in areas to be preserved for agricultural uses should be carried out in a manner which preserves the agricultural uses of the land as envisioned in the adopted regional land use plan	2.5	2.5	2.5	2.5
Subtotal	22.0	21.0	18.0	19.0
Rating	4.0	3.0	1.0	2.0
Objective No. 2—Conservation and Wise Use of the Surface Water and Groundwater Supplies	- -	- -	- -	- -
1. The use of the deep sandstone aquifer should be managed so that the potentiometric surface in that aquifer is sustained or raised under use and recharge conditions within the Southeastern Wisconsin Region. Declines in the potentiometric surface of the aquifer within the Region due to uses in areas beyond the Region should be identified for purposes of promoting interregional planning and action	4.0	3.0	1.0	2.0
2. The uses of the shallow aquifer should be managed so that the aquifer yields are sustainable	3.0	4.0	1.0	2.0
3. The uses of the deep and shallow aquifers should be managed so as to minimize the ecological impacts on the surface water system of the Region	4.0	3.0	2.0	1.0
4. Lake Michigan as a source of supply should be utilized recognizing the constraints of the current regulatory framework and the status and provisions of the Great Lakes-St. Lawrence River Basin Water Resources Compact	1.0	2.0	4.0	3.0

Table 145 (continued)

Standard	Alternative Plan[b]			
	1	2	3	4
Objective No. 2—Conservation and Wise Use of the Surface Water and Groundwater Supplies (continued)	- -	- -	- -	- -
5. The use of groundwater and surface water for water supply purposes should be carried out in a manner which minimizes adverse impacts to the water resources system, including lakes, streams, springs, and wetlands	4.0	3.0	2.0	1.0
6. Residential per capita water usages should be reduced to the extent practicable based upon the conclusions developed in SEWRPC Technical Report No. 43, *State-of-the-Art of Water Supply Practices*, and recognizing that differences in levels of conservation may be appropriate, depending upon the source of supply and related natural resources	2.5	2.5	2.5	2.5
7. Both indoor and outdoor water uses should be optimized through conservation practices which do not adversely affect the public health	2.5	2.5	2.5	2.5
8. Water uses for commercial, industrial, and institutional land uses should be reduced to the extent practicable through water conservation measures, duly considering the source of supply and related natural resources, as well as the economic viability and economic development needs of the Region	2.5	2.5	2.5	2.5
9. Unaccounted-for water in utility systems should be minimized	2.5	2.5	2.5	2.5
10. The type and extent of stormwater management and related land management practices should be determined through preparation of local stormwater management plans and land development practices and policies specifically considering the impact of those activities on groundwater recharge and should promote such practices which maintain or enhance the natural groundwater hydrology to the extent practicable, while protecting surface water and groundwater quality and quantity	2.5	2.5	2.5	2.5
Subtotal	28.5	27.5	22.5	21.5
Rating	4.0	3.0	2.0	1.0
Objective No. 3—Protection of Public Health, Safety, and Welfare	- -	- -	- -	- -
1. Water supply systems should be designed, constructed and operated to deliver finished water to users which meets the drinking water standards established by the Wisconsin Department of Natural Resources to protect the public health, safety, and welfare[c]	4.0	2.5	2.5	1.0
2. Water supply systems should be designed, constructed, and operated consistent with technically sound water supply industry standards directed toward the protection of the public health, safety, and welfare	2.5	2.5	2.5	2.5
3. The selection of sources of supply and the design, contribution and operation of related treatment facilities should be made cognizant of the potential presence of unregulated emerging pollutants, such as pharmaceuticals, personal care products, and certain viruses	2.5	2.5	2.5	2.5
4. The reuse of wastewater should be evaluated for applications where there is no potential for direct human consumption and limited potential for direct human contact, unless the pre-use treatment level is such as to preclude risks to public health	2.0	2.0	4.0	2.0
5. Surface water and groundwater supply treatment plants should be provided with state-of-the-art barriers to substances harmful to human health and safety	4.0	2.5	2.5	1.0
6. Water supply sources and treatment processes should be selected to minimize potential problems with subsequent treatment and disposal of created waste streams	4.0	2.5	2.5	1.0
7. Groundwater and surface water sources of water supply should be protected from sources of contamination by appropriate siting, design, and land use regulation	2.5	2.5	2.5	2.5
8. The level of treatment and design provided at public sewage treatment plants and industrial wastewater discharge locations should be determined directly related to the achievement of adopted water use objectives and supporting surface water and groundwater standards[d]	2.5	2.5	2.5	2.5

Table 145 (continued)

Standard	Alternative Plan[b]			
	1	2	3	4
Objective No. 3—Protection of Public Health, Safety, and Welfare (continued)	- -	- -	- -	- -
9. The density, design, operation, and level of treatment of onsite sewage disposal systems should be related to the achievement of the groundwater quality standards and the safety and public health requirements of any potentially affected water supplies	2.5	2.5	2.5	2.5
10. The type and extent of stormwater management or associated preventive land management practices to be applied in both urban and rural areas should be determined by State and local regulations, local stormwater management plans, county land and water management plans, and farm management plans directly related to protection of potentially affected water supplies and to the established water quality standards for the receiving surface water and groundwater systems	2.5	2.5	2.5	2.5
11. There should be no known wastewater or stormwater discharges to the surface water or groundwater systems used for water supply of inorganic compounds, synthetic compounds, volatile organics, or other substances in quantities at levels known to be bioaccumulative, acutely or chronically toxic or hazardous to human health, fish or other aquatic life, wildlife, and domestic animals	2.5	2.5	2.5	2.5
Subtotal	31.5	27.0	29.0	22.5
Rating	4.0	2.0	3.0	1.0
Objective No. 4—Economical and Efficient Systems	- -	- -	- -	- -
1. The sum of water supply system operating and capital investment costs should be minimized. Costs for waste disposal byproducts of water treatment, long-term energy and operation and maintenance, and legal costs should be considered	2.0	1.0	4.0	3.0
2. Maximum feasible use should be made of all existing and committed water supply facilities, which should be supplemented with additional facilities only as necessary to serve the anticipated water supply needs	2.0	3.5	3.5	1.0
3. The use of new or improved technologies and management practices should be allowed and encouraged if such technologies and practices offer economies in construction costs or by their superior performance lead to the achievement of water supply objectives at a lesser cost	2.5	2.5	2.5	2.5
4. Water supply facilities should be designed for staged or incremental construction where feasible and economical so as to limit total investment in such facilities and to permit maximum flexibility to accommodate changes in the rate of population growth and the rate of economic activity growth or changes in the technology for water supply management	1.0	2.0	3.0	4.0
Subtotal	7.5	9.0	13.0	10.5
Rating	1.0	2.0	4.0	3.0
Objective No. 5—Responsive and Adaptive Plans	- -	- -	- -	- -
1. The recommended regional water supply plan components should be adaptable to change in scope, capacity, and effectiveness to the extent practicable	1.0	2.0	3.0	4.0
2. The recommended water supply plan should be designed to incorporate redundancy, system backup features, and emergency operation requirements to the extent practicable in order to insure a safe delivery of water	1.0	2.0	3.0	4.0
3. The regional water supply plan components should be designed for staged incremental construction to the extent practical, so as to permit maximum flexibility to accommodate unanticipated changes in future conditions	1.0	2.0	3.0	4.0
4. The regional water supply plan should be adaptable to changes in the regulatory structure, including the 2001 Great Lakes-St. Lawrence River Basin Water Resources Compact and the State of Wisconsin 2003 Act 310	1.0	2.0	3.0	4.0

Table 145 (continued)

Standard	Alternative Plan[b]			
	1	2	3	4
Objective No. 5—Responsive and Adaptive Plans (continued)	- -	- -	- -	- -
5. The regional water supply plan should consider the possibility of long-term climate cycles that can affect recharge rates and water demand	4.0	3.0	2.0	1.0
6. The regional water supply plan should consider the possibility of changes in economic conditions, security issues, and regulations that can affect the demand for water supply and need for and types of water supply facilities	1.0	2.0	3.0	4.0
Subtotal	9.0	13.0	17.0	21.0
Rating	1.0	2.0	3.0	4.0

NOTE: The alternative plans are as follows:

Alternative Plan 1—2035 Forecast Conditions under Existing Trends and Committed Actions
Alternative Plan 2—2035 Forecast Conditions with Limited Expansion of Lake Michigan and Shallow Groundwater Aquifer Supplies
Alternative Plan 3—2035 Forecast Conditions with Groundwater Recharge Enhancement
Alternative Plan 4—Further Expansion of Lake Michigan Supply

[a] *Planning objectives, principles, and standards are presented in Chapter V of this report.*

[b] *Alternative plans are ranked 1 to 4, with 1 representing the alternative plan expected to best achieve the standard. When the performance of two or more alternative plans are anticipated to be the same, the ranking relative to the remaining alternative plans are averaged.*

[c] *Drinking water standards are set forth in Chapter V and Appendix H of this report.*

[d] *Water use objectives and supporting water quality standards and criteria are set forth in Appendices I and J of this report.*

Source: SEWRPC.

Standard 2—Areas of High Potential for Groundwater Contamination Should Be Excluded for the Siting of Potentially Contaminating Land Uses or Facilities

No differences are envisioned under the four alternative plans with respect to the siting of potentially contaminating land uses or facilities. Therefore, the expected abilities of the alternative plans to achieve this standard are equal and the plans were given identical ranks.

Standard 3—Important Groundwater Recharge and Discharge Areas Should Be Identified for Preservation or Application of Land Development Plans and Practices Which Maintain the Natural Surface and Groundwater Hydrology, While Protecting the Groundwater Quality

Important groundwater recharge areas in the Region were identified in a separate technical report developed as a part of the regional water supply planning program.[2] In addition, the location of known springs were identified and shown on Map 21 in Chapter II of this report. Under Alternative Plan 3, it is envisioned that about four square miles of area with moderate to very high groundwater recharge potential would be dedicated to rainfall infiltration

[2] *SEWRPC Technical Report No. 47,* Groundwater Recharge in Southeastern Wisconsin Estimated by a GIS-Based Water-Balance Model, *July 2008, prepared by the University of Wisconsin-Extension and the Wisconsin Geological and Natural History Survey.*

facilities. Therefore, this alternative plan was assigned the highest rank. Because it may be expected that preservation of these areas would be achieved, perhaps to a lesser, but equal, degree under Alternative Plans 1, 2, and 4, the expected abilities of these alternative plans to achieve this standard were given identical ranks.

Standard 4—Sources of Water Supply Should Be Specifically Allocated to Adequately Serve Lands Planned to Be Maintained in Agricultural Uses

Because of the decentralized nature of agricultural land use within the Region, allocation of water supply to agricultural uses does not involve construction of centralized transmission and distribution systems. Instead, agricultural uses tend to rely upon water that can be captured at or near the points of use. The model results documented in Chapter VIII indicate that the alternative plans that place less reliance on groundwater and make greater use of Lake Michigan water as a source of public water supply may be expected to result in greater water storage in the aquifers, as measured by associated drawups in the deep aquifer, and changes in baseflow contributions from the shallow aquifer to the surface water system. As a result, more water would be available in the aquifers for agricultural uses under alternative plans that place less reliance upon groundwater as a source of public water supply. Accordingly, such plans were judged to make available more water to serve lands planned to be maintained in agricultural uses. Based upon this evaluation, Alternative Plan 4 was judged to have the best ability to meet this standard and was assigned the best rank. While the sources of water envisioned to be used for public water supply under Alternative Plans 2 and 3 are the same, the additional recharge provided to the groundwater system under Alternative Plan 3 may be expected to provide a greater increase in storage in the aquifers than may be expected under Alternative Plan 2. Therefore, Alternative Plan 3 was assigned the next best rank. Because Alternative Plan 1 places the greatest reliance upon groundwater as a source of public water supply, it was judged to have the poorest ability to meet this standard and was assigned the poorest rank.

Standard 5—Primary Environmental Corridors Should Be Preserved in Essentially Natural, Open Uses, and the Extension of Urban Services, Including Public Water Supply Services, Into Such Corridors Should Be Avoided, Except for Corridor-Dependent Uses, Such As Recreational Facilities and Water Transmission Main, Sewage Conveyance Facilities, and Other Utility Crossings

Under all four alternative plans, it is expected that the delineated primary environmental corridors within the Region will be preserved as recommended in the adopted design year 2035 regional land use plan. The component of Alternative Plan 3 providing for the preservation of the areas with high, and very high, groundwater recharge strengthens the case for preserving the corridors. Thus, Alternative Plan 3 was assigned the highest rank. The expected abilities of the other three alternative plans to achieve this standard were given identical lower ranks.

Standard 6—Secondary Environmental Corridors and Isolated Natural Resource Areas Should Be Preserved in Essentially Natural, Open Uses to the Extent Practicable, As Determined in County and Local Plans

Under all four alternative plans, it is expected that the delineated secondary environmental corridors and isolated natural resource areas within the Region will be preserved as recommended in the adopted design year 2035 regional land use plan. Because the areas concerned are identical under all four alternative water supply plans, the expected abilities of the alternative plans to achieve this standard were considered equal and the plans were given identical ranks.

Standard 7—The Most Productive Soils, Those Designated By the U. S. Natural Resources Conservation Service As Comprising Agricultural Soil Capability Classes I and II, Should Be Preserved for Agricultural Use, to the Extent Practicable, Recognizing That Certain Class I and Class II Farmland Will Have to Be Converted to Urban Use in Order to Accommodate the Orderly Expansion of Urban Service Areas within the Region. The Extension of Urban Services, Including Public Water Supply Services, Into Such Areas Should Be Avoided, Except As These Lands Are Converted to Urban Uses

While the planned municipal water supply service areas are identical under all four alternative plans, Alternative Plan 3 envisions conversion of about four square miles of agricultural and other open lands as sites for rainfall infiltration facilities. Therefore, this alternative plan would not achieve this standard as well as the other three alternative plans. Therefore, Alternative Plans 1, 2, and 4 were given identical ranks and Alternative Plan 3 was given a lower rank.

Standard 8—Development of Water Sources in Areas to Be Preserved for Agricultural Uses Should Be Carried Out in a Manner Which Preserves the Agricultural Uses of the Land As Envisioned in the Adopted Regional Land Use Plan

It is not anticipated that siting of wells or transmission mains would require significant conversion of agricultural lands to other land uses. Alternative Plan 3 proposes conversion of about four square miles of agricultural and other open lands as sites for rainfall infiltration facilities. These sites were, however, located primarily to preserve baseflows in surface water features deemed to be especially dependent upon groundwater contributions. This use of rainfall infiltration facilities was not considered as development of a water source, and the alternative plans were given identical ranks.

Objective No. 2—Conservation and Wise Use of the Surface Water and Groundwater Supplies

Standard 1—The Use of the Deep Sandstone Aquifer Should Be Managed So That the Potentiometric Surface in That Aquifer is Sustained or Raised Under Use and Recharge Conditions within the Southeastern Wisconsin Region. Declines in the Potentiometric Surface of the Aquifer within the Region Due to Uses in Areas Beyond the Region Should Be Identified for Purposes of Promoting Interregional Planning and Action

The projected changes in the potentiometric surface in the sandstone aquifer under the conditions associated with each alternative plan are documented in Chapter VIII. Inspection of Maps 74, 84, 91, and 102 indicates that drawups in excess of five feet may be expected in the sandstone aquifer over most of the Region under Alternative Plans 2, 3, and 4, while drawdowns in excess of five feet may be expected in the sandstone aquifer over most of the Region under Alternative Plan 1. The greatest drawups, and the widest geographical extent of drawups in excess of five feet, may be expected to occur under Alternative Plan 3, followed in decreasing order by Alternative Plans 4 and 2. Additional expressions of these results are summarized in Table M-1 and Figure M-1 in Appendix M. Consequently, it may be expected that Alternative Plan 3 would best achieve this standard followed, in decreasing order, by Alternative Plans 4, 2, and 1. The alternative plans were ranked accordingly.

Standard 2—The Uses of the Shallow Aquifer Should Be Managed So That the Aquifer Yields Are Sustainable

As described in Chapter VIII, the impacts of pumping upon the shallow aquifer are buffered by the surface water system. Typically, the major effect of pumping from shallow wells is to reduce the amount of groundwater discharge to local surface water features. This effect can be represented as baseflow depletion from surface waterbodies. Because of this buffering effect, projected baseflow depletion from surface waterbodies was considered a better measure of the expected sustainability of an alternative plan than water table levels. Two measures of baseflow depletion were used to compare the four alternative plans: 1) the net baseflow depletion in the plan design year 2035 as projected by application of the regional aquifer simulation model under the conditions associated with each alternative plan; and 2) the projected baseflow reduction index (BRI) for the Region associated with each alternative plan. It is important to note that identical results were obtained using either of these measures. These comparisons are summarized in Table M-2 in Appendix M. In addition, the rankings of alternative plans with respect to this standard generated on a regional level using two other groundwater performance indicators, the demand to supply ratio (DSR) and the human impact ratio (HIR), were in agreement with the rankings generated based upon the projected baseflow reduction.

On a regional level, the smallest net baseflow reduction was projected to occur under Alternative Plan 3 followed, in order of increasing baseflow reduction, by Alternative Plans 4, 1, and 2. Based upon this, Alternative Plan 3 was assigned the best rank, followed by Alternative Plans 4, 1, and 2.

Standard 3—The Uses of the Deep and Shallow Aquifers Should Be Managed So As to Minimize the Ecological Impacts on the Surface Water System of the Region

The ecological impacts upon the surface water system that may be associated with uses of the deep and shallow aquifer fall into two broad classes: impacts associated with changes in surface water quantity; and impacts associated with changes in surface water quality. The expected impacts of the alternative plans upon surface water quantity were assessed by examining the general measures of baseflow reduction in surface waterbodies and by examining the projected specific baseflow reductions and augmentations at 100 surface water evaluation points associated with surface water features that were considered to be highly dependent on groundwater discharge. The major differences in impacts on surface water quality among the alternative plans were found to be the differences in chloride loadings on surface waters. Those differences are related to the use of water softening facilities at consumer locations. Because Lake Michigan water is considerably softer than groundwater in the Southeastern Wisconsin Region, it may be expected that alternative plans that make greater use of Lake Michigan water as a source of water supply would be associated with less need for water softening, and attendant lower total discharges of chloride to surface waters.

Another issue that needed to be considered with respect to Alternative Plan 4 if the required return flow to Lake Michigan were discharged to tributary streams, as in Subalternative 2, was the transfer of pollutants between river systems. Under that subalternative, there would be a transfer of pollutant loadings from the Fox River system to streams tributary to Lake Michigan. The quantitative impact of any increases in pollutant loadings, coupled with the increased hydraulic loading, would have to be addressed in further analyses if such return flow component is recommended and plan implementation pursued.

When the expected impacts related to water quantity and water quality were considered together, it was found that on a regional basis, the smallest ecological impacts were projected to occur under Alternative Plan 4 followed, in order of increasing expected impacts, by Alternative Plans 3, 2, and 1. Accordingly, Alternative Plan 4 was assigned the best rank, followed by Alternative Plans 3, 2, and 1.

Standard 4—Lake Michigan As a Source of Supply Should Be Utilized Recognizing the Constraints of the Current Regulatory Framework and the Status and Provisions of the Great Lakes-St. Lawrence River Basin Water Resources Compact

The Great Lakes-St. Lawrence River Basin Water Resources Compact places constraints upon the diversion of water from the Great Lakes basin. Under certain circumstances specified in the Compact, communities that straddle the subcontinental divide, and communities located in counties that straddle the subcontinental divide, may utilize water from Lake Michigan as a source of public water supply, if specified requirements are met. The requirements are more stringent for nonstraddling communities in straddling counties than for straddling communities. These requirements for straddling communities include: all the water diverted must be for public use and must be returned to the Lake less an allowance for consumptive use; the amount of water diverted is reasonable and cannot be avoided through efficient use and water conservation; the diversion will not result in adverse impacts to the Great Lakes basin; and water conservation measures are used to minimize the water withdrawn. For nonstraddling communities in straddling counties, these requirements include, in addition to those for straddling communities: review by a “regional body” comprised of the governors of the eight Great Lakes states, and the premiers of the Canadian provinces of Ontario and Quebec or their designees; and approval by a “council” comprised of the governors of the Great Lakes states or their designees. It should be noted in this respect, that the injection well component of Alternative Plan 3 constitutes a novel use of Great Lakes water. It is uncertain whether this use would be allowed under the Compact.

Based upon these considerations, it was determined to rank the relative achievement of this standard by the alternative plans based upon the stringency of the requirements that would need to be met under the Compact for implementation. Because no new diversion of Lake Michigan water out of the Great Lakes basin is envisioned under Alternative Plan 1, few requirements under the Compact would need to be met in order to implement it. Consequently, this alternative received the highest ranking. Alternative Plan 2 envisions provision of Lake Michigan to several straddling communities, but not to any nonstraddling communities in straddling counties. Because several communities would need to meet the requirements for straddling communities, but none would need to meet the additional requirements for nonstraddling communities in straddling counties, it was given the next best rating. Alternative Plan 4 envisions provision of Lake Michigan water to several nonstraddling communities in straddling counties, as well as provision of Lake Michigan water to those communities envisioned to receive it under Alternative Plan 2. Because some of the communities envisioned to receive Lake Michigan water under Alternative Plan 4 would need to meet more stringent requirements under the Compact than the communities receiving Lake Michigan water under Alternative Plan 2, Alternative Plan 4 was assigned the next best ranking. Because of the regulatory uncertainty associated with the injection well component of Alternative Plan 3, it was given the lowest ranking.

Standard 5—The Use of Groundwater and Surface Water for Water Supply Purposes Should Be Carried Out in a Manner Which Minimizes Adverse Impacts to the Water Resources System, Including Lakes, Streams, Springs, and Wetlands

The impacts upon the surface water system that may be associated with uses of the deep and shallow aquifer fall into two broad classes: impacts associated with changes in surface water quantity, and impacts associated with changes in surface water quality. The expected impacts of the alternative plans upon surface water quantity were assessed by examining the measures of baseflow reduction to surface waterbodies as described for the previous standard, and by examining the projected baseflow reductions and augmentations at 100 surface water evaluation points associated with surface water features that are considered to be highly dependent on groundwater discharge. The major expected difference in impacts on surface water quality among the alternative plans is expected to be the difference in chloride loadings on surface waters related to the use of water softening. As already noted, because Lake Michigan water is considerably softer than groundwater in the Southeastern Wisconsin Region, it is anticipated that alternative plans that make greater use of Lake Michigan water as a source of water supply would be associated with less need for water softening, and smaller total discharges of chloride to surface waters. Also, as already noted, another issue to be considered in this respect relative to Alternative Plan 4 is related to the transfer of pollutant loadings between watersheds. The impact of any increases in pollutant loadings, coupled with the increased hydraulic loadings, would have to be addressed in further analyses if such return flow component is recommended and plan implementation pursued.

When the expected impacts related to water quantity and water quality were considered together, it was found that on a regional level, the smallest impacts may be expected to occur under Alternative Plan 4 followed, in order of increasing expected impacts, by Alternative Plans 3, 2, and 1. Based upon this, Alternative Plan 4 was assigned the best rank, followed by Alternative Plans 3, 2, and 1.

Standard 6—Residential per Capita Water Usages Should Be Reduced to the Extent Practicable Based Upon the Conclusions Developed in SEWRPC Technical Report No. 43,* State-of-the-Art of Water Supply Practices*, and Recognizing That Differences in Levels of Conservation May Be Appropriate, Depending Upon the Source of Supply and Related Natural Resources

It is expected that the levels of residential per capita water use, and the degree of conservation of water by residential users, would be the same under all four alternative plans. Therefore, alternative plans were given equal rankings under this standard.

Standard 7—Both Indoor and Outdoor Water Uses Should Be Optimized through Conservation Practices Which Do Not Adversely Affect the Public Health

It is expected that the conservation practices used and the degree of conservation of water would be the same under all four alternative plans. Therefore, the alternative plans were given equal rankings under this standard.

Standard 8—Water Uses for Commercial, Industrial, and Institutional Land Uses Should Be Reduced to the Extent Practicable through Water Conservation Measures, Duly Considering the Source of Supply and Related Natural Resources, As Well As the Economic Viability and Economic Development Needs of the Region

It is expected that the conservation practices used and the degree of conservation of water would be the same under all four alternative plans. Therefore, the alternative plans were given identical equal rankings under this standard.

Standard 9—Unaccounted-For Water in Utility Systems Should Be Minimized

It is expected that water utilities will make the same levels of effort to minimize unaccounted-for water under all four alternative plans. Therefore, the alternative plans were given equal rankings under this standard.

Standard 10—The Type and Extent of Stormwater Management and Related Land Management Practices Should Be Determined through Preparation of Local Stormwater Management Plans and Land Development Practices and Policies Specifically Considering the Impact of Those Activities on Groundwater Recharge and Should Promote Such Practices Which Maintain or Enhance the Natural Groundwater Hydrology to the Extent Practicable, While Protecting Surface Water and Groundwater Quality and Quantity

Stormwater management and related land management practices are regulated under Chapters NR 151-155, NR 216, NR 243, and ATCP 50 of the *Wisconsin Administrative Code*. It is expected that these practices will be the same under all four alternative plans. Therefore, the alternative plans were given identical rankings under this standard.

Objective No. 3—Protection of Public Health, Safety, and Welfare

Standard 1—Water Supply Systems Should Be Designed, Constructed and Operated to Deliver Finished Water to Users Which Meets the Drinking Water Standards Established By the Wisconsin Department of Natural Resources to Protect the Public Health, Safety, and Welfare

It is expected that the procedures and standards followed in the design, construction, and operation of water supply systems would be the same under all four alternative plans. Those actions will typically result in finished water from both surface water and groundwater source of supply meeting all of the primary drinking water standards for purity. Surface water supplies typically also meet secondary drinking water standards, which primarily relate to aesthetic considerations and minimally concern public health and safety. Groundwater supplies often do not meet some of the secondary standards. Therefore, the alternatives with the greatest use of surface water were given the best rank under this standard, with deep aquifer supplies ranked better than shallow aquifer supplies. Accordingly, Alternative Plan 4 was given the best rank, while Alternative Plan 1 was given the lowest, with Alternative Plans 2 and 3 given intermediate equal rankings.

Standard 2—Water Supply Systems Should Be Designed, Constructed, and Operated Consistent with Technically Sound Water Supply Industry Standards Directed Toward the Protection of the Public Health, Safety, and Welfare

It is expected that the standards for design, construction, and operation of water supply systems would be the same under all four alternative plans. Therefore, the alternative plans were given identical rankings under this standard.

Standard 3—The Selection of Sources of Supply and the Design, Contribution and Operation of Related Treatment Facilities Should Be Made Cognizant of the Potential Presence of Unregulated Emerging Pollutants, Such As Pharmaceuticals, Personal Care Products, and Certain Viruses

Water utilities relying upon Lake Michigan water as a source of supply tend to provide more treatment of the water pumped than utilities relying upon groundwater. Accordingly, alternative plans which place greater reliance on groundwater as a source of water supply were judged to be more vulnerable to impacts of these contaminants than alternative plans that place greater reliance on Lake Michigan as a source of supply. However, surface waters—such as Lake Michigan—are typically more quickly susceptible to pollution by emerging contaminants than are groundwaters, and existing surface water treatment units are not effective in removing some of the contaminants concerned. On the other hand, surface water treatment plants are adept at modifying treatment systems to resolve any identified problems. Given the uncertainty with regard to emerging pollutants and the conflicting rationale for the relative differences in vulnerability to both surface water and groundwater supplies, all of the alternative plans were given equal rankings under this standard.

Standard 4—The Reuse of Wastewater Should Be Evaluated for Applications Where There is No Potential for Direct Human Consumption and Limited Potential for Direct Human Contact, Unless the Pre-Use Treatment Level is Such As to Preclude Risks to Public Health

Alternative Plans 1, 2, and 4 do not envision the reuse of wastewater. Therefore, the expected abilities of these alternative plans to achieve this standard are equal and these alternative plans were given identical ranks. Under Alternative Plan 3, it is envisioned that treated effluent from four wastewater treatment plants would be used to provide enhanced recharge to the shallow groundwater system. While the level of treatment envisioned was considered sufficient for the purposes of groundwater recharge, greater risks are associated with this alternative due to the possibility that some contaminants may not be removed by the treatment. Consequently, Alternative Plan 3 was given a lower rank than the other alternative plans.

Standard 5—Surface Water and Groundwater Supply Treatment Plants Should Be Provided with State-of-the-Art Barriers to Substances Harmful to Human Health and Safety

Because water utilities relying upon Lake Michigan water as a source of supply tend to provide more treatment of the water pumped than utilities relying upon groundwater, alternative plans that place greater reliance on surface water as a source of water supply were judged to have greater barriers in place to substances harmful to human health and safety than alternative plans that place greater reliance on groundwater as a source of supply. Accordingly, Alternative Plan 4, which places the least reliance upon groundwater as a source of supply was assigned the best rank. Alternative Plan 1, which places the greatest reliance on groundwater as a source of water supply was assigned the poorest rank. Alternative Plans 2 and 3 were given equal intermediate rankings under this standard.

Standard 6—Water Supply Sources and Treatment Processes Should Be Selected to Minimize Potential Problems with Subsequent Treatment and Disposal of Created Waste Streams

The discharge of chlorides associated with water softening to municipal sanitary sewage systems and sewage treatment plants, and to onsite sewage treatment systems constitute a waste stream capable of causing potential surface water and groundwater quality problems. As a result of the high solubility of chloride ions in water, chlorides are not removed by the wastewater treatment processes utilized in sewage treatment plants and by onsite treatment systems, and are consequently present in effluent discharged by these facilities. The need for water softening is related to the hardness of the water used for water supply. Because groundwater in southeastern Wisconsin contains considerably more hardness than Lake Michigan water, the relative need for softening among the alternative plans—and the resulting size of the chloride waste stream generated—may be expected to be related to the proportion of the Region utilizing groundwater as a source of water supply. Surface water treatment plants generate significant amounts of residuals, including settled solids and filter backwash water. Groundwater treatment systems also generate residuals, but typically in lesser quantities than surface water treatment plants. In situations where the groundwater is treated to remove radionuclides, the residuals will contain levels of that contaminant and may require disposal as a hazardous waste. Given these considerations, it was concluded that the difference in the chloride waste streams generated under the alternative plans was significant, and that the plans that place greater reliance on the use of groundwater as a source of supply should rank lower than the plans that place greater reliance on the use of surface water as a source of supply.

Alternative Plan 4 was judged to best achieve this standard because it places the least reliance upon groundwater as a source of water supply, and it was given the best rank. Because Alternative Plans 2 and 3 place less reliance on the use of groundwater than Alternative Plan 1, and because the sources of supply envisioned under Alternative Plans 2 and 3 were identical, these plans were given equal intermediate rankings. Because Alternative Plan 1 places the greatest reliance on groundwater as a source of water supply, it was given the poorest rank.

Standard 7—Groundwater and Surface Water Sources of Water Supply Should Be Protected from Sources of Contamination By Appropriate Siting, Design, and Land Use Regulation

The regulations affecting siting and design of sources of water supply and the relevant land use regulations are expected to be the same under all four alternative plans. Therefore, the alternative plans were given equal rankings under this standard.

Standard 8—The Level of Treatment and Design Provided At Public Sewage Treatment Plants and Industrial Wastewater Discharge Locations Should Be Determined Directly Related to the Achievement of Adopted Water Use Objectives and Supporting Surface Water and Groundwater Standards

The design of wastewater treatment plants and the levels of treatment provide at public sewage treatment plants and at industrial discharge locations are expected to be the same under all four alternative plans. Therefore, the alternative plans were given equal rankings under this standard.

Standard 9—The Density, Design, Operation, and Level of Treatment of Onsite Sewage Disposal Systems Should Be Related to the Achievement of the Groundwater Quality Standards and the Safety and Public Health Requirements of Any Potentially Affected Water Supplies

The design of densities, design, operation, and the levels of treatment of onsite sewage disposal systems are expected to be the same under all four alternative plans. Therefore, the alternative plans were given equal rankings under this standard.

Standard 10—The Type and Extent of Stormwater Management or Associated Preventive Land Management Practices to Be Applied in Both Urban and Rural Areas Should Be Determined By State and Local Regulations, Local Stormwater Management Plans, County Land and Water Management Plans, and Farm Management Plans Directly Related to Protection of Potentially Affected Water Supplies and to the Established Water Quality Standards for the Receiving Surface Water and Groundwater Systems

Stormwater management and related land management practices are regulated under Chapters NR 151-155, NR 216, NR 243, and ATCP 50 of the *Wisconsin Administrative Code*. It is expected that these practices will be the same under all four alternative plans. Therefore, the alternative plans were given equal rankings under this standard.

Standard 11—There Should Be No Known Wastewater or Stormwater Discharges to the Surface Water or Groundwater Systems Used for Water Supply of Inorganic Compounds, Synthetic Compounds, Volatile Organics, or Other Substances in Quantities At Levels Known to Be Bioaccumulative, Acutely or Chronically Toxic or Hazardous to Human Health, Fish or Other Aquatic Life, Wildlife, and Domestic Animals

Stormwater management is regulated under Chapters NR 151-155, NR 216, NR 243, and ATCP 50 of the *Wisconsin Administrative Code*. Wastewater discharges to surface waters are subject to effluent limitations as specified in Chapter NR 106 the *Wisconsin Administrative Code* and are regulated through the Wisconsin Pollutant Discharge Elimination System under Chapters NR 200 through 299 of the *Wisconsin Administrative Code*. It is expected that the requirements and associated practices will be the same under all four alternative plans. Therefore, the alternative plans were given equal rankings under this standard.

Objective No. 4—Economical and Efficient Systems

Standard 1—The Sum of Water Supply System Operating and Capital Investment Costs Should Be Minimized. Costs for Waste Disposal Byproducts of Water Treatment, Long-Term Energy and Operation and Maintenance, and Legal Costs Should Be Considered

The capital and operations and maintenance costs of the alternative plans were compared based upon the estimated present worth costs presented in Chapter VIII of this report. For Alternative Plans 1, 2, 3, and 4, these costs were estimated to be \$183 million, \$175 million, \$280 million, and \$228 million, respectively. Consequently, Alternative Plan 2 best met this standard and was given the best rank followed, in order of decreasing rank, by Alternative Plan 1, 3, and 4.

Standard 2—Maximum Feasible Use Should Be Made of All Existing and Committed Water Supply Facilities, Which Should Be Supplemented with Additional Facilities Only As Necessary to Serve the Anticipated Water Supply Needs

The performance of the alternative plans relative to this standard was assessed by comparing the net change in usage of existing water supply capacity under the conditions associated with each alternative. The alternative plans differ in two respects. First, some alternative plans would make greater use of existing, surplus capacity of the Lake Michigan treatment plants than others. Second, some alternative plans would entail abandoning more existing municipal wells than others. For each alternative, the capacity of existing and committed wells that would need to be abandoned was subtracted from the amount of additional Lake Michigan treatment plant capacity that would be utilized to calculate a net change in the amount of existing and committed water supply capacity utilized. This is summarized in Table M-3 in Appendix M. Under Alternative Plan 4 conditions, there would be a net increase in the amount of existing and committed water supply capacity utilized. A net increase may also be expected under Alternative Plan 1; however, it is expected to be smaller than the increase expected under Alternative Plan 2. Net decreases in the amount of existing and committed water supply capacity utilized may be expected under Alternative Plans 2 and 3. The magnitude of this anticipated net decrease would be the same under these two alternative plans. Therefore, Alternative Plan 4 was given the best rank under this standard, Alternative Plan 1 was given the next best rank, and Alternative Plans 2 and 3 were given the lowest and equal rankings under this standard.

Standard 3—The Use of New or Improved Technologies and Management Practices Should Be Allowed and Encouraged if Such Technologies and Practices Offer Economies in Construction Costs or By Their Superior Performance Lead to the Achievement of Water Supply Objectives At a Lesser Cost

The use of new or improved technologies and management practices is expected to be the same under all four alternative plans. Therefore, the alternative plans were given equal rankings under this standard.

Standard 4—Water Supply Facilities Should Be Designed for Staged or Incremental Construction Where Feasible and Economical So As to Limit Total Investment in Such Facilities and to Permit Maximum Flexibility to Accommodate Changes in the Rate of Population Growth and the Rate of Economic Activity Growth or Changes in the Technology for Water Supply Management

Staged construction is likely to be more feasible under alternative plans that rely more heavily on the use of groundwater than under those which rely more heavily on the use of large transmission mains to transmit water from surface sources to multiple user communities. Wells can be constructed or retired in a staggered fashion, while an entire transmission main must be in place to provide the required surface water to a community. Because Alternative Plan 1 places the greatest reliance on the use of groundwater and the least reliance on the use of multi-community transmission mains, it may be expected to provide the greatest opportunity for staged, or incremental, construction, and was accordingly assigned the best rank. While Alternative Plans 2 and 3 would entail construction of some large transmission mains, the scale of the transmission capacity would be smaller than that required under Alternative Plan 4. Because of the additional transmission mains that would be required to support the injection well component of Alternative Plan 3, Alternative Plan 2 was judged to offer greater potential for staged, or incremental, construction than Alternative Plan 3. Therefore, Alternative Plan 2 was assigned the next highest rank, followed by Alternative Plan 3. Because Alternative Plan 4 would entail construction of large transmission mains both to provide Lake Michigan water to multiple communities and to provide for return flow to Lake Michigan, it was judged to offer the least opportunity for staged or incremental construction, and was given the lowest rank.

Objective No. 5—Responsive and Adaptive Systems

Standard 1—The Recommended Regional Water Supply Plan Components Should Be Adaptable to Change in Scope, Capacity, and Effectiveness to the Extent Practicable

The adaptability of water supply plan components is a function of the scale of the infrastructure required for the plan to operate and the independence of the components from one another. Alternative plans which rely on the use of groundwater are likely to offer greater flexibility and adaptability than those that rely on large transmission mains to transmit water from surface sources to multiple communities. Wells can be constructed or retired in a staggered fashion. Moreover, the elapsed time between the identification of need and construction may be expected to be less for a well than that for a major transmission main. Because Alternative Plan 1 places the greatest reliance on groundwater as a source of supply and the least reliance on multi-community transmission mains, it was judged to be the most adaptable to change and was assigned the highest rank. While Alternative Plans 2 and 3 would entail construction of some large transmission mains, the scale of this infrastructure would be smaller than the scale of the infrastructure envisioned under Alternative Plan 4. Because of the additional transmission mains that would be required to support the injection well component of Alternative Plan 3, Alternative Plan 2 was judged to be more adaptable than Alternative Plan 3, and was assigned the next best rank followed by Alternative Plan 3. Because Alternative Plan 4 would entail construction of large transmission mains, both to provide Lake Michigan water to multiple communities, and to provide for return flow to Lake Michigan from those affected communities, it was judged to be the least adaptable to changes in scope, capacity, and effectiveness and was given the lowest rank.

Standard 2—The Recommended Water Supply Plan Should Be Designed to Incorporate Redundancy, System Backup Features, and Emergency Operation Requirements to the Extent Practicable in Order to Insure a Safe Delivery of Water

The scale and expense associated with constructing large transmission mains designed to serve multiple communities make it difficult to provide the same degree of redundancy in water supply infrastructure for alternative plans that rely more heavily on Lake Michigan as a source of supply as can be provided by alternative plans that rely more heavily on groundwater. As a result, the abilities of alternative plans that place greater reliance on groundwater as a source of water supply to meet this standard were judged to be greater than those of alternative plans that rely on the use of large, multi-community transmission mains to transmit water from Lake Michigan. Because Alternative Plan 1 places the greatest reliance on groundwater and the least reliance on multi-community transmission mains, it was judged to provide the greatest redundancy and backup capabilities and was assigned the highest rank. While Alternative Plans 2 and 3 would entail construction of some large transmission mains, the scale of this infrastructure would be smaller than the scale of the infrastructure envisioned under Alternative Plan 4. Because of the additional transmission mains that would be required to support the injection well component of Alternative Plan 3, Alternative Plan 2 was judged as able to provide greater redundancy and backup capabilities than Alternative Plan 3. Thus, Alternative Plan 2 was assigned the next highest rank followed by Alternative Plan 3. Because Alternative Plan 4 would entail construction of large transmission mains both to provide Lake Michigan water to multiple communities and to provide for return flow to Lake Michigan, and because the expense of duplicating this infrastructure was judged to be prohibitive, Alternative Plan 4 was given the lowest rank.

Standard 3—The Regional Water Supply Plan Components Should Be Designed for Staged Incremental Construction to the Extent Practical, So As to Permit Maximum Flexibility to Accommodate Unanticipated Changes in Future Conditions

As already noted, staged construction is likely to be more feasible under alternative plans that rely more heavily on the use of groundwater than under those which rely more heavily on large transmission mains. Because Alternative Plan 1 places the greatest reliance on groundwater as a source of supply, and the least reliance on multi-community transmission mains, it was judged to provide the greatest opportunity for staged, or incremental, construction and was assigned the highest rank. While Alternative Plans 2 and 3 would entail construction of some large transmission mains, the scale of this infrastructure would be smaller than the scale of the infrastructure envisioned under Alternative Plan 4. Because of the additional transmission mains that would be required to support the injection well component of Alternative Plan 3, Alternative Plan 2 was judged to provide more opportunity for staged, or incremental, construction than Alternative Plan 3. Therefore, Alternative Plan 2 was assigned the next best rank, followed by Alternative Plan 3. Because Alternative Plan 4 would entail construction of large transmission mains both to provide Lake Michigan water to multiple communities and to provide for return flow to Lake Michigan, it was judged to provide the least opportunity for staged or incremental construction, and was given the lowest rank.

Standard 4—The Regional Water Supply Plan Should Be Adaptable to Changes in the Regulatory Structure, Including the 2001 Great Lakes-St. Lawrence River Basin Water Resources Compact and the State of Wisconsin 2003 Act 310

Responses to changes in the regulatory structure are best addressed through the development of a water supply plan that is adaptable to changes in scope, capacity, and effectiveness. Therefore, the relative abilities of the alternative plans to achieve this standard were judged to be similar to their abilities to meet the first standard supporting this objective. Consequently, the alternative plans were given the same ranks under this standard as they were under the first standard supporting this objective.

Standard 5—The Regional Water Supply Plan Should Consider the Possibility of Long-Term Climate Cycles That Can Affect Recharge Rates and Water Demand

The forecast water demand, as presented in Chapter IV is expected to be the same for all four Alternative plans. Changes in groundwater recharge rates due to long-term climate cycles may be expected to have a greater impact on alternative plans that rely more heavily upon groundwater as a source of water supply than upon Lake

Michigan as a source of water supply. Therefore, it would be expected that the ability of Alternative Plan 4 to meet this standard would be greater than that of the other three alternative plans considered, since the other three alternative plans place greater reliance upon groundwater, Alternative Plan 4 was given the best rank. Since Alternative Plan 1 places greater reliance upon groundwater as a source of supply than the other alternative plans, it was judged as having the greatest sensitivity to changes in recharge rates related to long-term climate cycles and was assigned the lowest rank. While Alternative Plans 2 and 3 rely upon groundwater as a source of supply to the same extent, the enhanced groundwater recharge components of Alternative Plan 3 may be expected to mitigate some of the impacts on groundwater recharge that may be expected to result from long-term climate cycles. Consequently, it was assigned a higher rank than Alternative Plan 2.

Standard 6—The Regional Water Supply Plan Should Consider the Possibility of Changes in Economic Conditions, Security Issues, and Regulations That Can Affect the Demand for Water Supply and Need for And Types of Water Supply Facilities

Responses to changes in economic conditions, security issues, and regulations are best addressed through the development of a water supply plan that is adaptable to changes in scope, capacity, and effectiveness. Therefore, the relative abilities of the alternative plans to achieve this standard were judged to be similar to their abilities to meet the first standard supporting this objective. Consequently, the alternative plans were given the same ranking for this standard as they were for the first standard supporting this objective.

Other Considerations

Another consideration in the evaluation of the alternative water supply plans concerned the concept of environmental justice. This concept is intended to both prevent "disproportionately high and adverse" impacts of decisions on low-income and minority groups and to assure that such groups receive a proportionate share of benefits. In the comparative evaluation of the alternative plans, an attempt was made with the assistance of the Commission Environmental Justice Task Force to identify differential impacts of the alternative plans on low-income and minority groups. No specific differential impacts related to environmental justice were identified that could be used in the comparative evaluation of the alternative plans.

A final consideration given in the comparative evaluation of the alternative water supply plans related energy utilization under the alternatives. To examine this consideration, Commission staff developed estimates of the electric power requirements for treating and transporting water under each of the alternative water supply plans. The methods used to develop these estimates are described in Appendix L of this report, along with the estimates of the electric power requirements. For the Region, the differences in the electric power requirements among the four alternative plans considered were within about 5 percent of one another. It was therefore concluded that no significant differences existed among the plans with respect to energy use.

Conclusions

Table 145 sets forth the rank order ratings of each of the alternative plans relative to the standards supporting each of the water supply development and management objectives under the planning effort. Table 146 sets forth the resultant rank order ratings of each of the alternative plans considered relative to the objectives. Three aspects of the rankings are apparent. First, the numeric totals of the ranks show that there is little difference in rank order among the alternative plans considered based upon the ability of the plans to achieve the objectives. Alternative Plans 2, 3, and 4 may be expected to achieve the plan objectives more fully than Alternative Plan 1; however, none of the alternative plans may be expected to achieve the objectives to a significantly greater degree than the others. Second, the rank orders of each of the alternatives under each of the objectives relative to the rank orders of the other alternative plans indicates that each alternative plan ranks first or second in how well it may be expected to achieve some planning objectives, and third or fourth in how well it may be expected to achieve the others. Further examination of Table 145 supports this observation. Each alternative plan ranks first or second relative to several of the standards supporting the planning objectives. No single alternative plan was found to best meet all of the objectives. Thirdly, if the deep aquifer groundwater injection well component of Alternative Plan 3 were eliminated, Alternative Plan 3 would have ranked higher. Such a change to Alternative Plan 3 would improve its ranking for Standard 4 under Objective No. 2 and Standard 4 under Objective No. 5.

Table 146

RANK ORDER RATINGS OF ALTERNATIVE WATER SUPPLY PLANS RELATIVE TO THE WATER SUPPLY DEVELOPMENT AND MANAGEMENT OBJECTIVES[a]

Objective	Alternative Plan[b]			
	1	2	3	4
Support of Existing Land Use Patterns and Support and Direction of Planned Land Use Patterns	4.0	3.0	1.0	2.0
Conservation and Wise Use of the Surface Water and Groundwater Supplies	4.0	3.0	2.0	1.0
Protection of Public Health, Safety, and Welfare	4.0	2.0	3.0	1.0
Economical and Efficient Systems	1.0	2.0	4.0	3.0
Responsive and Adaptive Plans	1.0	2.0	3.0	4.0
Total	14.0	12.0	13.0	11.0

NOTE: The alternative plans are as follows:

Alternative Plan 1—2035 Forecast Conditions under Existing Trends and Committed Actions
Alternative Plan 2—2035 Forecast Conditions with Limited Expansion of Lake Michigan and Shallow Groundwater Aquifer Supplies
Alternative Plan 3—2035 Forecast Conditions with Groundwater Recharge Enhancement
Alternative Plan 4—Further Expansion of Lake Michigan Supply

[a]Planning objectives, principles, and standards are presented in Chapter V of this report.

[b]Alternative plans are ranked 1 to 4, with 1 representing the alternative plan expected to best achieve the standard. When the performance of two or more alternative plans is anticipated to be the same, the ranking relative to the remaining alternative plans are averaged.

Source: SEWRPC.

The pattern of rank ordering evident in Tables 145 and 146 indicate that each alternative plan contains sound components that merit consideration for inclusion in a composite plan. It was, therefore, concluded that a carefully constructed composite plan incorporating those components would be capable of meeting the agreed-upon objectives more fully than any of the four alternative plans considered and presented in Chapter VIII. That composite plan is described in the next section of this chapter along with the resources for selecting the components included in the composite plan.

DEVELOPMENT OF A COMPOSITE PLAN FOR FURTHER CONSIDERATION

Composite Plan Element 1—Components Common to All Initially Considered Alternative Plans

There are a number of facilities proposed to serve the existing and planned water supply service areas within the Region, the configuration of which are the same in all of the initially considered alternative plans. Sixty utilities, or portions of utilities, were found to have adequate available sources of supply under each of the initially considered alternative plans. While some infrastructure expansion may be needed by these utilities, the existing sources of supply were found to be adequate. The needed expansion of the infrastructure of the utilities were all included in the composite plan with no change in the source of supply. The utilities concerned and the needed infrastructure improvements are listed in Table 147 for existing utilities, and Table 148 for potential new utilities.

The potential new municipal utility areas listed in Table 147 and portions of some of the water supply service areas associated with the utilities listed in Table 147 include areas which are currently developed at urban densities and are currently served by private individual wells. These areas were designated as potential future

Table 147

COMPOSITE PLAN ELEMENT 1—EXISTING UTILITY COMPONENTS COMMON TO ALL INITIALLY CONSIDERED ALTERNATIVE PLANS

County and Utility	Programs and Facilities Description[a]
Kenosha County	- -
City of Kenosha Water Utility	No additions
Village of Paddock Lake Municipal Water Utility	Addition of two 0.25 MG elevated tanks, three shallow aquifer wells with 0.20 MG reservoir each
Village of Pleasant Prairie Water Utility	Addition of 0.75 MG elevated tank
Town of Bristol Utility District No. 3	No additions
Town of Somers Water Utility	No additions
Village of Silver Lake Planned Utility	Addition of three shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank
Village of Twin Lakes Planned Utility	Addition of five shallow aquifer wells with 0.1 MG reservoir each, two 0.3 MG elevated tanks
Town of Salem Planned Utility	Addition of eight shallow aquifer wells, four with 0.15 MG reservoirs, two 0.3 MG elevated tanks
Powers-Benedict-Tombeau Lakes Area Planned Utility	Addition of two shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank
Milwaukee County	- -
City of Cudahy Water Utility	Duplicate rapid mix facility
City of Franklin Water Utility	No additions
City of Glendale Water Utility	No additions
City of Milwaukee Water Works	No additions
City of Oak Creek Water and Sewer Utility	Addition of 20 mgd coag-floc-sed, 14 mgd filtration, 17.5 mgd pumping
City of South Milwaukee Water Utility	No additions
City of Wauwatosa Water Utility	No additions
City of West Allis Water Utility	No additions
Village of Brown Deer Public Water Utility	No additions
Village of Fox Point Water Utility	No additions
Village of Greendale Water Utility	No additions
Village of Shorewood Municipal Water Utility	No additions
Village of Whitefish Bay Water Utility	No additions
We Energies-Water Services	No additions
Ozaukee County	- -
Village of Belgium Municipal Water Utility	Addition of 0.45 MG reservoir at Well 3, service pumps at Wells 1 and 2
We Energies-Water Services	5,300 feet of 30-inch main (shared with Village of Germantown) in 107th Street; 16,100 feet of 20-inch main in Granville Road and Donges Bay Road
Town of Fredonia-Waubeka Area Planned Utility	Addition of one shallow aquifer well with 0.10 MG reservoir, 0.25 MG elevated tank
Racine County	- -
City of Burlington Municipal Waterworks	No additions
City of Racine Water and Wastewater Utility[b]	No additions
Village of Caledonia West Utility District[c]Oak Creek	No additions

Table 147 (continued)

County and Utility	Programs and Facilities Description[a]
Racine County (continued)	- -
Village of Caledonia West Utility District[c] Racine	No additions
Village of Caledonia East Utility District[d] Oak Creek	No additions
Village of Caledonia East Utility District[d] Racine	No additions
Village of Waterford Water and Sewer Utility	Addition of one shallow aquifer well with 0.40 MG reservoir
Village of Wind Point Municipal Water Utility	No additions
North Cape Sanitary District	Addition of one shallow aquifer well with 0.10 MG reservoir
Northwest Caledonia Area Planned Utility District	9,000 lineal feet of water transmission main
Town of Burlington-Bohner Lake Area Planned Utility District	Addition of two shallow aquifer wells, 0.30 MG elevated tank
Town of Dover-Eagle Lake Area Planned Utility District	Addition of two shallow aquifer wells, 0.30 MG elevated tank
Town of Norway Area Planned Utility	Addition of four shallow aquifer wells, one with 0.15 MG reservoir, two 0.25 MG elevated tanks
Village of Rochester Area Planned Utility	Addition of two shallow aquifer wells, two 0.10 MG elevated tanks
Town of Rochester Area Planned Utility	Addition of two shallow aquifer wells, two 0.10 MG elevated tanks
Town of Waterford Area Planned Utility	Addition of three shallow aquifer wells, one with 0.15 MG reservoir, two 0.3 MG elevated tanks
Walworth County	- -
City of Lake Geneva Municipal Water Utility	No additions
City of Whitewater Municipal Water Utility	No additions
Village of Darien Water Works and Sewer System	Increase Well 1 output from 325 to 425 gpm
Village of East Troy Municipal Water Utility	Addition of three shallow aquifer wells, two with 0.10 MG reservoir each
Village of Fontana Municipal Water Utility	No additions
Village of Genoa City Municipal Water Utility	Addition of two shallow aquifer wells and 0.25 MG elevated tank
Village of Sharon Waterworks and Sewer System	Addition of one shallow aquifer well with 0.30 MG reservoir, 0.20 MG elevated tank
Village of Walworth Municipal Water and Sewer Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.15 MG reservoir
Village of Williams Bay Municipal Water Utility	No additions
Town of Bloomfield Pell Lake Sanitary District No. 1	Addition of 0.2 MG elevated tank, one deep aquifer well with radium treatment and with 0.4 MG reservoir
Town of East Troy Sanitary District No. 3	Addition of one shallow aquifer well
Town of Geneva Lake Como Sanitary District No. 1	Addition of 0.20 MG elevated tank and 0.45 MG reservoir
Town of Troy Sanitary District No. 1	Addition of one shallow aquifer well with 0.12 MG reservoir
Town of Lyons Area Planned Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.3 MG elevated tank
Town of East Troy-Potter Lake Area Planned Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.3 MG elevated tank
Washington County	- -
City of West Bend Water Utility	Addition of one shallow aquifer well
Village of Jackson Water Utility	No additions
Village of Kewaskum Municipal Water Utility	Addition of 0.25 MG reservoir
Village of Slinger Utilities	Addition of two shallow aquifer wells with 0.20 MG reservoir each

Table 147 (continued)

County and Utility	Programs and Facilities Description[a]
Washington County (continued)	- -
Allenton Sanitary District No. 1	Addition of 0.20 MG elevated tank, one deep aquifer well with 0.30 MG reservoir
Village of Newburg Area Planned Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.30 MG elevated tank
Waukesha County	- -
City of Delafield Municipal Water Utility	Addition of five shallow aquifer wells, 0.40 MG elevated tank
City of New Berlin Water Utility (east)	Addition of 0.40 MG reservoir
City of Oconomowoc Utilities	No additions
Village of Butler Public Water Utility	Addition of 0.25 MG reservoir
Village of Dousman Water Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.40 MG reservoir
Village of Eagle Municipal Water Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.40 MG reservoir
Village of Hartland Municipal Water Utility	Addition of one shallow aquifer well
Village of Menomonee Falls Water Utility (east)	No additions
Village of Mukwonago Municipal Water Utility	Addition of three shallow aquifer wells
Village of Sussex Public Water Utility	Addition of one shallow aquifer well
Village of Big Bend Planned Utility	Addition of two shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank
Village of North Prairie Planned Utility	Addition of 0.50 MG elevated tank
Village of Wales Planned Utility	Addition of two shallow aquifer wells, 0.30 MG elevated tank
Town of Eagle-Eagle Spring Lake Area Planned Utility	Addition of one shallow aquifer well with 0.15 MG reservoir
Town of Oconomowoc-Okauchee Lake Area Planned Utility	Addition of four shallow aquifer wells, one with 0.15 MG reservoir, two 0.30 MG elevated tanks
Town of Summit-Golden Lake Area Planned Utility	Addition of one shallow aquifer well with 0.10 MG reservoir
Town of Ottawa-Pretty Lake Area Planned Utility	Addition of one shallow aquifer well with 0.10 MG reservoir

[a]*All utilities' programs include water conservation programs.*

[b]*Includes the Village of Sturtevant Water Utility which was purchased by the City of Racine Water and Wastewater Utility in 2007 and is now served by the City Utility on a retail basis.*

[c]*Includes the former Crestview Sanitary District and the former North Park Sanitary Districts which were consolidated in 2007 to form the Caledonia East Utility District.*

[d]*Includes the former Caddy Vista Sanitary District and the former Caledonia Utility District No. 1 which were consolidated in 2006 to form the Caledonia West Utility District.*

Source: Ruekert & Mielke, Inc., and SEWRPC.

municipal water supply service areas in order to permit a comprehensive assessment of the demands, added supply needed, and the areawide performance of the water supply system if such areas were served. However, the development of municipal water supply systems to serve these areas is envisioned only if a local need as demonstrated based upon groundwater quality or quantity concerns, and if a local initiative is undertaken to implement a municipal system. Such a local initiative typically includes, and is dependent upon, a survey to determine the local need and the interest of the residents in a given area regarding the provision of municipal water supply. In the absence of such a need and initiative, the residents and businesses in these areas would be expected to remain on individual wells.

Table 148

POTENTIAL NEW MUNICIPAL WATER UTILITIES COMPONENTS COMMON TO ALL INITIALLY CONSIDERED ALTERNATIVE PLANS

County and Utility	Programs and Facilities Description[a]
Kenosha County	- -
Village of Silver Lake Potential Utility	Addition of three shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank
Village of Twin Lakes Potential Utility	Addition of five shallow aquifer wells with 0.1 MG reservoir each, two 0.3 MG elevated tanks
Town of Salem Potential Utility	Addition of eight shallow aquifer wells, four with 0.15 MG reservoirs, two 0.3 MG elevated tanks
Powers-Benedict-Tombeau Lakes Area Potential Utility	Addition of two shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank
Ozaukee County	- -
Town of Fredonia-Waubeka Area Potential Utility	Addition of one shallow aquifer well with 0.10 MG reservoir, 0.25 MG elevated tank
Racine County	- -
Northwest Caledonia Area Potential Utility District	9,000 lineal feet of water transmission main
Town of Burlington-Bohner Lake Area Potential Utility District	Addition of two shallow aquifer wells, 0.30 MG elevated tank
Town of Dover-Eagle Lake Area Potential Utility District	Addition of two shallow aquifer wells, 0.30 MG elevated tank
Town of Norway Area Potential Utility	Addition of four shallow aquifer wells, one with 0.15 MG reservoir, two 0.25 MG elevated tanks
Village of Rochester Area Potential Utility	Addition of two shallow aquifer wells, two 0.10 MG elevated tanks
Town of Rochester Area Potential Utility	Addition of two shallow aquifer wells, two 0.10 MG elevated tanks
Town of Waterford Area Potential Utility	Addition of three shallow aquifer wells, one with 0.15 MG reservoir, two 0.3 MG elevated tanks
Walworth County	- -
Town of Lyons Area Potential Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.3 MG elevated tank
Town of East Troy-Potter Lake Area Potential Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.3 MG elevated tank
Washington County	- -
Village of Newburg Area Potential Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.30 MG elevated tank
Village of Richfield Potential Utility	Facilities are included with the Village of Germantown Water Utility. The Village of Richfield may develop a separate utility water supply system or may contract with the Village of Germantown for water supply to serve the utility
Waukesha County	- -
Village of Big Bend Planned Utility	Addition of two shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank
Village of North Prairie Potential Utility	Addition of 0.50 MG elevated tank
Village of Wales Potential Utility	Addition of two shallow aquifer wells, 0.30 MG elevated tank
Town of Eagle-Eagle Spring Lake Area Potential Utility	Addition of one shallow aquifer well with 0.15 MG reservoir
Town of Oconomowoc-Okauchee Lake Area Potential Utility	Addition of four shallow aquifer wells, one with 0.15 MG reservoir, two 0.30 MG elevated tanks
Town of Summit-Golden Lake Area Potential Utility	Addition of one shallow aquifer well with 0.10 MG reservoir
Town of Ottawa-Pretty Lake Area Potential Utility	Addition of one shallow aquifer well with 0.10 MG reservoir

[a]*All utilities' programs include water conservation programs.*

Source: Ruekert & Mielke, Inc., and SEWRPC.

Composite Plan Element 2—Expansion of Lake Michigan Supply Utilities and Planned Service Areas Common to Alternative Plans 2, 3, and 4

Common components under Alternative Plans 2, 3, and 4 include the conversion to Lake Michigan as a source of supply by selected utilities, or portions of utility service areas, which currently have a return flow to Lake Michigan. Some of these utilities, or portions of utility service areas, are located east of the subcontinental divide, and include the Village of Germantown Water Utility; the eastern portion of the City of Brookfield Municipal Water Utility service area; the Town of Yorkville Utility District No. 1; and the Village of Elm Grove. Others are located west of, or straddle, that divide. These include the central portion of the City of New Berlin Water Utility service area, and the City of Muskego Public Water Utility, which, while located west of the divide, are within the Milwaukee Metropolitan Sewerage District sanitary sewer service area, and, therefore, have return flow available. For purposes of the composite plan, this element assumes connection of the utilities concerned in the Milwaukee metropolitan area directly to the Milwaukee Water Works. There are other viable options for the connection of these utilities to a Lake Michigan supply, including through suburban water utilities and from the City of Oak Creek Utility. Specifically, in the case of the City of Brookfield and Village of Elm Grove a potential option exists to connect these service areas to the water supply systems of the cities of Wauwatosa and West Allis. Further evaluation of the best means for connection of the utilities envisioned to be served by a Lake Michigan supply under this composite plan element should be considered as part of the plan implementation process.

The comparative evaluation of the alternative plans indicated that these components of Alternative Plan 4 contributed directly to that alternative being ranked highest or second highest with regard to meeting Objectives 1, 2, and 3, relating to support of the land use plans; conservation and wise use of the surface water and groundwater resources; and the protection of public health, safety, and welfare. In addition, these components have the lowest cost of all of the options considered for the utilities directly involved. This is the case, primarily because of the savings associated with the reduction in use of household water softening systems and other point-of-entry treatment systems possible upon provision of Lake Michigan water supply. These components of Alternative Plans 2, 3, and 4 have particular advantages in meeting the standards relating to costs, groundwater sustainability, and surface water quality and quantity. Accordingly, these components were included in the composite plan. The components of this plan element are listed in Table 149.

Composite Plan Element 3—Further Expansion of Lake Michigan Supply: Selected Utilities Included in Alternative Plan 4

Alternative Plan 4 includes the provision of a Lake Michigan supply to four utilities in Ozaukee County, all located east of the subcontinental divide, and all with an existing return flow component. These utilities include the City of Cedarburg Light & Water Commission; the Village of Grafton Water and Wastewater Commission; the Village of Saukville Municipal Water Utility; and the Village of Fredonia Municipal Water Utility. The comparative evaluation of the alternative plans initially considered indicated that the provision of these components of Alternative Plan 4 contributed to that alternative being ranked highest or second highest with regard to meeting Objectives 1, 2, and 3 relating to support of the land use plans; conservation and wise use of the surface water and groundwater systems; and the protection of public health, safety, and welfare. In addition, these components already have the necessary return flow component in place. This reduces the cost and adaptability issues for these components that resulted in Alternative Plan 4 being rated low with regard to meeting Objectives 4 and 5 relating to economical and efficient systems and responsive and adaptive plans, respectively.

For the City of Cedarburg Light & Water Commission, the Village of Grafton Water and Wastewater Commission, and the Village of Saukville Municipal Water Utility, the provision of a Lake Michigan supply, as envisioned under Alternative Plan 4 was found to have the lowest cost of the alternative plans considered. For purposes of the composite plan, Subalternative 2 of Alternative Plan 4 was included in the composite plan. This subalternative envisions the connection of a new Lake Michigan water treatment plant to serve the Cedarburg Light & Water Commission and the Village of Grafton Water and Wastewater Commission. The Village of Saukville Municipal Water Utility service area would be connected to the City of Port Washington water supply system. Other options for the provision of a Lake Michigan supply to the Cedarburg Light & Water Commission and the Village of Grafton Water and Wastewater Commission exist and are described in Chapter VIII. These alternatives should be considered as part of the plan implementation process.

Table 149

COMPOSITE PLAN ELEMENT 2—EXPANSION OF LAKE MICHIGAN SUPPLY: UTILITIES AND PLANNED SERVICE AREAS COMMON TO ALTERNATIVE PLANS 2, 3, AND 4

County and Utility	Programs and Facilities Description[a]
Racine County	- -
Town of Yorkville Utility District No. 1	Lake Michigan supply connection
Washington County	- -
Village of Germantown	Lake Michigan supply connection
Waukesha County	- -
City of Brookfield Municipal Water Utility (east)	Lake Michigan supply connection
City of Muskego Public Water Utility	Lake Michigan supply connection
City of New Berlin (central)	Lake Michigan supply connection
Village of Elm Grove	Lake Michigan supply connection

[a]*All utilities' programs include water conservation programs.*

Source: Ruekert & Mielke, Inc., and SEWRPC.

For the Village of Fredonia Municipal Water Utility, the costs of Alternative Plan 4 were found to be considerably higher than the costs concerned under the other alternative plans considered. The capital cost of Alternative Plan 4 was estimated to be $6.7 million compared to about $1.4 million for Alternative Plans 1, 2, and 3. The annual operation and maintenance costs under Alternative Plan 4 were estimated to be about $190,000 per year lower than under Alternative Plans 1, 2, and 3, due, in large part, to the expected savings attendant to the reduction in the use of household water softening systems and other point-of-entry treatment devices possible upon provision of Lake Michigan water supply. However, because of the capital costs entailed, the present worth and equivalent annual costs of Alternative Plan 4 were found to be substantially higher than those of Alternative Plans 1, 2, and 3. Accordingly, those components of Alternative Plans 1, 2, and 3, concerned were selected for the provision of groundwater to the Village of Fredonia Municipal Water Utility service area. The components for this plan element of the composite plan are summarized in Table 150.

Composite Plan Element 4—Other Areas Considered for a Lake Michigan Supply under Alternative Plan 4

In addition to the utilities and portions of utility service areas considered above, Alternative Plan 4 also included the provision of a Lake Michigan supply to selected utilities which either straddle the subcontinental divide, or are located west of the subcontinental divide within Waukesha County which straddles the divide. The service areas concerned are: the western portion of the City of Brookfield Water Utility; City of Pewaukee Water Utility; City of Waukesha Water Utility; Village of Lannon; the western portion of the Village of Menomonee Falls Water Utility; Village of Pewaukee Water Utility; Village of Sussex Water Utility; Village of Union Grove Water Utility; and Town of Brookfield Sanitary District No. 4.

The comparative evaluation of the alternative plans initially considered indicated that the provision of Lake Michigan as a source of supply to these utilities, or portions of the utility service areas, significantly contributed to Alternative Plan 4 being ranked highest with regard to meeting Objectives 1, 2, and 3 relating to the support of the land use plans; conservation and wise use of the surface water and groundwater systems; and the protection of public health, safety, and welfare. These components of Alternative Plan 4 have particular advantages in meeting the standards relating to groundwater sustainability and surface water quantity and quality. However, these components of Alternative Plan 4 also contribute to the relative poor performance of this alternative with regard to meeting plan Objectives 4 and 5 relating to economical and efficient systems and responsive and adaptive

Table 150

COMPOSITE PLAN ELEMENT 3—FURTHER EXPANSION OF LAKE MICHIGAN SUPPLY: SELECTED UTILITIES INCLUDED IN ALTERNATIVE PLAN 4

County and Utility	Programs and Facilities Description[a]
Ozaukee County	- -
City of Cedarburg Light & Water Commission/Village of Grafton Water and Wastewater Commission	New 9.0 mgd Lake Michigan intake and water treatment plant connecting transmission mains
City of Port Washington Water Utility	3.0 mgd water treatment plant expansion, 3.0 mgd pumping station
Village of Saukville Municipal Water Utility	Lake Michigan supply connection

[a] *All utilities' programs include water conservation programs.*

Source: Ruekert & Mielke, Inc., and SEWRPC.

plans, respectively. This poor performance is largely related to the capital costs associated with the provision of a looped transmission main to serve the Waukesha County communities, and the required return flow system. Moreover, there is a varying degree of need for new water supply infrastructure in the communities involved. In the case of the City of Waukesha Water Utility, major infrastructure improvements are needed relatively soon to meet water quality requirements. In the case of most of the other utilities, the need for new major facility improvements can more readily be phased in over time. Given the cost, timing, and implementation issues which exist regarding the need to develop a cooperative project, the need to obtain approval of a diversion, and the need to develop the transmission and return flow facilities in a relatively short timeframe, it is recommended that groundwater supplies, as envisioned under Alternative Plans 1, 2, and 3 be included in the composite plan for the following communities: the western portion of the City of Brookfield Water Utility, City of Pewaukee Water Utility, Village of Lannon, the western portion of the Village of Menomonee Falls Water Utility, Village of Pewaukee Water Utility, Village of Sussex Water Utility, and Town of Brookfield Sanitary District No. 4.

There is a relatively short-term need for the City of Waukesha Water Utility to develop new water supply infrastructure. The City is the largest groundwater user in the Region and remains highly dependent upon the deep aquifer. Radium content compliance issues remain for the Utility to resolve. Isolating the City of Waukesha Water Utility from the other utilities noted above for consideration of a Lake Michigan supply will reduce the problems related to cost, implementation, and timing. Such isolation would, however, preserve some of the benefits of Alternative Plan 4 with regard to meeting Objectives 1, 2, and 3 relating to the support of the land use plans, groundwater sustainability, and the protection of surface water quality and quantity. It is also recognized that some implementation and cost issues will remain under both the Lake Michigan and the groundwater supply options for the City of Waukesha Water Utility. The impacts of isolating the City of Waukesha from other utilities considered for a Lake Michigan supply with respect to costs and other benefits are not readily discernable without further analysis. Furthermore, it may be expected that a plan relying on groundwater supplies would be viable to the year 2035, albeit with a reduction in potential related environmental benefits. Accordingly, in the development of the composite plan, two subalternatives were considered for the City of Waukesha Water Utility. Under the first subalternative, the City of Waukesha would continue to utilize groundwater as a source of supply, with the supply being obtained by about an equal use of the shallow and deep aquifers. Under the second subalternative, the City of Waukesha would be connected to a Lake Michigan supply with provision for a return flow. Two options would be considered for the return flow. One option would return the spent water as treated wastewater directly to Lake Michigan. The second option would return wastewater to a stream tributary to Lake Michigan.

For the Village of Union Grove Water Utility, the costs of Alternative Plan 4 are considerably higher than the costs under Alternative Plans 1, 2, and 3. The capital cost under Alternative Plan 4 is estimated to be $10.6

million compared to from $0.5 to $1.8 million for Alternative Plans 1, 2, and 3, depending on the alternative considered. The annual operation and maintenance costs under Alternative Plan 4 are estimated to provide a reduction of about $440,000 per year compared to Alternative Plan 1 due, in large part, to the expected reduction attributable to the elimination of household water softening systems and other point-of-entry treatment devices and the elimination of groundwater treatment costs. However, the present worth and equivalent annual costs of Alternative Plan 4 are almost three times higher than for Alternative Plans 1, 2, and 3. Accordingly, a variation of the components of Alternative Plans 2 and 3 for the Village of Union Grove Municipal Water Utility, are included in the composite plan. This would provide for the Utility to maintain its two existing deep aquifer wells, while developing two new shallow aquifer wells over time as the need occurs. The development of the new shallow aquifer wells would reduce pumping and treatment costs during periods of low and average demand, reserving the deep wells for use in high-demand periods.

The components for this plan element of the composite plan are summarized in Table 151.

Composite Plan Element 5—Miscellaneous Municipal Utility Components

There are a number of municipal utilities, in addition to those considered in the previous sections, for which differences exist between the alternative plans initially evaluated. The means to best serve each of these utilities was identified for each of the individual utilities concerned, and these means were incorporated in the composite plan.

Town of Bristol Utility District No. 1

Under Alternative Plan 1, the Town of Bristol Utility District No. 1 would continue to operate its existing wells, including one shallow aquifer well and two deep aquifer wells, along with the treatment of the deep aquifer wells for radium-reduction. Under Alternative Plans 2, 3, and 4, the Town of Bristol Utility District No. 1 would over time replace the District's treated deep aquifer wells with shallow wells.

For the Town of Bristol Utility District No. 1, the costs under Alternative Plan 1 are lower than the costs under Alternative Plans 2, 3, and 4. The capital cost of the new facilities under Alternative Plan 1 approximates $1.4 million, and the operation and maintenance costs $21,000 per year. Under Alternative Plans 2, 3, and 4, the capital cost approximates $3.3 million, and the operation and maintenance cost reductions $57,000 per year, compared to Alternative Plan 1. These reductions are associated with the reduced level of treatment required under Alternative Plans 2, 3, and 4. The present worth and equivalent annual cost under Alternative Plans 2, 3, and 4 were found to be about 70 percent higher than under Alternative Plan 1.

There is considerable population growth and attendant development expected in the water supply service area, with the plan design year 2035 population level expected to approximate 4,900 persons, an increase of 3,800 persons, or about 350 percent, over the year 2000 level of about 1,100 persons. This growth in population and service area will present opportunities to locate and site new shallow aquifer wells.

Under Alternative Plan 1, there is a projected continued, but relatively modest, drawdown in the deep sandstone aquifer in the immediate vicinity of the Town of Bristol Utility District No. 1. The maximum projected drawdown from 2005 to 2035 is estimated to be just under 50 feet. Under Alternative Plans 2, 3, and 4, there is a projected drawup in all of Kenosha County. The deep aquifer water levels reflect regional conditions and are not simply the result of the Town of Bristol Utility District No. 1 pumping conditions. However, some localized drawdown would be associated with Alternative Plan 1. Under Alternative Plans 2, 3, and 4, the simulation modeling indicated some localized impacts on stream baseflow conditions in the vicinity of the Town of Bristol Utility District No. 1. Those impacts were not apparent under Alternative Plan 1.

Based upon the foregoing considerations, the composite plan envisions the maintenance of the Town of Bristol Utility District No. 1 existing wells. Those wells would, over time, be supplemented by two new shallow aquifer wells. This would reduce the pumping and treatment costs associated with the deep wells, but maintain the capacity of those wells for use in periods of high demand.

Table 151

COMPOSITE PLAN ELEMENT 4—OTHER AREAS CONSIDERED FOR A LAKE MICHIGAN SUPPLY UNDER ALTERNATIVE PLAN 4 ENVISIONED TO REMAIN ON GROUNDWATER SUPPLIES

County and Utility	Programs and Facilities Description[a]
Ozaukee County	- -
Village of Fredonia Municipal Water Utility	Addition of one shallow aquifer well with 0.10 MG reservoir, and one 0.25 MG elevated tank
Racine County	- -
Village of Union Grove Municipal Water Utility	Addition of two shallow aquifer wells with 0.40 MG reservoir
Waukesha County	- -
City of Brookfield Municipal Water Utility (west)	No additions
City of Pewaukee Water and Sewer Utility	Addition of two shallow aquifer wells, service pumps
City of Waukesha Water Utility (Subalternative 1)	Addition of eight shallow aquifer wells
City of Waukesha Water Utility (Subalternative 2)	Lake Michigan supply connection
Village of Lannon Planned Utility	Addition of two shallow aquifer wells with 0.15 MG reservoir, and one 0.75 elevated tank
Village of Menomonee Falls Water Utility (west)	Addition of 0.20 MG elevated tank, two shallow aquifer wells
Village of Pewaukee Water Utility	Addition of one shallow aquifer well
Village of Sussex Public Water Utility	Addition of one shallow aquifer well
Town of Brookfield Sanitary District No. 4	Addition of 0.35 MG reservoir

[a]*All utilities' programs include water conservation programs.*

Source: Ruekert & Mielke, Inc., and SEWRPC.

Country Estates Sanitary District, Town of Lyons, Walworth County

Under Alternative Plan 1, the Country Estates Sanitary District would continue to operate its two existing deep aquifer wells, along with the treatment of the water from those wells for radium-reduction. Under Alternative Plans 2, 3, and 4, the Country Estates Sanitary District would replace the District's two deep aquifer wells with two shallow aquifer wells.

The costs under Alternative Plan 1 for the Country Estates Sanitary District were found to be lower than the costs under Alternative Plans 2, 3, and 4. The capital costs of the new facilities under Alternative Plan 1 were estimated at $0.5 million, and the operation and maintenance costs at $10,800 per year. Under Alternative Plans 2, 3, and 4, the capital costs were estimated at $1.7 million and the reduction in operation and maintenance costs at $3,000 per year, compared to Alternative Plan 1. The savings are associated with the reduced level of treatment required under Alternative Plans 2, 3, and 4. The present worth and equivalent annual costs under Alternative Plans 2, 3, and 4 were found to be well over twice those under Alternative Plan 1.

No significant population growth is expected in the water supply service area for the Country Estates Sanitary District. This limits opportunities for the location of new shallow aquifer wells. The projected 2035 pumpage for the Country Estates Sanitary District is relatively small, estimated at about 90,000 gpd on an average daily basis. The impacts under Alternative Plan 1 on the deep aquifer may be expected to be minimal.

Under Alternative Plans 2, 3, and 4 conditions, the simulation modeling indicates some localized impacts on stream baseflow conditions in the vicinity of the Country Estates Sanitary District. Those impacts are not apparent under Alternative Plan 1.

Based upon the foregoing conditions, the composite plan envisions the maintenance of the existing wells serving the Country Estates Sanitary District.

City of Delavan Water and Sewage Commission

Under Alternative Plan 1, the City of Delavan Water and Sewage Commission would continue to operate its three existing shallow aquifer wells and one deep aquifer well, with three new shallow wells being constructed over time. Under Alternative Plans 2, 3, and 4, the City of Delavan Water and Sewage Commission would replace one of the shallow wells, and develop five new shallow wells over time. The well to be replaced under these three alternative plans presently requires treatment to reduce trichloroethylene (TCE) contamination.

The costs for the City of Delavan Water and Sewage Commission are relatively similar under all of the alternative plans considered. The treatment system is reported to be working well and the concentrations of TCE in the source water are decreasing. Accordingly, the composite plan would provide for the continued use of the City of Delavan Water and Sewage Commission wells and the addition over time of three new shallow aquifer wells.

The City of Delavan water supply service area includes the Delavan Lake Sanitary District which is currently largely developed at urban densities, and served by individual, private wells. This area was designated as a potential future municipal water supply service area in order to permit a comprehensive assessment of the demands, added supply needed, and the areawide performance of the water supply system if such areas were served. However, the development of municipal water supply systems to serve these areas is envisioned only if a local need is demonstrated based upon groundwater quality or quantity concerns, and if a local initiative is undertaken to implement a municipal system. Such a local initiative typically includes, and is dependent upon, a survey to determine the local need and the interest of the residents in a given area regarding the provision of municipal water supply. In the absence of such a need and initiative, the residents and businesses in this area would be expected to remain on individual wells.

City of Elkhorn Water Utility

Under Alternative Plan 1, the City of Elkhorn Water Utility would continue to operate its five existing deep aquifer wells. Under Alternative Plans 2, 3, and 4, the City of Elkhorn Water Utility would replace three of the deep aquifer wells with shallow aquifer wells over time.

The costs under Alternative Plan 1 for the City of Elkhorn Water Utility would be lower than the costs under Alternative Plans 2, 3, and 4. The capital cost of the new facilities under Alternative Plan 1 was estimated at $0.5 million, and the operation and maintenance costs at $11,000 per year. Under Alternative Plans 2, 3, and 4, the capital cost was estimated at $3.5 million, and the reduction in operation and maintenance costs at $178,000, compared to Alternative Plan 1. The reductions are associated with the reduced level of pumping and treatment required under Alternative Plans 2, 3, and 4. The present worth and equivalent annual cost under Alternative Plan 1 and Alternative Plans 2, 3, and 4 were found to be similar.

Considerable population growth and attendant development is expected in the water supply service area, with the plan design year 2035 population level expected to approximate 15,000 persons, an increase of 7,300 persons, or about 90 percent, over the year 2000 level of 7,700. This growth in population and service area will present opportunities for the location of new shallow aquifer wells.

Under Alternative Plan 1, there is a projected continued, but relatively modest, drawdown in the deep sandstone aquifer in the immediate vicinity of the City of Elkhorn Water Utility. The maximum projected drawdown from 2005 to 2035 is estimated to be just over 30 feet. Under Alternative Plans 2, 3, and 4, the drawdown in the vicinity of the City of Elkhorn is projected to be less, with the maximum drawdown being about 10 feet. The deep aquifer water levels reflect regional conditions, and are not simply the result of the City of Elkhorn Water Utility pumping conditions. However, some localized drawdown would be associated with all of the alternative plans.

Under Alternative Plans 2, 3, and 4, the simulation modeling indicates some localized impacts on stream baseflow conditions in the vicinity of the City of Elkhorn. Those impacts may be expected to be more significant than under Alternative Plan 1.

Based upon the foregoing conditions, the composite plan envisions the maintenance of existing wells serving the City of Elkhorn Water Utility. Those wells would be supplemented by three new shallow aquifer wells over time. This would reduce the pumping and treatment costs associated with the deep aquifer wells, which would be retained for use in periods of high demand.

City of Hartford Water Utility

Under Alternative Plan 1, the City of Hartford Water Utility would continue to operate its six existing shallow aquifer wells and one deep aquifer well supplemented by two new shallow aquifer wells. Treatment of the water from the deep aquifer well would be provided. Under Alternative Plans 2, 3, and 4, the City of Hartford Water Utility would replace the deep aquifer well with shallow aquifer wells over time.

The costs under Alternative Plan 1 for the City of Hartford Water Utility are similar to the costs under Alternative Plans 2, 3, and 4. Considerable growth and development is expected in the water supply service area, with the plan design year 2035 population level expected to approximate 18,100 persons, an increase of 7,300 persons, or about 65 percent, over the year 2000 level of 10,800. This growth in population and attendant service area will present opportunities for the location of new shallow aquifer wells.

Under Alternative Plan 1, there is a projected continued, but relatively modest, drawdown in the deep sandstone aquifer in the immediate vicinity of the City of Hartford Water Utility. Under Alternative Plans 2, 3, and 4, there is no projected drawdown in the vicinity of the City of Hartford. The deep aquifer water levels reflect regional conditions and are not simply the result of the City of Hartford Water Utility pumping conditions. However, some localized drawdown would be associated with all of the alternative plans.

The simulation modeling indicates that under Alternative Plan 1 some localized impacts on stream baseflow conditions would occur in the vicinity of the City of Hartford. Those impacts may be expected to be more significant under Alternative Plans 2, 3, and 4.

Based upon the foregoing considerations, the composite plan envisions that the City of Hartford Water Utility would replace its existing deep aquifer well with new shallow aquifer wells. This would reduce the pumping and treatment costs associated with that well.

During 2009, the City of Hartford was nearing completion of the construction of a new shallow aquifer well. That well—Well No. 16—was expected to be operational in 2010, and has a relatively large capacity rating of 2.3 million gallons per day. In addition, the City of Hartford is in the process of constructing a new 750,000 gallon elevated storage tank which is also expected to be operational by 2010. Once these two water supply facilities are completed, the City of Hartford water supply system should be adequate to meet the planned year 2035 pumpage demands without the need for the existing deep aquifer well. The City expects to abandon the deep aquifer well once the new shallow aquifer well is operational.

The components for this plan element of the composite plan are summarized in Table 152.

Composite Plan Element 6—Private Water Supply Systems

In addition to the municipal water supply systems operating within the Region, there are a number of private, self-supplied water systems which may be expected to be in operation in the plan design year 2035. These include systems serving residential communities; industrial, commercial, institutional, and recreational land uses; agricultural and other irrigation operations; thermoelectric-power-generation facilities; and individual private residences. The composite plan envisions that the existing self-supplied water systems serving residential communities and most of the systems serving commercial, institutional, and recreational land uses located within the planned municipal water supply service areas, will be connected to municipal systems by the design year 2035.

Table 152

COMPOSITE PLAN ELEMENT 5—MISCELLANEOUS MUNICIPAL UTILITY COMPONENTS

County and Utility	Programs and Facilities Description[a]
Kenosha County	- -
Town of Bristol Utility District No. 1	Addition of two shallow aquifer wells, 0.50 MG elevated tank
Walworth County	- -
Country Estates Sanitary District	Addition of 0.20 MG elevated tank
City of Delavan Water and Sewage Commission	Addition of three shallow aquifer wells with iron removal treatment
City of Elkhorn Water Utility	Addition of three shallow aquifer wells, 0.35 MG treated water reservoir
Washington County	- -
City of Hartford Water Utility	Addition of one shallow aquifer well and one 0.75 MG elevated tank, replace deep aquifer pumping[b]

[a]*All utilities' programs include water conservation programs.*

[b]*The new City of Hartford well and elevated tank are under development and planned to be completed in 2009.*

Source: Ruekert & Mielke, Inc., and SEWRPC.

The private, self-supplied water supply systems which may be expected to be in place by the plan design year 2035 are described in the following paragraphs. It is recognized that there will be some changes in the composition of the private, self-supplied systems which cannot be specifically accounted for in a systems-level planning process, given the nature of the land uses which are involved. However, it is expected that the self-supplied water supply systems as described below will be representative of the 2035 conditions.

Residential Other than Municipal, Community Systems

By the plan design year 2035, it may be expected that 25 of the 170 privately owned, self-supplied, water systems operating within the Region in 2005, which provide water service to primarily residential land uses, would continue to provide service. These systems serve residential developments, such as mobile home parks, condominium complexes, and other residential groupings located beyond the existing and planned municipal water supply service areas. Under the composite plan, it is assumed that the 145 such self-supplied systems which existed in 2005 would be connected to expanded municipal systems, and that no new such private systems would be developed. The remaining 25 systems would utilize groundwater provided by 29 low-capacity, 11 high-capacity wells, and four wells of indeterminate capacity as a source of supply. Selected characteristics of these systems are presented in Table G-1 in Appendix G.

Industrial Water Supply Systems

By the plan design year 2035, there may be expected to be 63 privately owned, self-supplied, water systems operating within the Region which provide water service to primarily industrial land uses. Of these, 16 systems are currently classified as a low-capacity system, while 47 are classified as high-capacity systems. These systems currently all utilize groundwater as a source of supply through 62 low-capacity and 63 high-capacity wells. Selected characteristics of each system are presented in Table G-2 in Appendix G.

Commercial Water Supply Systems

By the plan design year 2035, there may be expected to be 258 privately owned, self-supplied, water systems operating within the Region which provide water service to primarily commercial land uses. Of these, 15 are currently classified as high-capacity systems, while 243 are classified as low-capacity well systems. These systems all currently utilize groundwater as a source of supply through 10 high-capacity wells and 284 low-capacity wells. Selected characteristics of each system are presented in Table G-3 in Appendix G.

Institutional and Recreational Water Supply Systems

By the plan design year 2035, there may be expected to be 279 privately owned, self-supplied, water systems operating within the Region which provide water service to primarily institutional and recreational land uses. Of these, 96 are currently classified as high-capacity systems, while 183 are classified as low-capacity well systems. These systems all currently utilize groundwater as a source of supply through 373 low-capacity wells, 37 high-capacity wells, and 29 wells of unknown capacity. Selected characteristics of each system are presented in Table G-4 in Appendix G.

Agricultural Water Supply Systems

By the plan design year 2035, there may be expected to be 53 privately owned, self-supplied, water systems operating within the Region which provide water for irrigation and other purposes to agricultural land uses. Of these systems, all are currently categorized as high-capacity systems. These systems all utilize groundwater as a source of supply through 80 high-capacity and 17 low-capacity wells. Selected characteristics of each system are presented in Table G-5 in Appendix G.

Irrigation Water Supply Systems

By the plan design year 2035, there may be expected to be 80 privately owned, self-supplied, water systems operating within the Region which provide irrigation water for land uses other than agricultural, such as golf courses. One of these systems is currently categorized as low-capacity, and 79 are categorized as high-capacity systems. All of these systems utilize groundwater as a source of supply through 103 high-capacity, 33 low-capacity wells, and six wells of indeterminate capacity. Selected characteristics of each system are presented in Table G-6 in Appendix G.

Thermoelectric-Power-Generation Water Supply Systems

By the plan design year 2035, there may be expected to be six existing privately owned, self-supplied, water systems operating within the Region which provide cooling water for thermoelectric-power-generation facilities. These facilities include the Pleasant Prairie Power Plant, a coal-based base load generating facility, and the Paris Generating Station, a gas-based, intermediate-use facility, both in Kenosha County; the coal-based base load Valley Power Plant and Oak Creek Power Plant, both in Milwaukee County; the Port Washington Power Plant, a facility converted, in 2006, from coal-based load facility to an intermediate-use, natural gas-based facility in Ozaukee County; and the Germantown Power Plant, a gas-based combustion turbine, intermittent-use facility in Washington County. Combined, these facilities were reported to use about two billion gallons of water per day in 2000. Most of that water was utilized by the Valley Power Plant, the Oak Creek Power Plant, and the Port Washington Power Plant, all of which utilize Lake Michigan water for once-through cooling systems. These systems typically return over 99 percent of the cooling water used back to the Lake. The Pleasant Prairie Power Plant is located approximately five miles west of the Lake Michigan shoreline, and a closed-loop system with large cooling towers is used. The amount of water used is reported to be about 11 million gallons per day, the majority which is make-up water for the plant cooling towers. We Energies reports that nearly 75 percent of the water used at that plant is evaporated to the atmosphere. The two small combustion turbine power plants in the Village of Germantown and the Town of Paris use limited amounts of well water for cooling and for nitrogen oxide control on an intermittent-use basis.

Self-Supplied Residential Water Systems

By the plan design year 2035, it may be expected that there will be about 174,000 persons, or about 8 percent of the total resident population of the Region, served by private, onsite, domestic wells. There are about 1,840 square miles of area located outside of the planned 2035 municipal water utility service areas, which are neither served, nor proposed to be served, by municipal water service. Assuming an average use of 65 gallons per capita per day, these private domestic wells would withdraw about 11.5 million gallons per day from the shallow groundwater aquifer. It may be expected that the households served by private domestic wells will also be served by onsite sewage disposal systems. Thus, the majority—approximately 90 percent—of the water withdrawn by these private, onsite, wells, or about 10.0 million gallons per day, would be expected to be returned to the groundwater aquifer via onsite sewage disposal systems.

Composite Plan Element 7—Water Conservation Measures

The composite plan includes provisions for comprehensive water conservation programs, including both supply side efficiency measures and demand side water conservation measures. These conservation programs are recommended to be applied on a utility-specific basis to reflect the source of supply and existing infrastructure, as summarized in Table 59 of Chapter IV of this report. That table was developed under, and was initially presented in the state-of-the-art of water supply practices report prepared under the regional water supply planning program.[3] Expected reductions in demand vary from 4 to 10 percent on an average daily demand basis and from 6 to 18 percent on a maximum day demand basis. The water conservation measures described are primarily related to the municipal water utility water service areas. However, the composite plan envisions that the low-level water conservation measures would also apply to private individual, self-supplied water systems.

Composite Plan Element 8—Groundwater Recharge Area Protection and Stormwater Management Practices Components

Alternative Plan 3 included a groundwater recharge area protection component and a stormwater management practices component. The comparative evaluation of the alternative plans indicates that the recommended protection of groundwater recharge areas and the recommended stormwater practices significantly contributed to Alternative Plan 3 being ranked highest or second highest with respect to meeting Objectives 1 and 2 relating to the support of the land use plans and the conservation and wise use of the surface water and groundwater systems, respectively. These components of Alternative Plan 3 have particular advantages with respect to meeting the standards relating to groundwater sustainability and surface water quantity and quality.

The groundwater recharge protection area component of the composite plan is directed toward the protection of the recharge of areas classified as having a high or very high recharge potential based upon the analyses of the recharge potential within the Region. As noted in Chapter VIII, this component may be expected to be largely achieved through implementation of the design year 2035 regional land use plan since that plan recommends preservation of the environmental corridors, isolated natural resource areas, and prime and other agricultural areas—areas that facilitate recharge. About 75 percent of the high recharge potential areas, and 78 percent of the very high recharge potential areas may, under the adopted land use plan, be expected to be preserved. Sound land subdivision design and stormwater management practices should also assist in maintaining the natural hydrology in the new rural, suburban, and low-density urban residential areas identified in the regional land use plan.

The stormwater management component of the composite plan would provide for the inclusion of stormwater management practices, including treatment and infiltration systems, which—to the extent practicable—maintain the natural hydrology of, and the recharge potential in all new residential and in some nonresidential developments. This component is intended to apply to residential and some nonresidential developments served by both municipal and private water supply systems in order to contribute to the sustainability of the groundwater supply, as well as for related stormwater management purposes. Such practices are considered important, even in areas served by individual wells and onsite sewage disposal systems where the majority of the water used is returned to the aquifer. Such areas do experience some losses in water used and the stormwater management practices can contribute to meeting broader aquifer recharge objectives. Both of these components may be expected to be achieved largely through implementation of the regional land use plan and through State and local programs and regulations. In this regard, provisions of Chapter NR 151 of the *Wisconsin Administrative Code* and through county and municipal stormwater management ordinances adopted in accordance with Chapter 216 of the *Wisconsin Administrative Code* are considered important regulations. The application of sound land subdivision design practices, particularly the application of conservation subdivision design, and of good stormwater management practices are recommended to enhance infiltration. Such practices are particularly important in areas where the groundwater analyses associated with well siting, as described under Composite Plan Element 9 identify potential negative impacts on surface waters as a result of well siting.

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[3]*SEWRPC Technical Report No. 43,* State-of-the-Art of Water Supply Practices, *June 2007.*

Composite Plan Element 9—Siting, Analysis, and Monitoring Practices for Shallow Wells Component

The composite plan includes provisions related to the siting of all new high-capacity wells, including the conduct of analyses, and the monitoring, of the potential and actual impacts of such wells on the shallow aquifer. The cones of depression produced by high-capacity wells in the shallow aquifer can result in adverse impacts such as reduced water extraction from nearby existing wells, especially individual residential wells, and baseflow depletion in nearby surface waterbodies. Where potential locations of multiple future wells are known, consideration should be given to analyses of the cumulative impacts of the multiple wells. These provisions of the composite plan are intended to minimize the adverse impacts and to mitigate the effects of these adverse impacts once new wells are in production.

While it is recognized that siting wells in the shallow aquifer is dependent upon locating productive areas, some additional factors should be considered when siting wells constructed in this aquifer. Preference should be given to site locations that are less likely to produce adverse impacts upon surface waterbodies and existing wells. In addition, preference should be given to sites adjacent to stream reaches located downstream from municipal wastewater treatment plants, and receiving effluent from such plants. This application of riverbank filtration has the potential to increase available water supplies without degrading the environment.

The composite plan includes components that provide for additional steps to be taken in the early stages of locating sites for wells in the shallow aquifer. Prior to drilling test wells, desktop analyses intended to develop a conceptual understanding of the hydrogeological system associated with each candidate site and its surrounding area should be undertaken. This should include an understanding of important interactions between the surface water system and the shallow groundwater system of the site and surrounding area. This understanding should include characterization of the subsurface geological setting, the hydraulic characteristics of the primary geological units, the water budget characteristics of the groundwater and surface water basin in which the candidate well sites are located, and the hydraulic characteristics of the aquifer targeted for the production well, as well as of other relevant factors which might contribute to a sound assessment of the likely impacts of the proposed high-capacity well upon nearby existing wells and surface waterbodies, including springs. In addition to assessing the likelihood of potential impacts, these analyses should identify areas of uncertainty related to the conceptual understanding developed, and should indicate what additional data or information would be needed in order to resolve these uncertainties and what additional analyses would need to be performed in order to better characterize potential impacts of the proposed well. The findings of these desktop analyses may lead to a conclusion to look for alternative sites, or may recommend additional data collection and analyses, to be performed either prior to, or concurrent with, the drilling and operation of a test well in order to resolve the identified uncertainties.

Following completion and interpretation of the desktop analyses and of subsequent analyses, installation of a test well would be appropriate. During the test well phase, water levels in nearby wells should be monitored, and, as necessary to address data uncertainties, monitoring wells should be installed and used. The test well should be operated at a pumping rate close to the anticipated discharge of the source well being considered and for a length of time sufficient to assess likely impacts of the installation and operation of the well.

Monitoring of water levels should continue once a new shallow aquifer well is placed into operation, particularly in locations where potential negative impacts are indicated. In those instances where impacts resulting from installation and operation of the well are likely to occur, the communities involved should develop and enter into an agreement to protect the water supply in the aquifer and to remedy in a timely fashion any problems with private wells resulting from installation and operation of the new well. In instances where potential negative impacts on surface waterbodies are identified, consideration should be given to alternative well sites, modified pumping schedules, and developing artificial recharge to compensate for surface water baseflow changes as described under the next plan component.

The well siting procedures are envisioned to also incorporate source water protection considerations. These considerations include well separation from potential sources of contamination, the establishment of wellhead protection areas, and the development and implementation of wellhead protection plans. Such measures are currently carried out for municipal utility wells as a matter of good practice and in order to comply with Wisconsin Department of Natural Resources (WDNR) regulations.

Composite Plan Element 10—Enhanced Recharge for the Shallow Aquifer

Alternative Plan 3 includes a rainfall infiltration component for enhanced recharge of the shallow aquifer. The comparative analyses of the alternative plans indicated that the reduction of such additional infiltration contributed to Alternative Plan 3 being ranked second highest with regard to meeting plan Objectives 1 and 2 relating to the support of the land use plans and the conservation and wise use of the surface water and groundwater systems, respectively. This component of Alternative Plan 3 has particular advantages with respect to meeting the standards relating to groundwater sustainability and surface water quantity and quality.

The composite plan includes a provision encouraging installation of enhanced rainfall infiltration systems in areas where evaluations conducted in conjunction with siting of wells in the shallow aquifer indicate probable reductions in groundwater contributions to nearby surface waterbodies due to the installation and operation of the well, and further analysis indicates that these reductions are likely to affect streamflows and water levels in lakes or wetlands. Installation of these systems is deemed to be especially important when impacts are anticipated in surface water features considered to be highly dependent on groundwater contributions. Locating sites for these systems requires site-specific analyses to ensure that the systems are located in the recharge areas of the waterbodies expected to be impacted, and are located in suitable areas for shallow groundwater recharge. A variety of designs and methods are possible for these systems and the appropriate design will need to be determined on a case-by-case basis. The systems could be in the form of rain gardens, larger bioretention basins, infiltration ponds, infiltration ditches, and other systems. Information on the available artificial recharge methodologies is presented in the state-of-the-art report on water supply practices.[4]

Another option for increasing recharge is to remove drain tile fields from selected agricultural lands, and especially from lands being converted from rural to urban use. Such actions may be appropriate where multiple objectives providing for wetland and wildlife creation are considered along with enhanced groundwater recharge. For purposes of developing costs and effectiveness estimates under the composite plan, the facilities envisioned are similar to those provided under Alternative Plan 3. Those facilities consist of areas of 10 to 50 acres in size which are regraded and revegetated to enhance groundwater recharge. A consideration of various measures developed on a site-specific basis will likely be the most effective means of providing the groundwater recharge. The rainfall infiltration facilities can be developed to serve multiple purposes over-and-above groundwater recharge, including reducing stormwater runoff rates and volumes; providing aesthetic amenities; and improved wildlife habitat. Such sites may also be used to provide buffer areas along streams and watercourses; preserve floodprone lands in natural open uses; and potentially expand environmental corridor lands. Sites must be specifically located and designed to serve the desired purposes. For purpose of the component plan, groundwater recharge systems were placed in areas where potentially significant shallow aquifer pumping impacts on the surface water system were expected based upon groundwater-surface water modeling at the systems level. As described under Composite Plan Element 9 and in the subsequent section, more-detailed site-specific analyses relating to the location of new high-capacity wells are envisioned under the composite plan.

Well Siting and Surface Water System Protection Procedures under Composite Plan Elements 8, 9, and 10

Composite Plan Elements 8, 9, and 10 are intended to form the basis of a process to minimize the negative impacts on surface water systems associated with high-capacity well development. The conceptual process would provide for initial analyses of potential well sites in order to select sites which minimize impacts as envisioned in

[4]Ibid.

Composite Plan Element 9. These initial siting analyses would guide the selection of well sites, and would be followed by more-detailed analyses of the potential well impacts of selected sites. Where significant potential negative impacts to surface water systems, or to existing wells, are identified, a mitigation plan would be developed incorporating enhanced recharge based upon the stormwater management and infiltration measures envisioned under Composite Plan Elements 8 and 10. In addition, other mitigation measures, such as pumping protocols and impacted well compensation measures, could be considered. Measures to mitigate impacts on surface waterbodies could be designed to provide artificial recharge which would offset the losses in stream baseflow to the extent practical. As previously indicated, where the potential location of multiple wells are known, consideration should be given to the cumulative impacts of such multiple wells.

DESCRIPTION OF SUBALTERNATIVES TO THE COMPOSITE WATER SUPPLY PLAN AND RELATED IMPACTS

Based upon the comparative evaluation of the four alternative regional water supply plans initially considered as described in Chapter VIII, two subalternatives to the composite water supply plan were developed and evaluated. These subalternatives were judged to be better than the initially considered alternatives with regard to the achievement of the water supply system development and management objectives and supporting standards set forth in Chapter V. The two subalternatives to the composite plan are comprised of the 10 elements of the composite plan described in the previous section and are the same in all respects, except for the source of supply considered for the City of Waukesha Water Utility and the interrelated number of rainfall infiltration systems. Under the first subalternative to the composite plan, the City of Waukesha would continue to utilize groundwater as a source of supply, with the supply being obtained by about an equal use of the shallow and deep aquifers. Under the second subalternative, the City of Waukesha would be provided with a Lake Michigan supply and a return flow component would be required for the water used. Each of the two subalternatives to the composite plan and the associated groundwater and surface water impacts are described below:

Subalternative 1 to the Composite Plan—Design Year 2035 Condition Intermediate Expansion of Lake Michigan Supply and the City of Waukesha Water Utility Remaining on Groundwater Supplies

This subalternative to the composite plan incorporates a combination of water supply facilities, including existing and committed facilities, and an expanded use of Lake Michigan supply for selected municipal water supply systems. Under this Subalternative, the City of Waukesha Water Utility would continue to use the groundwater aquifers as a source of supply. The Subalternative also includes water conservation measures, groundwater recharge, and stormwater management components, recommendations for well siting analyses and monitoring, and enhanced groundwater recharge. More specifically, Subalternative 1 to the Composite Plan includes the following components:

- For most utilities, existing or committed year 2007 water supply and treatment facilities where no existing or potential future water quantity or quality problems indicate changes are needed. These utilities and the associated water supply components are listed in Table 147.

- The water supply service areas designated as potential new municipal utility service areas are listed in Table 148. These include areas which are currently developed at urban densities and are currently served by private individual wells. These areas are designated as potential future municipal water supply service areas in order to permit a comprehensive assessment of the demands, added supply needed, and the areawide performance of the water supply system if such areas were served. However, the development of municipal water supply systems to serve these areas is envisioned only if a local need is demonstrated based upon groundwater quality or quantity concerns, and if a local initiative is undertaken to implement a municipal system. In the absence of such a need and initiative, the residents and businesses in these areas would be expected to remain on individual wells.

- Conversion to Lake Michigan as a source of supply for selected utilities, or for portions of selected utility service areas, located either east of the subcontinental divide or which are located west of that divide, but are part of a community which straddles that divide. As previously noted, there are optional viable means for providing the Lake Michigan supply to these utilities which should be considered further in subsequent planning and engineering as part of the plan implementation. Each of these utilities currently has a return flow to Lake Michigan. These utilities, or portions of utility service areas, are listed in Tables 149 and 150.

- Selected utilities which are envisioned to remain on groundwater supplies following a comparative evaluation of the option for connection to a Lake Michigan source of supply as an alternative to remaining on groundwater supplies. These utilities and the associated water supply components are listed in Table 151. For this subalternative composite plan, the City of Waukesha Water Utility would remain on groundwater supplies.

- Selected utilities where alternative groundwater supplies were considered and evaluated. These utilities and the associated groundwater supply components judged to be the best means to provide service are listed in Table 152.

- The connection to municipal water supply systems of the existing self-supplied water systems serving residential communities and a selected number of the systems serving commercial, institutional, and recreational land uses located within the planned municipal water supply service areas. The continued use of private water supply systems to serve residential and nonresidential land uses located beyond the planned water supply service areas, including agricultural land uses. The number and location of such systems are described under Composite Plan Element 6.

- Water conservation programs implemented in the manner developed and documented in SEWRPC Technical Report No. 43, *State-of-the-Art of Water Supply Practices*, May 2007, and as incorporated into the forecast of water demand as set forth in Chapter IV.

- Groundwater recharge area protection and stormwater management practices as described under Composite Plan Element 8.

- High-capacity well siting, analysis and monitoring practices as described under Composite Plan Element 9.

- Enhanced recharge of the shallow aquifer using rainfall infiltration facilities as described under Composite Plan Element 10. It is envisioned that there would be a total of 37 rainfall infiltration systems under Subalternative 1 to the Composite Plan. The general locations of the rainfall infiltration systems that were envisioned under Subalternative 1 to the Composite Plan are shown on Map 108. These sites were selected at a level of detail sufficient for identification of the simulation model cells in which the sites concerned would fall. The areas of these facilities range from about 10 to 50 acres. For the groundwater-surface simulation modeling purposes, it was assumed that these facilities would, on average, contribute an additional 15 inches of recharge per unit area per year to the shallow aquifer system over and above the recharge normally provided over the Region. The additional recharge contributed by these facilities would be derived from precipitation falling on the facilities themselves and on areas naturally tributary to the facilities. For the purpose of estimating the infiltration amounts, it was assumed that each facility would have a tributary area equal to twice the area of the facility itself.

  It is important to note that the actual location and configuration of the tributary areas associated with each site would be a function of the topography of the areas in which the facilities would be located, and that site-specific studies will be required to determine the location, area and configuration of each infiltration area, and of the size of the tributary areas associated with each facility. It is estimated that these facilities would contribute an additional approximately 526 million gallons per year of recharge to the shallow aquifer system on an average annual basis.

Map 108

COMPOSITE PLAN - DESIGN YEAR 2035 GROUNDWATER RECHARGE FACILITIES

LEGEND

SHALLOW AQUIFER RECHARGE FACILITIES
RAINFALL INFILTRATION FACILITIES
PRESENT UNDER BOTH
SUBALTERNATIVES 1 AND 2

MILLION GALLONS PER YEAR (MGY)

- 0.1 - 5.0
- 5.1 - 10.0
- 10.1 - 15.0
- 15.1 - 20.0
- 20.1 - 25.0

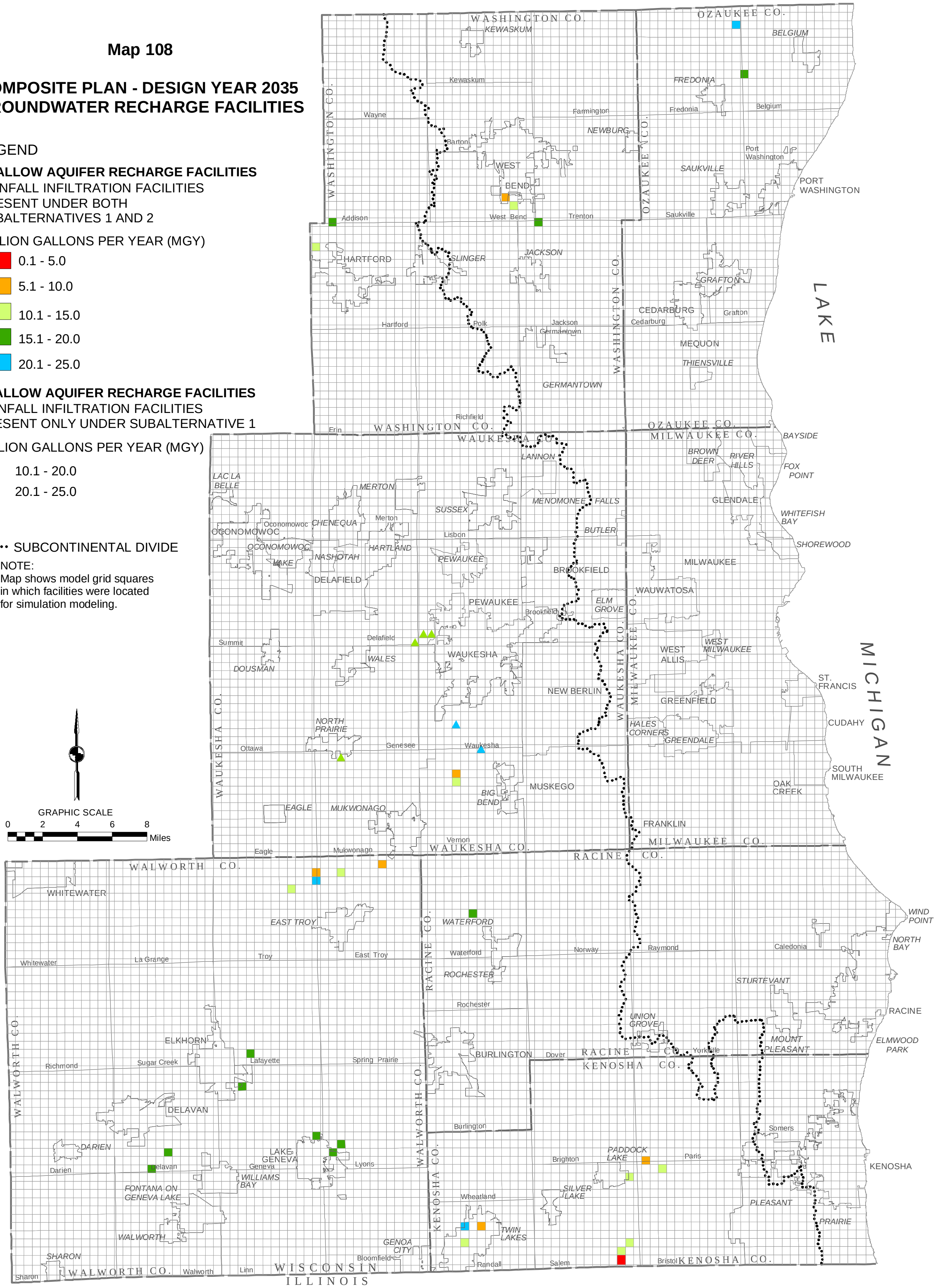
SHALLOW AQUIFER RECHARGE FACILITIES
RAINFALL INFILTRATION FACILITIES
PRESENT ONLY UNDER SUBALTERNATIVE 1

MILLION GALLONS PER YEAR (MGY)

- 10.1 - 20.0
- 20.1 - 25.0

SUBCONTINENTAL DIVIDE

NOTE:
Map shows model grid squares
in which facilities were located
for simulation modeling.



Source: SEWRPC.

As described in Chapter VIII, several criteria were used in selecting sites for these facilities. First, facilities were sited on lands currently in selected environmental corridors, agricultural lands, or other open lands. The siting of facilities on lands designated as primary or secondary environmental corridor would be limited to corridors with components considered compatible with the siting of such facilities based upon the guidelines set forth in the regional land use plan. Second, facilities were located upgradient from surface water features which may be expected, by the year 2035, to experience reductions in baseflow greater than 10 percent over year 2000 conditions. The upgradient locations were identified using the available water table elevation map for the Region.[5] In some instances, because of a lack of other suitable sites, facilities were located upgradient from tributary streams discharging into surface water features which may be expected to experience by the design year 2035 reductions in baseflow greater than 10 percent over 2005 conditions. Third, facilities were sited in locations identified as having moderate to very high groundwater recharge potential as indicated by the soil-water balance model[6] developed by the Wisconsin Geological and Natural History Survey for use in the regional water supply planning program. This model accounts for various processes that divert precipitation from becoming groundwater recharge, including interception of precipitation by the plant canopy, runoff from the land surface, evapotranspiration of water from the soil, and storage of soil moisture within the root zone. In characterizing these processes, the model takes into account several factors, including topography, hydrologic soil group, soil water storage, and land use. Fourth, where multiple potential sites were available for the potential location of a facility, a number of other criteria were considered including vertical hydraulic conductivity, depth to water table, and depth to bedrock. It is important to note that while the siting criteria used were deemed adequate for the purposes of simulation modeling and systems level planning, actual siting of these facilities would require site-specific investigations to determine, in greater depth and detail, the suitability of the topography, soils, direction of shallow groundwater flow, and other factors associated with candidate sites for enhancing groundwater recharge, including, importantly, the cost and availability of land. The estimated costs associated with these facilities are given in Table 153.

Under Subalternative 1 to the Composite Plan, the sources of supply and the anticipated utilization of those sources may be summarized as follows:

- Design year 2035 total average annual groundwater pumpage is estimated to approximate 88 mgd, with about 61 mgd, or about 69 percent, from the shallow aquifer; and about 27 mgd, or about 31 percent, from the deep aquifer. This compares to a year 2005 total pumpage of about 77 mgd, and to a plan condition 2035 pumpage of about 106 mgd under Alternative Plan 1 as initially considered.

- Design year 2035 municipal water utility average annual groundwater pumpage is estimated to approximate 71 mgd. This compares to a year 2005 pumpage of about 49 mgd, and to a plan condition year 2035 pumpage of 89 mgd under Alternative Plan 1 as initially considered.

- Design year 2035 municipal water supply pumpage of Lake Michigan water is estimated to approximate 232 mgd. This compares to a year 2005 pumpage of about 209 mgd, and a plan condition 2035 pumpage of 214 mgd under Alternative Plan 1 as initially considered.

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[5]*SEWRPC Technical Report No. 37,* Groundwater Resources of Southeastern Wisconsin, *June 2002.*

[6]*SEWRPC Technical Report No. 47,* op. cit.

Table 153

CAPITAL COSTS AND OPERATIONS AND MAINTENANCE COSTS OF RAINFALL INFILTRATION SYSTEMS IN SUBALTERNATIVE 1 TO THE COMPOSITE PLAN

County	Sites	Area (acres)	Land Value ($ per acre)	Capital Cost ($ X 1,000)				Annual O & M Cost ($ X 1,000)	
				Total Land Acquisition	Regrading and Revegetation	Engineering and Contingencies	Total	Minimal Maintenance[a]	Intensive Active Management[b]
Kenosha................	9	275	10,839	2,981	1,100	1,428	5,509	13.8	110.0
Milwaukee.............	0	- -	8,465	- -	- -	- -	- -	- -	- -
Ozaukee	2	90	5,865	528	360	311	1,199	4.5	36.0
Racine..................	1	40	5,167	207	160	128	495	2.0	16.0
Walworth...............	12	440	6,449	2,838	1,760	1,609	6,207	22.0	176.0
Washington...........	5	180	6,840	1,231	720	683	2,634	9.0	72.0
Waukesha.............	8	265	9,900	2,624	1,060	1,289	4,973	13.3	106.0
Total	37	1,290	- -	10,409	5,160	5,448	21,017	64.6	516.0

[a]*Minimal maintenance consists of a minimal level of mowing of the facility.*

[b]*Intensive active management includes periodic burning, weed management, brush reduction, and monitoring of vegetation and hydrology.*

Source: SEWRPC.

Map 109 illustrates the areas served by municipal utilities and the sources of supply for those utilities under Subalternative 1 to the Composite Plan. The new sources of supply and attendant facilities for each water utility in the Region, and the costs of those facilities under this Subalternative, are listed in Table 154. This Subalternative has an estimated capital cost of $296.6 million, and an annual reduction in operation and maintenance cost of $1.4 million. Based upon an analysis period of 50 years and an annual interest rate of 6 percent, the estimated present worth cost of this alternative is $206.2 million, and the equivalent annual cost is $13.1 million. The operation and maintenance cost used for purposes of comparison of both Subalternative 1 of the Composite Plan and Subalternative 2 of the Composite Plan with Alternative Plan 1 was the net amount arrived at by combining the operation and maintenance costs of the proposed new facilities; the expected savings due to the elimination of individual household water softening systems and other household point-of-entry treatment devices; and the reductions in costs due to the elimination of no longer needed existing utility facilities. The operation and maintenance cost of those existing facilities was not included in any of the alternative plans being considered.

Groundwater and Surface Water Impacts of Subalternative 1 to the Composite Plan

The potential impacts of the pumping conditions attendant to Subalternative 1 to the Composite Plan on the groundwater and surface water systems of the Region were estimated by simulation modeling and by a parallel water budget analysis. The methods used to evaluate these impacts are the same as those that were used to evaluate the four alternative plans described in Chapter VIII of this report, and as previously described in this chapter.

Groundwater Impacts in the Deep Aquifer

Simulated Water Levels in the Deep Aquifer

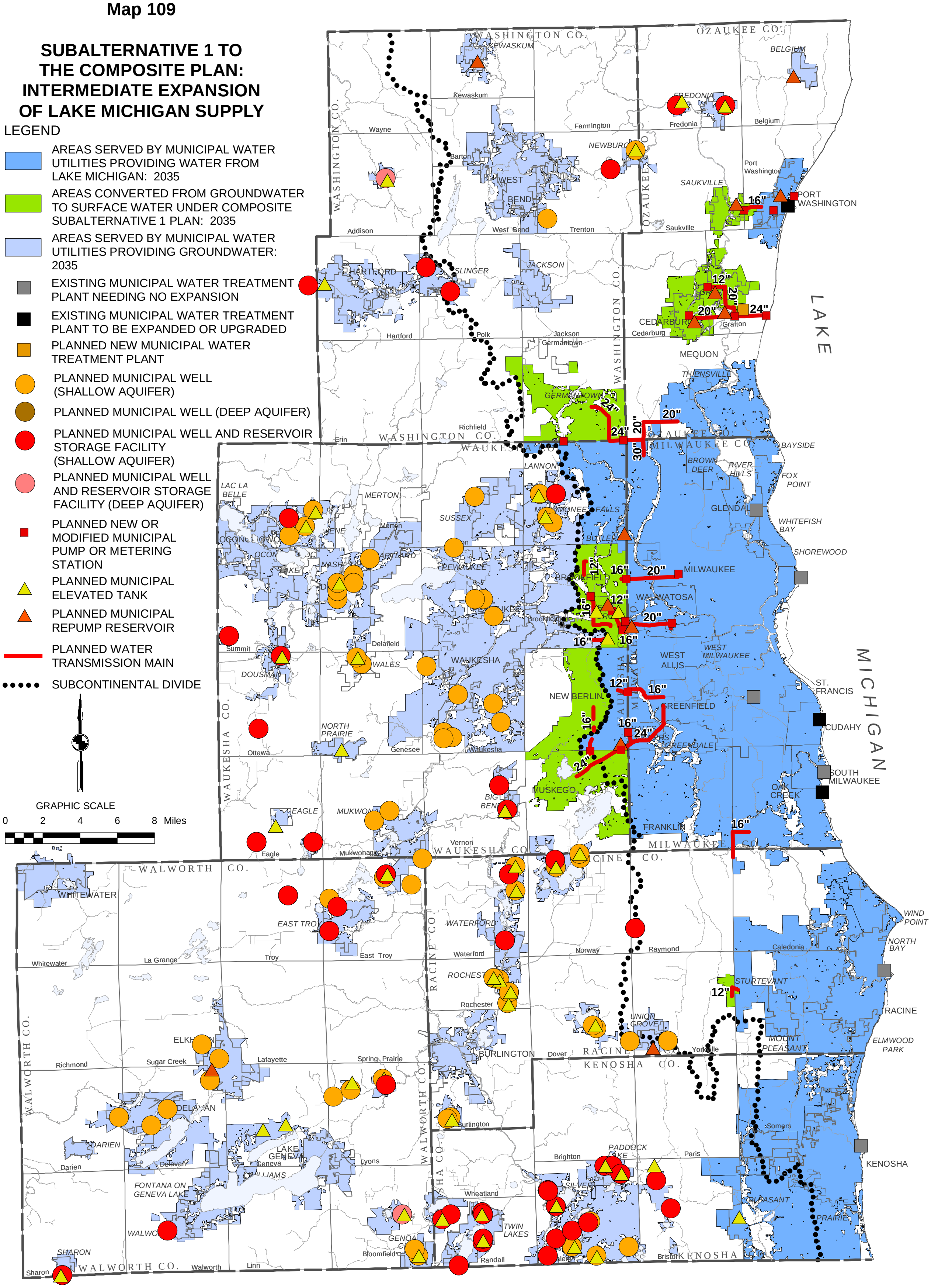
Results of the groundwater simulation modeling suggest that under Subalternative 1 to the Composite Plan conditions, drawups relative to 2005 conditions may be expected to occur in the deep aquifer over most of the Region except for Walworth County and much of Kenosha County. These impacts are graphically shown on Map 110, and are most evident in portions of central and eastern Waukesha County, most of Milwaukee County, southern Ozaukee County, and southeastern Washington County where the impacts may exceed 55 feet of drawup. It should be noted that there will remain impacts on the deep aquifer from pumping in areas to the south of the Region in northeastern Illinois. The impacts of pumping in areas located beyond the Region may account for the smaller drawups anticipated in Kenosha and Walworth Counties. For analytical purposes, the pumping in northeastern Illinois was held at the year 2000 level for the planning period of 2000 through 2035. At the time that these analyses were conducted, no comprehensive areawide water supply plan was in place for the northeastern Illinois area, and no basis, therefore, existed for forecasting potential changes in the pumpage concerned. Thus, the impacts under future conditions may be somewhat different than developed under this planning program. However, the relative differences between alternative plans as herein reported may be expected to be valid.

Table 155 summarizes the simulated drawdowns in the upper sandstone aquifer over the period 2005 to 2035. In five of the seven counties, fewer than about 7 percent of model cells show average drawdowns over 2005 levels in the upper sandstone aquifer under Subalternative 1 to the Composite Plan conditions. Exceptions occur in Kenosha and Walworth Counties where about 44 percent and 85 percent, respectively, of model cells show drawdowns over the 2005 levels in the upper sandstone aquifer under Subalternative 1 to the Composite Plan conditions. Average drawdowns projected in this aquifer range from less than three feet for cells showing drawdowns in Waukesha County, to about four feet for cells showing drawdowns in Walworth County. Maximum drawdowns projected for this aquifer range from slightly over 12 feet for cells showing drawdowns in Kenosha County, to about 22 feet for cells showing drawdowns in Walworth County. The majority of model cells simulated as experiencing drawdowns in excess of five feet were located in extreme western Kenosha County or southeastern Walworth County.

Table 155 also summarizes simulated drawups in the upper sandstone aquifer over the period 2005 to 2035 under Subalternative 1 to the Composite Plan conditions. The percentage of cells in the model showing drawups over 2005 levels ranges from about 12 percent in Kenosha County, to 100 percent in Milwaukee and Ozaukee, Counties. Average drawups in this aquifer range from about three feet for cells showing drawups in Walworth

Map 109

SUBALTERNATIVE 1 TO THE COMPOSITE PLAN: INTERMEDIATE EXPANSION OF LAKE MICHIGAN SUPPLY



Source: Ruekert & Mielke, Inc. and SEWRPC.

Table 154

PRINCIPAL FEATURES AND COSTS OF NEW, EXPANDED, AND UPGRADED WATER SUPPLY FACILITIES AND PROGRAMS UNDER SUBALTERNATIVE 1 TO THE COMPOSITE WATER SUPPLY PLAN, DESIGN YEAR 2035

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Kenosha County	- -	- -	- -	- -	- -
City of Kenosha Water Utility	No additions	- -	41.7	657	42
Village of Paddock Lake Municipal Water Utility	Addition of two 0.25 MG elevated tanks, three shallow aquifer wells with 0.20 MG reservoir each	4,032	54.0	3,135	199
Village of Pleasant Prairie Water Utility	Addition of 0.75 MG elevated tank	1,620	39.7[d]	2,104	134
Town of Bristol Utility District No. 1	Addition of two shallow aquifer wells, 0.50 MG elevated tank, 0.40 MG reservoir	2,654	10.0[e]	2,428[e]	154[e]
Town of Bristol Utility District No. 3	No additions	- -	0.1[d]	2	0
Town of Somers Water Utility	No additions	- -	3.5[d]	55	3
Village of Silver Lake Planned Utility	Addition of three shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank	3,437	93.4	1,694	107
Village of Twin Lakes Planned Utility	Addition of five shallow aquifer wells with 0.1 MG reservoir each, two 0.3 MG elevated tanks	5,317	158.7	3,782	240
Town of Salem Planned Utility	Addition of eight shallow aquifer wells, four with 0.15 MG reservoirs, two 0.3 MG elevated tanks	7,294	288.9	5,710	362
Powers-Benedict-Tombeau Lakes Area Planned Utility	Addition of two shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank	2,584	57.9	1,694	107
Land Acquisition for Wells and Storage Tanks	33 acres	2,310	- -	2,310	147
Countywide	Nine rainfall infiltration systems	5,509	41.2	6052	384
Subtotal	23 Wells, 28 Storage Tanks, Nine Rainfall Infiltration Systems	34,757	789.1	29,623	1,879
Milwaukee County	- -	- -	- -	- -	- -
City of Cudahy Water Utility	Duplicate rapid mix facility	100	7.5	118	7
City of Franklin Water Utility	No additions	- -	13.4[d]	211	13
City of Glendale Water Utility	No additions	- -	6.1[d]	96	6
City of Milwaukee Water Works	No additions	- -	263.1	4,146	263
City of Oak Creek Water and Sewer Utility	Addition of 20 mgd coag-floc-sed, 14 mgd filtration, 17.5 mgd pumping	13,220	547.4[f]	21,169	1,343
City of South Milwaukee Water Utility	No additions	- -	8.6	136	9
City of Wauwatosa Water Utility	No additions	- -	19.6[d]	309	20

Table 154 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Milwaukee County (continued)	- -	- -	- -	- -	- -
City of West Allis Water Utility	No additions	- -	25.2[d]	397	25
Village of Brown Deer Public Water Utility	No additions	- -	4.8[d]	76	5
Village of Fox Point Water Utility	No additions	- -	2.6[d]	41	3
Village of Greendale Water Utility	No additions	- -	5.6[d]	88	6
Village of Shorewood Municipal Water Utility	No additions	- -	1.4[d]	22	1
Village of Whitefish Bay Water Utility	No additions	- -	5.8[d]	91	6
We Energies-Water Services	No additions	- -	1.0[d]	16	1
Subtotal	0 Wells, 0 Storage Tanks, Two Treatment Plant Upgrades	13,320	912.1	26,916	1,708
Ozaukee County	- -	- -	- -	- -	- -
City of Cedarburg Light & Water Commission/ Village of Grafton Water and Wastewater Commission	New 9.0 MGD Lake Michigan intake and water treatment plant, connecting transmission mains	47,048	-1,904.0[g]	20,978[g]	1,331[g]
City of Port Washington Water Utility	Addition of 3.0 MGD coag-floc-sed, filtration, 3.0 MGD pumping	6,895	86.2	9,136	580
Village of Belgium Municipal Water Utility	Addition of 0.45 MG reservoir at Well 3, service pumps at Wells 1 and 2	586	2.0	298	19
Village of Fredonia Municipal Water Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.20 MG reservoir	1,417	23.5	886	56
Village of Saukville Municipal Water Utility	Lake Michigan Supply Connection[h]	3,870[h]	-287.8[i]	-526[i]	-33[i]
We Energies-Water Services	5,300 lineal feet of 30 inch main (shared with Village of Germantown) in 107th street, 16,100 lineal feet of 20 inch main in Granville Road and Donges Bay Road	3,300	231.8[d,j]	5,153[j]	327[j]
Town of Fredonia-Waubeka Area Planned Utility	Addition of one shallow aquifer well with 0.10 MG reservoir, 0.25 MG elevated tank	1,460	24.3	899	57
Land Acquisition for Wells, Storage Tanks and Water Treatment Plant	9 acres	630	- -	630	40
Countywide	Two rainfall infiltration systems	1,199	13.5	1,412	90
Subtotal	Two Wells, Five Storage Tanks, One Treatment Plant Upgrade, One New Treatment Plant, One Lake Michigan Connection, Two Rainfall Infiltration Systems	66,405	-1,810.5	38,866	2,467

Table 154 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Racine County	- -	- -	- -	- -	- -
City of Burlington Municipal Waterworks	No additions	- -	12.6	199	13
City of Racine Water and Wastewater Utility[k]	No additions	- -	45.9	724	46
Village of Caledonia West Utility District[l] (Oak Creek)	No additions	- -	0.4[d]	6	1
Village of Caledonia West Utility District[l] (Racine)	No additions	- -	3.1[d]	49	3
Village of Caledonia East Utility District[m] (Oak Creek)	No additions	- -	1.9[d]	30	2
Village of Caledonia East Utility District[m] (Racine)	No additions	- -	3.5[d]	55	4
Village of Union Grove Municipal Water Utility	Addition of two shallow aquifer wells, 0.40 MG reservoir	1,776	12.1[e]	947[e]	60[e]
Village of Waterford Water and Sewer Utility	Addition of one shallow aquifer well with 0.40 MG reservoir	1,151	15.7	1,481	94
Village of Wind Point Municipal Water Utility	No additions	- -	0.8[d]	13	1
North Cape Sanitary District	Addition of one shallow aquifer well with 0.05 MG reservoir	155	2.1	194	12
Town of Yorkville Water Utility District 1	Lake Michigan supply connection[n]	459[n]	-38.0[o]	-140[o]	-9[o]
Northwest Caledonia Area Planned Utility District	9,000 lineal feet of water transmission main	1,557	3.1[p]	726	46
Town of Burlington-Bohner Lake Area Planned Utility District	Addition of two shallow aquifer wells, 0.30 MG elevated tank	1,941	42.1	1,278	81
Town of Dover-Eagle Lake Area Planned Utility District	Addition of two shallow aquifer wells, 0.30 MG elevated tank	1,941	47.0	1,315	83
Town of Norway Area Planned Utility	Addition of four shallow aquifer wells, one with 0.15 MG reservoir, two 0.25 MG elevated tanks	4,024	112.9	2,825	179
Village of Rochester Area Planned Utility	Addition of two shallow aquifer wells, two 0.10 MG elevated tanks	1,844	27.6	1,125	71
Town of Rochester Area Planned Utility	Addition of two shallow aquifer wells, two 0.10 MG elevated tanks	1,844	30.7	1,148	73
Town of Waterford Area Planned Utility	Addition of three shallow aquifer wells, one with 0.15 MG reservoir, two 0.3 MG elevated tanks	3,485	114.4	2,571	163
Land Acquisition for Wells and Storage Tanks	29 acres	2,030	- -	2,030	129
Countywide	One rainfall infiltration system	495	6.0	590	37
Subtotal	19 Wells, 15 Storage Tanks, One Lake Michigan Supply Connection, One Rainfall Infiltration System	22,702	443.9	17,166	1,089

Table 154 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Walworth County	- -	- -	- -	- -	- -
City of Delavan Water and Sewerage Commission	Addition of three shallow aquifer wells with iron removal treatment	3,075	75.2	1,544	98
City of Elkhorn Light and Water	Addition of three shallow aquifer wells, 0.35 MG treated water reservoir	2,342	-103[e]	444[e]	28[e]
City of Lake Geneva Municipal Water Utility	No additions	- -	11.3	178	11
City of Whitewater Municipal Water Utility	No additions	- -	13.7	216	14
Village of Darien Water Works and Sewer System	Increase Well 1 output from 325 to 425 gpm	30	15.2	74	5
Village of East Troy Municipal Water Utility	Addition of three shallow aquifer wells, two with 0.10 MG reservoir each	2,199	55.6	1,792	114
Village of Fontana Municipal Water Utility	No additions	- -	2.0	32	2
Village of Genoa City Municipal Water Utility	Addition of two shallow aquifer wells and 0.25 MG elevated tank	1,898	48.1	1,592	101
Village of Sharon Waterworks and Sewer System	Addition of one shallow aquifer well with 0.30 MG reservoir, 0.20 MG elevated tank	1,512	17.1	1,935	123
Village of Walworth Municipal Water and Sewer Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.15 MG reservoir	1,333	30.6	1,038	66
Village of Williams Bay Municipal Water Utility	No additions	- -	4.3	68	4
Town of Bloomfield Pell Lake Sanitary District No. 1	Addition of 0.2 MG elevated tank, one deep aquifer well with radium treatment and with 0.4 MG reservoir	1,891	39.6	2,416	153
Town of East Troy Sanitary District No. 3	Addition of one shallow aquifer well	130	0.1	136	8
Town of Geneva Lake Como Sanitary District No. 1	Addition of 0.20 MG elevated tank and 0.45 MG reservoir	1,066	12.4	1,206	77
Town of Troy Sanitary District No. 1	Addition of one shallow aquifer well with 0.01 MG reservoir	80	0.2	87	6
Country Estates Sanitary District	Addition of 0.20 MG elevated tank	480	10.8	719	46
Town of Lyons Area Planned Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.3 MG elevated tank	2,169	38.9	1,362	86
Town of East Troy-Potter Lake Area Planned Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.3 MG elevated tank	2,169	34.6	1,329	84

Table 154 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Walworth County (continued)	- -	- -	- -	- -	- -
Land Acquisition for Wells and Storage Tanks	28 acres	1,960	- -	1,960	124
Countywide	12 rainfall infiltration systems	6,207	66.0	7,247	460
Subtotal	20 Wells, 18 Storage Tanks, 12 Rainfall Infiltration Systems	28,541	372.7	25,375	1,610
Washington County	- -	- -	- -	- -	- -
City of Hartford Utilities	Addition of one shallow aquifer well, with reservoir treatment system, 0.75 MG elevated tank, and interconnecting piping, replace deep aquifer pumping (these facilities are under development and are anticipated to be operational during 2009)	7,500	39.4[e]	6,979[e]	443[e]
City of West Bend Water Utility	Addition of one shallow aquifer well	625	58.4	1,443	92
Village of Germantown Water Utility	Lake Michigan supply connection[n]	8,404[n]	-1,724.0[q]	-18,400[q]	-1,167[q]
Village of Jackson Water Utility	No additions	- -	7.4	117	7
Village of Kewaskum Municipal Water Utility	Addition of 0.25 MG reservoir	351	4.4	420	27
Village of Slinger Utilities	Addition of two shallow aquifer wells with 0.20 MG reservoir each	1,824	31.9	1,730	110
Allenton Sanitary District No. 1	Addition of 0.20 MG elevated tank, one deep aquifer well with 0.30 MG reservoir	1,672	20.3	1,374	87
Village of Newburg Area Planned Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.30 MG elevated tank	2,169	39.9	1,938	123
Land Acquisition for Wells and Storage Tanks	10 acres	700	- -	700	44
Countywide	Five rainfall infiltration systems	2,634	27.0	3,059	194
Subtotal	Seven Wells, Nine Storage Tanks, One Lake Michigan Supply Connection, Five Rainfall Infiltration Systems	25,879	-1,495.3	-640	-40
Waukesha County	- -	- -	- -	- -	- -
City of Brookfield Municipal Water Utility (east)	Lake Michigan supply connection[n]	19,682[n]	-1,093.0[r]	3,365[r]	213[r]
City of Brookfield Municipal Water Utility (west)	No additions	- -	35.0	552	35
City of Delafield Municipal Water Utility	Addition of five shallow aquifer wells, 0.40 MG elevated tank	4,019	110.1	3,259	207
City of Muskego Public Water Utility	Lake Michigan supply connection[n]	12,675[n]	-1,508.0[s]	-10,679[s]	-678[s]
City of New Berlin Water Utility (east)	Addition of 0.40 MG reservoir	526	8.5[d]	320	20
City of New Berlin Water Utility (central)	Lake Michigan supply connection[n]	6,685[n]	-1,377.0[t]	-14,811[t]	-939[t]
City of Oconomowoc Utilities	No additions	- -	17.4	274	17

Table 154 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Waukesha County (continued)	- -	- -	- -	- -	- -
City of Pewaukee Water and Sewer Utility	Addition of two shallow aquifer wells, service pumps	1,300	54.9	1,996	127
City of Waukesha Water Utility	Addition of eight shallow aquifer wells with treatment, radium treatment for Well No. 6	24,035	2,918.5[e]	58,783[e]	3,730[e]
Village of Butler Public Water Utility	Addition of 0.25 MG reservoir	351	0.8	307	19
Village of Dousman Water Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.40 MG reservoir	1,631	26.2	1,957	124
Village of Eagle Municipal Water Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.40 MG reservoir	1,631	17.8	1,850	117
Village of Hartland Municipal Water Utility	Addition of one shallow aquifer well	625	17.7	526	33
Village of Menomonee Falls Water Utility (east)	No additions	- -	12.2[d]	192	12
Village of Menomonee Falls Water Utility (west)	Addition of 0.20 MG elevated tank, two shallow aquifer wells	1,755	32.9	1,387	88
Village of Mukwonago Municipal Water Utility	Addition of three shallow aquifer wells	2,195	77.7	2,676	170
Village of Pewaukee Water Utility	Addition of one shallow aquifer well	625	36.2	989	63
Village of Sussex Public Water Utility	Addition of one shallow aquifer well	625	42.9	642	41
Town of Brookfield Sanitary District No. 4	Addition of 0.35 MG reservoir	467	6.0	562	36
Village of Big Bend Planned Utility	Addition of two shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank	2,584	76.1	1,822	116
Village of Elm Grove Planned Utility	Lake Michigan supply connection[n]	2,797[n]	-470.0[u]	-4,497[u]	-285[u]
Village of Lannon Planned Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.75 MG elevated tank	3,098	117.9	2,381	151
Village of North Prairie Planned Utility	Addition of 0.50 MG elevated tank	878	19.5	592	38
Village of Wales Planned Utility	Addition of two shallow aquifer wells, 0.30 MG elevated tank	1,941	41.8	1,277	81
Town of Eagle-Eagle Spring Lake Area Planned Utility	Addition of one shallow aquifer well with 0.15 MG reservoir	853	5.2	454	29
Town of Oconomowoc-Okauchee Lake Area Planned Utility	Addition of four shallow aquifer wells, one with 0.15 MG reservoir, two 0.30 MG elevated tanks	4,110	116.6	2,899	184
Town of Ottawa-Pretty Lake Area Planned Utility	Addition of one shallow aquifer well with 0.10 MG reservoir	787	3.1	409	26

Table 154 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Waukesha County (continued)	- -	- -	- -	- -	- -
Town of Summit-Golden Lake Area Planned Utility	Addition of one shallow aquifer well with 0.10 MG reservoir	787	2.1	403	26
Land Acquisition for Wells and Storage Tanks.............................	48 acres	3,360	- -	3,360	213
Countywide	Eight rainfall infiltration systems	4,973	39.7	5,599	355
Subtotal	38 Wells, 22 Storage Tanks, Four Lake Michigan Supply Connections, Eight Rainfall Infiltration Systems	104,995	-611.2	68,846	4,329
Total	109 Wells, 97 Storage Tanks, Seven Lake Michigan Supply Connections, Two Treatment Plant Upgrades, One New Treatment Plant, 37 Rainfall Infiltration Systems	296,599	-1,399.2	206,152	13,082

[a]*All utilities' programs include water conservation programs.*

[b]*Costs presented are those associated with the costs for new, expanded, or upgraded facilities. The operation and maintenance costs are for increased incremental costs associated with new, expanded, or upgraded facilities and for water conservation measures. Alternative Plan 1 is being considered as the base for alternative plans evaluation. The costs for the Composite Plan include an adjustment in the operation and maintenance costs to reflect existing facilities not used under the Composite Plan compared to Alternative Plan 1.*

[c]*The estimated annual cost for water conservation is included as an operation and maintenance cost for all utilities.*

[d]*Water utilities which purchase water on a wholesale basis will have continued or increased costs for the purchase of water. For purposes of the cost-effectiveness analyses of the alternative water supply plans, only the incremental operation and maintenance cost associated with any increased water supply facility water production costs are considered. Alternative Plan 1 is being used as the base to which the other alternative plans will be compared. For this base alternative, only the operation and maintenance cost for new, expanded, or upgraded facilities are included since the cost for operation and maintenance of existing facilities which are common to all alternatives are not included for any alternatives.*

[e]*The annual O&M cost includes a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under the Composite Plan.*

[f]*There is expected to be an estimated average reduction of $376,000 per year for savings associated with existing residences which would be able to discontinue their point-of-entry water treatment systems in the Cities of Oak Creek and Franklin. However, there is also an expected cost involved in developing local water distribution systems. The cost savings due to discontinuation of the point-of-entry water treatment system and the costs of the local distribution systems are common to all alternative plans and are not specifically accounted for in this table.*

[g]*The annual O&M cost for the Cedarburg Light & Water Commission and the Village of Grafton Water and Wastewater Commission include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under the Composite Plan. The annual O&M costs also include an expected average reduction of $2,483,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.*

[h]*See Table 126 in Chapter VIII for details.*

Footnotes to Table 154 (continued)

[i]*The annual O&M cost for the Village of Saukville Water Utility includes an estimated annual water production cost of $120,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under the Composite Plan. The annual O&M costs also include an expected average reduction of $455,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.*

[j]*The annual O&M cost for the We Energies-Water Services Mequon and Thiensville service area includes an estimated average annual water production cost of $219,000 per year based upon the estimated incremental cost of $230 per million gallons for water production at the City of Milwaukee Water Works treatment process. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed cost and other costs. There is also expected to be an estimated average reduction of $1,520,000 per year for savings associated with existing residences which would be able to discontinue their point-of-entry water treatment systems. However, there are also expected costs involved in developing a local water distribution system. The cost savings due to discontinuation of the point-of-entry water treatment systems and the cost of the local distribution systems are common to all alternative plans and are not specifically accounted for in this table.*

[k]*Includes the Village of Sturtevant Water Utility which was purchased by the City of Racine Water and Wastewater Utility in 2007 and is now served by the City Utility on a retail basis.*

[l]*Includes the former Crestview Sanitary District and the former North Park Sanitary Districts which were consolidated in 2007 to form the Caledonia East Utility District.*

[m]*Includes the former Caddy Vista Sanitary District and the former Caledonia Utility District No. 1 which were consolidated in 2006 to form the Caledonia West Utility District.*

[n]*See Table 98 in Chapter VIII for details.*

[o]*The annual O&M cost for the Town of Yorkville Utility District No. 1 includes an estimated annual water production cost of $17,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 2. The annual O&M costs also include an expected average reduction of $28,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.*

[p]*The annual O&M cost for the Northwest Caledonia Area does not include the incremental cost for water production, as that cost is included in the expanded City of Oak Creek Water Utility costs.*

[q]*The annual O&M cost for the Village of Germantown Water Utility includes an estimated annual water production cost of $215,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 2. The annual O&M costs also include an expected average reduction of $1,720,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.*

[r]*The annual O&M cost for the City of Brookfield Water Utility for the eastern portion of the City includes an estimated annual water production cost of $205,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 2. The annual O&M costs also include an expected average reduction of $1,440,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.*

[s]*The annual O&M cost for the City of Muskego Water Utility includes an estimated annual water production cost of $133,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 2. The annual O&M costs also include an expected average reduction of $1,519,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.*

Footnotes to Table 154 (continued)

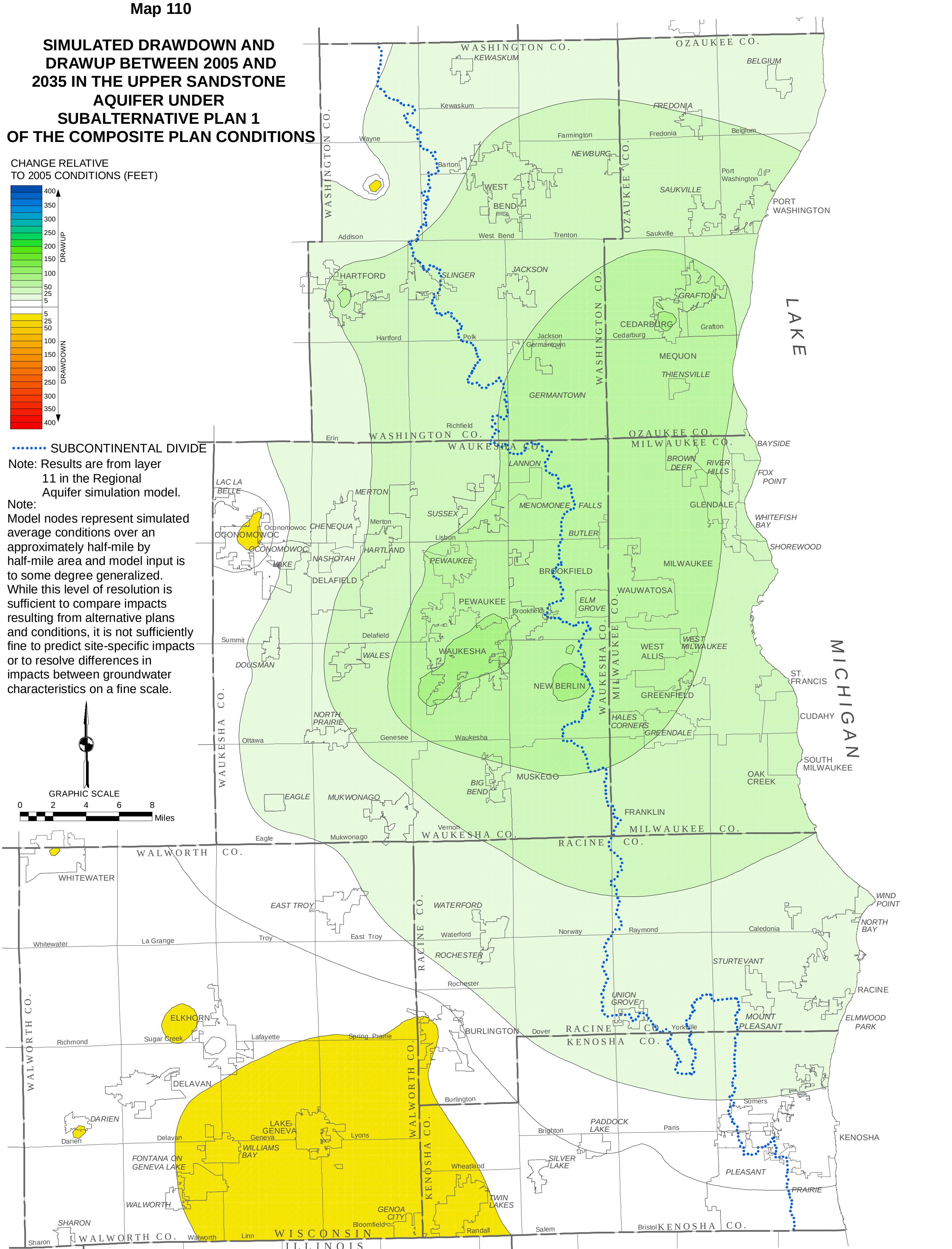
[t]*The annual O&M cost for the City of New Berlin Water Utility for the central portion of the City includes an estimated annual water production cost of $185,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 2. The annual O&M costs also include an expected average reduction of $1,260,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.*

[u]*The annual O&M cost for the Village of Elm Grove includes an estimated annual water production cost of $62,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs also include an expected average reduction of $596,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.*

Source: Ruekert & Mielke, Inc., and SEWRPC.

Map 110

SIMULATED DRAWDOWN AND DRAWUP BETWEEN 2005 AND 2035 IN THE UPPER SANDSTONE AQUIFER UNDER SUBALTERNATIVE PLAN 1 OF THE COMPOSITE PLAN CONDITIONS



Source: U.S. Geological Survey.

Table 155

AVERAGE AND MAXIMUM SIMULATED DRAWDOWN AND DRAWUP IN THE UPPER SANDSTONE AQUIFER UNDER SUBALTERNATIVE 1 TO THE COMPOSITE PLAN CONDITIONS: 2005-2035[a]

County	Drawdown			Drawup		
	Percent of Model Cells	Average (feet)	Maximum (feet)	Percent of Model Cells	Average (feet)	Maximum (feet)
Kenosha	44.2	3.1	12.4	55.8	4.3	10.9
Milwaukee	0.0	0.0	0.0	100.0	47.8	68.9
Ozaukee	0.0	0.0	0.0	100.0	39.3	83.7
Racine	7.0	3.1	14.8	93.0	16.9	33.2
Walworth	84.8	4.1	21.8	15.2	3.1	11.9
Washington	0.3	3.7	15.1	99.7	29.3	225.2
Waukesha	2.6	2.7	15.4	97.4	37.6	100.7

[a]*Results are from Layer 11 in the groundwater simulation model.*

Source: U.S. Geological Survey.

County, to about 48 feet for cells showing drawups in Milwaukee County. Maximum simulated drawups in this aquifer range from about 11 feet in Kenosha County to about 225 feet in Washington County. Model cells in most of the Region exhibited simulated drawups in the upper sandstone aquifer under Subalternative 1 to the Composite Plan conditions greater than five feet (see Map 110). Exceptions to this were located in much of Kenosha and Walworth Counties.

Table 156 summarizes the variation in the simulated drawups in terms of the percentage of cells showing drawups over the period 2005 to 2035 greater than the thresholds given in the column headings. In much of the Region, drawups in excess of 10 feet were common in the upper sandstone aquifer under Subalternative 1 to the Composite Plan conditions, representing over 78 percent of model cells in all Counties except for Kenosha and Walworth Counties. In portions of the Region, drawups in excess of 50 feet were common in the upper sandstone aquifer under Subalternative 1 to the Composite Plan conditions. While no model cells in Kenosha, Racine, or Walworth Counties show drawups in excess of 50 feet, drawups in excess of 50 feet were found in Milwaukee, Ozaukee, Washington, and Waukesha Counties, ranging from about 12 percent of cells in Washington County to about 46 percent of cells in Milwaukee County. Drawups in excess of 100 feet were detected only in a few cells in Washington County under Subalternative 1 to the Composite Plan conditions and represented less than 1 percent of model cells in that County.

Previous simulation modeling results suggest that the top of the Sinnipee Group dolomite below the Maquoketa shale had become unsaturated by the year 2000 in central Waukesha County.[7] The simulation results suggest that under Subalternative 1 to the Composite Plan conditions, such unsaturated conditions may be expected to occur over a much smaller geographical area than that suggested in the previous study. An unsaturated condition at this depth, depending on how it spreads, could influence deep aquifer well yields and groundwater geochemistry around deep aquifer wells open to the Sinnipee Group, the St. Peter Formation, and below. Because of the model resolution and because the model does not explicitly simulate unsaturated flow, however, assessing the potential for this condition would require further more-detailed evaluation if associated with the recommended plan.

[7]Ibid.

Table 156

SIMULATED DRAWUP IN THE UPPER SANDSTONE AQUIFER UNDER SUBALTERNATIVE 1 TO THE COMPOSITE PLAN CONDITIONS: 2005-2035[a]

County	Percent of Model Cells Showing Drawup Greater Than						
	One Foot	Five Feet	10 Feet	50 Feet	100 Feet	150 Feet	200 Feet
Kenosha	48.0	31.9	1.6	0.0	0.0	0.0	0.0
Milwaukee	100.0	100.0	100.0	45.7	0.0	0.0	0.0
Ozaukee	100.0	100.0	100.0	34.5	0.0	0.0	0.0
Racine	91.5	87.4	78.5	0.0	0.0	0.0	0.0
Walworth	11.0	3.3	0.4	0.0	0.0	0.0	0.0
Washington	99.7	92.7	86.6	11.6	0.1	0.1	0.1
Waukesha	96.3	88.0	78.7	36.5	0.0	0.0	0.0

[a]*Results are from Layer 11 in the groundwater simulation model.*

Source: U.S. Geological Survey.

Water Budget Analysis

Table 157 shows results by County from a water budget analysis of the deep groundwater system under Subalternative 1 to the Composite Plan conditions. This analysis developed the anticipated values of two groundwater performance indicators—the demand to supply ratio and the human influence ratio—under Subalternative 1 to the Composite Plan conditions for the years 2005 and 2035. The analysis indicates that in 2005 the demand to supply ratio ranges from about 0.10 in Kenosha County to about 5.77 in Waukesha County under Subalternative 1 to the Composite Plan conditions. Under these conditions, the values of the demand to supply ratio for Ozaukee, Racine, and Waukesha Counties in 2005 may be expected to exceed one, indicating water budget deficits in the deep aquifer underlying these counties. The analysis also projects that under Subalternative 1 to the Composite Plan conditions the demand to supply ratio may be expected to range from about 0.02 in Ozaukee County to about 4.72 in Waukesha County in 2035. Under these conditions, the values of this indicator are anticipated to increase in Kenosha, Racine, and Walworth Counties and to decrease in Milwaukee, Ozaukee, Washington, and Waukesha Counties between 2005 and 2035. For 2035, the values of the demand to supply ratio for Racine and Waukesha Counties may be expected to exceed one, indicating water budget deficits in the deep aquifer underlying these Counties. In 2035, the value of the demand to supply ratio for Walworth County may be expected to be near one, indicating that this County would be near water budget deficit conditions in the underlying deep aquifer.

The analysis also indicates that in 2005 the human influence ratio ranged from about -0.88 in Waukesha County to about -0.04 in Kenosha County under Subalternative 1 to the Composite Plan conditions and projects that in 2035 this indicator may be expected to range from about -0.91 in Waukesha County to about -0.01 in Ozaukee County under Subalternative 1 to the Composite Plan conditions. These values suggest that the net effect of human activities under these conditions would be to remove water from the deep groundwater system. In particular, the values for Waukesha County suggest that pumping dominates all outflows from the deep aquifer in this County under the plan conditions concerned. In Kenosha, Milwaukee, Racine, Walworth, and Waukesha Counties, the projected values of this indicator for 2035 are lower than the 2005 values, indicating that the influence of human withdrawals on the water budget of the deep groundwater may be expected to increase in these Counties under Subalternative 1 to the Composite Plan conditions. In Ozaukee and Washington Counties, the projected values of this indicator for 2035 are higher than the 2005 values, indicating a reduction in the influence of human withdrawals on the water budget of the deep groundwater system may be expected in these Counties under Subalternative 1 to the Composite Plan conditions. Despite this anticipated reduction, under these conditions the deep groundwater systems in Racine, Walworth, and Waukesha Counties are anticipated to remain heavily influenced by human activities in 2035.

Table 157

PROJECTED GROUNDWATER PERFORMANCE INDICATORS FOR THE SANDSTONE AQUIFERS UNDER SUBALTERNATIVE 1 TO THE COMPOSITE PLAN CONDITIONS: 2005 AND 2035

County	Demand to Supply Ratio[a]		Human Influence Ratio[b]	
	2005	2035	2005	2035
Kenosha	0.101	0.137	-0.041	-0.051
Milwaukee	0.567	0.369	-0.197	-0.238
Ozaukee	1.040	0.017	-0.317	-0.008
Racine	1.963	2.244	-0.500	-0.607
Walworth	0.745	0.986	-0.326	-0.411
Washington	0.453	0.294	-0.191	-0.143
Waukesha	5.773	4.719	-0.881	-0.905

[a]*The demand to supply ratio is defined as the ratio of net pumping demand on an aquifer to that aquifer's sustainable, or natural, supply. Generally, this indicator ranges from 0—representing no human impact—upward. Values over 1.0 indicate that more groundwater is being extracted than can be replaced in a long-term, sustainable fashion. The year 2005 and 2035 conditions for this indicator are compared to predevelopment conditions.*

[b]*The human impact ratio, is defined as the ratio of human-induced groundwater inflows to total inflows minus the ratio of human-induced groundwater outflows to total outflows. This indicator is an expression of the relative magnitude of human alteration of the groundwater system. Values range from minus 1.0 in areas where wells have become the only discharge from an aquifer by eliminating all other groundwater discharges, through 0 representing no net human impact, to plus 1.0 representing situations where human additions are the only inputs to the aquifer. The year 2005 and 2035 conditions for this indicator are compared to predevelopment conditions.*

Source: University of Wisconsin-Milwaukee.

Groundwater Impacts in the Shallow Aquifer

As noted in Chapter VIII, except in those portions of the Region where the shallow aquifers are confined by clay-rich glacial tills, the effects of alternative plans upon surface water baseflow conditions will generally be more informative of the impacts upon the shallow groundwater system than the associated changes in water levels in the sand and gravel and Silurian dolomite aquifers.

Impacts to Groundwater-Derived Baseflow to Surface Waters

On a Regional scale, pumping under Subalternative 1 to the Composite Plan conditions may be expected to increase from 79.9 million gallons per day (mgd) in 2005, to 88.7 mgd in 2035, representing a total increase in pumping of 8.8 mgd. The simulation modeling indicated that, within the Region as a whole, under Subalternative 1 to the Composite Plan conditions, a net amount of about 5.6 mgd of water are contributed to storage in the confined and unconfined aquifers and to cross-boundary flow out of the planning area. Thus, in a mass balance analysis for sources of water to wells from waterbodies in southeastern Wisconsin there needs to be an accounting for 14.4 mgd. The simulation modeling indicated that 6.6 mgd, or about 46 percent, of this additional extracted water was derived from groundwater flow that in the absence of pumping would have been discharged to surface water features. An additional 7.8 mgd, or about 54 percent, was derived directly from surface water features due to reversed hydraulic gradients at the groundwater-surface water interface.

Streams, rivers, and lakes of the surface water system of the Region were represented in the model by 3,756 cells designated as stream nodes. The simulation modeling indicated that under 2005 pumping conditions, about 92 percent of these nodes were receiving baseflow from groundwater, while about 5 percent are losing baseflow to groundwater. By 2035, these percentages may be expected to change slightly under Subalternative 1 to the Composite Plan conditions, with about 91 percent of these nodes expected to receive baseflow from groundwater, and about 6 percent as losing baseflow to groundwater. The analyses conducted consider only the impacts on the groundwater-derived baseflow of the streamflow. Groundwater-derived baseflow typically comprises from 10 to 50 percent of total streamflow.

Table 158 summarizes simulated changes in baseflow to the surface waters of the Region under Subalternative 1 to the Composite Plan conditions over the period 2005 to 2035. In aggregate, by 2035 surface waterbodies in the Region may be expected to experience a baseflow depletion of about 12.1 mgd. The amounts of depletion will vary among the Counties, ranging from an augmentation of baseflow of about 2.4 mgd in Ozaukee County, to a depletion of baseflow of about 6.0 mgd in Waukesha County. The aggregate depletion is the net result of 4.7 mgd of inflow depletion and 7.4 mgd of outflow depletion. It is important to note that these aggregate totals may obscure differences in baseflow changes among specific sites within each County. While the County totals project overall depletions within each County, some individual waterbodies may experience either depletion or augmentation.

Model nodes showing greater than 10 percent and greater than 25 percent baseflow depletion under Subalternative 1 to the Composite Plan conditions are shown on Maps 111 and 112, respectively. As noted in Chapter VIII, these data are considered as valid when considered in the aggregate for the purpose of comparing alternative plans. Additional analyses would be needed for consideration of site-specific impacts. Several notable areas of baseflow depletion are indicated by the modeling results. Nodes for which the simulation analyses indicated greater than 10 percent baseflow reduction include those representing portions of the mainstem of the Milwaukee River between West Bend and Newburg in Washington County; portions of Quaas Creek in Washington County; the Rubicon River and the East Branch of the Rubicon River in Washington County; the Fox River between the City of Pewaukee in Waukesha County and the Village of Waterford in Racine County including some portions of Vernon Marsh; portions of several tributaries to the Fox River in Waukesha County including Pebble Brook, Pebble Creek, the Pewaukee River, and Sussex Creek; Lake Beulah in Walworth County; a portion of the White River in Walworth County; a portion of Turtle Creek in Walworth County; Jackson Creek in Walworth County; Eagle Lake and a portion of the West Branch of the Root River Canal in Racine County; and the Des Plaines River near Union Grove in Racine and Kenosha Counties. Maps 111 and 112 also highlight those streams which receive a significant amount of wastewater treatment plant effluent, and are, thus, somewhat less sensitive to reductions in baseflows. It is important to note that several of the streams expected to show baseflow reductions in excess of 10 percent under Subalternative 1 to the Composite Plan conditions receive wastewater treatment plant effluent. In those streams, the impacts of a reduced groundwater-derived baseflow are generally mitigated or improved with respect to streamflow. However, adverse water quality impacts may remain.

Model nodes which the simulation modeling indicated as exhibiting greater than 25 percent baseflow reduction include those representing portions of the Rubicon River and the East Branch of the Rubicon River in Washington County; Pebble Brook in Waukesha County; Jackson Creek in Walworth County; and a portion of the Des Plaines River near Union Grove in Racine County. Some of the streams simulated to show baseflow reductions in excess of 25 percent under Subalternative 1 to the Composite Plan conditions receive wastewater treatment plant effluent as shown on Map 112. As already noted, the impacts of a reduced groundwater-derived baseflow are generally mitigated or improved with respect to streamflow in streams which receive wastewater treatment plant effluent. However, adverse water quality impacts may remain.

Maps 111 and 112 also depict model nodes which show potential augmentation of baseflow under Subalternative 1 to the Composite Plan conditions greater than 10 percent and greater than 25 percent, respectively. As previously noted, these results are considered valid for the purpose of comparing alternative plans; however, additional analyses would be needed for consideration of site-specific impacts. Several notable areas of baseflow augmentation are indicated by the modeling results. Nodes for which the simulation modeling indicated greater than 10 percent baseflow augmentation include those representing Mole Creek, Pigeon Creek, Trinity Creek and upstream portions of Sauk Creek in Ozaukee County; Butler Ditch, Hale Creek, Underwood Creek, and Lake Denoon, in Waukesha County; the Wind Lake subwatershed of the Fox River watershed in Waukesha and Racine Counties, including Big Muskego, Little Muskego, and Wind Lakes and the Muskego Drainage Canal; Ryan and Tess Corners Creeks and the mainstem of the Menomonee River between the confluence with the Little Menomonee River and Honey Creek in Milwaukee County; the Little Menomonee River in Milwaukee and Ozaukee Counties; and Silver Lake in Kenosha County.

Table 158

SIMULATED BASEFLOW DEPLETION TO SURFACE WATERS UNDER SUBALTERNATIVE 1 TO THE COMPOSITE PLAN CONDITIONS: 2005-2035

Baseflow to Surface Water	2000 Baseflow (million gallons per day)	2035 Baseflow (million gallons per day)	Difference (million gallons per day)[a]	Percent Change[a]
Kenosha County				
Inflow to Surface Water	41.63	40.68	-0.95	-2.3
Outflow from Surface Water	0.40	1.07	-0.67	-167.1
Subtotal	41.23	39.61	-1.62	-3.9
Milwaukee County				
Inflow to Surface Water	11.45	11.58	0.13	1.1
Outflow from Surface Water	2.98	2.97	0.01	0.4
Subtotal	8.47	8.61	0.14	1.7
Ozaukee County				
Inflow to Surface Water	17.34	19.74	2.40	13.8
Outflow from Surface Water	0.46	0.44	0.02	4.3
Subtotal	16.88	19.30	2.42	14.3
Racine County				
Inflow to Surface Water	41.70	41.60	-0.10	-0.2
Outflow from Surface Water	0.07	0.48	-0.41	-618.9
Subtotal	41.63	41.12	-0.41	-1.2
Walworth County				
Inflow to Surface Water	103.99	101.71	-2.28	-2.2
Outflow from Surface Water	8.99	10.39	-1.40	-15.7
Subtotal	95.00	91.32	-3.68	-3.9
Washington County				
Inflow to Surface Water	63.52	61.49	-2.03	-3.2
Outflow from Surface Water	2.52	3.32	-0.80	-31.7
Subtotal	61.00	58.17	-2.83	-4.6
Waukesha County				
Inflow to Surface Water	89.55	87.72	-1.83	-2.0
Outflow from Surface Water	1.27	5.46	-4.19	-329.8
Subtotal	88.28	82.26	-6.02	-6.8
Southeastern Wisconsin Region				
Inflow to Surface Water	369.18	364.52	-4.66	-1.3
Outflow from Surface Water	16.69	24.13	-7.44	-44.6
Total	352.49	340.39	-12.10	-3.4

[a]*A positive difference or change represents augmentation of baseflow to surface waters, a negative difference or change represents depletion of baseflow to surface waters.*

Source: U.S. Geological Survey.

Model nodes which the simulation modeling indicated as exhibiting greater than 25 percent baseflow potential augmentation include those representing Pigeon Creek, Trinity Creek, and the Little Menomonee River in Ozaukee County; Butler Ditch, Hale Creek, Lake Denoon, and upper portions of the Wind Lake subwatershed of the Fox River watershed in Waukesha County; and Tess Corners Creek in Milwaukee County.

Map 111

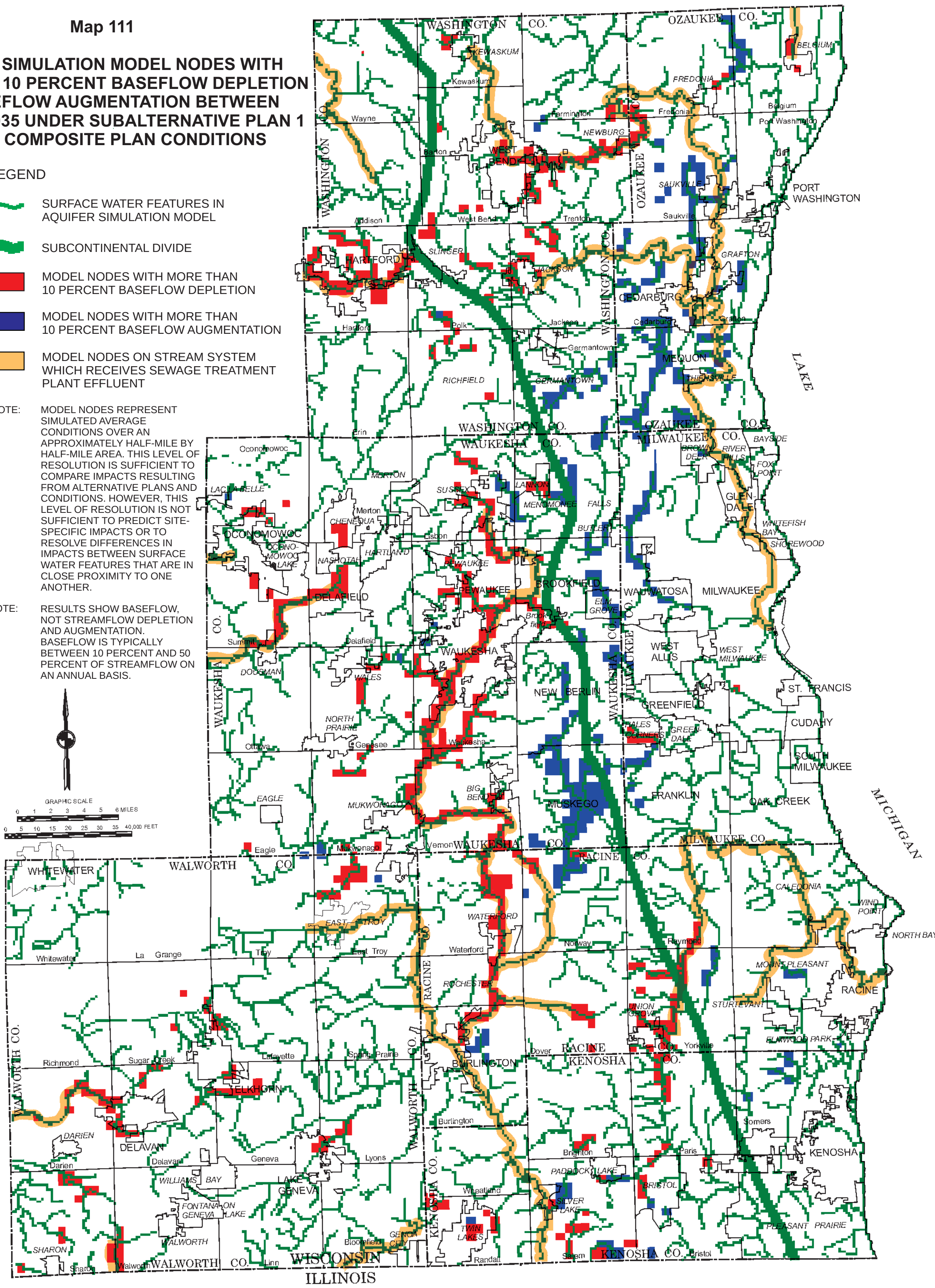
AQUIFER SIMULATION MODEL NODES WITH MORE THAN 10 PERCENT BASEFLOW DEPLETION OR BASEFLOW AUGMENTATION BETWEEN 2005 AND 2035 UNDER SUBALTERNATIVE PLAN 1 TO THE COMPOSITE PLAN CONDITIONS

LEGEND

- SURFACE WATER FEATURES IN AQUIFER SIMULATION MODEL
- SUBCONTINENTAL DIVIDE
- MODEL NODES WITH MORE THAN 10 PERCENT BASEFLOW DEPLETION
- MODEL NODES WITH MORE THAN 10 PERCENT BASEFLOW AUGMENTATION
- MODEL NODES ON STREAM SYSTEM WHICH RECEIVES SEWAGE TREATMENT PLANT EFFLUENT

NOTE: MODEL NODES REPRESENT SIMULATED AVERAGE CONDITIONS OVER AN APPROXIMATELY HALF-MILE BY HALF-MILE AREA. THIS LEVEL OF RESOLUTION IS SUFFICIENT TO COMPARE IMPACTS RESULTING FROM ALTERNATIVE PLANS AND CONDITIONS. HOWEVER, THIS LEVEL OF RESOLUTION IS NOT SUFFICIENT TO PREDICT SITE-SPECIFIC IMPACTS OR TO RESOLVE DIFFERENCES IN IMPACTS BETWEEN SURFACE WATER FEATURES THAT ARE IN CLOSE PROXIMITY TO ONE ANOTHER.

NOTE: RESULTS SHOW BASEFLOW, NOT STREAMFLOW DEPLETION AND AUGMENTATION. BASEFLOW IS TYPICALLY BETWEEN 10 PERCENT AND 50 PERCENT OF STREAMFLOW ON AN ANNUAL BASIS.



Source: U.S. Geological Survey.

Map 112

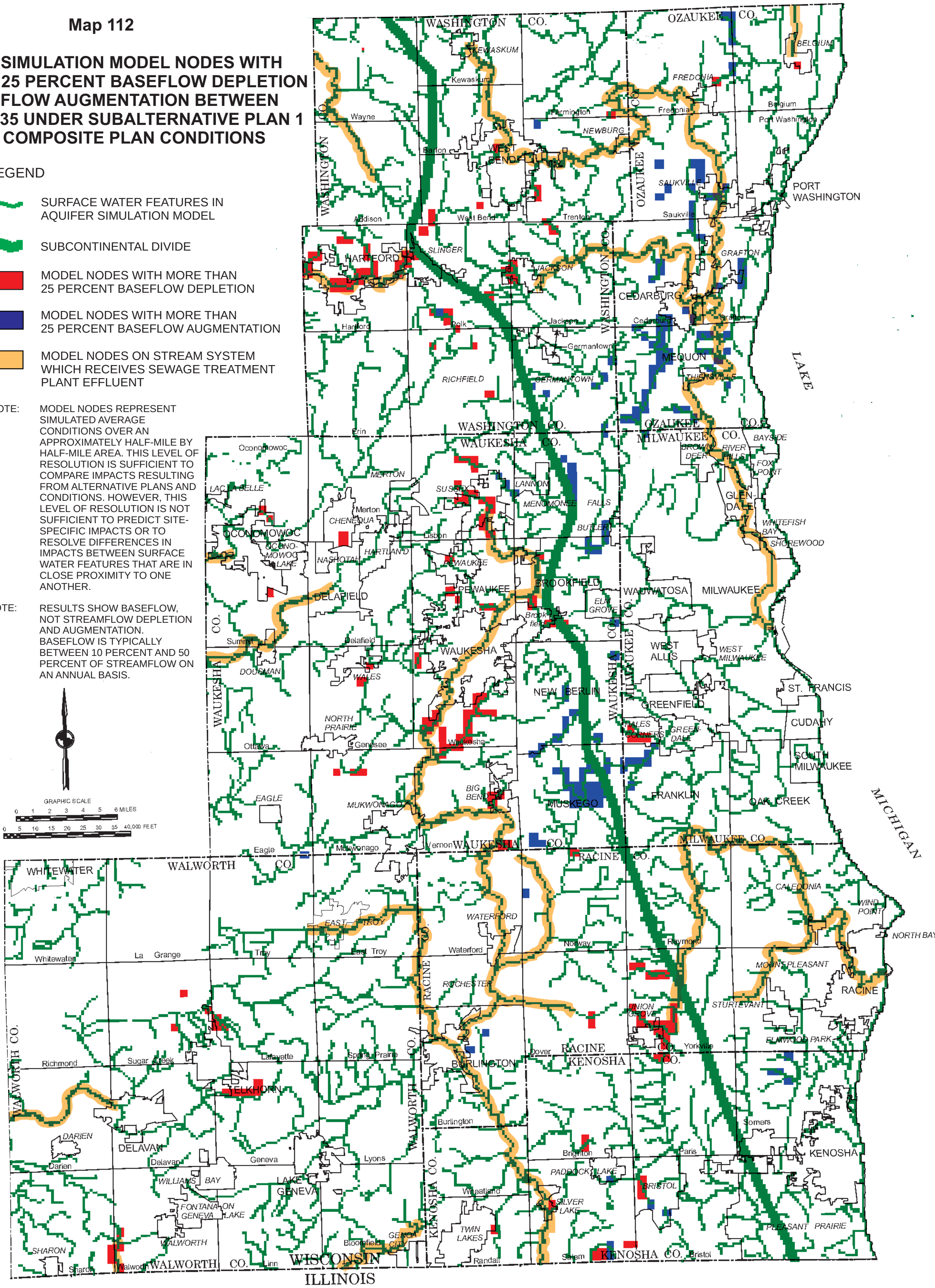
AQUIFER SIMULATION MODEL NODES WITH MORE THAN 25 PERCENT BASEFLOW DEPLETION OR BASEFLOW AUGMENTATION BETWEEN 2005 AND 2035 UNDER SUBALTERNATIVE PLAN 1 TO THE COMPOSITE PLAN CONDITIONS

LEGEND

- SURFACE WATER FEATURES IN AQUIFER SIMULATION MODEL
- SUBCONTINENTAL DIVIDE
- MODEL NODES WITH MORE THAN 25 PERCENT BASEFLOW DEPLETION
- MODEL NODES WITH MORE THAN 25 PERCENT BASEFLOW AUGMENTATION
- MODEL NODES ON STREAM SYSTEM WHICH RECEIVES SEWAGE TREATMENT PLANT EFFLUENT

NOTE: MODEL NODES REPRESENT SIMULATED AVERAGE CONDITIONS OVER AN APPROXIMATELY HALF-MILE BY HALF-MILE AREA. THIS LEVEL OF RESOLUTION IS SUFFICIENT TO COMPARE IMPACTS RESULTING FROM ALTERNATIVE PLANS AND CONDITIONS. HOWEVER, THIS LEVEL OF RESOLUTION IS NOT SUFFICIENT TO PREDICT SITE-SPECIFIC IMPACTS OR TO RESOLVE DIFFERENCES IN IMPACTS BETWEEN SURFACE WATER FEATURES THAT ARE IN CLOSE PROXIMITY TO ONE ANOTHER.

NOTE: RESULTS SHOW BASEFLOW, NOT STREAMFLOW DEPLETION AND AUGMENTATION. BASEFLOW IS TYPICALLY BETWEEN 10 PERCENT AND 50 PERCENT OF STREAMFLOW ON AN ANNUAL BASIS.



Source: U.S. Geological Survey.

As indicated on Maps 111 and 112, most of the surface water features potentially impacted by baseflow augmentations do not receive wastewater treatment plant effluent.

These simulated baseflow reductions and augmentations need to be carefully interpreted. As noted above, the groundwater model used simulates changes in baseflow, not changes in total streamflow. A change in baseflow does not necessarily indicate a change in total streamflow. For example, in some streams much of a reduction in baseflow may be returned to the surface water system through discharge from wastewater treatment plants. This is the case for the Fox River where 15 municipal wastewater treatment plants discharge treated effluent into the River or its tributaries. Increases in runoff due to changes in land use may also serve to augment streamflow in streams experiencing baseflow reductions. Increases in streamflow due to increases in runoff may be associated with potential negative water quality and quantity impacts, including increases in nonpoint source pollution loadings and increases in peak period flows. Such impacts would tend to make the preservation of groundwater-derived baseflow desirable to the extent practical. In addition, because of the resolution provided by the model grid, any simulated change in baseflow represents an average change over an area of one-quarter square mile. Because variations may occur within the area represented by a model cell, this average may not be completely representative of individual surface water features within the cell, particularly small surface water features in cells containing multiple surface water features.

Simulated baseflow changes between 2005 and 2035 were evaluated at 100 model nodes containing surface water evaluation sites. Decreases in baseflow under Subalternative 1 to the Composite Plan conditions were simulated to occur at 58 evaluation sites; with simulated decreases in excess of 10 percent of 2005 baseflow at 19 of these sites and simulated decreases in excess of 25 percent of 2005 baseflow at six of these sites. Increases in baseflow were simulated to occur at 28 of the 100 evaluation sites, with simulated increases in excess of 10 percent of 2005 baseflow at nine of the sites and simulated increases in excess of 25 percent of 2005 baseflow at five of the sites. The remaining 14 evaluation sites either experienced no change in baseflow or were not simulated as having streamflow in 2005.

Simulated Water Levels in the Shallow Aquifer

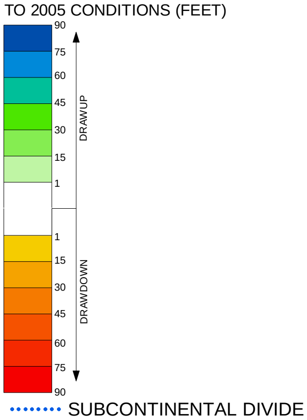
The results of the simulation modeling indicate that under Subalternative 1 to the Composite Plan conditions, additional drawdowns may be expected to occur in the shallow aquifer over much of the Region as shown on Maps 113 and 114. Table 159 provides a summary of the simulated drawdowns and drawups in the glacial sand and gravel aquifer over the period 2005 to 2035. The percentage of cells in the model showing drawdowns over 2005 levels ranges from about 35 percent in Ozaukee County to about 88 percent in Walworth County. Average drawdowns projected in this aquifer are relatively small, ranging from about 0.2 foot for cells showing drawdowns in Ozaukee County, to about 1.1 feet for cells showing drawdowns in Waukesha County. This reflects, in part, the damping effect that surface waters have on changes in the shallow groundwater system. Often the major effect of pumping from shallow wells is to reduce groundwater discharge to local surface water features. In addition, these relatively small drawdowns reflect the effects of the enhanced recharge to the shallow groundwater system provided by components of Subalternative 1 to the Composite Plan. The maximum drawdowns projected for this aquifer range from about five feet for cells showing drawdowns in Milwaukee County, to about 71 feet for cells showing drawdowns in Racine County.

Table 160 summarizes the variation among model cells in terms of the percentage of the cells showing simulated drawdowns over the period 2005 to 2035 greater than the thresholds given in the column headings. In most of the Region, drawdowns greater than 10 feet are relatively rare in the glacial aquifer under Subalternative 1 to the Composite Plan conditions. None of the model cells in Milwaukee and Ozaukee Counties and fewer than 1 percent of the model cells in Kenosha, Racine, and Walworth Counties indicate drawdowns in excess of 10 feet. Drawdowns in excess of 10 feet were slightly more common in Washington and Waukesha Counties, representing about 1 percent of cells in each of these Counties.

Map 113

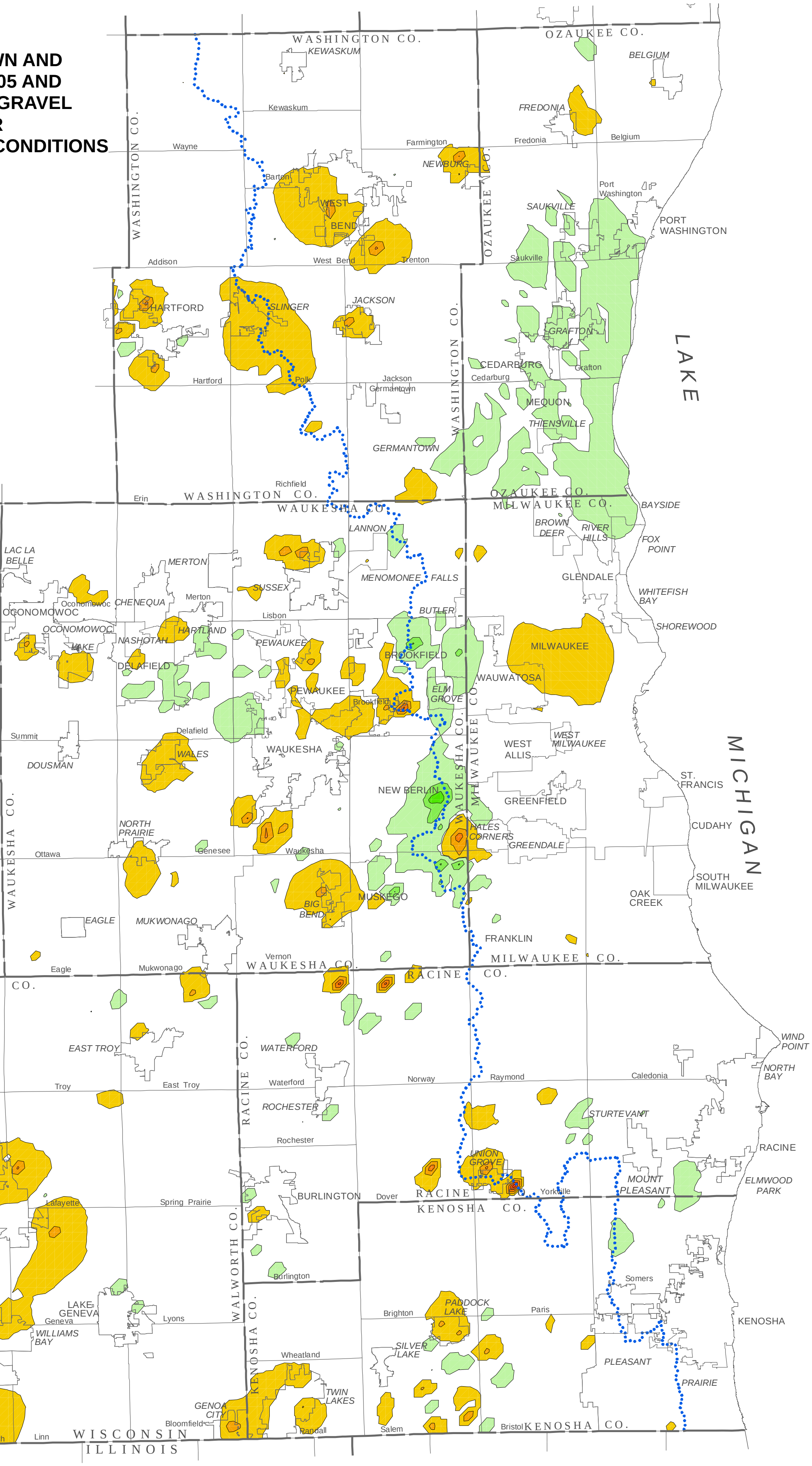
SIMULATED DRAWDOWN AND DRAWUP BETWEEN 2005 AND 2035 IN THE SAND AND GRAVEL AQUIFER UNDER SUBALTERNATIVE PLAN 1 CONDITIONS

CHANGE RELATIVE TO 2005 CONDITIONS (FEET)



Note: Results are from layer 1 in the Regional Aquifer simulation model.

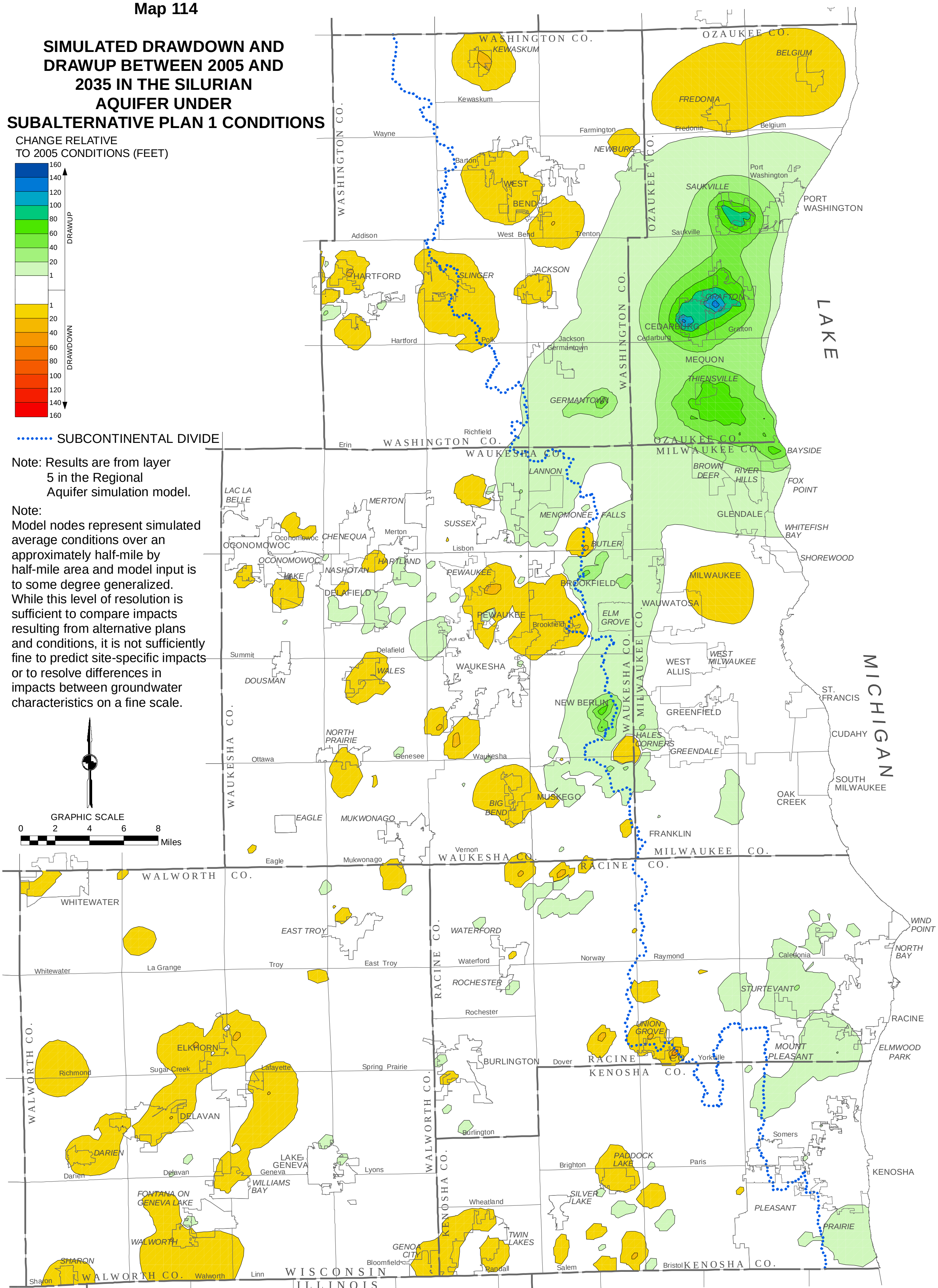
Note:
Model nodes represent simulated average conditions over an approximately half-mile by half-mile area and model input is to some degree generalized. While this level of resolution is sufficient to compare impacts resulting from alternative plans and conditions, it is not sufficiently fine to predict site-specific impacts or to resolve differences in impacts between groundwater characteristics on a fine scale.



Source: U.S. Geological Survey.

Map 114

SIMULATED DRAWDOWN AND DRAWUP BETWEEN 2005 AND 2035 IN THE SILURIAN AQUIFER UNDER SUBALTERNATIVE PLAN 1 CONDITIONS



Note: Results are from layer 5 in the Regional Aquifer simulation model.

Note: Model nodes represent simulated average conditions over an approximately half-mile by half-mile area and model input is to some degree generalized. While this level of resolution is sufficient to compare impacts resulting from alternative plans and conditions, it is not sufficiently fine to predict site-specific impacts or to resolve differences in impacts between groundwater characteristics on a fine scale.

Source: U.S. Geological Survey.

Table 159

AVERAGE AND MAXIMUM SIMULATED DRAWDOWN AND DRAWUP IN THE GLACIAL SAND AND GRAVEL AQUIFER UNDER SUBALTERNATIVE 1 TO THE COMPOSITE PLAN CONDITIONS BY COUNTY: 2005-2035[a]

County	Drawdown			Drawup		
	Percent of Model Cells	Average (feet)	Maximum (feet)	Percent of Model Cells	Average (feet)	Maximum (feet)
Kenosha	55.7	0.6	28.9	44.3	0.2	8.2
Milwaukee	57.0	0.5	4.6	43.1	0.3	8.1
Ozaukee	34.8	0.2	7.5	65.2	1.5	12.6
Racine	43.8	0.7	71.4	56.2	0.2	9.0
Walworth	87.8	0.7	33.1	12.2	0.2	4.0
Washington	68.4	0.9	34.4	31.6	0.1	4.0
Waukesha	48.9	1.0	49.2	51.1	0.9	38.2

[a]*Results are from Layer 1 in the groundwater simulation model.*

Source: U.S. Geological Survey.

Table 160

SIMULATED DRAWDOWN IN THE GLACIAL SAND AND GRAVEL AQUIFER UNDER SUBALTERNATIVE 1 TO THE COMPOSITE PLAN CONDITIONS BY COUNTY: 2005-2035[a]

County	Percent of Model Cells Showing Drawdown Greater Than				
	One Foot	Five Feet	10 Feet	50 Feet	100 Feet
Kenosha	6.4	1.4	0.8	0.0	0.0
Milwaukee	8.4	0.0	0.0	0.0	0.0
Ozaukee	1.1	0.1	0.0	0.0	0.0
Racine	3.0	0.9	0.3	0.2	0.0
Walworth	14.8	2.2	0.7	0.0	0.0
Washington	11.9	3.3	1.0	0.0	0.0
Waukesha	8.9	2.5	1.1	0.0	0.0

[a]*Results are from Layer 1 in the groundwater simulation model.*

Source: U.S. Geological Survey.

Model cells showing simulated drawdowns were distributed throughout the Region; however, there were areas showing a high proportion of cells with drawdowns greater than one foot as shown on Map 113. These areas include western Kenosha County; north-central Milwaukee County; south-central Racine County; central and western Walworth County; and central Washington County. Areas with high proportions of cells showing drawdowns greater than one foot were also scattered throughout Waukesha County.

Table 159 also summarizes simulated drawups in the glacial sand and gravel aquifer over the period 2005 to 2035. The percentage of cells in the model showing drawups over 2005 levels ranges from about 12 percent in Walworth County to about 65 percent in Ozaukee County. Average drawups projected in this aquifer are relatively small, ranging from about 0.1 foot for cells showing drawups in Washington County, to 1.5 foot for cells showing drawups in Ozaukee County. Maximum simulated drawups in this aquifer range from about four feet in Walworth and Washington Counties to about 38 feet in Waukesha County. While model cells showing simulated drawups in the glacial sand and gravel aquifer were distributed throughout the Region, areas that contain a high proportion of cells showing drawups greater than one foot were found primarily in southern Ozaukee County and in central and eastern Waukesha County as shown on Map 113.

Table 161 presents a summary of simulated drawdowns and drawups in the Silurian aquifer over the period 2005 to 2035. The percentage of cells in the model showing drawdowns over 2005 levels ranges from about 28 percent in Milwaukee County, to about 89 percent in Walworth County. Average drawdowns projected in this aquifer are relatively small, ranging from about 0.5 foot for cells showing drawdowns in Milwaukee County, to about 2.2 feet for cells showing drawdowns in Ozaukee County. Maximum drawdowns projected for the Silurian aquifer range from about 2.2 feet for cells showing drawdowns in Milwaukee County, to about 61 feet for cells showing drawdowns in Racine County.

Table 162 summarizes the variation among the model cells in terms of the percentage of cells showing simulated drawdowns over the period 2005 to 2035 greater than the thresholds given in the column headings. In most of the Region, drawdowns greater than 10 feet are relatively rare in the Silurian aquifer under Subalternative 1 to the Composite Plan conditions. Fewer than 1 percent of cells in Kenosha, Milwaukee, Ozaukee, Racine, Walworth, and Waukesha Counties showed drawdowns in excess of 10 feet. Model cells showing simulated drawdowns were distributed throughout the Region; however, there were areas showing a high proportion of cells with drawdowns greater than one foot. These areas include western Kenosha County, northern portions of Ozaukee County, north-central Milwaukee County, south-central Racine County, central and western Walworth County, and central and north-central Washington County. Areas with high proportions of cells showing drawdowns greater than one foot were also scattered throughout Waukesha County as shown on Map 114.

Table 161 also summarizes simulated drawups in the Silurian aquifer over the period 2005 to 2035. The percentage of cells in the model showing drawups over 2005 levels ranges from about 11 percent in Walworth County to about 72 percent in Milwaukee County. With one exception, average drawups projected in this aquifer are relatively small, ranging from about 0.2 foot for cells showing drawups in Walworth County to about 2.9 feet for cells showing drawups in Milwaukee County. The model projects the highest average drawup in Ozaukee County—about 31 feet. Maximum simulated drawups in this aquifer range from about five feet in Walworth County to about 134 feet in Ozaukee County. Map 114 shows that while model cells showing simulated drawups in the Silurian aquifer were distributed throughout the Region, areas showing a high proportion of cells with drawups greater than one foot were found in southern and central Ozaukee County, in northern Milwaukee County along the Milwaukee-Ozaukee County line, in southeastern Washington County, and in eastern Waukesha County. Much of the simulated drawup in southern Ozaukee and northern Milwaukee Counties may be attributable to the shift of the source of water supply in Mequon in areas served by public sanitary sewer system from private wells to a Lake Michigan supply under Subalternative 1 to the Composite Plan. Smaller areas showing a high proportion of cells with drawups greater than one foot were found in northwestern Racine County and in eastern Racine and Kenosha Counties.

Water Budget Analysis

Table 163 shows results by County of a water budget analysis for the shallow groundwater system under Subalternative 1 to the Composite Plan conditions. This analysis was based upon anticipated values of three groundwater performance indicators—the demand to supply ratio, the human influence ratio, and the baseflow reduction index—under Subalternative 1 to the Composite Plan conditions for the years 2005 and 2035. The analysis indicates that in 2005 the demand to supply ratio ranged from about 0.05 in Walworth and Kenosha Counties to about 0.20 in Ozaukee County under Subalternative 1 to the Composite Plan conditions. The analysis projects that in 2035 this indicator may be expected to range from about 0.08 in Walworth County to about 0.13 in Milwaukee and Waukesha Counties under Subalternative 1 to the Composite Plan conditions. While under these conditions increases in this indicator are projected to occur in Kenosha, Racine, Walworth, Washington, and Waukesha Counties, all values of the demand to supply ratio for the shallow aquifer are projected to be well below 1.0, indicating little evidence of a water budget deficit in the shallow aquifer.

Table 161

AVERAGE AND MAXIMUM SIMULATED DRAWDOWN AND DRAWUP IN THE SILURIAN AQUIFER UNDER SUBALTERNATIVE 1 TO THE COMPOSITE PLAN CONDITIONS: 2005-2035[a]

County	Drawdown			Drawup		
	Percent of Model Cells	Average (feet)	Maximum (feet)	Percent of Model Cells	Average (feet)	Maximum (feet)
Kenosha	56.3	0.6	29.6	43.7	0.7	19.7
Milwaukee	28.1	0.5	2.2	71.9	2.9	72.3
Ozaukee	32.2	2.2	20.0	67.8	30.9	133.5
Racine	34.4	0.8	61.0	65.6	0.6	26.7
Walworth	89.0	0.7	32.2	11.0	0.2	5.1
Washington	60.3	1.2	28.4	39.7	2.6	66.7
Waukesha	44.0	1.2	38.5	56.0	2.1	75.5

[a]*Results are from Layer 5 in the groundwater simulation model.*

Source: U.S. Geological Survey.

Table 162

SIMULATED DRAWDOWN IN THE SILURIAN AQUIFER UNDER SUBALTERNATIVE 1 TO THE COMPOSITE PLAN CONDITIONS: 2005-2035[a]

County	Percent of Model Cells Showing Drawdown Greater Than				
	One Foot	Five Feet	10 Feet	50 Feet	100 Feet
Kenosha	7.0	1.4	0.6	0.0	0.0
Milwaukee	4.9	0.0	0.0	0.0	0.0
Ozaukee	21.2	2.6	0.4	0.0	0.0
Racine	3.9	0.9	0.3	0.1	0.0
Walworth	15.5	2.3	0.7	0.0	0.0
Washington	14.2	3.6	1.1	0.0	0.0
Waukesha	10.8	2.7	0.8	0.0	0.0

[a]*Results are from Layer 5 in the groundwater simulation model.*

Source: U.S. Geological Survey.

The analysis also indicated that in 2005 the human influence ratio ranged from about -0.19 in Ozaukee County to about -0.04 in Walworth County under Subalternative 1 to the Composite Plan conditions, and projects that in 2035 this indicator may be expected to range from about -0.13 in Milwaukee and Waukesha Counties to about -0.05 in Ozaukee County under Subalternative 1 to the Composite Plan conditions. These values suggest that the net effect of human activities under these conditions would be to remove water from the shallow groundwater system. In Kenosha, Racine, Walworth, Washington, and Waukesha Counties, the projected values of this indicator for 2035 are lower than the 2005 values, indicating that the influence of human withdrawals on the water budget of the shallow groundwater system may be expected to increase in these Counties under Subalternative 1 to the Composite Plan conditions. In Milwaukee and Ozaukee Counties, the projected values of this indicator for 2035 is higher than the 2005 values, indicating a reduction in the influence of human withdrawals on the water budget of the shallow groundwater system may be expected under Subalternative 1 to the Composite Plan conditions. Despite this anticipated reduction, under the plan conditions the shallow groundwater system underlying Milwaukee County may be expected to remain more heavily influenced by human activities in 2035 than those in several of the other counties in the Region.

Table 163

PROJECTED GROUNDWATER PERFORMANCE INDICATORS FOR THE GLACIAL SAND AND GRAVEL AND SILURIAN DOLOMITE AQUIFERS UNDER 2005 AND 2035 SUBALTERNATIVE 1 TO THE COMPOSITE PLAN CONDITIONS

County	Demand to Supply Ratio[a]		Human Influence Ratio[b]		Baseflow Reduction[c] from 2005 Levels (percent)
	2005	2035	2005	2035	2035
Kenosha	0.047	0.087	-0.047	-0.085	-4.74
Milwaukee	0.159	0.131	-0.150	-0.127	2.18
Ozaukee	0.199	0.054	-0.188	-0.054	15.75
Racine	0.061	0.069	-0.060	-0.069	-1.20
Walworth	0.045	0.077	-0.044	-0.075	-4.68
Washington	0.083	0.116	-0.081	-0.113	-4.03
Waukesha	0.089	0.133	-0.086	-0.127	-6.28

[a]*The demand to supply ratio is defined as the ratio of net pumping demand on an aquifer to that aquifer's sustainable, or natural, supply. Generally, this indicator ranges from 0—representing no human impact—upward. Values over 1.0 indicate that more groundwater is being extracted than can be replaced in a long-term, sustainable fashion. The year 2005 and 2035 conditions for this indicator are compared to predevelopment conditions.*

[b]*The human impact ratio, is defined as the ratio of human-induced groundwater inflows to total inflows minus the ratio of human-induced groundwater outflows to total outflows. This indicator is an expression of the relative magnitude of human alteration of the groundwater system. Values range from minus 1.0 in areas where wells have become the only discharge from an aquifer by stopping all other groundwater discharges, through 0 representing no net human impact, to plus 1.0 representing situations where human additions are the only inputs to the aquifer. The year 2005 and 2035 conditions for this indicator are compared to predevelopment conditions.*

[c]*The base flow reduction index is defined as the ratio of the reduction of groundwater-derived baseflow discharge due to pumping to the groundwater-derived baseflow at a defined base time. The year 2035 conditions for this indicator are compared to 2005 conditions.*

Source: University of Wisconsin-Milwaukee.

Finally, the analysis indicated that in 2035 the baseflow reduction index may be expected to range from about -6.3 percent in Waukesha County to about 15.8 percent in Milwaukee County under Subalternative 1 to the Composite Plan conditions. The value of the baseflow reduction index in Kenosha, Racine, Walworth, Washington, and Waukesha Counties in 2035 is expected to be negative, indicating that reductions in average groundwater-derived baseflow to surface waters may be expected. The positive value of the indicator in Milwaukee and Ozaukee Counties indicates that the average level of groundwater-derived baseflow to surface waters in these Counties may be expected to increase under Subalternative 1 to the Composite Plan conditions. Three caveats should be kept in mind when interpreting the changes in the baseflow reduction index. First, these are countywide averages developed for purposes of comparing alternative plans at the systems level. Within any county, changes in baseflow may be expected to vary among waterbodies. Second, a change in baseflow does not indicate a change in total streamflow. The index only considers the groundwater component of streamflow. The impact on streamflow will typically be less in terms of percent reduction or increase. For those streams which receive discharges of sewage treatment plant effluent, the baseflow and streamflow amounts will be artificially increased and make surface water flows less sensitive to changes in groundwater-derived baseflow. Third, for all Counties showing reductions, the 2035 magnitudes of average baseflow reduction under Subalternative 1 to the Composite Plan conditions are less than 10 percent, suggesting small average reductions relative to 2005 conditions.

Other Surface Water Impacts

Surface Water Quality Impacts

Under Subalternative 1 to the Composite Plan, the source of supply used by several utilities located east of the subcontinental divide would be shifted from groundwater to Lake Michigan water. This includes several utilities that are provided with sewage conveyance and treatment services by the Milwaukee Metropolitan Sewerage District (MMSD). This shift would result in a reduction in the hardness of the water provided by these utilities and would eliminate the need for household water softening facilities. This would, in turn, result in reductions in the concentration of chloride in the sewage conveyed to the sewage treatment facilities serving the affected communities, and in the chloride loads discharged by these facilities into Cedar Creek, the Milwaukee River and Lake Michigan. For example, a reduction in the average concentration of chloride in sewage conveyed to the MMSD treatment facilities from the communities concerned of 100 milligrams per liter (mg/l) would result in an annual reduction in chloride discharge to Lake Michigan of about 3.8 million pounds. Given that the average concentrations of chloride in the effluent discharged by municipal wastewater treatment plants located west of the subcontinental divide that treat wastewater from communities using groundwater as a source of supply for which data were available ranges between 400 mg/l and 550 mg/l, it is likely that significant reduction in chloride loading to Lake Michigan may be expected under Subalternative 1 to the Composite Plan conditions.

For most other utilities, Subalternative 1 to the Composite Plan generally envisions expanded use of groundwater from sources similar to the existing sources. This subalternative may, therefore, be expected to produce relatively little change in surface water quality within the Region.

Conclusions Concerning Groundwater-Surface Water Impacts of Subalternative 1 to the Composite Plan

The results of the simulation modeling indicated that under Subalternative 1 to the Composite Plan conditions, drawups may be expected to occur in the deep aquifer in most model cells in the Region, except for cells in Kenosha and Walworth Counties. The magnitude of the average drawups over 2005 conditions in this aquifer may be expected to range between three feet and 48 feet by county. The maximum drawup over 2005 conditions in this aquifer may be expected to be about 225 feet in Washington County. In all Counties of the Region, except for Kenosha and Walworth Counties, drawups over 2005 conditions in excess of 10 feet may be expected to be common. In addition, in Milwaukee, Ozaukee, and Waukesha Counties, drawups over 2005 conditions in excess of 50 feet may be expected to be common. These drawups reflect both the shift from the use of groundwater as a source of water supply to the use of Lake Michigan by some communities, and a shift by some communities away from the deep groundwater system as a source of water supply toward the shallow groundwater system as envisioned under Subalternative 1 to the Composite Plan. Some drawdowns may be expected to occur in some model cells, primarily in Kenosha and Walworth Counties, over the planning period under this subalternative to the Composite Plan. The magnitude of the average drawdowns over 2005 conditions in this aquifer may be expected to be relatively small, ranging between about three feet and four feet for those counties experiencing drawdowns. The maximum drawdown over 2005 conditions in this aquifer may be expected to be about 22 feet. The drawdowns and the smaller drawups expected in Kenosha and Walworth Counties may be attributed, in part, to the influence of groundwater use in northeastern Illinois. In addition, these areas are also located a considerable distance from the communities whose source of water supply is envisioned to change from the deep aquifer to Lake Michigan under Subalternative 1 to the Composite Plan. Water budget analyses indicate that the deep groundwater system is likely to be heavily influenced by human activities under Subalternative 1 to the Composite Plan conditions, with the net effect of human activities being to remove water from the deep groundwater system. This analysis also indicates that some counties of the Region may experience water budget deficits in the deep aquifer under Subalternative 1 to the Composite Plan conditions.

On a regional scale, pumping under Subalternative 1 to the Composite Plan conditions may be expected to increase 11.6 mgd to about 91.5 mgd between 2005 and 2035. The simulation modeling indicates that under Subalternative 1 to the Composite Plan conditions, a net amount of about 5.6 mgd of water from the Region would be contributed to accumulation in storage in the aquifers and to cross-boundary flow out of the planning area, requiring a mass balance analysis to account for 17.2 mgd of water. About 46 percent of this water to be accounted for would be derived from groundwater flow that, in the absence of pumping, would be discharged to surface water features, and about 54 percent would be derived directly from surface water features due to reversed hydraulic gradients at the groundwater-surface water interface. The impact of pumping on surface waters can be represented as groundwater-derived baseflow depletion. Groundwater-derived baseflow is the amount of flow in the waterbody from upgradient groundwater discharge. The overland component of total streamflow and any discharge of treated wastewater are not included in baseflow, and the simulation modeling results do not include, or account for, these components. Typically baseflow represents about 10 percent to 50 percent of streamflow on an annual basis. In aggregate, by 2035 surface waterbodies in the Region may be expected to experience a base-flow depletion relative to 2005 conditions of about 12.1 mgd, or slightly over 3 percent. On average, baseflow reduction under Subalternative 1 to the Composite Plan conditions are less than or slightly over 10 percent, suggesting small average reductions relative to 2005 conditions. These aggregate total and average values may, however, obscure site-specific differences in baseflow changes within each county. While the county totals project overall depletions within each county, individual waterbodies may experience either depletion or augmentation. The reductions in groundwater-derived baseflow at 26 of 100 surface water evaluation sites were in excess of 10 percent.

The results of the simulation modeling indicate that under Subalternative 1 to the Composite Plan conditions, additional drawdowns over 2005 conditions may be expected to occur in the shallow aquifer over much of the Region. The magnitude of the drawdowns is estimated to be relatively small; in most Counties, the drawdown may be expected to average less than 1.3 feet. The relatively small magnitude of the drawdown may be attributed, in part, to the buffering effects of surface water baseflow interactions.

In the glacial sand and gravel aquifer, additional drawdowns may be expected to occur in 35 percent to 88 percent of model cells by county over the period 2005 to 2035. The magnitude of average drawdowns over 2005 conditions in this aquifer may be expected to be small, less than about one foot in all counties of the Region. While the maximum drawdown over 2005 conditions in this aquifer may be expected to be about 71 feet, only a small percentage of model cells were simulated to experience drawdowns over 2005 conditions in excess of 10 feet. With some exceptions, similar impacts were simulated to occur in the Silurian dolomitic aquifer. Additional drawdowns may be expected to occur in this aquifer in 28 percent to 89 percent of model cells by county over the planning period. While the maximum drawdown over 2005 conditions in this aquifer was simulated to be about 61 feet, only a small percentage of model cells in most counties were simulated to experience drawdowns over 2005 conditions in excess of 10 feet. Water budget analyses indicate that in most counties of the Region, the influence of human activities on the shallow groundwater system will increase under Subalternative 1 to the Composite Plan conditions. While the net effect of human activities in all counties of the Region will result in the removal of water from the shallow groundwater system, there is little evidence that a water budget deficit will occur where more groundwater will be extracted than can be replaced in a long-term sustainable fashion in the shallow groundwater system. This is likely due, in large part, to the buffering effects of surface waters.

Although the results of the simulation modeling indicate that the changes in the shallow aquifer system are expected to be relatively small in much of the Region under Subalternative 1 to the Composite Plan conditions, some larger changes may be expected to occur. Some locations may be expected to experience additional drawdowns in excess of 10 feet in the Silurian dolomitic aquifer. These drawdowns appear to result, at least in part, from the reliance upon the shallow groundwater system as a major source of water. By contrast, the simulation modeling results indicate that large drawups may be expected to occur in the Silurian dolomitic aquifer under Subalternative 1 to the Composite Plan conditions in southern and central Ozaukee and northern Milwaukee Counties. These drawups may be attributed to the shift in the source of water supply to Lake Michigan as envisioned under Subalternative 1 to the Composite Plan. In addition, the modeling results indicate that drawups may be expected to occur in the Silurian dolomitic aquifer in southeastern Washington County and eastern Waukesha County. These drawups may be attributed to the shift in source of water supply to Lake Michigan.

Subalternative 2 to the Composite Plan—Design Year 2035 Condition Intermediate Expansion of Lake Michigan Supply and the City of Waukesha Water Utility Converted to a Lake Michigan Supply

Subalternative 2 to the Composite Plan incorporates a combination of water supply facilities based upon a refinement of the existing and committed water supply facilities and an intermediate-level expanded use of Lake Michigan supply for selected municipal water supply systems. Under this Subalternative, the City of Waukesha Water Utility would utilize Lake Michigan as a source of supply. This Subalternative also includes water conservation measures, groundwater recharge, and stormwater management components, well siting analyses and monitoring, and enhanced groundwater recharge. Subalternative 2 to the Composite Plan includes all of the components of Subalternative Plan 1, except for the groundwater-based water supply facilities serving the City of Waukesha Water Utility and selected rainfall infiltration systems related to those facilities. Under Subalternative 2 to the Composite Plan, the City of Waukesha Water Utility would be provided with Lake Michigan water and return flow both in a manner consistent with the Great Lakes-St. Lawrence River Water Resources Compact.

Under Subalternative 2 to the Composite Plan, it is envisioned that a total of 31 rainfall infiltration systems would be provided, as shown on Map 108. This is six fewer systems than included under Subalternative 1 to the Composite Plan. Based upon the criteria of locating such facilities upgradient from surface water features which may be expected to experience reductions in baseflow of 10 percent or greater, 31 facilities were envisioned under Subalternative 2 to the Composite Plan. It is estimated that these facilities would contribute an additional approximately 438 million gallons per year of recharge to the shallow aquifer system on an average annual basis. The costs of this component of Subalternative 2 to the Composite Plan are summarized in Table 164.

Four alternatives were considered with regard to the means of returning spent Lake Michigan water used west of the divide by the City of Waukesha Water Utility. Under the first return flow alternative, an amount of wastewater treatment plant effluent from the City of Waukesha sewerage service areas equal to at least the amount of water to be withdrawn would be conveyed back to Lake Michigan via pumping stations and pipelines, discharging directly to the Lake. Under the second return flow alternative, wastewater treatment plant effluent from the service area would be conveyed by a pumping station and pipeline discharging to a stream tributary to Lake Michigan. For purposes of designing and developing costs for the second return flow alternative, it was assumed that the return flow would be discharged to Underwood Creek, a stream tributary to the Menomonee River which flows to Lake Michigan. A third alternative would be to return the flow to the North Branch of the Root River which is also a stream tributary to Lake Michigan. A fourth return flow alternative would provide for the return to both Underwood Creek and the Root River. It is recognized that implementation of any one of the return flow alternatives would require subsequent more-detailed, second-level evaluations of costs, environmental impacts, and pipe routing evaluations. The return flow alternatives were developed to illustrate the range of options available and to identify and provide information on the costs and impacts of these alternatives at a systems-level of planning.

The first return flow alternative would provide for treated wastewater from the wastewater treatment plant operated by the City of Waukesha to be conveyed directly to Lake Michigan via two pumping stations and pipelines. The return flow would be actively managed to minimize the impacts on the Fox River during low-flow periods. Since wastewater flows to treatment plants typically consist of amounts of water 15 percent or more greater than the amounts of water used in the service area, active management of the return flow is possible while meeting the return flow requirements. Return Flow Alternative 1 is shown on Map 115, and the components and costs are summarized in Table 165.

Under the second return flow alternative, return flow from the City of Waukesha wastewater treatment plant would be effected by conveying treated effluent through a pumping station and a pipeline discharging to Underwood Creek, a stream tributary to the Menomonee River which flows into Lake Michigan. The return flow would be actively managed to minimize return flow during flood-flow periods on Underwood Creek and the Menomonee River, and to minimize impacts on the Fox River during low-flow periods. Return Flow Alternative 2 is shown on Map 115 and the component and costs are summarized in Table 166.

Table 164

CAPITAL COSTS AND OPERATIONS AND MAINTENANCE COSTS OF RAINFALL INFILTRATION SYSTEMS UNDER SUBALTERNATIVE 2 TO THE COMPOSITE PLAN

County	Sites	Area (acres)	Land Value ($ per acre)	Capital Cost ($ X 1,000)				Annual O & M Cost ($ X 1,000)	
				Total Land Acquisition	Regrading and Revegetation	Engineering and Contingencies	Total	Minimal Maintenance[a]	Intensive Active Management[b]
Kenosha................	9	275	10,839	2,981	1,100	1,428	5,509	13.8	110.0
Milwaukee.............	0	- -	8,465	- -	- -	- -	- -	- -	- -
Ozaukee	2	90	5,865	528	360	311	1,199	4.5	36.0
Racine...................	1	40	5,167	207	160	128	495	2.0	16.0
Walworth...............	12	440	6,449	2,838	1,760	1,609	6,207	22.0	176.0
Washington...........	5	180	6,840	1,231	720	683	2,634	9.0	72.0
Waukesha.............	2	50	9,900	495	200	243	938	2.5	20.0
Total	31	1,075	- -	8,280	4,300	4,402	16,982	53.8	430.0

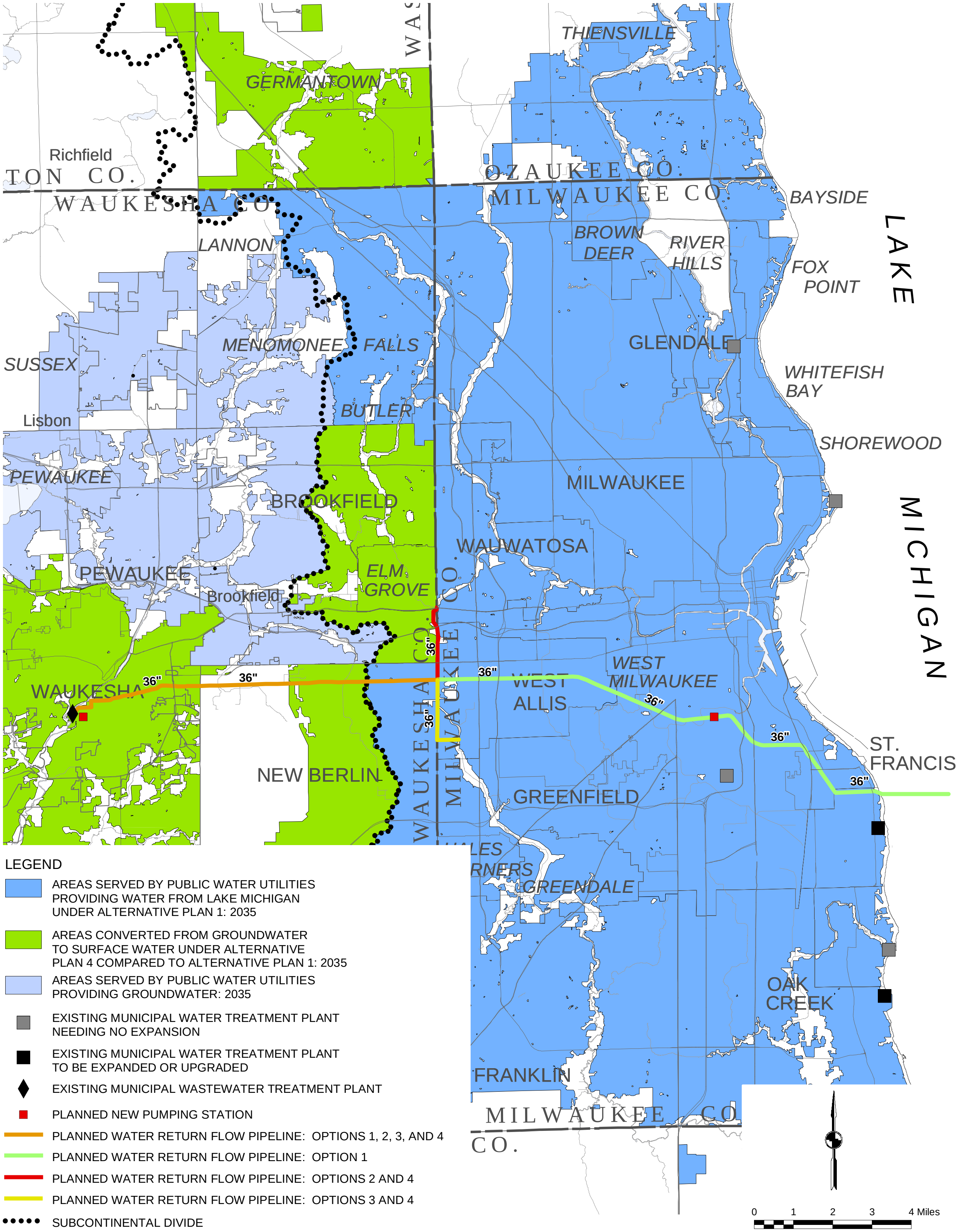
[a]*Minimal maintenance consists of a minimal level of mowing of the facility.*

[b]*Intensive active management includes periodic burning, weed management, brush reduction, and monitoring of vegetation and hydrology.*

Source: SEWRPC.

Map 115

ALTERNATIVES 1 AND 2 FOR RETURN FLOW FOR SUBALTERNATIVE 2 TO THE COMPOSITE PLAN: RETURN FLOW PIPELINES TO LAKE MICHIGAN AND UNDERWOOD CREEK



Source: Ruekert & Mielke, Inc. and SEWRPC.

Table 165

PRINCIPAL FEATURES AND COSTS OF FACILITIES UNDER ALTERNATIVE 1 FOR THE RETURN FLOW COMPONENT OF SUBALTERNATIVE 2 TO THE COMPOSITE PLAN

Component	Capital Cost ($ X 1,000)	Annual O&M Cost ($ X 1,000)
Pumping Station at Waukesha Wastewater Treatment Plant	$ 2,408,000[a]	$482,000
Pumping Station in Milwaukee County	2,120,000	482,000
36-Inch Main from Waukesha Wastewater Treatment Plant to 124th Street	14,850,000	14,000
36-Inch Main from 124th Street to Lake Michigan Outfall Pipe	24,302,000	19,000
Outfall Pipe	4,151,000	2,000
Total	$47,831,000	$999,000

[a]*Includes $288,000 for control system to support active management of the return flow.*

Source: SEWRPC.

Table 166

PRINCIPAL FEATURES AND COSTS OF FACILITIES UNDER ALTERNATIVE 2 FOR THE RETURN FLOW COMPONENT OF SUBALTERNATIVE 2 TO THE COMPOSITE PLAN

Component	Capital Cost ($ X 1,000)	O&M Cost ($ X 1,000)
Pumping Station at Waukesha Wastewater Treatment Plant	$ 2,408,000[a]	$482,000
36-Inch Main from Waukesha Wastewater Treatment Plant to Underwood Creek	17,844,000	17,000
Total	$20,252,000	$499,000

[a]*Includes $288,000 for control system to support active management of the return flow.*

Source: SEWRPC.

Under the third return flow alternative, return flow from the City of Waukesha wastewater treatment plant would be effected by conveying treated effluent through a pumping station and a pipeline discharging to the Root River which flows into Lake Michigan. Under the fourth return flow alternative, return flow would be conveyed to both the Root River and Underwood Creek. In either case, the return flow would be actively managed to cease return flow during flood-flow periods on the Root River, Underwood Creek, and the Menomonee River, and to minimize impacts on the Fox River during low-flow periods. Return Flow Alternatives 3 and 4 are also shown on Map 115. The total costs of these two return flow alternatives may be expected to be within the range of costs represented by the costs of the first and second return flow alternatives considered.

Because of the relative elevation of the City of Waukesha wastewater treatment plant and the discharge elevation of the return flow under the return flow alternatives considered, it may be possible to achieve a net positive energy generation associated with the return flow. Pumping at the Waukesha wastewater treatment plant would be needed for the return flow to reach the vicinity of the subcontinental divide. However, the potential energy available from the return flow to the discharge location could potentially be captured and converted into electric power using an in-line turbine generator system. Approximately 80 feet of hydraulic head would be available to power a turbine generator unit set in the discharge pipeline. The energy generated may exceed the amount of energy used. This could improve the sustainability of this plan component. Accordingly, it is recommended that the potential for power generation associated with the return flow be evaluated as part of the plan implementation phases.

Because of the need for further more-detailed environmental assessment of the return flow alternatives, no final recommendations relating to the return flow component was included in Subalternative 2 to the Composite Plan. Rather, the selection of the best return flow option was left open until completion of a more-detailed environmental evaluation during the plan implementation phase. The cost of a return flow directly to Lake Michigan would be significantly higher than the cost of a return flow to a stream tributary to Lake Michigan. This is to be expected, given the longer pipeline requirement. For purposes of presenting the costs for Subalternative 2 to the Composite Plan, a range of costs was used to represent the possible high and low costs of the return flow alternatives considered.

Another option for providing return flow component for the City of Waukesha water supply service area has been raised by the Wisconsin Department of Natural Resources. That option would entail the abandonment of, or substantially reduced use of, the City of Waukesha wastewater treatment plant, and the concomitant conveyance of wastewater to the MMSD sewerage system. Wastewater from the Waukesha service area would be treated through connection to the MMSD sewerage system. This option for providing return flow was not recommended for further consideration, as it was concluded that the costs involved would be well in excess of the cost of the return flow alternatives previously described.

This conclusion was based upon analyses conducted under the 2007 regional water quality management plan update.[8] Under that planning effort, an evaluation was made of the costs of abandoning the City of South Milwaukee wastewater treatment plant and connecting the service area concerned to the MMSD sewerage system. The wastewater treatment plant capacity involved was 6.0 mgd on an average annual basis, and 25 mgd on a peak flow basis. Given the location of the South Milwaukee plant relative to the MMSD South Shore plant, no significant conveyance costs were involved. The connection of the City of South Milwaukee to the MMSD was estimated to have a capital cost of about $25.9 million, with an annual operation and maintenance cost of $314,000. The present worth of the connection was estimated to be $36.9 million and the equivalent annual cost was estimated to be $2.3 million. Connection of the City of Waukesha sewerage system to the MMSD system would involve a pipeline connection similar to that included under the second return flow option previously described. In addition, significantly higher MMSD treatment plant expansion costs than entailed in the City of South Milwaukee connection would be expected due to the much higher wastewater flows involved. The MMSD sewerage system is not sized to convey or treat the sewage generated by the City of Waukesha system. Moreover, if active management of the return flow was envisioned it would be necessary to maintain a wastewater treatment plant operation or a significant storage facility at the City of Waukesha. This would be needed to allow for some discharge to the Fox River during low-flow periods and to avoid discharging peak wet weather flows into the MMSD sewerage system. The continued operation of the Waukesha wastewater treatment plant would also ensure that any unforeseen bypassing would be localized in the Waukesha sewerage system and not exported to another location. Thus, a pipeline from Waukesha to a MMSD sewage treatment plant would be required and treatment plant capacity duplicating the City of Waukesha capacity would be needed. Accordingly, it was concluded that the option of connecting the City of Waukesha sewerage service area to the MMSD sewerage system did not warrant further consideration.

The source of the Lake Michigan supply for the City of Waukesha Water Utility could be potentially provided by the City of Milwaukee Water Works, the City of Oak Creek Water Utility, or the City of Racine Water and Wastewater Utility, as described in Chapter VIII. For purposes of designing and developing the costs under

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[8] *SEWRPC Planning Report No. 50,* A Regional Water Quality Management Plan Update for the Greater Milwaukee Watersheds, *December 2007.*

Subalternative 2 to the Composite Plan, the source of the supply was assumed to be the City of Milwaukee Water Works. This source of supply was considered to be the least costly based upon the analysis of the costs of this option under the initially considered Alternative Plans 2, 3, and 4 as documented in Chapter VIII. Other options and related costs for the provision of a Lake Michigan supply to the City of Waukesha Water Utility include the City of Oak Creek and the City of Racine utilities and were evaluated under Alternative Plan 4, also as documented in Chapter VIII. Such alternative connections were found viable and may warrant consideration under the plan implementation phase. In addition, the use of a common water main to serve the City of Waukesha Water Utility and the eastern portion of the City of Brookfield Water Utility and the Village of Elm Grove could constitute a viable refinement of the composite plan and may also warrant consideration under the plan implementation phase.

As previously noted, Subalternatives 1 and 2 of the Composite plan propose a new Lake Michigan water treatment plant to serve the City of Cedarburg and the Village of Grafton areas and connection of the Village of Saukville area to the City of Port Washington water supply system. Other options for the provision of a Lake Michigan supply to the Cedarburg Light & Water Commission and the Village of Grafton Water and Wastewater Commission were evaluated under Alternative Plan 4 as documented in Chapter VIII. Those alternatives are considered as viable options which may warrant further consideration under the plan implementation phase.

Under Subalternative 2 to the Composite Plan, the sources of supply and the anticipated utilization of those sources may be summarized as follows:

- Design year 2035 total average annual groundwater pumpage is estimated to approximate 78 mgd, with about 56 mgd, or about 72 percent, from the shallow aquifer and about 22 mgd, or about 27 percent, from the deep aquifer. This compares to a year 2005 total pumpage of about 77 mgd and to a plan condition 2035 pumpage of about 106 mgd under Alternative Plan 1 as initially considered.

- Design year 2035 municipal water utility average annual groundwater pumpage is estimated to approximate 61 mgd. This compares to a year 2005 pumpage of about 49 mgd, and to a plan condition year 2035 pumpage of 89 mgd under Alternative Plan 1 as initially considered.

- Design year 2035 municipal water supply pumpage of Lake Michigan water is estimated to approximate 242 mgd. This compares to a year 2005 pumpage of about 209 mgd, and a plan condition 2035 pumpage of 214 mgd under Alternative Plan 1 as initially considered.

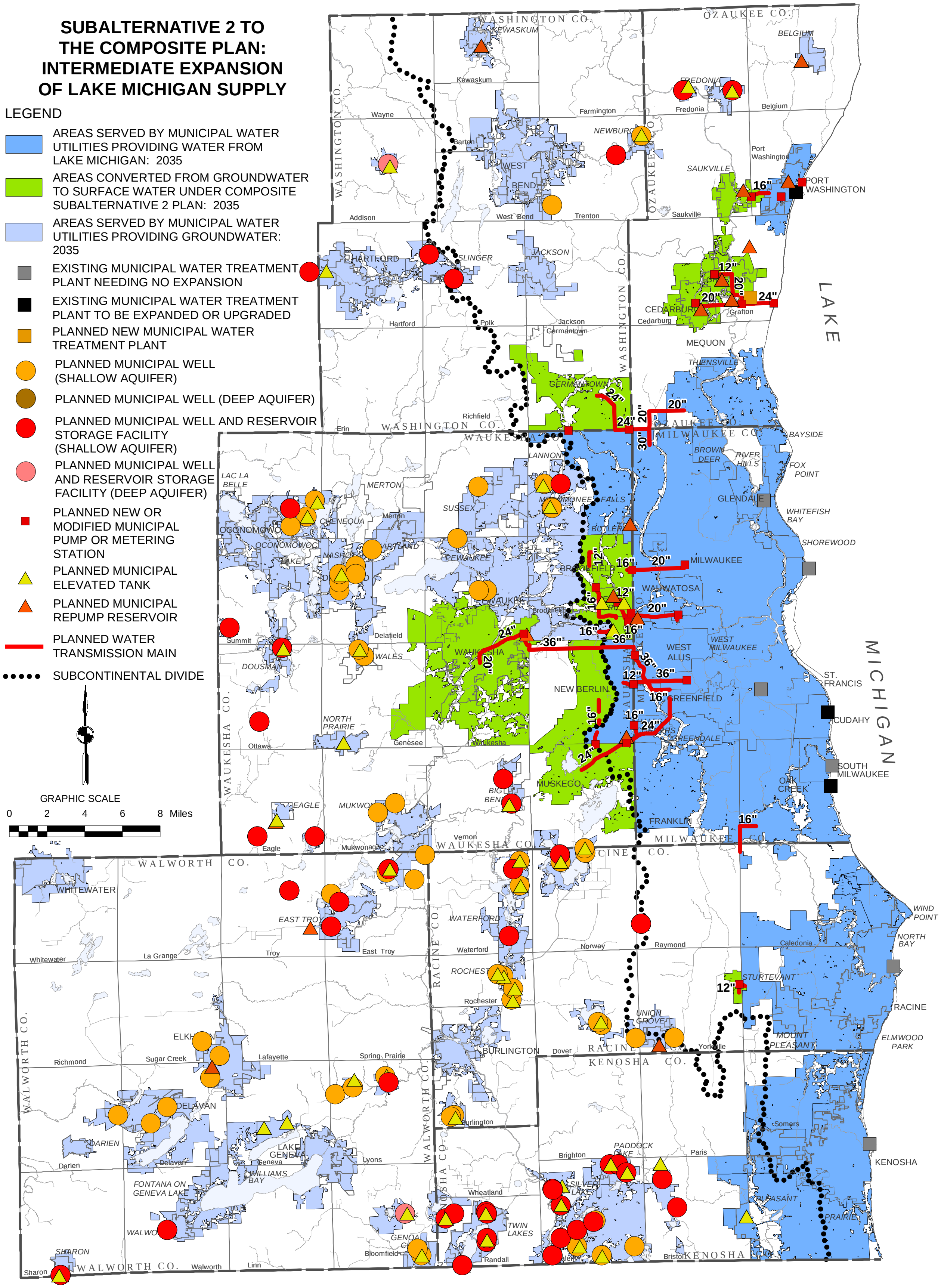
Map 116 illustrates the areas served by municipal utilities and the sources of supply for those utilities under Subalternative 2 to the Composite Plan. The Waukesha Water Utility supply connection and the attendant costs are summarized in Table 167. The new sources of supply and attendant facilities for each water utility in the Region, and the costs of those facilities under Subalternative 2 to the Composite Plan, are listed in Table 168.

Subalternative 2 to the Composite Plan has an estimated capital cost which ranges from $328.7 million to $356.3 million, depending upon the return flow alternative included. Reductions in operation and maintenance costs are estimated to range from $8.2 million to $8.7 million.[9] Based upon an analysis period of 50 years and an annual interest rate of 6 percent, the present worth cost of this alternative is estimated to range from $134.2 million to $169.8 million, and the equivalent annual cost is estimated to range from $8.5 million to $10.8 million. The operation and maintenance costs used for purposes of comparison of Subalternative Plan 2 to the Composite Plan with Alternative Plan 1 is the net amount arrived at by combining the operation and

[9]*The operation and maintenance cost savings of from $8.2 million to $8.7 million is the result of an operation and maintenance cost for the water supply facilities which ranges from $8.0 million to $8.5 million, coupled with a savings of $16.7 million due to the elimination of household water softening facilities.*

Map 116

SUBALTERNATIVE 2 TO THE COMPOSITE PLAN: INTERMEDIATE EXPANSION OF LAKE MICHIGAN SUPPLY



NOTE: This plan map does not indicate the return flow alternatives. These are shown on Map 115.

Source: Ruekert & Mielke, Inc. and SEWRPC.

Table 167

PRINCIPAL FEATURES AND COSTS OF NEW, EXPANDED, AND UPGRADED WATER SUPPLY FACILITIES FOR THE CITY OF WAUKESHA WATER UTILITY UNDER SUBALTERNATIVE 2 TO THE COMPOSITE PLAN: DESIGN YEAR 2035 FORECAST CONDITIONS

Project Description	Project Location	Capacity	Units	Unit Cost	Number of Units	Capital Cost ($)	Annual O&M Cost ($)
New SW Zone Pumping Station	Milwaukee County	13.5	mgd	$2,120,000	1	$ 2,120,000	$ 803,000
36-Inch Water Main	Milwaukee County	- -	L.F.	368	31,100	11,444,800	9,000
New County Line Pumping Station	Milwaukee County	13.5	mgd	2,120,000	1	2,120,000	803,000
36-Inch Water Main	Waukesha County	- -	L.F.	294	38,000	11,172,000	11,000
New Waukesha Pumping Station and Storage Reservoir	Waukesha	13.5	mgd	5,820,000	1	5,820,000	803,000
24-Inch Water Main	Waukesha	- -	L.F.	198	13,000	2,574,000	4,000
20-Inch Water Main	Waukesha	- -	L.F.	184	6,800	1,251,200	2,000
Miscellaneous Internal Systems Upgrade	Milwaukee County	- -	- -	- -	- -	3,961,000[a]	- -
Total	- -	- -	- -	--	- -	$40,463,000	$2,435,000

[a] *Allowance of 25 percent of Milwaukee County facility costs to cover inter-improvements.*

Source: SEWRPC.

Table 168

PRINCIPAL FEATURES AND COSTS OF NEW, EXPANDED, AND UPGRADED WATER SUPPLY FACILITIES AND PROGRAMS UNDER SUBALTERNATIVE 2 TO THE COMPOSITE WATER SUPPLY PLAN, DESIGN YEAR 2035

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Kenosha County	- -	- -	- -	- -	- -
City of Kenosha Water Utility	No additions	- -	41.7	657	42
Village of Paddock Lake Municipal Water Utility	Addition of two 0.25 MG elevated tanks, three shallow aquifer wells with 0.20 MG reservoir each	4,032	54.0	3,135	199
Village of Pleasant Prairie Water Utility	Addition of 0.75 MG elevated tank	1,620	39.7[d]	2,104	134
Town of Bristol Utility District No. 1	Addition of two shallow aquifer wells, 0.50 MG elevated tank, 0.40 MG reservoir	2,654	10.0[e]	2,428[e]	154[e]
Town of Bristol Utility District No. 3	No additions	- -	0.1[d]	2	0
Town of Somers Water Utility	No additions	- -	3.5[d]	55	3
Village of Silver Lake Planned Utility	Addition of three shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank	3,437	93.4	1,694	107
Village of Twin Lakes Planned Utility	Addition of five shallow aquifer wells with 0.1 MG reservoir each, two 0.3 MG elevated tanks	5,317	158.7	3,782	240
Town of Salem Planned Utility	Addition of eight shallow aquifer wells, four with 0.15 MG reservoirs, two 0.3 MG elevated tanks	7,294	288.9	5,710	362
Powers-Benedict-Tombeau Lakes Area Planned Utility	Addition of two shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank	2,584	57.9	1,694	107
Land Acquisition for Wells and Storage Tanks	32 acres	2,310	- -	2,310	147
Countywide	Nine rainfall infiltration systems	5,509	41.2	6052	384
Subtotal	23 Wells, 28 Storage Tanks, Nine Rainfall Infiltration Systems	34,757	789.1	29,623	1,879
Milwaukee County	- -	- -	- -	- -	- -
City of Cudahy Water Utility	Duplicate rapid mix facility	100	7.5	118	7
City of Franklin Water Utility	No additions	- -	13.4[d]	211	13
City of Glendale Water Utility	No additions	- -	6.1[d]	96	6
City of Milwaukee Water Works	No additions	- -	263.1	4,146	263
City of Oak Creek Water and Sewer Utility	Addition of 20 mgd coag-floc-sed, 14 mgd filtration, 17.5 mgd pumping	13,220	547.4[f]	21,169	1,343
City of South Milwaukee Water Utility	No additions	- -	8.6	136	9
City of Wauwatosa Water Utility	No additions	- -	19.6[d]	309	20

Table 168 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Milwaukee County (continued)	- -	- -	- -	- -	- -
City of West Allis Water Utility	No additions	- -	25.2[d]	397	25
Village of Brown Deer Public Water Utility	No additions	- -	4.8[d]	76	5
Village of Fox Point Water Utility	No additions	- -	2.6[d]	41	3
Village of Greendale Water Utility	No additions	- -	5.6[d]	88	6
Village of Shorewood Municipal Water Utility	No additions	- -	1.4[d]	22	1
Village of Whitefish Bay Water Utility	No additions	- -	5.8[d]	91	6
We Energies-Water Services	No additions	- -	1.0[d]	16	1
Subtotal	0 Wells, 0 Storage Tanks, Two Treatment Plant Upgrades	13,320	912.1	26,916	1,708
Ozaukee County	- -	- -	- -	- -	- -
City of Cedarburg Light & Water Commission/ Village of Grafton Water and Wastewater Commission	New 9.0 MGD Lake Michigan intake and water treatment plant, connecting transmission mains	47,048	-1,904.0[g]	20,978[g]	1,331[g]
City of Port Washington Water Utility	Addition of 3.0 MGD coag-floc-sed, filtration, 3.0 MGD pumping	6,895	86.2	9,136	580
Village of Belgium Municipal Water Utility	Addition of 0.45 MG reservoir at Well 3, service pumps at Wells 1 and 2	586	2.0	298	19
Village of Fredonia Municipal Water Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.20 MG reservoir	1,417	23.5	886	56
Village of Saukville Municipal Water Utility	Lake Michigan Supply Connection[h]	3,870[h]	-287.8[i]	-526[i]	-33[i]
We Energies-Water Services	5,300 lineal feet of 30 inch main (shared with Village of Germantown) in 107th street, 16,100 lineal feet of 20 inch main in Granville Road and Donges Bay Road	3,300	231.8[d,j]	5,153	327
Town of Fredonia-Waubeka Area Planned Utility	Addition of one shallow aquifer well with 0.10 MG reservoir, 0.25 MG elevated tank	1,460	24.3	899	57
Land Acquisition for Wells, Storage Tanks and Water Treatment Plant	Nine acres	630	- -	630	40
Countywide	Two rainfall infiltration systems	1,199	13.5	1,412	90
Subtotal	Two Wells, Five Storage Tanks, One Treatment Plant Upgrade, One New Treatment Plant, Two Rainfall Infiltration Systems	66,405	-1,810.5	38,866	2,467

Table 168 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Racine County	- -	- -	- -	- -	- -
City of Burlington Municipal Waterworks	No additions	- -	12.6	199	13
City of Racine Water and Wastewater Utility[k]	No additions	- -	45.9	724	46
Village of Caledonia West Utility District[l] (Oak Creek)	No additions	- -	0.4[d]	6	1
Village of Caledonia West Utility District[l] (Racine)	No additions	- -	3.1[d]	49	3
Village of Caledonia East Utility District[m] (Oak Creek)	No additions	- -	1.9[d]	30	2
Village of Caledonia East Utility District[m] (Racine)	No additions	- -	3.5[d]	55	4
Village of Union Grove Municipal Water Utility	Addition of two shallow aquifer wells, 0.40 MG reservoir	1,776	12.1[e]	947[e]	60[e]
Village of Waterford Water and Sewer Utility	Addition of one shallow aquifer well with 0.40 MG reservoir	1,151	15.7	1,481	94
Village of Wind Point Municipal Water Utility	No additions	- -	0.8[d]	13	1
North Cape Sanitary District	Addition of one shallow aquifer well with reservoir	155	2.1	194	12
Town of Yorkville Water Utility District 1	Lake Michigan supply connection[n]	459[n]	-38.0[o]	-140[o]	-9[o]
Northwest Caledonia Area Planned Utility District	9,000 lineal feet of water transmission main	1,557	3.1[p]	726	46
Town of Burlington-Bohner Lake Area Planned Utility District	Addition of two shallow aquifer wells, 0.30 MG elevated tank	1,941	42.1	1,278	81
Town of Dover-Eagle Lake Area Planned Utility District	Addition of two shallow aquifer wells, 0.30 MG elevated tank	1,941	47.0	1,315	83
Town of Norway Area Planned Utility	Addition of four shallow aquifer wells, one with 0.15 MG reservoir, two 0.25 MG elevated tanks	4,024	112.9	2,825	179
Village of Rochester Area Planned Utility	Addition of two shallow aquifer wells, two 0.10 MG elevated tanks	1,844	27.6	1,125	71
Town of Rochester Area Planned Utility	Addition of two shallow aquifer wells, two 0.10 MG elevated tanks	1,844	30.7	1,148	73
Town of Waterford Area Planned Utility	Addition of three shallow aquifer wells, one with 0.15 MG reservoir, two 0.3 MG elevated tanks	3,485	114.4	2,571	163
Land Acquisition for Wells and Storage Tanks	29 acres	2,030	- -	2,030	129
Countywide	One rainfall infiltration system	495	6.0	590	37
Subtotal	19 Wells, 15 Storage Tanks, One Lake Michigan Supply Connection, One Rainfall Infiltration System	22,702	443.9	17,166	1,089

Table 168 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Walworth County	- -	- -	- -	- -	- -
City of Delavan Water and Sewerage Commission	Addition of three shallow aquifer wells with iron removal treatment	3,075	75.2	1,544	98
City of Elkhorn Light and Water	Addition of three shallow aquifer wells, 0.35 MG treated water reservoir	2,342	-103.0[e]	444[e]	28[e]
City of Lake Geneva Municipal Water Utility	No additions	- -	11.3	178	11
City of Whitewater Municipal Water Utility	No additions	- -	13.7	216	14
Village of Darien Water Works and Sewer System	Increase Well 1 output from 325 to 425 gpm	30	15.2	74	5
Village of East Troy Municipal Water Utility	Addition of three shallow aquifer wells, two with 0.10 MG reservoir each	2,199	55.6	1,792	114
Village of Fontana Municipal Water Utility	No additions	- -	2.0	32	2
Village of Genoa City Municipal Water Utility	Addition of two shallow aquifer wells and 0.25 MG elevated tank	1,898	48.1	1,592	101
Village of Sharon Waterworks and Sewer System	Addition of one shallow aquifer well with 0.30 MG reservoir, 0.20 MG elevated tank	1,512	17.1	1,935	123
Village of Walworth Municipal Water and Sewer Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.15 MG reservoir	1,333	30.6	1,038	66
Village of Williams Bay Municipal Water Utility	No additions	- -	4.3	68	4
Town of Bloomfield Pell Lake Sanitary District No. 1	Addition of 0.2 MG elevated tank, one deep aquifer well with radium treatment and with 0.4 MG reservoir	1,891	39.6	2,416	153
Town of East Troy Sanitary District No. 3	Addition of one shallow aquifer well	130	0.1	136	8
Town of Geneva Lake Como Sanitary District No. 1	Addition of 0.20 MG elevated tank and 0.45 MG reservoir	1,066	12.4	1,206	77
Town of Troy Sanitary District No. 1	Addition of one shallow aquifer well with 0.01 MG reservoir	80	0.2	87	6
Country Estates Sanitary District	Addition of 0.20 MG elevated tank	480	10.8	719	46
Town of Lyons Area Planned Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.3 MG elevated tank	2,169	38.9	1,362	86
Town of East Troy-Potter Lake Area Planned Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.3 MG elevated tank	2,169	34.6	1,329	84
Land Acquisition for Wells and Storage Tanks	28 acres	1,960	- -	1,960	124
Countywide	12 rainfall infiltration systems	6,207	66.0	7,247	460
Subtotal	20 Wells, 18 Storage Tanks, 12 Rainfall Infiltration Systems	28,541	372.7	25,375	1,610

Table 168 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Washington County	- -	- -	- -	- -	- -
City of Hartford Utilities	Addition of one shallow aquifer well, treatment system, 0.75 MG elevated tank, and interconnecting piping (these facilities are under development and are anticipated to be operational in 2009)	7,500	39.4[e]	6,979[e]	443[e]
City of West Bend Water Utility	Addition of one shallow aquifer well	625	58.4	1,443	92
Village of Germantown Water Utility	Lake Michigan supply connection[h]	8,404[h]	-1,724.0[q]	-18,400[q]	-1,167[q]
Village of Jackson Water Utility	No additions	- -	7.4	117	7
Village of Kewaskum Municipal Water Utility	Addition of 0.25 MG reservoir	351	4.4	420	27
Village of Slinger Utilities	Addition of two shallow aquifer wells with 0.20 MG reservoir each	1,824	31.9	1,730	110
Allenton Sanitary District No. 1	Addition of 0.20 MG elevated tank, one deep aquifer well with 0.30 MG reservoir	1,672	20.3	1,374	87
Village of Newburg Area Planned Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.30 MG elevated tank	2,169	39.9	1,938	123
Land Acquisition for Wells and Storage Tanks	10 acres	700	- -	700	44
Countywide	Five rainfall infiltration systems	2,634	27.0	3,059	194
Subtotal	Seven Wells, Eight Storage Tanks, One Lake Michigan Supply Connection, Five Rainfall Infiltration Systems	25,879	-1,495.3	-640	-40
Waukesha County	- -	- -	- -	- -	- -
City of Brookfield Municipal Water Utility (east)	Lake Michigan supply connection[n]	19,682[n]	-1,093.0[r]	3,365[r]	213[r]
City of Brookfield Municipal Water Utility (west)	No additions	- -	35.0	552	35
City of Delafield Municipal Water Utility	Addition of five shallow aquifer wells, 0.40 MG elevated tank	4,019	110.1	3,259	207
City of Muskego Public Water Utility	Lake Michigan supply connection[n]	12,675[n]	-1,508.0[s]	-10,679[s]	-678[s]
City of New Berlin Water Utility (east)	Addition of 0.40 MG reservoir	526	8.5[d]	320	20
City of New Berlin Water Utility (central)	Lake Michigan supply connection[n]	6,685[n]	-1,377.0[t]	-14,811[t]	-939[t]
City of Oconomowoc Utilities	No additions	- -	17.4	274	17
City of Pewaukee Water and Sewer Utility	Addition of two shallow aquifer wells, service pumps	1,300	54.9	1,996	127
City of Waukesha Water Utility	Lake Michigan supply connection[u]	60,752 to 88,331[u]	-4,385.5 to -3,885.0[v]	-8,030 to 27,517[v]	-509 to 1,746[v]
Village of Butler Public Water Utility	Addition of 0.25 MG reservoir	351	0.8	307	19

Table 168 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Waukesha County (continued)	- -	- -	- -	- -	- -
Village of Dousman Water Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.40 MG reservoir	1,631	26.2	1,957	124
Village of Eagle Municipal Water Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.40 MG reservoir	1,631	17.8	1,850	117
Village of Hartland Municipal Water Utility	Addition of one shallow aquifer well	625	17.7	526	33
Village of Menomonee Falls Water Utility (east)	No additions	- -	12.2[d]	192	12
Village of Menomonee Falls Water Utility (west)	Addition of 0.20 MG elevated tank, two shallow aquifer wells	1,755	32.9	1,387	88
Village of Mukwonago Municipal Water Utility	Addition of three shallow aquifer wells	2,195	77.7	2,676	170
Village of Pewaukee Water Utility	Addition of one shallow aquifer well	625	36.2	989	63
Village of Sussex Public Water Utility	Addition of one shallow aquifer well	625	42.9	642	41
Town of Brookfield Sanitary District No. 4	Addition of 0.35 MG reservoir	467	6.0	562	36
Village of Big Bend Planned Utility	Addition of two shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank	2,584	76.1	1,822	116
Village of Elm Grove Planned Utility	Lake Michigan supply connection[h]	2,797[h]	-470.0[w]	-4,497[w]	-285[w]
Village of Lannon Planned Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.75 MG elevated tank	3,098	117.9	2,381	151
Village of North Prairie Planned Utility	Addition of 0.50 MG elevated tank	878	19.5	592	38
Village of Wales Planned Utility	Addition of two shallow aquifer wells, 0.30 MG elevated tank	1,941	41.8	1,277	81
Town of Eagle-Eagle Spring Lake Area Planned Utility	Addition of one shallow aquifer well with 0.15 MG reservoir	853	5.2	454	29
Town of Oconomowoc-Okauchee Lake Area Planned Utility	Addition of four shallow aquifer wells, one with 0.15 MG reservoir, two 0.30 MG elevated tanks	4,110	116.6	2,899	184
Town of Ottawa-Pretty Lake Area Planned Utility	Addition of one shallow aquifer well with 0.10 MG reservoir	787	3.1	409	26
Town of Summit-Golden Lake Area Planned Utility	Addition of one shallow aquifer well with 0.10 MG reservoir	787	2.1	403	26
Land Acquisition for Wells and Storage Tanks	40 acres	2,800	- -	2,800	178
Countywide	Two rainfall infiltration systems	938	7.5	1,056	67
Subtotal	30 Wells, 22 Storage Tanks, Five Lake Michigan Supply Connections, Eight Rainfall Infiltration Systems	137,117 to 164,696	-7,947.4 to -7,446.9	-3,070 to 32,477	-193 to 2,062

Table 168 (continued)

County and Utility	Programs and Facilities Description[a]	Capital Cost[b] ($ X 1,000)	Annual O & M Cost[b,c,d] ($ X 1,000)	Present Worth Cost ($ X 1,000)	Equivalent Annual Cost ($ X 1,000)
Total	101 Wells, 97 Storage Tanks, Eight Lake Michigan Supply Connections, Two Treatment Plant Upgrades, One New Treatment Plant, 31 Rainfall Infiltration Systems	328,721 to 356,300	-8,735.4 to -8,234.9	134,236 to 169,783	8,520 to 10,795

[a] *All utilities' programs include water conservation programs.*

[b] *Costs presented are those associated with the costs for new, expanded, or upgraded facilities. The operation and maintenance costs are for increased incremental costs associated with new, expanded, or upgraded facilities and for water conservation measures. Alternative Plan 1 is being considered as the base for alternative plans evaluation. The costs for the Composite Plan will include an adjustment in the operation and maintenance costs to reflect existing facilities not used in the Composite Plan compared to Alternative Plan 1.*

[c] *The estimated annual cost for water conservation is included as an operation and maintenance cost for all utilities.*

[d] *Water utilities which purchase water on a wholesale basis will have continued or increased costs for the purchase of water. For purposes of the cost-effectiveness analyses of the alternative water supply plans, only the incremental operation and maintenance cost associated with any increased water supply facility water production costs are considered. Alternative Plan 1 is being used as the base to which the other alternative plans will be compared. For this base alternative, only the operation and maintenance cost for new, expanded, or upgraded facilities are included since the cost for operation and maintenance of existing facilities which are common to all alternatives are not included for any alternatives.*

[e] *The annual O&M cost includes a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under the Composite Plan.*

[f] *There is expected to be an estimated average reduction of $376,000 per year for savings associated with existing residences which would be able to discontinue their point-of-entry water treatment systems in the Cities of Oak Creek and Franklin. However, there is also an expected cost involved in developing local water distribution systems. The cost savings due to discontinuation of the point-of-entry water treatment systems and the costs of the local distribution systems are common to all alternative plans and are not specifically accounted for in this table.*

[g] *The annual O&M cost for the Cedarburg Light & Water Commission and the Village of Grafton Water and Wastewater Commission include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under the Composite Plan. The annual O&M costs also include an expected average reduction of $2,483,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.*

[h] *See Table 126 in Chapter VIII for details.*

[i] *The annual O&M cost for the Village of Saukville Water Utility includes an estimated annual water production cost of $120,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under the Composite Plan. The annual O&M costs also include an expected average reduction of $455,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.*

[j] *The annual O&M cost for the We Energies-Water Services Mequon and Thiensville service area includes an estimated average annual water production cost of $219,000 per year based upon the estimated incremental cost of $230 per million gallons for water production at the City of Milwaukee Water Works treatment process. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed cost and other costs. There is also expected to be an estimated average reduction of $1,520,000 per year for savings associated with existing residences which would be able to discontinue their point-of-entry water treatment systems. However, there are also expected costs involved in developing a local water distribution system. The cost savings due to discontinuation of the point-of-entry water treatment system and the cost of the local distribution system are common to all alternative plans and are not specifically accounted for in this table.*

[k] *Includes the Village of Sturtevant Water Utility which was purchased by the City of Racine Water and Wastewater Utility in 2007 and is now served by the City Utility on a retail basis.*

[l] *Includes the former Crestview Sanitary District and the former North Park Sanitary Districts which were consolidated in 2007 to form the Caledonia East Utility District.*

[m] *Includes the former Caddy Vista Sanitary District and the former Caledonia Utility District No. 1 which were consolidated in 2006 to form the Caledonia West Utility District.*

Footnotes Table 168 (continued)

[n]*See Table 98 for details.*

[o]*The annual O&M cost for the Town of Yorkville Utility District No. 1 includes an estimated annual water production cost of $17,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 2. The annual O&M costs also include an expected average reduction of $28,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.*

[p]*The annual O&M cost for the Northwest Caledonia Area does not include the incremental cost for water production, as that cost is included in the expanded City of Oak Creek Water Utility costs.*

[q]*The annual O&M cost for the Village of Germantown Water Utility includes an estimated annual water production cost of $215,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 2. The annual O&M costs also include an expected average reduction of $1,720,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.*

[r]*The annual O&M cost for the City of Brookfield Water Utility for the eastern portion of the City includes an estimated annual water production cost of $205,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 2. The annual O&M costs also include an expected average reduction of $1,440,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.*

[s]*The annual O&M cost for the City of Muskego Water Utility includes an estimated annual water production cost of $133,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 2. The annual O&M costs also include an expected average reduction of $1,519,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.*

[t]*The annual O&M cost for the City of New Berlin Water Utility for the central portion of the City includes an estimated annual water production cost of $185,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 2. The annual O&M costs also include an expected average reduction of $1,260,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.*

[u]*See Tables 165, 166, and 167 for details.*

[v]*The annual O&M cost for the City of Waukesha Water Utility includes an estimated annual water production cost of $739,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs include a reduction in cost for existing groundwater supply facilities which were needed under Alternative Plan 1, the base condition, but eliminated under Alternative Plan 4. The annual O&M costs also include an expected average reduction of $7,268,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.*

[w]*The annual O&M cost for the Village of Elm Grove includes an estimated annual water productions cost of $62,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The annual O&M costs also include an expected average reduction of $596,000 per year for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices. Water distribution system expansion costs are not included, as they are common to all alternative plans.*

Source: Ruekert & Mielke, Inc., and SEWRPC.

maintenance costs of the proposed new facilities; the expected savings due to the elimination of household water softening systems and other point-of-entry treatment devices; and the reductions in costs due to the elimination of no longer needed existing utility facilities.

Groundwater and Surface Water Impacts of Subalternative 2 to the Composite Plan

The potential impacts of the pumping conditions attendant to Subalternative 2 to the Composite Plan on the groundwater and surface water systems of the Region were estimated by simulation modeling and by a parallel water budget analysis. In addition, surface water quantity and quality analyses were conducted based upon stream gaging records developed under the SEWRPC-USGS cooperative stream gaging program, wastewater treatment plant loading and performance data included in the WDNR Compliance Maintenance Annual Reports (CMAR), and water supply system data reported to the Public Service Commission of Wisconsin.

Groundwater Impacts in the Deep Aquifer

Simulated Water Levels in the Deep Aquifer

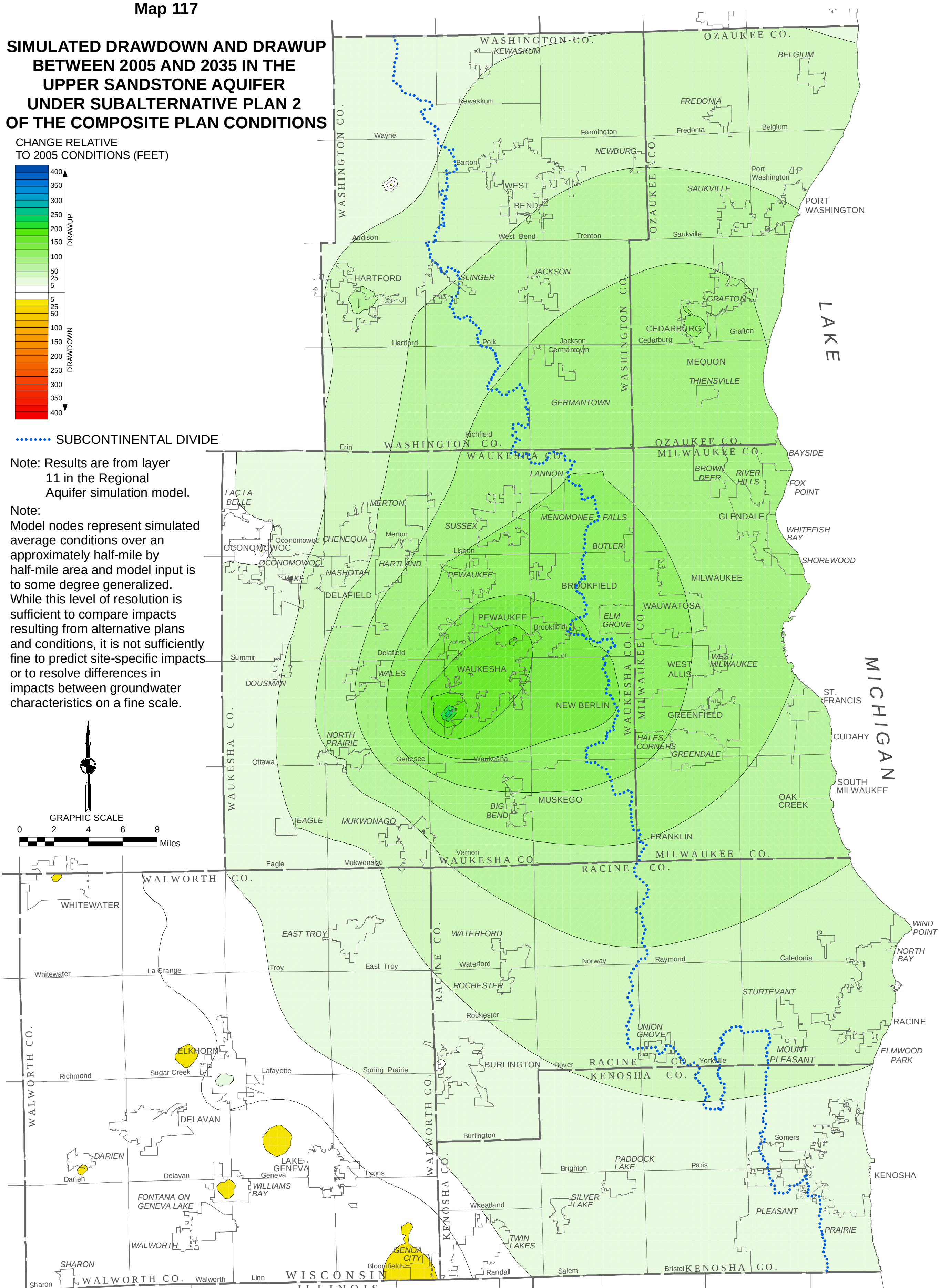
Results of the groundwater simulation indicate that under Subalternative 2 to the Composite Plan conditions, drawups relative to 2005 conditions may be expected to occur in the deep aquifer over most of the Region. These impacts are graphically shown on Map 117, and are most evident in portions of central Waukesha County where those impacts may exceed 150 feet of drawup in central and eastern Waukesha County and exceed 500 feet in most of Milwaukee County, in eastern and central Waukesha County, in much of southern Ozaukee County, and in southeastern Washington County. It should be noted that there will remain impacts on the deep aquifer from pumping in areas to the south of the Region in northeastern Illinois. The smaller drawups shown in Kenosha and Walworth Counties on Map 117 may be attributed, in part, to the out-of-Region pumpage. For analytical purposes, the pumping in northeastern Illinois has been held at the year 2000 level for the planning period of 2000 through 2035. At the time these analyses were conducted, no comprehensive areawide water supply plan was in place for the northeastern Illinois area, and no basis, therefore, existed for forecasting potential changes in the pumpage concerned. Thus, the impacts under future conditions may be somewhat different than developed under this planning program. However, the relative differences between alternative plans as herein reported may be expected to be valid.

Some exceptions to the general potential drawups in the deep aquifer under this subalternative occur in Kenosha, Walworth, Washington, and Waukesha Counties; however, except in Walworth County, model cells showing drawdowns constitute less than 2 percent of model cells as given in Table 169. In Walworth County about 60 percent of model cells exhibit drawdowns over 2005 levels in the upper sandstone aquifer under Subalternative 2 to the Composite Plan conditions. For cells showing drawdowns in Walworth County, the average drawdown projected in this aquifer was almost two feet and the maximum drawdown projected for this aquifer was about 14 feet. There was relatively little variation in drawdown in terms of the percentage of cells showing simulated drawdowns over the period 2005 to 2035 greater than the thresholds given in the column headings under Subalternative 2 to the Composite Plan conditions. Less than 2 percent of model cells showing drawdowns had drawdowns greater than five feet and only about 0.1 percent of model cells showing drawdowns had drawdowns greater than 10 feet in this County.

Table 169 also summarizes simulated drawups in the upper sandstone aquifer over the period 2005 to 2035 under Subalternative 2 to the Composite Plan conditions. The percentage of cells in the model showing drawups over 2005 levels ranges from about 40 percent in Walworth County to 100 percent in Milwaukee, Ozaukee, Racine, Washington, and Waukesha Counties. Average drawups in this aquifer are projected to range from eight feet for cells showing drawups in Walworth County to about 85 feet for cells showing drawups in Milwaukee County. Maximum simulated drawups in this aquifer range from 30 feet in Kenosha County to about 248 feet in Waukesha County. Model cells in most of the Region showed simulated drawups in the upper sandstone aquifer under Subalternative 2 to the Composite Plan conditions greater than five feet as shown on Map 117. Exceptions were found in most of Walworth County and extreme southwestern Kenosha County.

Map 117

SIMULATED DRAWDOWN AND DRAWUP BETWEEN 2005 AND 2035 IN THE UPPER SANDSTONE AQUIFER UNDER SUBALTERNATIVE PLAN 2 OF THE COMPOSITE PLAN CONDITIONS



Note: Results are from layer 11 in the Regional Aquifer simulation model.

Note:
Model nodes represent simulated average conditions over an approximately half-mile by half-mile area and model input is to some degree generalized. While this level of resolution is sufficient to compare impacts resulting from alternative plans and conditions, it is not sufficiently fine to predict site-specific impacts or to resolve differences in impacts between groundwater characteristics on a fine scale.

Source: U.S. Geological Survey.

Table 169

AVERAGE AND MAXIMUM SIMULATED DRAWDOWN AND DRAWUP IN THE UPPER SANDSTONE AQUIFER UNDER SUBALTERNATIVE 2 TO THE COMPOSITE PLAN CONDITIONS: 2005-2035[a]

County	Drawdown			Drawup		
	Percent of Model Cells	Average (feet)	Maximum (feet)	Percent of Model Cells	Average (feet)	Maximum (feet)
Kenosha	1.8	1.6	4.3	98.2	15.3	30.0
Milwaukee	0.0	0.0	0.0	100.0	84.7	117.2
Ozaukee	0.0	0.0	0.0	100.0	58.6	109.7
Racine	0.0	0.0	0.0	100.0	39.3	68.1
Walworth	60.2	1.9	14.2	39.8	8.0	39.9
Washington	0.0	6.6	6.6	100.0	46.0	235.4
Waukesha	0.0	5.8	5.8	100.0	76.8	247.9

[a]*Results are from Layer 11 in the groundwater simulation model.*

Source: U.S. Geological Survey.

Table 170

SIMULATED DRAWUP IN THE UPPER SANDSTONE AQUIFER UNDER SUBALTERNATIVE 2 TO THE COMPOSITE PLAN CONDITIONS: 2005-2035[a]

County	Percent of Model Cells Showing Drawup Greater Than						
	One Foot	Five Feet	10 Feet	50 Feet	100 Feet	150 Feet	200 Feet
Kenosha	97.4	92.8	75.8	0.0	0.0	0.0	0.0
Milwaukee	100.0	100.0	100.0	100.0	13.9	0.0	0.0
Ozaukee	100.0	100.0	100.0	54.8	0.7	0.0	0.0
Racine	99.9	99.9	98.0	22.2	0.0	0.0	0.0
Walworth	35.1	21.0	11.5	0.0	0.0	0.0	0.0
Washington	99.9	99.9	91.9	39.8	0.1	0.1	0.1
Waukesha	99.9	98.3	93.5	67.1	35.7	4.7	0.1

[a]*Results are from Layer 11 in the groundwater simulation model.*

Source: U.S. Geological Survey.

Table 170 summarizes the variation in drawup in terms of the percentage of cells showing simulated drawups over the period 2005 to 2035 greater than the given thresholds. In much of the Region, drawups in excess of 10 feet were common in the upper sandstone aquifer under Subalternative 2 to the Composite Plan conditions, representing over 90 percent of the model cells in all of the Counties, except for Kenosha and Walworth Counties. In much of the Region, drawups in excess of 100 feet were common in the upper sandstone aquifer under Subalternative 2 to the Composite Plan conditions. While no model cells in Kenosha or Walworth Counties show drawups in excess of 50 feet, drawups in excess of 50 feet were found in Milwaukee, Ozaukee, Racine, Washington, and Waukesha Counties, ranging from about 22 percent of cells in Racine County to 100 percent of cells in Milwaukee County. Drawups in excess of 200 feet were detected in Washington and Waukesha Counties under Subalternative 2 to the Composite Plan conditions; however, they accounted for less than 1 percent of model cells in each of these Counties.

Previous simulation modeling results suggest that the top of the Sinnipee Group dolomite below the Maquoketa shale had become unsaturated by the year 2000 in central Waukesha County.[10] The simulation results suggest that under Subalternative 2 to the Composite Plan conditions, such unsaturated conditions may be expected to occur over a much smaller area. An unsaturated condition at this depth, depending on how it spreads, could influence deep aquifer well yields and groundwater geochemistry around deep aquifer wells open to the Sinnipee Group, the St. Peter Formation, and below. Because of the model resolution and because the model does not explicitly simulate unsaturated flow, however, assuming the potential for this condition would require further more-detailed evaluation if associated with the recommended plan.

Water Budget Analysis

Table 171 shows results by County of a water budget analysis for the deep groundwater system under Subalternative 2 to the Composite Plan conditions. This analysis was based upon anticipated values of two groundwater performance indicators—the demand to supply ratio and the human influence ratio—under Subalternative 2 to the Composite Plan conditions for the years 2005 and 2035. The analysis indicates that in 2005 the demand to supply ratio ranged from about 0.10 in Kenosha County to about 5.77 in Waukesha County under Subalternative 2 to the Composite Plan conditions. Under these conditions, the values of the demand to supply ratio for Ozaukee and Racine Counties in 2005 also may be expected to exceed one, indicating water budget deficits in the deep aquifer underlying these counties. The analysis also projects that under Subalternative 2 to the Composite Plan conditions the demand to supply ratio would range from about 0.02 in Ozaukee County to about 3.20 in Waukesha County in 2035. The values of this indicator are anticipated to increase in Kenosha, Racine, and Walworth Counties and to decrease in Milwaukee, Ozaukee, Washington, and Waukesha Counties between 2005 and 2035. In 2035, the values of the demand to supply ratio for Racine and Waukesha Counties may be expected to exceed one, indicating water budget deficits in the deep aquifer underlying these Counties. In addition, in 2035, the value of the demand to supply ratio for Walworth County may be expected to be near one, indicating that this County would be near water budget deficit conditions in the deep aquifer underlying it.

The analysis also indicated that in 2005 the human influence ratio ranged from about -0.88 in Waukesha County to about -0.04 in Kenosha County under Subalternative 2 to the Composite Plan conditions and projects that in 2035 this indicator would range from about -0.77 in Waukesha County to about -0.01 in Ozaukee County under Subalternative 2 to the Composite Plan conditions. These values suggest that the net effect of human activities under these conditions would be to remove water from the deep groundwater system. In particular, the values for Waukesha County suggest that pumping dominates all outflows from the deep aquifer in this County under Subalternative 2 to the Composite Plan conditions. In Kenosha, Milwaukee, Racine, and Walworth Counties, the projected values of this indicator for 2035 are lower than the 2005 values, indicating that the influence of human withdrawals on the water budget of the deep groundwater may be expected to increase in these Counties under Subalternative 2 to the Composite Plan conditions. In Ozaukee, Washington, and Waukesha Counties, the projected values of this indicator for 2035 are higher than the 2005 values, indicating a reduction in the influence of human withdrawals on the water budget of the deep groundwater system would be expected in these Counties under Subalternative 2 to the Composite Plan conditions. Despite this anticipated reduction under the plan conditions, the deep groundwater systems underlying Racine, Walworth, and Waukesha Counties are anticipated to remain heavily influenced by human activities.

Groundwater Impacts in the Shallow Aquifer

As noted in Chapter VIII, except in those portions of the Region where the shallow aquifers are confined by clay-rich glacial tills, the effects of alternative plans upon surface water baseflow conditions will generally be more informative of the impacts upon the shallow groundwater system than the associated changes in water levels in the sand and gravel and Silurian dolomite aquifers.

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[10]*SEWRPC Technical Report No. 41*, op. cit.

Table 171

PROJECTED GROUNDWATER PERFORMANCE INDICATORS FOR THE SANDSTONE AQUIFERS UNDER SUBALTERNATIVE 2 TO THE COMPOSITE PLAN CONDITIONS: 2005 AND 2035

County	Demand to Supply Ratio[a]		Human Influence Ratio[b]	
	2005	2035	2005	2035
Kenosha	0.101	0.137	-0.041	-0.048
Milwaukee	0.567	0.369	-0.197	-0.230
Ozaukee	1.040	0.017	-0.317	-0.008
Racine	1.963	2.244	-0.500	-0.554
Walworth	0.745	0.986	-0.326	-0.423
Washington	0.453	0.294	-0.191	-0.152
Waukesha	5.773	3.197	-0.881	-0.769

[a]*The demand to supply ratio is defined as the ratio of net pumping demand on an aquifer to that aquifer's sustainable, or natural, supply. Generally, this indicator ranges from 0—representing no human impact—upward. Values over 1.0 indicate that more groundwater is being extracted than can be replaced in a long-term, sustainable fashion. The year 2005 and 2035 conditions for this indicator are compared to predevelopment conditions.*

[b]*The human impact ratio, is defined as the ratio of human-induced groundwater inflows to total inflows minus the ratio of human-induced groundwater outflows to total outflows. This indicator is an expression of the relative magnitude of human alteration of the groundwater system. Values range from minus 1.0 in areas where wells have become the only discharge from an aquifer by stopping all other groundwater discharges, through 0 representing no net human impact, to plus 1.0 representing situations where human additions are the only inputs to the aquifer. The year 2005 and 2035 conditions for this indicator are compared to predevelopment conditions.*

Source: University of Wisconsin-Milwaukee.

Impacts to Groundwater-Derived Baseflow to Surface Waters

On a Regional scale, pumping under Subalternative 2 to the Composite Plan conditions may be expected to decrease from 79.9 mgd in 2005, to 78.9 mgd in 2035, representing a total decrease in pumping of 1.0 mgd. The simulation modeling indicated that, within the Region as a whole, under Subalternative 2 to the Composite Plan conditions a net amount of about 8.8 mgd of water are contributed to storage in the confined and unconfined aquifers and to cross-boundary flow out of the planning area. Thus, in a mass balance analysis for sources of water to wells from waterbodies in southeastern Wisconsin there needs to be an accounting for 7.8 mgd. The simulation modeling indicated that 3.5 mgd, or about 45 percent, of this additional extracted water was derived from groundwater flow that in the absence of pumping would have been discharged to surface water features. An additional 4.5 mgd, or about 55 percent, was derived directly from surface water features due to reversed hydraulic gradients at the groundwater-surface water interface.

Streams, rivers, and lakes of the surface water system of the Region were represented in the model by 3,756 cells designated as stream nodes. The simulation modeling indicated that under 2005 pumping conditions, about 92 percent of these nodes were receiving baseflow from groundwater, while about 5 percent were losing baseflow to groundwater. By 2035, these percentages may be expected to change slightly under Subalternative 2 to the Composite Plan conditions, with about 92 percent of these nodes expected to receive baseflow from groundwater, and about 6 percent as losing baseflow to groundwater. The analyses conducted consider only the impacts on the groundwater-derived baseflow of the streamflow. Groundwater-derived baseflow typically comprises from 10 to 50 percent of total streamflow.

Table 172 summarizes simulated changes in baseflow to the surface waters of the Region under Subalternative 2 to the Composite Plan conditions over the period 2005 to 2035. In aggregate, by 2035 surface waterbodies in the Region may be expected to experience a net baseflow depletion of about 7.0 mgd. The amounts of depletion will vary among the Counties, ranging from an augmentation of baseflow of about 2.5 mgd in Ozaukee County, to a

Table 172

SIMULATED BASEFLOW DEPLETION TO SURFACE WATERS UNDER SUBALTERNATIVE 2 TO THE COMPOSITE PLAN CONDITIONS: 2005-2035

Baseflow to Surface Water	2000 Baseflow (million gallons per day)	2035 Baseflow (million gallons per day)	Difference (million gallons per day)[a]	Percent Change[a]
Kenosha County				
Inflow to Surface Water	41.63	40.70	-0.93	-2.2
Outflow from Surface Water	0.40	1.07	-0.67	-166.9
Subtotal	41.23	39.63	-1.60	-3.9
Milwaukee County				
Inflow to Surface Water	11.45	11.61	0.16	1.4
Outflow from Surface Water	2.98	2.96	0.02	0.6
Subtotal	8.47	8.65	0.18	2.0
Ozaukee County				
Inflow to Surface Water	17.34	19.83	2.49	14.4
Outflow from Surface Water	0.46	0.44	0.02	4.0
Subtotal	16.88	19.39	2.51	14.9
Racine County				
Inflow to Surface Water	41.70	41.64	-0.06	-0.1
Outflow from Surface Water	0.07	0.49	-0.42	-617.2
Subtotal	41.63	41.15	-0.48	-1.1
Walworth County				
Inflow to Surface Water	103.99	101.93	-2.06	-2.0
Outflow from Surface Water	8.99	10.38	-1.39	-15.4
Subtotal	95.00	91.55	-3.45	-3.6
Washington County				
Inflow to Surface Water	63.52	61.56	-1.96	-3.1
Outflow from Surface Water	2.52	3.32	-0.80	-31.6
Subtotal	61.00	58.24	-2.76	-4.5
Waukesha County				
Inflow to Surface Water	89.55	89.56	0.01	<0.1
Outflow from Surface Water	1.27	2.64	-1.37	-108.1
Subtotal	88.28	86.92	-1.36	-1.5
Southeastern Wisconsin Region				
Inflow to Surface Water	369.18	366.83	-2.35	-0.6
Outflow from Surface Water	16.69	21.30	-4.61	-27.8
Total	352.49	345.53	-6.96	-2.0

[a] *A positive difference or change represents augmentation of baseflow to surface waters, a negative difference or change represents depletion of baseflow to surface waters.*

Source: U.S. Geological Survey.

depletion of about 3.4 mgd in Walworth County. The aggregate depletion is the net result of 2.4 mgd of inflow depletion and 4.6 mgd of outflow depletion. It is important to note that these aggregate totals may obscure differences in baseflow changes among specific sites within each County. While the County totals project overall depletions within each County, some individual waterbodies may experience either depletion or augmentation.

Model nodes showing greater than 10 percent and greater than 25 percent potential baseflow depletion under Subalternative 2 to the Composite Plan conditions are shown on Maps 118 and 119, respectively. As previously noted, these data are considered valid when considered in the aggregate for the purpose of comparing alternative plans. Additional analyses would be needed for consideration of site-specific impacts. Several notable areas of baseflow depletion are indicated by the modeling results. Nodes for which the simulation analyses indicated greater than 10 percent baseflow reduction include those representing the mainstem of the Milwaukee River between West Bend and Newburg in Washington County; Quaas Creek in Washington County; the Rubicon River and the East Branch of the Rubicon River in Washington County; Sussex Creek, the Pewaukee River, portions of Poplar Creek, and the mainstem of the Fox River between the confluence with Poplar Creek and the confluence with Genesee Creek in Waukesha County; Whitnall Park Creek in Milwaukee County; Lake Beulah, Jackson Creek, portions of the White River, Darien Creek, and Turtle Creek in Walworth County; in Walworth County; the West Branch of the Root River Canal in Racine County; and a portion of the Des Plaines River in Kenosha and Racine Counties. Maps 118 and 119 also highlight those streams which receive a significant amount of wastewater treatment plant effluent, and are, thus, less sensitive to reductions in baseflows. It is important to note that several of the streams expected to show baseflow reductions in excess of 10 percent under Subalternative 2 to the Composite Plan conditions receive wastewater treatment plant effluent. In those streams, the impacts of a reduced groundwater-derived baseflow are generally mitigated or improved with respect to streamflow. However, adverse water quality impacts may remain.

Model nodes which the simulation modeling indicated as exhibiting greater than 25 percent baseflow reductions include those representing portions of the Rubicon River and the East Branch of the Rubicon River in Washington County; Tess Corners Creek in Milwaukee County, Jackson Creek in Walworth County; a portion of the West Branch of the Root River Canal in Racine County; and a portion of the Des Plaines River in Racine County.

Maps 118 and 119 also depict model nodes which show augmentation of baseflow under Subalternative 2 to the Composite Plan conditions greater than 10 percent and greater than 25 percent, respectively. Several notable areas of baseflow augmentation are indicated in the model results. Nodes for which simulation analyses indicated greater than 10 percent baseflow augmentation include those representing some of the headwaters of the Menomonee River in Washington and Ozaukee Counties; portions of the Nor-X-Way Channel in Washington and Waukesha Counties; Mole, Pigeon, and Trinity Creeks and portions of Ulao Creek in Ozaukee County; the Little Menomonee River in Ozaukee and Milwaukee Counties; Butler Ditch, Hale Creek, Underwood Creek, Lake Denoon, and portions of Deer Creek in Waukesha County; the Wind Lake subwatershed of the Fox River watershed in Waukesha and Racine Counties, including Big Muskego, Little Muskego, and Wind Lakes and the Muskego and Wind Lake Drainage Canals; Tess Corners Creek and the mainstem of the Menomonee River between the confluences with the Little Menomonee River and Honey Creek in Milwaukee County; and Browns Lake and a portion of the East Branch of the Root River Canal in Racine County; and Silver Lake in Kenosha County.

Model nodes which the simulation modeling indicated as exhibiting greater than 25 percent baseflow augmentation include those representing Trinity and Pigeon Creeks and portions of Mole and Ulao and Sauk Creeks in Ozaukee County; Butler Ditch, Lake Denoon, and upper portions of the Wind Lake subwatershed of the Fox River watershed in Waukesha County; and Tess Corners Creek in Milwaukee County.

As indicated on Maps 118 and 119, most of the surface water features impacted by baseflow augmentations do not receive wastewater treatment plant effluent.

These simulated baseflow reductions and augmentations need to be carefully interpreted. As noted above, the groundwater model used simulates changes in baseflow, not changes in total streamflow. A change in baseflow does not necessarily indicate a change in total streamflow. For example, in some streams much of a reduction in baseflow may be returned to the surface water system through discharge from wastewater treatment plants. This is the case for the Fox River where 15 municipal wastewater treatment plants discharge treated effluent into the River or its tributaries. Increases in runoff due to changes in land use may also serve to augment streamflow in

Map 118

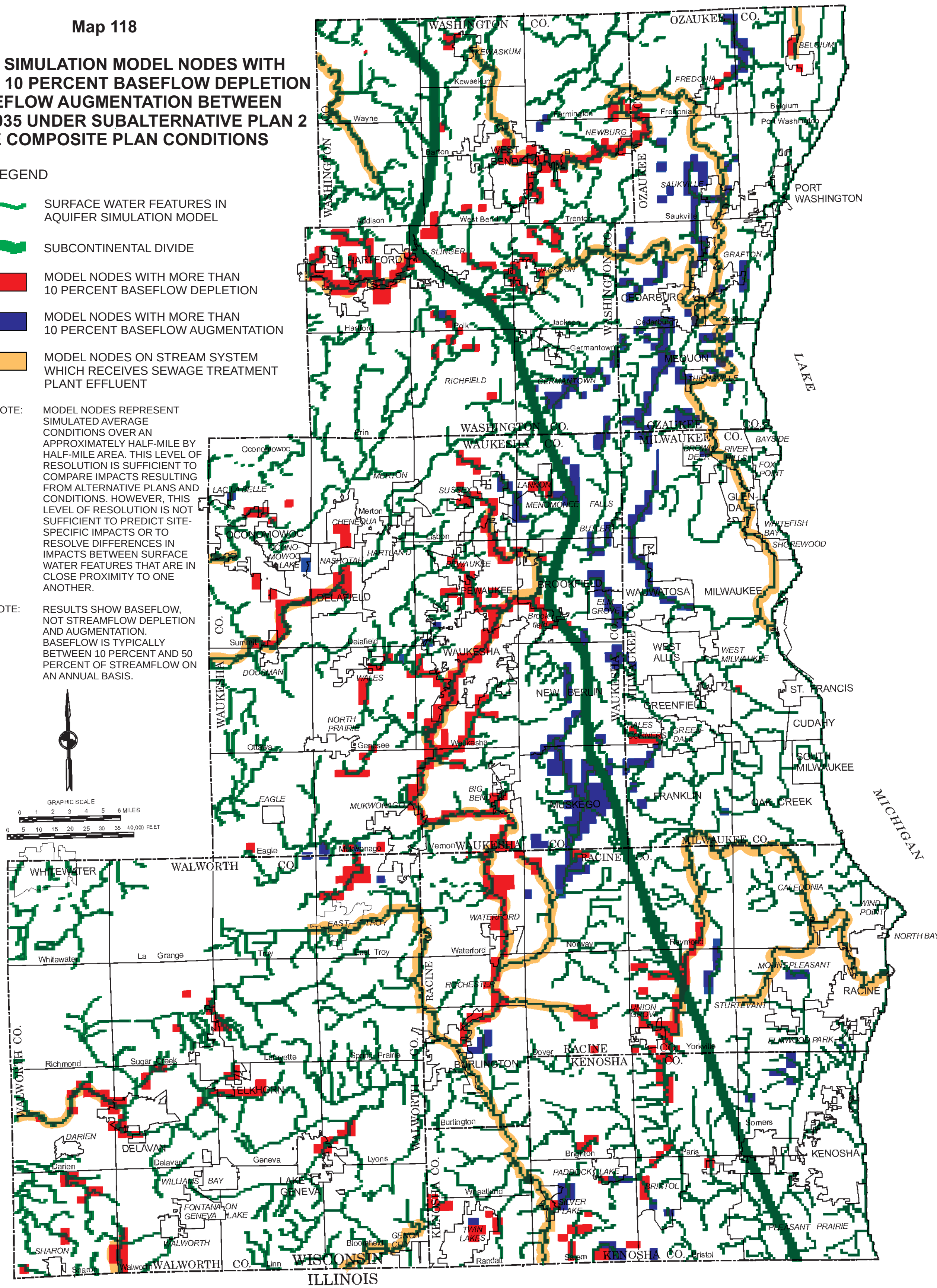
AQUIFER SIMULATION MODEL NODES WITH MORE THAN 10 PERCENT BASEFLOW DEPLETION OR BASEFLOW AUGMENTATION BETWEEN 2005 AND 2035 UNDER SUBALTERNATIVE PLAN 2 TO THE COMPOSITE PLAN CONDITIONS

LEGEND

- SURFACE WATER FEATURES IN AQUIFER SIMULATION MODEL
- SUBCONTINENTAL DIVIDE
- MODEL NODES WITH MORE THAN 10 PERCENT BASEFLOW DEPLETION
- MODEL NODES WITH MORE THAN 10 PERCENT BASEFLOW AUGMENTATION
- MODEL NODES ON STREAM SYSTEM WHICH RECEIVES SEWAGE TREATMENT PLANT EFFLUENT

NOTE: MODEL NODES REPRESENT SIMULATED AVERAGE CONDITIONS OVER AN APPROXIMATELY HALF-MILE BY HALF-MILE AREA. THIS LEVEL OF RESOLUTION IS SUFFICIENT TO COMPARE IMPACTS RESULTING FROM ALTERNATIVE PLANS AND CONDITIONS. HOWEVER, THIS LEVEL OF RESOLUTION IS NOT SUFFICIENT TO PREDICT SITE-SPECIFIC IMPACTS OR TO RESOLVE DIFFERENCES IN IMPACTS BETWEEN SURFACE WATER FEATURES THAT ARE IN CLOSE PROXIMITY TO ONE ANOTHER.

NOTE: RESULTS SHOW BASEFLOW, NOT STREAMFLOW DEPLETION AND AUGMENTATION. BASEFLOW IS TYPICALLY BETWEEN 10 PERCENT AND 50 PERCENT OF STREAMFLOW ON AN ANNUAL BASIS.



Source: U.S. Geological Survey.

Map 119

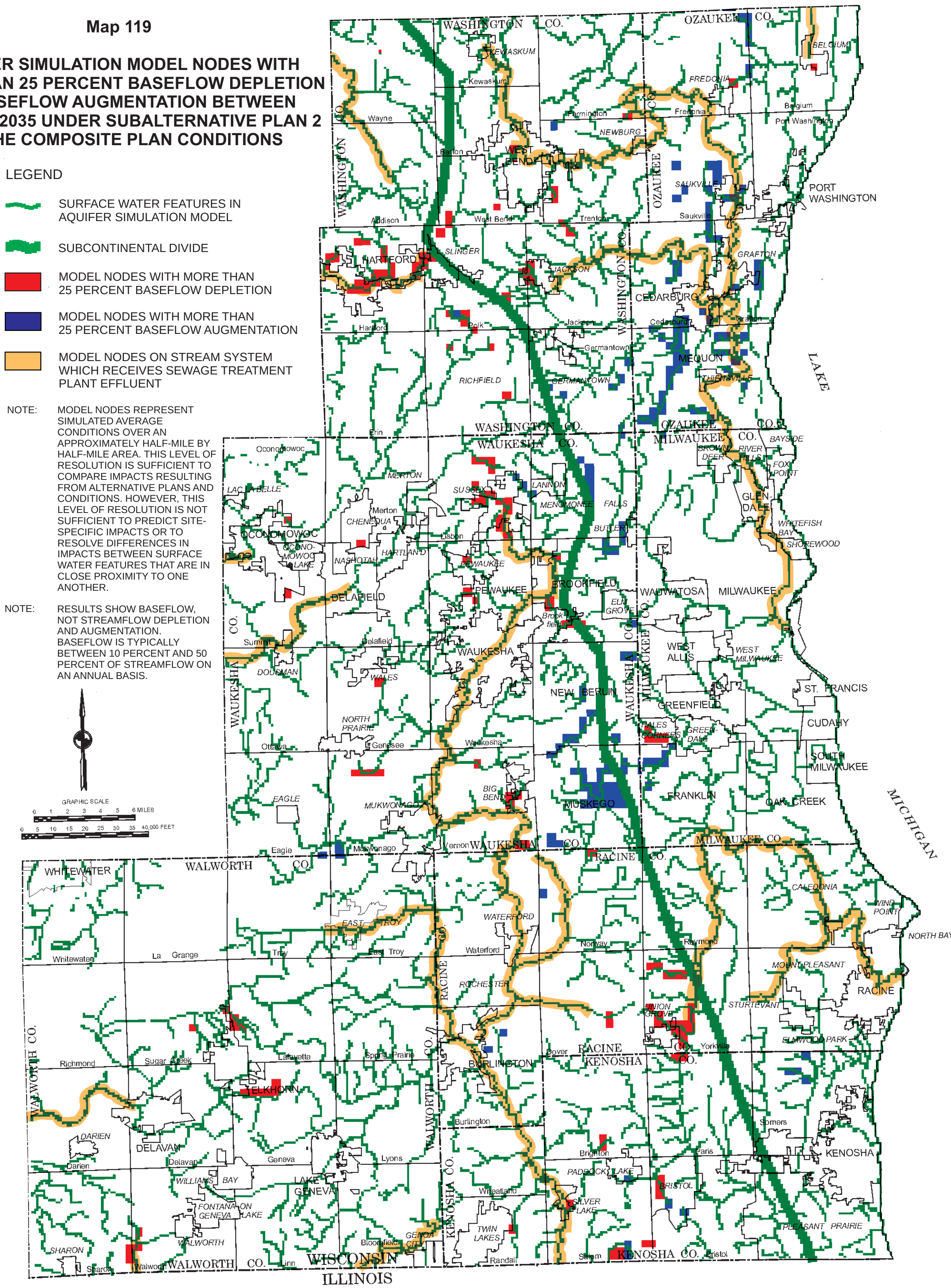
AQUIFER SIMULATION MODEL NODES WITH MORE THAN 25 PERCENT BASEFLOW DEPLETION OR BASEFLOW AUGMENTATION BETWEEN 2005 AND 2035 UNDER SUBALTERNATIVE PLAN 2 TO THE COMPOSITE PLAN CONDITIONS

LEGEND

- SURFACE WATER FEATURES IN AQUIFER SIMULATION MODEL
- SUBCONTINENTAL DIVIDE
- MODEL NODES WITH MORE THAN 25 PERCENT BASEFLOW DEPLETION
- MODEL NODES WITH MORE THAN 25 PERCENT BASEFLOW AUGMENTATION
- MODEL NODES ON STREAM SYSTEM WHICH RECEIVES SEWAGE TREATMENT PLANT EFFLUENT

NOTE: MODEL NODES REPRESENT SIMULATED AVERAGE CONDITIONS OVER AN APPROXIMATELY HALF-MILE BY HALF-MILE AREA. THIS LEVEL OF RESOLUTION IS SUFFICIENT TO COMPARE IMPACTS RESULTING FROM ALTERNATIVE PLANS AND CONDITIONS. HOWEVER, THIS LEVEL OF RESOLUTION IS NOT SUFFICIENT TO PREDICT SITE-SPECIFIC IMPACTS OR TO RESOLVE DIFFERENCES IN IMPACTS BETWEEN SURFACE WATER FEATURES THAT ARE IN CLOSE PROXIMITY TO ONE ANOTHER.

NOTE: RESULTS SHOW BASEFLOW, NOT STREAMFLOW DEPLETION AND AUGMENTATION. BASEFLOW IS TYPICALLY BETWEEN 10 PERCENT AND 50 PERCENT OF STREAMFLOW ON AN ANNUAL BASIS.



Source: U.S. Geological Survey.

streams experiencing baseflow reductions. Increases in streamflow due to increases in runoff may be associated with potential negative water quality and quantity impacts, including increases in nonpoint source pollution loadings and increases in peak period flows. Such impacts would tend to make the preservation of groundwater-derived baseflow desirable to the extent practical. In addition, because of the resolution provided by the model grid, any simulated change in baseflow represents an average change over an area of one-quarter square mile. Because variations may occur within the area represented by a model cell, this average may not be completely representative of individual surface water features within the cell, particularly small surface water features in cells containing multiple surface water features.

Simulated baseflow changes between 2005 and 2035 were evaluated at 100 model nodes containing surface water evaluation sites. Decreases in baseflow under Subalternative 2 to the Composite Plan conditions were simulated to occur at 54 evaluation sites, with simulated decreases in excess of 10 percent of 2005 baseflow at 14 of these sites and simulated decreases in excess of 25 percent of 2005 baseflow at four of these sites. Increases in baseflow were simulated to occur at 32 evaluation sites, with simulated increases in excess of 10 percent of 2005 baseflow at 12 of these sites and simulated increases in excess of 25 percent of 2005 baseflow at six of these sites. The remaining 14 evaluation sites either experienced no change in baseflow or were not simulated as having streamflow in 2005.

Simulated Water Levels in the Shallow Aquifer

The results of the simulation modeling indicate that under Subalternative 2 to the Composite Plan conditions, additional drawdowns may be expected to occur in the shallow aquifer over much of the Region, as shown on Maps 120 and 121. Table 173 provides a summary of the simulated drawdowns and drawups in the glacial sand and gravel aquifer over the period 2005 to 2035. The percentage of cells in the model showing drawdowns over 2005 levels ranges from about 35 percent in Ozaukee County to about 81 percent in Walworth County. Average drawdowns projected in this aquifer are relatively small, ranging from about 0.2 foot for cells showing drawdowns in Ozaukee County, to about 1.1 feet for cells showing drawdowns in Waukesha County. This reflects the damping effect that surface waters have on changes in the shallow groundwater system. Often the major effect of pumping from shallow wells is to reduce groundwater discharge to local surface water features. The maximum drawdowns projected for this aquifer are considerably higher, ranging from about five feet for cells showing drawdowns in Milwaukee County, to about 71 feet for cells showing drawdowns in Racine County.

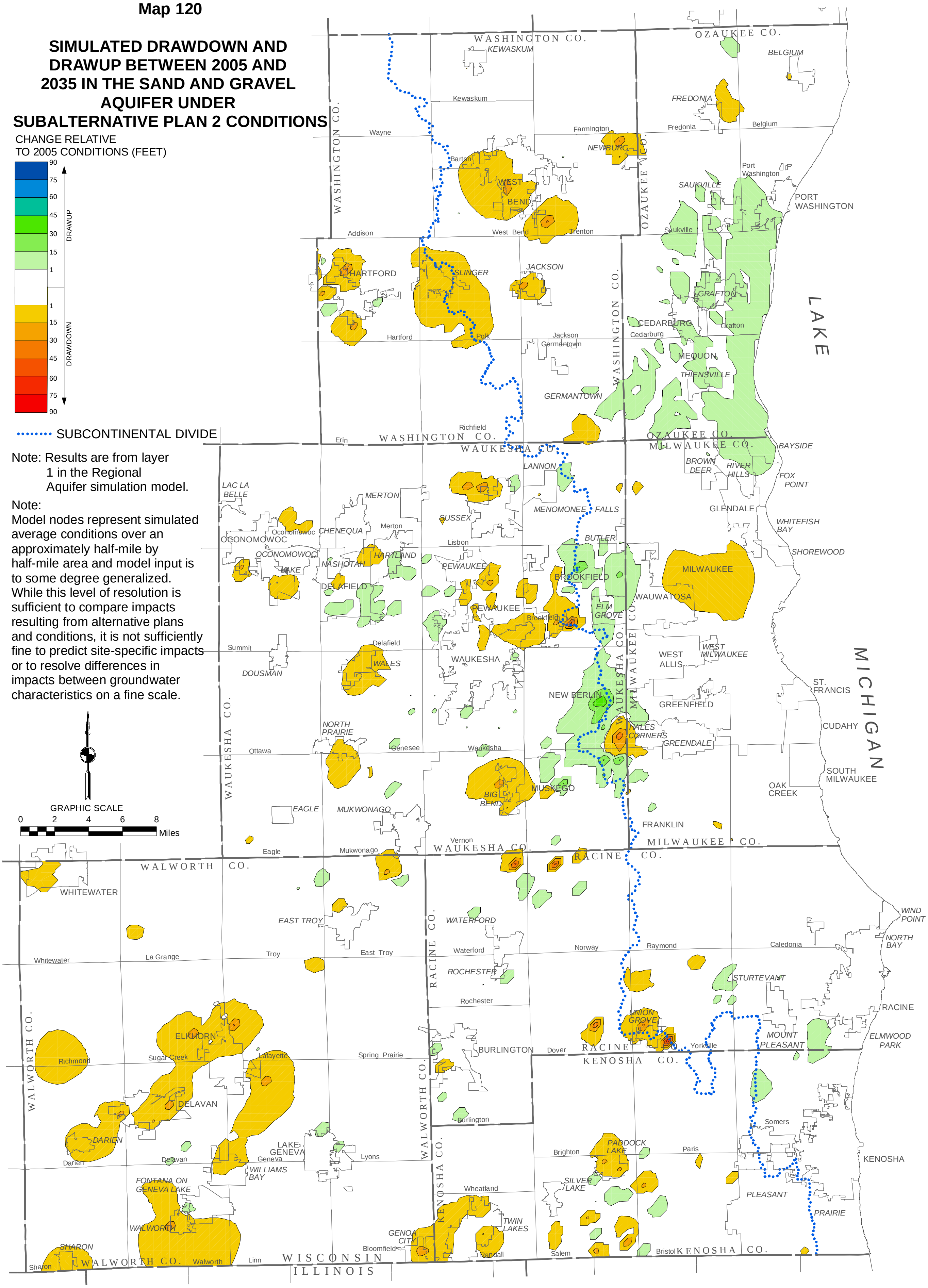
Table 174 summarizes the variation among model cells in terms of the percentage of the cells showing simulated drawdowns over the period 2005 to 2035 greater than the thresholds given in the column headings. In most of the Region, drawdowns greater than 10 feet are relatively rare in the glacial aquifer under Subalternative 2 to the Composite Plan conditions. None of the model cells in Milwaukee County, and fewer than 1 percent of the model cells in Kenosha, Ozaukee, Racine, Walworth, and Waukesha Counties indicate drawdowns in excess of 10 feet. Drawdowns in excess of 10 feet may be expected to be somewhat more common in Washington County, representing about 1 percent of the cells in this County.

Model cells showing simulated drawdowns were distributed throughout the Region; however, there were areas that showed a high proportion of cells showing drawdowns greater than one foot. These areas include western Kenosha County; north-central Milwaukee County; south-central Racine County; central and western Walworth County; and central Washington County. Areas with a high proportion of cells showing drawdowns greater than one foot are also scattered throughout western and southern Waukesha County, as shown on Map 120.

Table 173 also summarizes simulated drawups in the glacial sand and gravel aquifer over the period 2005 to 2035. The percentage of cells in the model showing drawups over 2005 levels ranges from about 19 percent in Walworth County to about 65 percent in Ozaukee County. Average drawups projected in this aquifer are relatively small, ranging from about than 0.1 foot for cells showing drawups in Racine, Walworth, and Washington Counties, to about 1.5 feet for cells showing drawups in Ozaukee County. Maximum simulated drawups in this aquifer range from about four feet in Walworth and Washington Counties to about 38 feet in Waukesha County.

Map 120

SIMULATED DRAWDOWN AND DRAWUP BETWEEN 2005 AND 2035 IN THE SAND AND GRAVEL AQUIFER UNDER SUBALTERNATIVE PLAN 2 CONDITIONS



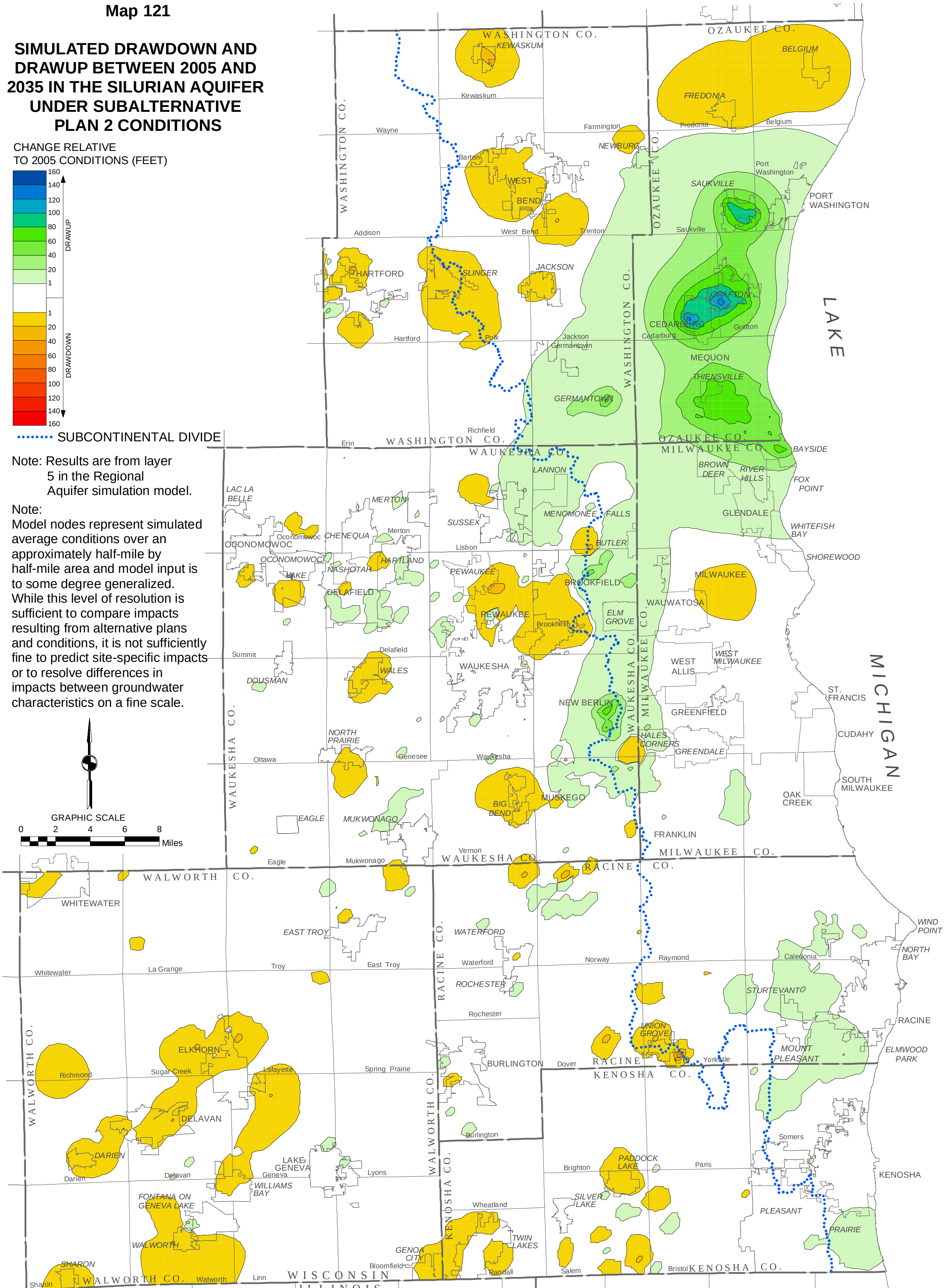
Note: Results are from layer 1 in the Regional Aquifer simulation model.

Note:
Model nodes represent simulated average conditions over an approximately half-mile by half-mile area and model input is to some degree generalized. While this level of resolution is sufficient to compare impacts resulting from alternative plans and conditions, it is not sufficiently fine to predict site-specific impacts or to resolve differences in impacts between groundwater characteristics on a fine scale.

Source: U.S. Geological Survey.

Map 121

SIMULATED DRAWDOWN AND DRAWUP BETWEEN 2005 AND 2035 IN THE SILURIAN AQUIFER UNDER SUBALTERNATIVE PLAN 2 CONDITIONS



Note: Results are from layer 5 in the Regional Aquifer simulation model.

Note:
Model nodes represent simulated average conditions over an approximately half-mile by half-mile area and model input is to some degree generalized. While this level of resolution is sufficient to compare impacts resulting from alternative plans and conditions, it is not sufficiently fine to predict site-specific impacts or to resolve differences in impacts between groundwater characteristics on a fine scale.

Source: U.S. Geological Survey.

Table 173

AVERAGE AND MAXIMUM SIMULATED DRAWDOWN AND DRAWUP IN THE GLACIAL SAND AND GRAVEL AQUIFER UNDER SUBALTERNATIVE 2 TO THE COMPOSITE PLAN CONDITIONS BY COUNTY: 2005-2035[a]

County	Drawdown			Drawup		
	Percent of Model Cells	Average (feet)	Maximum (feet)	Percent of Model Cells	Average (feet)	Maximum (feet)
Kenosha	52.0	0.7	28.9	48.0	0.2	8.2
Milwaukee	50.0	0.6	4.6	50.0	0.3	8.1
Ozaukee	34.7	0.2	7.4	65.3	1.5	12.6
Racine	37.7	0.8	71.4	62.3	0.1	9.0
Walworth	80.8	0.8	33.1	19.2	0.1	4.0
Washington	63.9	1.0	34.4	36.1	0.1	4.0
Waukesha	38.4	1.1	49.2	61.6	0.8	38.3

[a]*Results are from Layer 1 in the groundwater simulation model.*

Source: U.S. Geological Survey.

Table 174

SIMULATED DRAWDOWN IN THE GLACIAL SAND AND GRAVEL AQUIFER UNDER SUBALTERNATIVE 2 TO THE COMPOSITE PLAN CONDITIONS BY COUNTY: 2005-2035[a]

County	Percent of Model Cells Showing Drawdown Greater Than				
	One Foot	Five Feet	10 Feet	50 Feet	100 Feet
Kenosha	6.4	1.4	0.8	0.0	0.0
Milwaukee	8.1	0.0	0.0	0.0	0.0
Ozaukee	1.0	0.1	0.0	0.0	0.0
Racine	3.0	0.9	0.3	0.2	0.0
Walworth	14.2	2.2	0.7	0.0	0.0
Washington	11.5	3.3	1.0	0.0	0.0
Waukesha	7.9	2.0	0.8	0.0	0.0

[a]*Results are from Layer 1 in the groundwater simulation model.*

Source: U.S. Geological Survey.

While model cells showing simulated drawups in the glacial sand and gravel aquifer were distributed throughout the Region, areas with a high proportion of cells showing drawups greater than one foot were found primarily in southern and central Ozaukee County and in central and eastern Waukesha County, as shown on Map 120.

Table 175 presents a summary of simulated drawdowns and drawups in the Silurian aquifer over the period 2005 to 2035. The percentage of cells in the model showing drawdowns over 2005 levels ranges from about 20 percent in Milwaukee County, to about 78 percent in Walworth County. Average drawdowns projected in this aquifer are relatively small, ranging from about 0.5 foot for cells showing drawdowns in Milwaukee County, to about 2.2 feet for cells showing drawdowns in Ozaukee County. As already noted, the small average drawdown in this aquifer over most of the Region reflects the damping effect that surface waters have on changes in the shallow groundwater system.

Table 175

AVERAGE AND MAXIMUM SIMULATED DRAWDOWN AND DRAWUP IN THE SILURIAN AQUIFER UNDER SUBALTERNATIVE 2 TO THE COMPOSITE PLAN CONDITIONS: 2005-2035[a]

County	Drawdown			Drawup		
	Percent of Model Cells	Average (feet)	Maximum (feet)	Percent of Model Cells	Average (feet)	Maximum (feet)
Kenosha	50.5	0.7	29.6	49.5	0.6	19.7
Milwaukee	19.6	0.5	2.0	80.4	2.7	72.4
Ozaukee	32.2	2.2	19.9	67.8	30.9	133.6
Racine	27.3	1.0	61.0	72.7	0.6	26.7
Walworth	78.3	0.8	32.2	21.7	0.1	5.1
Washington	56.8	1.3	28.4	43.2	2.4	66.8
Waukesha	31.8	1.4	38.4	68.2	1.8	75.7

[a]*Results are from Layer 5 in the groundwater simulation model.*

Source: U.S. Geological Survey.

Table 176

SIMULATED DRAWDOWN IN THE SILURIAN AQUIFER UNDER SUBALTERNATIVE 2 TO THE COMPOSITE PLAN CONDITIONS: 2005-2035[a]

County	Percent of Model Cells Showing Drawdown Greater Than				
	One Foot	Five Feet	10 Feet	50 Feet	100 Feet
Kenosha	7.0	1.4	0.6	0.0	0.0
Milwaukee	4.1	0.0	0.0	0.0	0.0
Ozaukee	20.9	2.6	0.4	0.0	0.0
Racine	3.8	0.9	0.3	0.1	0.0
Walworth	14.6	2.3	0.5	0.0	0.0
Washington	14.0	3.6	1.1	0.0	0.0
Waukesha	9.7	2.2	0.6	0.0	0.0

[a]*Results are from Layer 5 in the groundwater simulation model.*

Source: U.S. Geological Survey.

Maximum drawdowns projected for the Silurian aquifer are considerably higher than the average drawdowns, ranging from about two feet for cells showing drawdowns in Milwaukee County, to about 61 feet for cells showing drawdowns in Racine County.

Table 176 summarizes the variation among the model cells in terms of the percentage of the cells showing simulated drawdowns over the period 2005 to 2035 greater than the thresholds given in the column headings. In most of the Region, drawdowns greater than 10 feet are relatively rare in the Silurian aquifer under Subalternative 2 to the Composite Plan conditions. None of the model cells in Milwaukee County and fewer than 1 percent of the model cells in Kenosha, Ozaukee, Racine, Walworth, and Waukesha Counties indicate drawdowns in excess of 10 feet. Drawdowns in excess of 10 feet may be expected to be somewhat more common in Washington County, representing slightly more than 1 percent of cells in this County. Model cells showing simulated drawdowns were distributed throughout the Region; however, there were areas that showed a high proportion of cells showing drawdowns greater than one foot. At the resolution of the model, these areas include western Kenosha County, northern Ozaukee County, north-central Milwaukee County, south-central Racine County, central and western Walworth County, and central and north-central Washington County. Areas with high proportions of cells showing drawdowns greater than one foot are also scattered throughout Waukesha County as shown on Map 121.

Table 175 also summarizes simulated drawups in the Silurian aquifer over the period 2005 to 2035. The percentage of cells in the model showing drawups over 2005 levels ranges from about 22 percent in Walworth County to about 80 percent in Milwaukee County. With one exception, average drawups projected in this aquifer are relatively small, ranging from about 0.1 foot for cells showing drawups in Walworth County to about 2.7 feet for cells showing drawups in Milwaukee County. The model projects a higher average drawup for cells in Ozaukee County. In this County, the average drawup projected by the model was about 31 feet. Maximum simulated drawups in this aquifer range from about five feet in Walworth County to about 134 feet in Ozaukee County. While model cells showing simulated drawups in the Silurian aquifer were distributed throughout the Region, areas containing a high proportion of cells showing drawups greater than one foot were found in southern and central Ozaukee County, in northern Milwaukee County along the Milwaukee-Ozaukee County line, in southeastern Washington County, and in eastern Waukesha County. Much of the simulated drawup in these areas may be attributed to shifting of the source of water supply from shallow wells to Lake Michigan as envisioned under Subalternative 2 to the Composite Plan. Smaller areas containing high proportions of cells showing drawups greater than one foot were found in northwestern Racine County and in eastern Racine and Kenosha Counties.

Water Budget Analysis

Table 177 shows results by County from a water budget analysis for the shallow groundwater system under Subalternative 2 to the Composite Plan conditions. This analysis was based upon anticipated values of three groundwater performance indicators—the demand to supply ratio, the human influence ratio, and the baseflow reduction index—under Subalternative 2 to the Composite Plan conditions for the years 2005 and 2035. The analysis indicates that in 2005 the demand to supply ratio ranged from about 0.04 in Walworth County to about 0.20 in Ozaukee County under Subalternative 2 to the Composite Plan conditions. The analysis projects that in 2035 this indicator would range from about 0.07 in Racine County to about 0.13 in Milwaukee County under Subalternative 2 to the Composite Plan conditions. While under these conditions increases in this indicator are projected to occur in Kenosha, Racine, Walworth, Washington, and Waukesha Counties, all values of the demand to supply ratio for the shallow aquifer are projected to be well below 1.0, indicating little evidence of a water budget deficit in the shallow aquifer.

The analysis also indicated that in 2005 the human influence ratio ranged from about -0.19 in Ozaukee County to about -0.04 in Walworth County under Subalternative 2 to the Composite Plan conditions, and projects that in 2035 this indicator may be expected to range from about -0.13 in Milwaukee County to about -0.05 in Ozaukee County under Subalternative 2 to the Composite Plan conditions. These values suggest that the net effect of human activities under these conditions would be to remove water from the shallow groundwater system. In Kenosha, Racine, Walworth, Washington, and Waukesha Counties, the projected values of this indicator for 2035 are lower than the 2005 values, indicating that the influence of human withdrawals on the water budget of the shallow groundwater system may be expected to increase in these Counties under Subalternative 2 to the Composite Plan conditions. In Milwaukee and Ozaukee Counties, the projected values of this indicator for 2035 are higher than the 2005 values, indicating a reduction in the influence of human withdrawals on the water budget of the shallow groundwater system may be expected in this County under Subalternative 2 to the Composite Plan conditions. Despite this anticipated reduction, under plan conditions the shallow groundwater system underlying Milwaukee County may be expected to remain more heavily influenced by human activities in 2035 than those in several of the other counties in the Region.

Finally, the analysis indicated that in 2035 the baseflow reduction index may be expected to range from about -4.7 percent in Kenosha County to about 16.1 percent in Ozaukee County. Under Subalternative 2 to the Composite Plan conditions, the value of the baseflow reduction index in Kenosha, Racine, Walworth,

Table 177

PROJECTED GROUNDWATER PERFORMANCE INDICATORS FOR THE GLACIAL SAND AND GRAVEL AND SILURIAN DOLOMITE AQUIFERS UNDER 2005 AND 2035 SUBALTERNATIVE 2 TO THE COMPOSITE PLAN CONDITIONS

County	Demand to Supply Ratio[a]		Human Influence Ratio[b]		Baseflow Reduction[c] from 2000 Levels (percent)
	2005	2035	2005	2035	2035
Kenosha	0.047	0.087	-0.047	-0.085	-4.70
Milwaukee	0.159	0.131	-0.150	-0.127	2.43
Ozaukee	0.199	0.054	-0.188	-0.054	16.10
Racine	0.061	0.069	-0.060	-0.069	-1.10
Walworth	0.045	0.077	-0.044	-0.075	-4.39
Washington	0.083	0.116	-0.081	-0.113	-3.91
Waukesha	0.089	0.104	-0.086	-0.102	-1.76

[a]*The demand to supply ratio is defined as the ratio of net pumping demand on an aquifer to that aquifer's sustainable, or natural, supply. Generally, this indicator ranges from 0—representing no human impact—upward. Values over 1.0 indicate that more groundwater is being extracted than can be replaced in a long-term, sustainable fashion. The year 2005 and 2035 conditions for this indicator are compared to predevelopment conditions.*

[b]*The human impact ratio is defined as the ratio of human-induced groundwater inflows to total inflows minus the ratio of human-induced groundwater outflows to total outflows. This indicator is an expression of the relative magnitude of human alteration of the groundwater system. Values range from minus 1.0 in areas where wells have become the only discharge from an aquifer by stopping all other groundwater discharges, through 0 representing no net human impact, to plus 1.0 representing situations where human additions are the only inputs to the aquifer. The year 2005 and 2035 conditions for this indicator are compared to predevelopment conditions.*

[c]*The base flow reduction index is defined as the ratio of the reduction of groundwater-derived baseflow discharge due to pumping to the groundwater-derived baseflow at a defined base time. The year 2005 and 2035 conditions for this indicator are compared to predevelopment conditions.*

Source: University of Wisconsin-Milwaukee.

Washington, and Waukesha Counties in 2035 is expected to be negative, indicating that reductions in average groundwater-derived baseflow to surface waters may be expected. The positive value of the indicator in Milwaukee and Ozaukee Counties indicates that the average level of groundwater-derived baseflow to surface waters in this County may be expected to increase under Subalternative 2 to the Composite Plan conditions. Three caveats should be kept in mind when interpreting the changes in the baseflow reduction index. First, these are countywide averages developed for purposes of comparing alternative plans at the systems level. Within any county, changes in baseflow may be expected to vary among waterbodies. Second, a change in baseflow does not indicate a change in total streamflow. The index only considers the groundwater component of streamflow. The impact on streamflow will typically be less in terms of percent reduction or increase. For those streams which receive discharges of sewage treatment plant effluent, the baseflow and streamflow amounts will be artificially increased and make surface water flows less sensitive to changes in groundwater-derived baseflow. Third, for all Counties experiencing reductions in average baseflow, the 2035 magnitudes of average baseflow reduction under Subalternative 2 to the Composite Plan conditions are less than 10 percent, suggesting small average reductions relative to 2005 conditions.

Other Surface Water Impacts

Impacts on Water Quantity in the Fox River

The City of Waukesha currently utilizes groundwater as a source of supply and subsequently discharges it as treated wastewater to the Fox River which is located in the Mississippi River basin. Under Subalternative 2 to the Composite Plan, it is envisioned that Waukesha would be provided with Lake Michigan water as a source of supply. Discharges by the Waukesha wastewater treatment plant currently constitute a major source of water to the Fox River. Reductions in those discharges associated with a return flow of water to the Great Lakes basin, as envisioned in Subalternative 2 to the Composite Plan and as required by the Great Lakes-St. Lawrence River Basin Water Resources Compact, could potentially produce adverse environmental impacts in the form of reduced flows in the Fox River.

The impact of wastewater treatment plant discharges on the flows in the Fox River was described in Chapter VIII of this report. Flow data for the Waukesha wastewater treatment plant were compared to stream discharge data provided by the streamflow gage located on the Fox River at Waukesha (USGS Gage 05543830).[11] The flow data were disaggregated into months and the locations of the 10th percentile, 25th percentile, 50th percentile, 75th percentile, and 90th percentile ranks were determined for each month.[12] These monthly flow percentiles were compared to the average monthly flow from the Waukesha wastewater treatment plant in order to estimate the percentage of the streamflow immediately downstream of the plant's outfall which was comprised of treated effluent. Mean daily streamflows at the Waukesha stream gage over its period of record was about 68 mgd.

At the Waukesha treatment plant's outfall, treated effluent from the plant represents a seasonally substantial portion of discharge during the summer and fall at times when flow in the River is less than the monthly median daily average. At the 50th percentile, discharge of treated effluent from the Waukesha plant is estimated to represent about one quarter of the flow immediately below the outfall during the months of July through September. This indicates that during these months, treated effluent represents more than one quarter of the flow immediately below the plant's outfall about half the time. At the 25th percentile, discharges of treated effluent from the plant represents about one third of the streamflow immediately below the plant's outfall during the months of June through October. This indicates that during these months, treated effluent represents more than one third of the streamflow immediately below the plant's outfall about 25 percent of the time. At the 10th percentile, discharges of treated effluent from the wastewater treatment plant represents between 40 percent and 50 percent of the streamflow immediately below the plant's outfall during June through December and about 50 percent of stream flow during September. This indicates that during these months, treated effluent represents more than 40 percent of the streamflow immediately below the plant's outfall about 10 percent of the time.

The analysis indicates that treated effluent from the Waukesha wastewater treatment plant constitutes a major component of baseflow to the Fox River immediately downstream from the treatment plant outfall. In the summer and fall during periods when flow is at or below the 10th percentile, treated effluent from this plant accounts for about 40 percent to 50 percent of the flow immediately downstream from the plant outfall. Therefore, actions that would eliminate discharges from this wastewater treatment plant may be expected to result in significant seasonal reductions in flow in the Fox River immediately downstream of the treatment plant. It may be expected that these periods of reduced flow would occur about 10 percent of the time. In addition, reductions in flow in the Fox River might also occur if discharges from this wastewater treatment plant were reduced substantially rather than eliminated, although the magnitude of the reductions in flow in the River and how often the impacts would be likely to occur would depend upon the magnitude of the reductions in discharges from the wastewater treatment plant.

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[11]*This stream gage is operated under the long-standing SEWRPC-U.S. Geological Survey (USGS) cooperative stream gaging program. It was chosen because of its location in the watershed and because it has a long period of record of 44 years.*

[12]*A percentile rank is percentage of values which are lower than a given value. For example, the 10th percentile represents the upper boundary of the lowest 10 percent of the data. The interpretation of this statistic is that on 10 percent of the dates in this month during the period of record, average daily discharge at this gage was less than or equal to this value. Similarly, the 90th percentile represents the upper boundary of the lowest 90 percent of the data and is interpreted in a similar manner.*

The provision of Lake Michigan water as a source of supply to the City of Waukesha would be unlikely to require completely eliminating discharges to the Fox River from the City wastewater treatment plant. Comparison of the average daily pumpage by the Waukesha Water Utility to the average daily discharges reported by the Waukesha wastewater treatment plant in the CMAR reports for 2003 through 2007 indicates that the water utility pumpage accounts for about 85 percent of the water treated and discharged by the wastewater treatment plant. The remaining 15 percent is derived from clearwater infiltration and inflow into the sanitary sewerage system, and originates west of the subcontinental divide. Assuming that this proportion is typical of the sewerage systems, it indicates that, on average, about 85 percent of the treated effluent discharged by the treatment plant would need to be returned to the Lake Michigan watershed. The remaining 15 percent of the treated effluent would be available for discharge to the Fox River.

This indicates that the impacts of the return flow required under Subalternative 2 to the Composite Plan on water quantity in the Fox River could be reduced through active management of the return flow to the Lake Michigan watershed and the discharges to the Fox River. Under such management, during periods of low flow a portion of the effluent treated by the Waukesha wastewater treatment plant could be discharged to the Fox River in order to enhance the flows in the River. During periods of typical flows, most or all of the treated effluent could be returned to Lake Michigan. As long the amount of water returned to the Lake Michigan on an annual basis was equal to the amount withdrawn less the allowance for consumptive use, the return flow requirement should be satisfied.

It is important to note the limitations of this analysis. First, the analysis assumes that effluent additions to streamflow are conservative and additive in the stream. This is not the case, in part, because of flow interactions between the Fox River and the inflow of groundwater to the large stone quarries operating in the area, and pumped outflow from those quarries to the stream system. In addition, this analysis does not take into account other potential interactions between groundwater and the Fox River. Second, this analysis does not examine the response of the shallow groundwater system to a conversion to Lake Michigan water as a source of supply.

Impacts to Water Quantity in Underwood Creek or the Root River of Return Flow under Subalternative 2 Conditions

Under the second return flow alternative considered under Subalternative 2 to the Composite Plan, return flow from the City of Waukesha Water Utility service area may be effected by conveying treated effluent from the City of Waukesha wastewater treatment plant through a series of pumping stations and pipelines discharging into Underwood Creek, a tributary to the Menomonee River which flows into Lake Michigan, or to the Root River, a tributary to Lake Michigan. Alternatively, the return flow could be divided between Underwood Creek and the Root River. The return flow to these tributaries could have beneficial impacts during low flow periods when both tributary streams have very limited stream flow. For example, the 10th percentile flow in Underwood Creek is only 3.0 cubic feet per second under existing conditions. This could be increased to about 16 cubic feet per second by return flow. The return flow, if not actively managed, could, however, have adverse impacts on flood flows and stages, on streambank erosion, and on recreational uses of the stream system as a result of the reintroduction of wastewater treatment plant effluent to the streams involved.

The impacts of the return flow envisioned under this subalternative on the water quantity in Underwood Creek could be reduced through active management of the return flow to the Creek and the Waukesha wastewater treatment plant discharges to the Fox River. During periods of high flow, treated effluent from the Waukesha wastewater treatment plant could be discharged to the Fox River which currently receives the Waukesha wastewater treatment plant effluent. During periods of typical flows, the treated effluent from the Waukesha treatment plant could be discharged to Underwood Creek as return flow. For the purposes of the systems level analysis, it was assumed that this would provide conservative protection against flooding. This would allow, for example, discontinuing discharge to the receiving stream whenever the flow in that stream reached a selected recurrence interval whereby there would be a potential for impact. Such a recurrence interval could be selected to be conservatively safe, such as a four month recurrence interval, having a probability of occurring three times each year. It was assumed for the purposes of this analysis that the impacts of return flow on water quantity in the

Root River would be similar to those in Underwood Creek, and that a similar active management strategy could be pursued to reduce the impacts during periods of high flow. As already noted, only about 85 percent of the treated effluent would need to be returned to the Lake Michigan basin. The remaining amount would be available for discharge to the Fox River. It appears that this amount would be adequate both to supplement flow in the Fox River during low flow periods, and to discharge to the Fox River during periods of higher flows in Underwood Creek or the Root River. Should this return flow subalternative be selected and pursued, more detailed studies of the impacts of providing return flow through discharge of treated effluent into streams tributary to Lake Michigan will be necessary. Such studies would need to address, among others, the issues of water quality, baseflow enhancement, streambank erosion, and recreational use impacts.

Surface Water Quality Impacts

Under Subalternative 2 to the Composite Plan, the source of supply used by several utilities located east of the subcontinental divide would be shifted from groundwater to Lake Michigan water. This would result in a reduction in the hardness of the water provided by these utilities and would eliminate the need for household water softening facilities. This would also result in reductions in the concentration of chlorides in the sewage conveyed to the wastewater treatment facilities serving the areas concerned, and in the chloride loads discharged by these facilities into receiving waters, such as Cedar Creek, the Milwaukee River, and Lake Michigan. A reduction in the average concentrations of chloride in sewage conveyed to wastewater treatment facilities serving these communities of 100 mg/l would result in an annual reductions of chloride discharged to Cedar Creek, the Milwaukee River, and Lake Michigan of about 500,000 pounds, 1.1 million pounds and 3.1 million pounds, respectively. Available data indicate that the average concentrations of chloride in effluent discharged by municipal wastewater treatment plants serving communities that use groundwater as a source of supply may be expected to range between 400 and 550 mg/l. Therefore, reductions in chloride loadings to Cedar Creek, the Milwaukee River, and Lake Michigan on the order of magnitude indicated above may indeed be expected under Subalternative 2 to the Composite Plan conditions.

Potential surface water quality impacts are associated with the second return flow alternative considered under Subalternative 2 to the Composite Plan. Potential impacts may be expected to affect Underwood Creek and the Menomonee River, or the Root River, because, as noted above, under some of the options for this subalternative, treated effluent from the City of Waukesha wastewater treatment plant would be discharged to those streams. The potential impacts were assessed by comparing the concentrations of several pollutants in the treated effluent, as reported to the WDNR by the operators of the Waukesha wastewater treatment plant to ambient concentrations of these pollutants in Underwood Creek and the Root River as reported by SEWRPC.[13] It is important to note that these comparisons are based upon a summary statistical level of analysis. More detailed studies of the impacts of providing return flow through tributary streams upon surface water quality would be necessary, if this return flow subalternative were to be adopted and implemented.

Average concentrations of ammonia-nitrogen, biochemical oxygen demand, and total suspended solids were found to be lower in treated effluent discharged by the Waukesha plant than the average ambient concentrations in Underwood Creek and the Menomonee River. Similarly, average concentrations of ammonia-nitrogen, biochemical oxygen demand, and total suspended solids were found to be lower in the treated effluent than the average ambient concentrations in the Root River. The Creek and River concentrations meet, or nearly meet, the standards supporting the applicable water use objectives for constituents other than bacteria. These differences suggest that it is unlikely that water quality problems associated with these pollutants would occur as a result of providing return flow though these tributaries. However, more detailed analyses, including instream water quality modeling would be needed to determine if the applicable water use objectives and supporting standards, as set forth in the regional water quality management plan could be achieved following the implementation of the recommended water quality management measures.

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[13]*SEWRPC Technical Report No. 39,* Water Quality Conditions and Sources of Pollution in the Greater Milwaukee Watersheds, *November 2007.*

The average concentration of total phosphorus in the treated effluent discharged by the Waukesha plant was found to be roughly equal to the average ambient concentration in Underwood Creek, and slightly higher than the average ambient concentrations in the Menomonee River and Root River. These differences suggest that providing return flow through discharging treated effluent into Underwood Creek and the Root River, as envisioned in the second return flow alternative considered under Subalternative 2 to the Composite Plan, has the potential to increase the concentrations of total phosphorus in the Menomonee River downstream from the confluence with Underwood Creek, or in the Root River. The potential increases are likely to be relatively small based upon systems level analyses, and similar reductions in phosphorus loadings on the Fox River may be expected. More-detailed studies of these impacts would be necessary if this return flow subalternative were to be selected and pursued.

The phosphorus loading to Lake Michigan associated with the return flow is also a concern. Such loading is estimated to be about 12 pounds per day, insignificant when compared to the current loadings. As an example, the current phosphorus loadings from point and nonpoint sources in the Milwaukee River, Kinnickinnic River, Root River, and Menomonee River and the Milwaukee County Lake Michigan direct drainage area are estimated to total over 2,000 pounds of phosphorus per day. Thus, the loadings associated with the return flow from Waukesha may be expected to be on the order of 0.6 percent of the loading to Lake Michigan from the adjacent tributary area.

Average concentrations of chloride were found to be higher in the treated effluent discharged by the Waukesha wastewater treatment plant than the average ambient concentration in Underwood Creek, the Menomonee River, and the Root River. The use of Lake Michigan as a source of water supply by the City of Waukesha Water Utility, as envisioned under Subalternative 2 to the Composite Plan, would result in a reduction in the hardness of the water provided by the utility and would eliminate the need for water softening by households served. This would result in reductions in the concentration of chlorides in the sewage conveyed to the Waukesha plant, and in the chloride loads discharged by this plant to receiving waters. The magnitudes of these reductions are uncertain, and therefore, the potential impacts upon Underwood Creek and the Menomonee and Root Rivers are not clear. If reduced use of water softening resulted in a 50 percent reduction in the average concentration of chloride in the treated effluent, the average chloride concentration in the effluent would approximate the average ambient concentrations in these streams.

Given the potential issues regarding water quality in the receiving streams being considered, a more-detailed evaluation of the instream water quality conditions with the return flow would be needed to determine what water quality control measures may be needed to achieve the water use objectives and supporting standards concerned. Such an evaluation would typically require water quality modeling and would be carried out under more-detailed facility planning if the return flow component discharging to streams were to be adopted and proposed for implementation.

For most other utilities within the Region, Subalternative 2 to the Composite Plan recommends use of expanded sources of groundwater that are similar to existing sources. Because of this, it is anticipated that this alternative will produce few changes in surface water quality within the Region, other than those described above.

Conclusions Concerning Groundwater-Surface Water Impacts of Subalternative 2 to the Composite Plan

The results of the simulation modeling indicated that under Subalternative 2 to the Composite Plan conditions, drawups may be expected to occur in the deep aquifer over most of the Region. The magnitude of the average drawups over 2005 conditions in this aquifer may be expected to range between 8 and 85 feet by county. The maximum drawup over 2005 conditions in this aquifer may be expected to be about 248 feet. In all counties of the Region, except for Kenosha and Walworth Counties, drawups over 2005 conditions in excess of 50 feet may be expected to be common. These drawups reflect both the shift by some utilities from the use of groundwater as a source of water supply to the use of Lake Michigan, and a shift by some utilities from the deep groundwater system as a source of water supply to the shallow groundwater system as envisioned under Subalternative 2 to the Composite Plan. Some drawdowns may be expected to occur in some model cells in Walworth County over the planning period under this alternative plan. The magnitude of the drawdowns over 2005 conditions in this aquifer may be expected to be relatively small with average drawdowns for Walworth County simulated as being about two feet and the maximum drawdown simulated as being about 14 feet. Some drawdowns may also be expected in some relatively small areas of Kenosha, Washington, and Waukesha Counties. The drawdowns and the smaller drawups expected in Kenosha and Walworth Counties may be attributed, in part, to the influence of groundwater use in northeastern Illinois. In addition, these areas are also located a considerable distance from the utility service areas whose source of water supply is envisioned to change from the deep aquifer to Lake Michigan under Subalternative 2 to the Composite Plan. Water budget analyses indicate that the deep groundwater system is likely to be heavily influenced by human activities under Subalternative 2 to the Composite Plan conditions, with the net effect of human activities being to remove water from the deep groundwater system. This analysis also indicates that some counties of the Region may experience water budget deficits in the deep aquifer under Subalternative 2 to the Composite Plan conditions.

On a Regional scale, pumping under Subalternative 2 to the Composite Plan conditions may be expected to increase from 1.7 mgd to about 81.7 mgd between 2005 and 2035. The simulation modeling indicates that under Subalternative 2 to the Composite Plan conditions, a net amount of about 8.8 mgd of water from the Region would be contributed to storage in the aquifers and to cross-boundary flow out of the planning area, requiring a mass balance analysis to account for about 10.5 mgd of water. About 45 percent of this water to be accounted for would be derived from groundwater flow that, in the absence of pumping, would be discharged to surface water features, and about 55 percent would be derived directly from surface water features due to reversed hydraulic gradients at the groundwater-surface water interface. The impact of pumping on surface waters can be represented as groundwater-derived baseflow depletion. Groundwater-derived baseflow is the amount of flow in the waterbody from upgradient groundwater discharge. The overland component of total streamflow and any discharge of treated wastewater are not included in baseflow, and the simulation modeling results do not include, or account for, these components. Typically baseflow represents about 10 percent to 50 percent of streamflow on an annual basis. In aggregate, by 2035 surface waterbodies in the Region may be expected to experience a baseflow depletion relative to 2005 conditions of about 7.0 mgd, or about 2 percent. On average, baseflow reduction under Subalternative 2 to the Composite Plan conditions approximate 10 percent, suggesting small average reductions relative to 2005 conditions. These aggregate total and average values may, however, obscure site-specific differences in baseflow changes within each county. While the county totals project overall depletions within each county, individual waterbodies may experience either depletion or augmentation. The reductions in groundwater-derived baseflow at 14 of 100 surface water evaluation sites were in excess of 10 percent.

The results of the simulation modeling indicate that under Subalternative 2 to the Composite Plan conditions, additional drawdowns over 2005 conditions may be expected to occur in the shallow aquifer over much of the Region. However, the magnitude of the drawdowns is estimated to be relatively small; in most counties, the drawdowns may be expected to average less than 1.5 feet. The relatively small magnitude of the drawdowns may be attributed to the buffering effects of surface water baseflow interactions and to the increases in baseflow that occur in some parts of the Region under Subalternative 2 to the Composite Plan conditions.

In the glacial sand and gravel aquifer, additional drawdowns may be expected to occur in 35 to 81 percent of the model cells by county over the period 2005 to 2035. The magnitude of average drawdowns over 2005 conditions in this aquifer was simulated to be small, less than 1.5 feet in all counties of the Region. While the maximum drawdown over 2005 conditions in this aquifer may be expected to be about 71 feet, only a small percentage of model cells were simulated to experience drawdowns over 2005 conditions in excess of 10 feet. In other parts of the Region, especially southern Ozaukee County and eastern Waukesha County, it is expected that drawups over 2005 conditions will occur in the sand and gravel aquifer under Subalternative 2 to the Composite Plan conditions. In most of the areas simulated to experience drawups, only a small percentage of model cells were simulated to experience drawups over 2005 conditions in excess of 10 feet. With some exceptions, similar impacts were simulated to occur in the Silurian dolomitic aquifer. Additional drawdowns may be expected to occur in this aquifer in 20 to 78 percent of model cells by county over the planning period. While the maximum drawdown over 2005 conditions in this aquifer was simulated to be about 61 feet, only a small percentage of model cells in most counties were simulated to experience drawdowns over 2005 conditions in excess of 10 feet. In other parts of the Region, especially southern and central Ozaukee County, southeastern Washington County, and eastern Waukesha County, it is expected that drawups over 2005 conditions will occur in the Silurian dolomitic aquifer under Subalternative 2 to the Composite Plan conditions. Water budget analyses indicate that in most counties of the Region, the influence of human activities on the shallow groundwater system will increase under Subalternative 2 to the Composite Plan conditions. While the net effect of human activities in all counties of the Region will result in the removal of water from the shallow groundwater system, there is little evidence that a water budget deficit will occur where more groundwater will be extracted than can be replaced in a long-term sustainable fashion in the shallow groundwater system. This is likely due, in large part, to the buffering effects of surface waters.

Although the results of the simulation modeling indicate that the changes in the shallow aquifer system are expected to be relatively small in much of the Region under Subalternative 2 to the Composite Plan, some larger changes may be expected to occur in some areas. Most of Ozaukee County and portions of southeastern Washington and eastern Waukesha Counties may be expected to experience drawups in the Silurian dolomitic aquifer, in excess of 10 feet in many locations, especially in Ozaukee County, and in excess of 50 feet in some locations. These drawups are attributable to several factors envisioned under Subalternative 2 to the Composite Plan including the shift in the source of water supply in areas served by public sanitary sewer system in Mequon from private wells to Lake Michigan and the shift in the source of water supply for several communities that are located on either side of the subcontinental divide from groundwater to Lake Michigan. The relatively large magnitude of these changes also results from the fact that overlying clay-rich glacial tills act to confine this aquifer.

During low flow periods, there is the potential for the return flow component of Subalternative 2 to the Composite Plan to produce adverse impacts upon water quantity in the Fox River downstream from the City of Waukesha wastewater treatment plant. These impacts could, however, be mitigated through a strategy of active management of the discharge of the fraction of wastewater treatment plant effluent that exceeds the amount of Lake Michigan water provided to the City. The impacts on water quantity of providing return flow through discharge of treated effluent to streams tributary are likely to be small. There is the potential for positive impacts to occur during low flow periods, and for negative impacts to occur during high flow periods. At periods of high flow, negative impacts could also be mitigated through a strategy of active management of the discharge of the fraction of wastewater treatment plant effluent that exceeds the amount of Lake Michigan water provided to the City. Water quality impacts may also expected to be modest based upon systems level analyses; however, both the water quantity and water quality impacts would have to be studied in more detail if this alternative under Subalternative 2 to the Composite Plan were selected and implementation pursued.

COMPARATIVE EVALUATION OF SUBALTERNATIVE COMPOSITE PLANS

This section presents the findings of a comparative evaluation of the two Subalternatives to the Composite Plan. The evaluation is based upon the extent to which each of the subalternatives may be expected to meet the agreed-upon water supply development and management objectives and, thereby, identifies the technical, economic, and environmental performance of the subalternatives. The estimated capital costs of the subalternatives range from about $297 million for Subalternative 1, to between $329 million and $356 million for Subalternative 2, depending upon which option for return flow is considered. The gross annual operation and maintenance costs of new facilities under the two subalternatives range between $8.0 million for Subalternative 1 to from about $8.0 million to $8.5 million for Subalternative 2, depending upon which option for return flow is considered. It is anticipated that under the plan conditions there would be a reduced use of water softening measures in those areas proposed for conversion to a Lake Michigan water supply. It is expected that this would result in a cost reduction related to the elimination of the need to use household water softening facilities ranging from $9.4 million under Subalternative 1, to $16.7 million under Subalternative 2. When the expected reductions in cost attributable to the potential elimination of individual residential water softening facilities are included, Subalternative 1 would result in a net annual savings to the public of about $1.4 million, while Subalternative 2 would result in a net annual |

savings to the public of between about $8.2 million and $8.7 million. Equivalent annual costs are estimated to be about $13.1 million for Subalternative 1, and to range between $8.5 million and $10.8 million for Subalternative 2, depending upon which option for return flow would be found best.

Method of Evaluation

A rank-based method similar to that used to evaluate the four alternative plans initially considered was used to compare the anticipated performance of the two Subalternatives to the Composite Plan. In this method, the alternative plans were evaluated and ranked on the basis of the ability to achieve the agreed-upon water supply development and management objectives. Because there were only two subalternatives to be considered, a value of 1.0 was assigned to the subalternative that was found to best meet the supporting standards, and a rating of 2.0 was assigned to the other subalternative. In instances where the two subalternative plans were expected to have similar performance relative to an objective, rankings of 1.5 were given to both. The rankings of each alternative plan under each of the five objectives were then totaled to establish the rank order of the plans.

Evaluation

The rank-based evaluation of the two Subalternatives to the Composite Plan with respect to the standards supporting the agreed-upon water supply objectives is presented in Table 178. The logic of the rankings of the standards is similar to that used to evaluate the four alternatives initially evaluated as documented earlier in this chapter. Table 179 presents the ranking of the Subalternatives to the Composite Plan for each of the objectives assessed in Table 178. Several aspects of the rankings warrant comment. First, the rankings for the majority of the standards are equal. This is to be expected since the Subalternatives to the Composite Plan were designed to meet the planning objectives and standards to the maximum extent practicable. Second, Subalternative 2 to the Composite Plan may be expected to achieve the plan objectives more fully than Subalternative 1 for three of the five plan objectives. These plan objectives relate to support of the land use plans; the conservation and wise use of the water sources; and the protection of public health, safety, and welfare. Thirdly, Subalternative 1 and Subalternative 2 to the Composite Plan are considered to meet the plan objectives equally well for the plan objective concerning economy and efficiency. Finally, Subalternative 1 to the Composite Plan is considered to better meet the plan objective concerning responsive and adaptive plans.

Consideration was also given in the evaluation of the two subalternatives to the energy-related impacts of the subalternatives. To determine these impacts, the Commission staff developed estimates of the electric power requirements for treating and transporting water under each of the subalternatives. The methods used to develop these estimates are described and the estimates are presented in Appendix L of this report. For the Region as a whole, the difference in the electric power requirements between the two subalternatives to the Composite Plan was less than 1 percent.

Conclusions

Subalternative 2 is considered more cost-effective than Subalternative 1 when including cost savings attendant to the discontinuance of household water softening and other point-of-use water treatment devices. Subalternative 2 offers an opportunity to utilize existing excess Lake Michigan water production capacity, and to provide potential cost advantages to both the supplier and supplied utilities. Subalternative 2 would provide greater drawups in the deep groundwater aquifer. This factor is important in addressing the objectives of 2003 Wisconsin Act 310 and the recommendations of the State Groundwater Advisory Committee created by that law. This is also important because the groundwater modeling analyses conducted under the planning effort indicated that it is possible that unsaturated conditions may exist in the Sinnipee Group of the upper portions of the deep aquifer below east-central Waukesha County. This condition could be exacerbated by further pumping of the aquifer. If unsaturated conditions develop in depth, and spread in extent, with continued pumping, it could limit the sustainability of well yields and affect deep aquifer well water quality due to the increased potential for oxidation and related pollution of the water. Also, Subalternative 2 may be expected to have less reduction in baseflow to surface waters, and greater reductions in chloride discharges to surface waters than Subalternative 1. It was concluded that Subalternative 2 meets the water supply development and management objectives and supporting standards more fully than Subalternative 1. Subalternative 2 of the Composite Plan was therefore presented for public review and comment as the preliminary recommended water supply plan for the Southeastern Wisconsin Region.

Table 178

RATINGS OF SUBALTERNATIVES TO THE COMPOSITE PLAN RELATIVE TO PLANNING STANDARDS[a]

Standard	Subalternative Composite Plan[b] 1	2
Objective No. 1—Support of Existing Land Use Patterns and Support and Direction of Planned Land Use Patterns	- -	- -
1. Public water supply systems should be designed to serve lands planned to be developed for urban uses, in accordance with the adopted regional land use plan	1.5	1.5
2. Areas of high potential for groundwater contamination should be excluded for the siting of potentially contaminating land uses or facilities	1.5	1.5
3. Important groundwater recharge and discharge areas should be identified for preservation or application of land development plans and practices which maintain the natural surface and groundwater hydrology, while protecting the groundwater quality	1.5	1.5
4. Sources of water supply should be specifically allocated to adequately serve lands planned to be maintained in agricultural uses	2.0	1.0
5. Primary environmental corridors should be preserved in essentially natural, open uses, and the extension of urban services, including public water supply services, into such corridors should be avoided, except for corridor-dependent uses, such as recreational facilities and water transmission main, sewage conveyance facilities, and other utility crossings	1.5	1.5
6. Secondary environmental corridors and isolated natural resource areas should be preserved in essentially natural, open uses to the extent practicable, as determined in county and local plans	1.5	1.5
7. The most productive soils, those designated by the U.S. Natural Resources Conservation Service as comprising agricultural soil capability Classes I and II, should be preserved for agricultural use, to the extent practicable, recognizing that certain Class I and Class II farmland will have to be converted to urban use in order to accommodate the orderly expansion of urban service areas within the Region. The extension of urban services, including public water supply services, into such areas should be avoided, except as these lands are converted to urban uses	1.5	1.5
8. Development of water sources in areas to be preserved for agricultural uses should be carried out in a manner which preserves the agricultural uses of the land as envisioned in the adopted regional land use plan	1.5	1.5
Subtotal	12.5	11.5
Rating	2.0	1.0
Objective No. 2—Conservation and Wise Use of the Surface Water and Groundwater Supplies	- -	- -
1. The use of the deep sandstone aquifer should be managed so that the potentiometric surface in that aquifer is sustained or raised under use and recharge conditions within the Southeastern Wisconsin Region. Declines in the potentiometric surface of the aquifer within the Region due to uses in areas beyond the Region should be identified for purposes of promoting interregional planning and action	2.0	1.0
2. The uses of the shallow aquifer should be managed so that the aquifer yields are sustainable	2.0	1.0
3. The uses of the deep and shallow aquifers should be managed so as to minimize the ecological impacts on the surface water system of the Region	2.0	1.0
4. Lake Michigan as a source of supply should be utilized recognizing the constraints of the current regulatory framework and the status and provisions of the Great Lakes-St. Lawrence River Basin Water Resources Compact	1.5	1.5

Table 178 (continued)

Standard	Subalternative Composite Plan[b]	
	1	2
Objective No. 2—Conservation and Wise Use of the Surface Water and Groundwater Supplies (continued)	- -	- -
5. The use of groundwater and surface water for water supply purposes should be carried out in a manner which minimizes adverse impacts to the water resources system, including lakes, streams, springs, and wetlands	2.0	1.0
6. Residential per capita water usages should be reduced to the extent practicable based upon the conclusions developed in SEWRPC Technical Report No. 43, *State-of-the-Art of Water Supply Practices*, and recognizing that differences in levels of conservation may be appropriate, depending upon the source of supply and related natural resources	1.5	1.5
7. Both indoor and outdoor water uses should be optimized through conservation practices which do not adversely affect the public health	1.5	1.5
8. Water uses for commercial, industrial, and institutional land uses should be reduced to the extent practicable through water conservation measures, duly considering the source of supply and related natural resources, as well as the economic viability and economic development needs of the Region	1.5	1.5
9. Unaccounted-for water in utility systems should be minimized	1.5	1.5
10. The type and extent of stormwater management and related land management practices should be determined through preparation of local stormwater management plans and land development practices and policies specifically considering the impact of those activities on groundwater recharge and should promote such practices which maintain or enhance the natural groundwater hydrology to the extent practicable, while protecting surface water and groundwater quality and quantity	1.5	1.5
Subtotal	17.0	13.0
Rating	2.0	1.0
Objective No. 3—Protection of Public Health, Safety, and Welfare	- -	- -
1. Water supply systems should be designed, constructed and operated to deliver finished water to users which meets the drinking water standards established by the Wisconsin Department of Natural Resources to protect the public health, safety, and welfare[c]	1.5	1.5
2. Water supply systems should be designed, constructed, and operated consistent with technically sound water supply industry standards directed toward the protection of the public health, safety, and welfare	1.5	1.5
3. The selection of sources of supply and the design, contribution and operation of related treatment facilities should be made cognizant of the potential presence of unregulated emerging pollutants, such as pharmaceuticals, personal care products, and certain viruses	1.5	1.5
4. The reuse of wastewater should be evaluated for applications where there is no potential for direct human consumption and limited potential for direct human contact, unless the pre-use treatment level is such as to preclude risks to public health	1.5	1.5
5. Surface water and groundwater supply treatment plants should be provided with state-of-the-art barriers to substances harmful to human health and safety	1.5	1.5
6. Water supply sources and treatment processes should be selected to minimize potential problems with subsequent treatment and disposal of created waste streams	2.0	1.0
7. Groundwater and surface water sources of water supply should be protected from sources of contamination by appropriate siting, design, and land use regulation	1.5	1.5

Table 178 (continued)

Standard	Subalternative Composite Plan[b]	
	1	2
Objective No. 3—Protection of Public Health, Safety, and Welfare (continued)	- -	- -
8. The level of treatment and design provided at public sewage treatment plants and industrial wastewater discharge locations should be determined directly related to the achievement of adopted water use objectives and supporting surface water and groundwater standards[d]	1.5	1.5
9. The density, design, operation, and level of treatment of onsite sewage disposal systems should be related to the achievement of the groundwater quality standards and the safety and public health requirements of any potentially affected water supplies	1.5	1.5
10. The type and extent of stormwater management or associated preventive land management practices to be applied in both urban and rural areas should be determined by State and local regulations, local stormwater management plans, county land and water management plans, and farm management plans directly related to protection of potentially affected water supplies and to the established water quality standards for the receiving surface water and groundwater systems	1.5	1.5
11. There should be no known wastewater or stormwater discharges to the surface water or groundwater systems used for water supply of inorganic compounds, synthetic compounds, volatile organics, or other substances in quantities at levels known to be bioaccumulative, acutely or chronically toxic or hazardous to human health, fish or other aquatic life, wildlife, and domestic animals	1.5	1.5
Subtotal	17.0	16.0
Rating	2.0	1.0
Objective No. 4—Economical and Efficient Systems	- -	- -
1. The sum of water supply system operating and capital investment costs should be minimized. Costs for waste disposal byproducts of water treatment, long-term energy and operation and maintenance, and legal costs should be considered	1.5	1.5
2. Maximum feasible use should be made of all existing and committed water supply facilities, which should be supplemented with additional facilities only as necessary to serve the anticipated water supply needs	2.0	1.0
3. The use of new or improved technologies and management practices should be allowed and encouraged if such technologies and practices offer economies in construction costs or by their superior performance lead to the achievement of water supply objectives at a lesser cost	1.5	1.5
4. Water supply facilities should be designed for staged or incremental construction where feasible and economical so as to limit total investment in such facilities and to permit maximum flexibility to accommodate changes in the rate of population growth and the rate of economic activity growth or changes in the technology for water supply management	1.0	2.0
Subtotal	6.0	6.0
Rating	1.5	1.5
Objective No. 5—Responsive and Adaptive Plans	- -	- -
1. The recommended regional water supply plan components should be adaptable to change in scope, capacity, and effectiveness to the extent practicable	1.0	2.0
2. The recommended water supply plan should be designed to incorporate redundancy, system backup features, and emergency operation requirements to the extent practicable in order to insure a safe delivery of water	1.0	2.0
3. The regional water supply plan components should be designed for staged incremental construction to the extent practical, so as to permit maximum flexibility to accommodate unanticipated changes in future conditions	1.0	2.0

Table 178 (continued)

Standard	Subalternative Composite Plan[b] 1	2
Objective No. 5—Responsive and Adaptive Plans (continued)	- -	- -
4. The regional water supply plan should be adaptable to changes in the regulatory structure, including the 2001 Great Lakes-St. Lawrence River Basin Water Resources Compact and the State of Wisconsin 2003 Act 310	1.0	2.0
5. The regional water supply plan should consider the possibility of long-term climate cycles that can affect recharge rates and water demand	2.0	1.0
6. The regional water supply plan should consider the possibility of changes in economic conditions, security issues, and regulations that can affect the demand for water supply and need for and types of water supply facilities	1.0	2.0
Subtotal	7.0	11.0
Rating	1.0	2.0

NOTE: The alternative plans are as follows:

Subalternative 1 to the Composite Plan—2035 Forecast Conditions with Intermediate Expansion of Lake Michigan Supply and the City of Waukesha Water Utility Remaining on Groundwater

Subalternative 2 to the Composite Plan—2035 Forecast Conditions with Intermediate Expansion of Lake Michigan Supply and the City of Waukesha Water Utility Converted to Lake Michigan Supply

[a]*Planning objectives, principles, and standards are presented and discussed in Chapter V of this report.*

[b]*Alternative plans are ranked 1 or 2, with 1 representing the alternative plan expected to best achieve the standard. When the performance of the two subalternative plans are anticipated to be the same, each subalternative was ranked 1.5.*

[c]*Drinking water standards are set forth in Chapter V and Appendix H of this report.*

[d]*Water use objectives and supporting water quality standards and criteria are set forth in Appendices I and J of this report.*

Source: SEWRPC.

WATER SUPPLY SUSTAINABILITY AND RELATIONSHIP TO THE REGIONAL LAND USE PLAN

As indicated in Chapters I and IV and in the prospectus for the regional water supply planning program, the design year 2035 regional land use plan served as the basis for the forecasts of employment, population, and land use patterns envisioned in the regional water supply plan. It was, however, recognized that the regional water supply planning program might identify a need to refine or revise the design year 2035 land use plan owing to water supply considerations which were not known during development of that plan. Thus, it was envisioned that the regional water supply plan could potentially include recommendations for appropriate amendments to the regional land use plan. This iterative process has served well in the past for development of comprehensive integrated regional land use, transportation system, and water resources plans.

The potential need to amend the regional land use plan as a result of the findings of the regional water supply plan relates to the sustainability of the water supply sources in the plan. Should there be a finding that sources of supply are not sustainable under the conditions envisioned in the adopted regional land use plan, consideration would be given to amending that plan.

Table 179

RATINGS OF SUBALTERNATIVES TO THE COMPOSITE PLAN RELATIVE TO PLANNING OBJECTIVES[a]

Objective	Subalternative Composite Plan[b] 1	2
Support of Existing Land Use Patterns and Support and Direction of Planned Land Use Patterns	2.0	1.0
Conservation and Wise Use of the Surface Water and Groundwater Supplies	2.0	1.0
Protection of Public Health, Safety, and Welfare	2.0	1.0
Economical and Efficient Systems	1.5	1.5
Responsive and Adaptive Plans	1.0	2.0
Total	8.5	6.5

NOTE: The alternative plans are as follows:

Subalternative 1 to the Composite Plan—2035 Forecast Conditions with Intermediate Expansion of Lake Michigan Supply and the City of Waukesha Water Utility Remaining on Groundwater

Subalternative 2 to the Composite Plan—2035 Forecast Conditions with Intermediate Expansion of Lake Michigan Supply and the City of Waukesha Water Utility Converted to Lake Michigan Supply

[a] *Planning objectives, principles, and standards are presented and discussed in Chapter V of this report.*

[b] *Alternative plans are ranked 1 or 2, with 1 representing the alternative plan expected to best achieve the standard. When the performance of the two subalternative plans are anticipated to be the same, each subalternative was ranked 1.5.*

Source: SEWRPC.

Sustainability with respect to water supply resources may be defined as the condition of beneficially using water supply resources in such a way that while current and probable future needs are met, the resource is not unacceptably damaged or diminished, but essentially conserved for future use. For the purposes of the regional water supply planning effort, the phrase "unacceptably damaged or diminished" was defined as a change in an important physical property of the groundwater or surface water system—such as water level, water quality, recharge rate, or discharge rate—that approaches a significant percentage of the normal range of variability of that property. Changes that were 10 percent or less of the annual or historic period of record range for any property were considered acceptable, unless it could be shown that the cumulative effect of the changes will cause a permanent change in an aquatic ecosystem by virtue of increasing the extremes of that property to levels known to be harmful.

The sources of water supply envisioned to be used under the initially recommended plan include: Lake Michigan surface water, accounting for 76 percent of the use; deep aquifer groundwater, accounting for 7 percent of the use; and shallow aquifer groundwater, accounting for 17 percent of the use. The Lake Michigan supplies may be assumed to be fully sustainable assuming sound management and a return flow as envisioned in the plan. Water levels in the deep sandstone aquifer under most of the Region may be expected to rise under the use and recharge conditions envisioned under the preliminary recommended regional water supply plan. This increase in water levels should ensure the sustainability of this aquifer.

Because unconfined shallow aquifers are hydraulically connected to surface waterbodies, water levels in the shallow aquifer are buffered by the surface water system. Consequently, groundwater-derived baseflow to surface waterbodies is considered to be a better indicator of the potential impacts on the shallow groundwater system than water levels in the shallow aquifer. Under the preliminary recommended plan, some surface waters in the Region may be expected to experience reductions in groundwater-derived baseflow. In many of the streams that may be expected to experience reductions in groundwater-derived baseflow, however, the baseflows are supplemented by discharges of effluent from wastewater treatment plants. For these streams, the impact of groundwater-derived baseflow reductions upon total streamflow may be expected to be small or negligible, since the groundwater withdrawals for the utility systems concerned are returned to the streams through the wastewater treatment plants. The preliminary recommended plan envisions mitigative measures for those waterbodies expected to experience reductions in groundwater-derived baseflow that do not receive contributions of treated effluent; however, some reduction in groundwater-derived baseflow, representing about 2 percent of the total regional baseflow, may be expected. These changes in surface water baseflow range from a loss of about 4 percent, to an augmentation of about 15 percent, on average within each county concerned. Given that groundwater-derived baseflow typically comprises only a portion of total streamflow, this was considered to be a small impact within a range considered acceptable.

Given the abovenoted findings related to water supply source sustainability, it was concluded that no changes to the regional land use plan were needed for water supply purposes. Accordingly, no such recommendations are included in the final recommended regional water supply plan.

CONSIDERATION OF A HIGHER LEVEL OF WATER CONSERVATION

Water Conservation Levels Initially Envisioned in the Composite Water Supply Plan

As previously noted, the preliminary recommended plan included provisions for the conduct of comprehensive water conservation programs, including both supply side water efficiency measures and demand side water conservation measures. Under the composite water supply plan, the conservation programs were developed on a utility-specific basis to reflect the source of supply and existing infrastructure considerations, as summarized in Table 59 of Chapter IV. That table was developed under, and was initially presented in the state-of-the-art water supply practices report prepared under the regional water supply planning program.[14] Reductions in demand were expected to vary from 4 to 10 percent on an average daily demand basis, and from 6 to 18 percent on a maximum daily demand basis, depending upon the level of water conservation programming assigned to each water utility.

The water conservation measures considered are listed below. These measures are intended to constitute a guide to be used by local water utilities within the Region in developing utility-specific conservation programs. Those utility-specific programs are intended to be consistent with any requirements which may derive from the Great Lakes-St. Lawrence River Basin Water Resources Compact, and from related State regulations which are under development. Additional measures may also be applicable if needed to meet sewerage system protection or stormwater management objectives.

<u>Base-Level Program</u>: Base-level conservation programs are to be designed to provide about a 4 percent reduction in average daily demand, and from 6 to 10 percent reduction in maximum daily demand. Such programs may include:

- Water supply system efficiency actions including water audits, meter testing, leak detection and repair, water main maintenance and replacement, water system audits, and water production system refinement. These measures are, at least in part, being applied by most of the water utilities within the Region;

- Moderate levels of public information and education programming, including redesign of water bills, collation and distribution of educational materials, and presentations to school and civic groups; and

[14]*SEWRPC Technical Report No. 43,* State-of-the-Art of Water Supply Practices*, July 2007.*

- Outdoor watering reduction measures such as the use of rain barrels, and imposition of lawn and landscape plant watering restrictions, including time-of-day and limited-day watering requirements.

Intermediate-Level Program: Intermediate-level conservation programs are to be designed to provide about a 6 to 8 percent reduction in average daily demand and a 12 to 16 percent reduction in maximum daily demand. Such programs may include:

- All of the components of a base-level program;
- Higher levels of public information and education programming, including the development of school curriculum and broader informational programs involving newspapers, websites, and flyers;
- Residential, commercial, industrial, and institutional plumbing system retrofits, including the provision and installation of low-volume shower heads and toilet displacement device kits;
- Use of water conservation rate structures; and
- More aggressive outdoor watering restrictions.

Advanced-Level Program: Advance-level conservation programs are to be developed to provide about a 10 percent reduction in average daily demand and an 18 percent reduction in maximum daily demand. Such programs may include:

- All of the components of an intermediate-level program;
- Fixture and plumbing management, including toilet, water softener, and clothes washing machine replacement rebate programs; and
- Even more aggressive water conservation rate structures and outdoor watering restrictions.

The level of water conservation included in the preliminary recommended plan for each of the water utilities in the Region is summarized in Appendix N. As previously noted, the water conservation program level and components are intended to be applied on a water utility-specific basis based upon the water supply infrastructure needs, and the type and sustainability of the water supply involved. A specific level of water conservation was initially applied to the forecast 2035 average and maximum daily demand for each water utility in the Region. The levels of water conservation were refined for the design of the preliminary recommended plan to reflect the plan source of supply and infrastructure needs. Specific changes to the level of water conservation were made to reflect changes in groundwater supply facilities which have been completed to resolve quality issues, planned changes in the source of supply, and a recognition of relatively significant infrastructure needs associated with potential new municipal water supply systems. The plan design year 2035 pumpage and attendant needed facilities were not specifically revised, given that the indicated revisions would be very limited with respect to the capacity of the plan components, and would not be expected to significantly impact the comparative evaluation of the alternative plans or plan costs.

For purposes of the preliminary recommended plan, the levels of water conservation which were determined to apply were established using the guidelines summarized below:

Base-Level Program. This level was applied to the following utility categories:

- Utilities currently utilizing Lake Michigan as a source of supply and needing no major infrastructure to meet current and future needs.

- Utilities currently utilizing Lake Michigan as a source of supply and needing no major infrastructure to meet current and near-term future needs, but requiring major new infrastructure to meet long-term future needs associated with new development.

Intermediate-Level Program. This level program was applied to the following utility categories:

- Utilities to be converted to a Lake Michigan supply with an existing return flow and requiring significant additional infrastructure for the new supply connection.

- Utilities continuing to utilize groundwater as a source of supply with no, or modest, infrastructure needs and no outstanding significant groundwater quality issues to resolve.

Advanced-Level Program.

- Utilities to be converted to a Lake Michigan supply with a need for a new return flow system, as well as supply infrastructure, thus, entailing significant additional infrastructure cost.

- Utilities utilizing groundwater as a source of supply with major infrastructure needs and/or outstanding significant water quality issues to resolve or special environmentally sensitive surface water protection considerations.

The water conservation-related water demand reduction procedure was not intended to compromise fire-fighting capabilities. Fire-fighting capability is typically established by meeting pressure and flow requirements within the water supply distribution system. These requirements are typically designed to be met over and above the maximum day pumpage and are provided by system storage and pumping stations. As local utility water supply systems are developed, care should be taken to ensure that fire-fighting capability is not compromised by the implementation of water conservation programs. It should be noted that the sizing and cost associated with portions of the water supply infrastructure related to fire-fighting capability, such as storage and some water mains may not be affected by water conservation measures.

For purposes of the preliminary recommended plan, consideration of the utility-based considerations noted above resulted in the application of the three levels of water conservation given in Table 180. The base-level program was envisioned to be utilized by about 1.59 million persons, or about 70 percent of the year 2035 planned service area population. The intermediate-level program was envisioned to be utilized by about 0.5 million persons, or about 22 percent of the planned year 2035 planned service area population. The advanced-level program was envisioned to be utilized by about 0.18 million persons, or about 8 percent of the planned year 2035 service area population.

The cost of the water conservation measures envisioned was estimated to total $1,300,000 per year for the Region as a whole. These costs were accounted for in the Composite Plan in the costs for each alternative or subalternative as presented in the previous sections of this chapter. The cost for the water supply facilities envisioned under the Composite Plan is lower than it would have been if no water conservation measures were included. The revised costs for water conservation, as set forth in Appendix N, was estimated to be $1,200,000.

Optional Higher-Level Water Conservation Program

A higher-level water conservation alternative was considered for inclusion as a subalternative of the composite plan. That option would increase the level of water conservation in programs utilized throughout the Region as follows:

- Areas envisioned in the composite plan to have a base-level program would have an intermediate-level program;

Table 180

APPLICATION OF WATER CONSERVATION MEASURES ENVISIONED UNDER THE SUBALTERNATIVES TO THE COMPOSITE WATER SUPPLY PLAN

County	2035 Population Served			
	Base-Level Water Conservation Program[a]	Intermediate-Level Water Conservation Program	Advanced-Level Water Conservation Program	Total
Kenosha	166,200	9,900	34,000	210,100
Milwaukee	1,007,100	- -	- -	1,007,100
Ozaukee	58,050	42,300	750	101,100
Racine	167,000	26,600	20,000	213,600
Walworth	27,900	97,150	14,950	140,000
Washington	44,300	111,300	1,700	157,300
Waukesha	119,250	214,250	113,300	446,800
Total	1,589,800	501,500	184,700	2,276,000

[a]*Includes population envisioned to be served by individual, self-supplied wells.*

Source: SEWRPC.

- Areas envisioned in the composite plan to have an intermediate-level program would have an advanced-level program; and

- Areas envisioned in the composite plan to have an advanced-level program would be modified to have a yet higher-level program.

The program effectiveness and potential water conservation measures associated with the low-level, intermediate-level and advanced-level programs were previously summarized. The high-level program would be expected to entail all of the measures included in the advanced-level program, plus the installation of rain-harvesting systems for various outdoor water uses, and graywater reuse systems for toilet flushing purposes.

The rainwater-harvesting system envisioned would be designed to capture rainwater from the roofs of buildings. The system would include a catchment system consisting of a rooftop collection area; a means for conveying the water, including gutters, downspouts, and piping; filter system and a storage tank; and a pumped system to distribute the water as needed. As reported in the state-of-the-art report on water supply practices, all collected rainwater contains some suspended solids and other contaminants, such as bird droppings, air pollution fallout, and shingle deterioration and gutter metal transfer. Thus, great care must be taken to prevent unintended human consumption of the water. Some systems have been designed to incorporate first flow diverters, or presettling facilities, to reduce the sediment and related contaminant content of the runoff. It is estimated that rain-harvesting systems are capable of capturing for use about 9,000 gallons per year per 1,000 square feet of a roof area during the period when outdoor water uses are practiced. Given the amount of water typically expected to be used for outdoor uses, the additional savings in water over-and-above the savings associated with the advanced-level water conservation programs, may be expected to approximate nine gallons per capita per day, or about 13 percent of the residential water use. The initial cost of a rain-harvesting system is estimated to range from $3,000 to $9,000 and the annual maintenance cost is estimated to range from $100 to $200.

The graywater system envisioned would include a shower-water collection system, piping and valves, and a disinfections system with a connection to the flush tank of the toilet system. The graywater recovery and use system is envisioned to capture water from a single shower bath installation. The recovered water would be filtered, stored in a reservoir, treated with ultraviolet light, and then reutilized for toilet flushing. Such a system is estimated to be capable of recovering about 8,000 gallons of water per year. The expected savings in water use are estimated to be nine gallons of water per person per day, or about 13 percent of typical residential water use. The cost of such a system is estimated to range from \$5,000 to \$12,000 for a new residence, but substantially higher for retrofitting an existing residence. The annual operation and maintenance cost are estimated to range from \$100 to \$300.

As an option under the composite plan, the higher-level water conservation program may be expected to result in the water use reductions summarized in Table 181. The attendant costs are also set forth in this table. The water savings and attendant costs were calculated assuming a 50 percent participation rate in the high-level program. On a regional basis, water use may be expected to be reduced by about 6.4 mgd, or by about 2 percent, on an average daily use basis, and by about 14.6 mgd, or also about 2 percent, on a maximum daily use basis.

Table 181 indicates that implementation of the higher-level water conservation program would, under the preliminary recommended plan have a capital cost of about \$415.0 million, and an annual operation and maintenance cost of about \$13.3 million. Based upon an analysis period of 50 years, and an annual interest rate of 6 percent, the estimated present worth of this alternative would be \$290.0 million, and the equivalent annual cost \$18.4 million. The higher-level water conservation program, thus, has a cost of about two times that of the entire composite plan, with the majority of the costs associated with the high-level water conservation program components of the rain-harvesting and graywater treatment and use systems. These costs make the incorporation of the higher level of water conservation into the preliminary recommended plan impractical. In addition, a review of the groundwater and surface water impacts of the composite plan indicate that the sources of supply are largely sustainable under that plan without the higher-level water conservation option. Accordingly, it was determined that the preliminary recommended plan include an aggressive and practical water conservation program comprised of a utility-specific judicious selection of measures contained under the low-level, intermediate-level, and advanced-level water conservation programs previously described. The option always exists for individual water utilities, or individual water users, to adopt higher levels of water conservation than are included in the preliminary recommended plan. The use of such measures is encouraged where such use is deemed appropriate based upon utility, business, or individual homeowner preference.

The water conservation programs developed by the water utilities will have to be specifically designed to meet the rules being developed under the ongoing WDNR rulemaking process. This rulemaking process is being carried out to meet the requirements of the Great Lakes-St. Lawrence River Basin Water Resources Compact and Wisconsin Act 227, related groundwater protection legislation, and the September 2006 Report to the Governor on Water Conservation. The Wisconsin Act 227 requires that the WDNR establish statewide water conservation and efficiency goals and objectives and rules specifying the requirements for water conservation and efficiency for applicants in cases of new or increased diversions. The WDNR is to initiate the water conservation rulemaking process during the second half of 2009, with completion expected in late 2010. The conservation measures to be considered may include measures for sanitary sewerage system protection and stormwater management, as well as for water supply. The proposed water conservation programs and measures included in the preliminary recommended water supply plan were based upon careful consideration of a wide range of water conservation measures and levels of implementation as documented in the state-of-the-art of water supply practices report. Accordingly, the recommendation should serve as a sound basis for development of local utility-specific water conservation programs within the framework of the WDNR regulations being developed.

SUMMARY

A comparative evaluation of the four alternative water supply plans presented in Chapter VIII resulted in a conclusion that each of the alternative plans contained sound components that merited consideration for inclusion in a composite plan. Therefore, it was concluded that a carefully constructed composite plan incorporating these components would be capable of meeting the agreed-upon objectives more fully than any of the four alternative plans concerned.

Table 181

COSTS AND EFFECTIVENESS OF ENHANCED WATER CONSERVATION OPTION FOR THE COMPOSITE PLAN

		Total Capital Cost		Water Demand Changes					
				Average Daily Demand Reduction			Maximum Daily Demand Reduction		
Water Conservation Program Category	2035 Population Affected	Capital Cost ($ X 1,000)	Annual Operation and Maintenance Cost ($ X 1,000)	Per Capita Use (gallons per day)	Per Capita (percent)	Total Average Daily Demand (mgd)	Per Capita Use (gallons per day)	Per Capita (percent)	Total Maximum Daily Use (mgd)
Base-Level Program Converted to Intermediate-Level Program	1,589,800	- -	949[a]	2.0	3	3.2	7	6	9.5
Intermediate-Level Program Converted to Advanced-Level Program	501,500	- -	346[b]	3.0	4	1.5	5	4	2.5
Advanced-Level Program Converted to Enhanced-Level Program	184,700	415,000[c]	12,005[d]	18.0	26	1.7	28	48	2.6
Total	2,276,000	415,000	13,300	23	- -	6.4	40	- -	14.6

Present Worth Cost	
Present Worth of Capital =	$185,000,000
Present Worth of O&M =	105,000,000
Total Present Worth Cost =	$290,000,000

[a]*Cost estimated at $0.60 per capita per year as difference between low-level and intermediate-level programs. Costs were applied to the average population level between years 2000 and 2035.*

[b]*Cost estimated at $1.00 per capital per year as difference between intermediate-level and advanced-level programs. Costs were applied to the average population level between 2000 and 2035.*

[c]*Cost based upon $4,500 per capita, or about $12,000 per household, with a 50 percent implementation level.*

[d]*Costs based upon $130 per capita, or about $350 per household, with a 50 percent implementation level.*

Source: SEWRPC.

Two subalternatives to the composite water supply plan were developed and evaluated. The two subalternatives to the composite plan were comprised of the 10 elements of the composite plan as described previously and are the same in all respects, except for the source of supply considered for the City of Waukesha Water Utility and the interrelated number of rainfall infiltration systems. Under the first subalternative plan, the City of Waukesha would continue to utilize groundwater as a source of supply, with the supply being obtained about equally from the shallow and deep aquifers. Under the second subalternative, the City of Waukesha would be connected to a Lake Michigan supply and a return flow component would be included for the water used by the City of Waukesha Water Utility.

A comparative evaluation of the two subalternatives to the Composite Plan indicated that both subalternatives could be expected to meet most of the plan objectives and supporting standards. This is to be expected, given that the subalternatives to the Composite Plan were designed with the intent of meeting those objectives and standards. However, Subalternative 2 to the Composite Plan was found to meet the objectives more fully, primarily because it offers advantages related to the long-term sustainability of the deep aquifer, reductions in chloride discharges to the surface waters, and improvement in groundwater-derived baseflow inputs to the surface water system. Subalternative Plan 2 also offers an opportunity to utilize excess Lake Michigan water production capacity and provide potential cost advantages to both supplier and supplied utilities. Subalternative 2 to the Composite Plan also better preserves the groundwater aquifer for other land uses, such as agriculture. Accordingly, it was concluded that Subalternative 2 to the Composite Plan should be considered as the preliminary recommended plan to be presented for public review and reaction; and based upon that review and reaction, to be refined as may be found necessary to produce a final recommended plan.

The preliminary recommended plan includes the following elements:

- For the vast majority of water utilities, the existing sources of supply—generally Lake Michigan, the shallow aquifer, or a combination of shallow and deep aquifers underlying the Region—were determined to be adequate to meet existing and planned water demands. Therefore, the plan proposes that these utilities continue to utilize their existing sources of supply. The utilities concerned are given in Table 182.

- The plan proposes that, over time, five utilities—the City of Delavan Water and Sewage Utility, the City of Elkhorn Water Utility, the City of Hartford Water Utility, Village of Union Grove, and the Town of Bristol Utility District No. 1—place greater reliance on use of the shallow groundwater aquifer as a source of water supply, either by replacing existing deep wells with shallow aquifer wells or by supplementing pumpage from existing deep wells with pumpage from shallow aquifer wells as new wells are constructed. In the case of the City of Hartford Water Utility, a new shallow aquifer well, treatment system, elevated storage tank, and interconnecting piping were expected to be operational during 2010. This will enable the Utility to abandon the existing deep aquifer well.

- The plan proposes the conversion to Lake Michigan as a source of water supply of existing utility service areas, or portions of utility service areas, which currently have return flow to Lake Michigan in place. Seven of these service areas—the eastern portion of the City of Brookfield Municipal Water Utility service area, the City of Cedarburg Light & Water Commission, the Village of Elm Grove, the Village of Germantown Water Utility, the Village of Grafton Water and Wastewater Commission, the Village of Saukville Municipal Water Utility, and the Town of Yorkville Utility District No. 1—are located east of the subcontinental divide. Two of the service areas—the central portion of the City of New Berlin Water Utility and the City of Muskego Public Water Utility—are located in communities that straddle the subcontinental divide, but are within the Milwaukee Metropolitan Sewerage District sanitary sewer service area and, therefore, have existing return flow.

- The plan proposes that the City of Waukesha would be connected to a Lake Michigan supply and would provide a return flow to Lake Michigan. Return flow could be provided by returning treated wastewater either to Lake Michigan or to streams tributary to Lake Michigan.

Table 182

UTILITIES CONSIDERED TO HAVE ADEQUATE SOURCES OF WATER SUPPLY UNDER THE PRELIMINARY RECOMMENDED REGIONAL WATER SUPPLY PLAN

County and Utility	Source of Supply
Kenosha County	
City of Kenosha Water Utility	Lake Michigan Self-Supplied
Village of Paddock Lake Municipal Water Utility	Groundwater Shallow Aquifer
Village of Pleasant Prairie Water Utility	Lake Michigan Purchased Supply
Town of Bristol Utility District No. 3	Lake Michigan Purchased Supply
Town of Somers Water Utility	Lake Michigan Purchased Supply
Milwaukee County	
City of Cudahy Water Utility	Lake Michigan Self-Supplied
City of Franklin Water Utility	Lake Michigan Purchased Supply
City of Glendale Water Utility	Lake Michigan Purchased Supply
City of Milwaukee Water Utility	Lake Michigan Self-Supplied
City of Oak Creek Water and Sewer Utility	Lake Michigan Self-Supplied
City of South Milwaukee Water Utility	Lake Michigan Self-Supplied
City of Wauwatosa Water Utility	Lake Michigan Purchased Supply
City of West Allis Water Utility	Lake Michigan Purchased Supply
Village of Brown Deer Public Water Utility	Lake Michigan Purchased Supply
Village of Fox Point Water Utility	Lake Michigan Purchased Supply
Village of Greendale Water Utility	Lake Michigan Purchased Supply
Village of Shorewood Municipal Water Utility	Lake Michigan Purchased Supply
Village of Whitefish Bay Water Utility	Lake Michigan Purchased Supply
We Energies-Water Services	Lake Michigan Purchased Supply
Ozaukee County	
Village of Belgium Municipal Water Utility	Groundwater Shallow Aquifer
We Energies-Water Services	Lake Michigan Purchased Supply
Racine County	
City of Burlington Municipal Waterworks	Groundwater Deep Aquifer
City of Racine Water and Wastewater Utility[a]	Lake Michigan Self-Supplied
Village of Caledonia West Utility District[b] Oak Creek	Lake Michigan Purchased Supply
Village of Caledonia West Utility District[b] Racine	Lake Michigan Purchased Supply
Village of Caledonia East Utility District[c] Oak Creek	Lake Michigan Purchased Supply
Village of Caledonia East Utility District[c] Racine	Lake Michigan Purchased Supply
Village of Waterford Water and Sewer Utility	Groundwater Deep and Shallow Aquifers
Village of Wind Point Municipal Water Utility	Lake Michigan Purchased Supply
North Cape Sanitary District	Groundwater Shallow Aquifer

County and Utility	Source of Supply
Walworth County	
City of Lake Geneva Municipal Water Utility	Groundwater Shallow Aquifer
City of Whitewater Municipal Water Utility	Groundwater Deep Aquifer
Village of Darien Water Works and Sewer System	Groundwater Deep and Shallow Aquifers
Village of East Troy Municipal Water Utility	Groundwater Deep and Shallow Aquifers
Village of Fontana Municipal Water Utility	Groundwater Deep and Shallow Aquifers
Village of Genoa City Municipal Water Utility	Groundwater Deep and Shallow Aquifers
Village of Sharon Waterworks and Sewer System	Groundwater Deep and Shallow Aquifers
Village of Walworth Municipal Water and Sewer Utility	Groundwater Shallow Aquifer
Village of Williams Bay Municipal Water Utility	Groundwater Deep and Shallow Aquifers
Country Estates Sanitary District	Groundwater Deep Aquifer
Town of Bloomfield Pell Lake Sanitary District No. 1	Groundwater Deep Aquifer
Town of East Troy Sanitary District No. 3	Groundwater Deep and Shallow Aquifers
Town of Geneva Lake Como Sanitary District No. 1	Groundwater Deep Aquifer
Town of Troy Sanitary District No. 1	Groundwater Shallow Aquifer
Washington County	
City of West Bend Water Utility	Groundwater Shallow Aquifer
Village of Jackson Water Utility	Groundwater Shallow Aquifer
Village of Kewaskum Municipal Water Utility	Groundwater Shallow Aquifer
Village of Slinger Utilities	Groundwater Shallow Aquifer
Allenton Sanitary District No. 1	Groundwater Deep Aquifer
Waukesha County	
City of Delafield Municipal Water Utility	Groundwater Deep and Shallow Aquifers
City of New Berlin Water Utility (east)	Lake Michigan Purchased Supply
City of Oconomowoc Utilities	Groundwater Deep and Shallow Aquifers
Village of Butler Public Water Utility	Lake Michigan Purchased Supply
Village of Dousman Water Utility	Groundwater Deep and Shallow Aquifers
Village of Eagle Municipal Water Utility	Groundwater Shallow Aquifer
Village of Hartland Municipal Water Utility	Groundwater Shallow Aquifer
Village of Menomonee Falls Water Utility (east)	Lake Michigan Purchased Supply
Village of Mukwonago Municipal Water Utility	Groundwater Deep and Shallow Aquifers
Village of Sussex Public Water Utility	Groundwater Deep and Shallow Aquifers

[a] *Includes the Village of Sturtevant Water Utility which was purchased by the City of Racine Water and Wastewater Utility in 2007 and is now served by the City Utility on a retail basis.*

[b] *Includes the former Caddy Vista Sanitary District and the Former Caledonia Sanitary District No. 1 which were consolidated in 2007 to form the Caledonia West Utility District.*

[c] *Includes the former Crestview Sanitary District and the former North Park Sanitary Districts which were consolidated in 2007 to form the Caledonia East Utility District.*

Source: SEWRPC.

Table 183

POTENTIAL NEW MUNICIPAL WATER UTILITIES ENVISIONED UNDER THE PRELIMINARY RECOMMENDED REGIONAL WATER SUPPLY PLAN

County and Utility
Kenosha County
Village of Silver Lake Potential Utility
Village of Twin Lakes Potential Utility
Town of Salem Potential Utility
Powers-Benedict-Tombeau Lakes Area Potential Utility
Ozaukee County
Town of Fredonia-Waubeka Area Potential Utility
Racine County
Northwest Caledonia Area Potential Utility District
Town of Burlington-Bohner Lake Area Potential Utility District
Town of Dover-Eagle Lake Area Potential Utility District
Town of Norway Area Potential Utility
Village of Rochester Area Potential Utility
Town of Rochester Area Potential Utility
Town of Waterford Area Potential Utility
Walworth County
Town of Lyons Area Potential Utility
Town of East Troy-Potter Lake Area Potential Utility
Washington County
Village of Newburg Area Potential Utility
Waukesha County
Village of Big Bend Potential Utility
Village of North Prairie Potential Utility
Village of Wales Potential Utility
Town of Eagle-Eagle Spring Lake Area Potential Utility
Town of Oconomowoc-Okauchee Lake Area Potential Utility
Town of Ottawa-Pretty Lake Area Potential Utility
Town of Summit-Golden Lake Area Potential Utility

Source: SEWRPC.

- The plan proposes that certain areas of existing urban development that are currently served by private, onsite wells be provided by municipal water supply, either through the extension of service by existing utilities, or, in some cases, by the creation of new utilities. Such conversion is proposed only when local need is demonstrated and a local initiative is undertaken to implement a municipal system. Absent such a demonstrated need and initiative, residents and businesses of the areas would remain on individual wells indefinitely. Potential new utilities that may be required are listed in Table 183.

- The plan envisions that the existing, self-supplied water systems serving residential communities and most of the systems serving commercial, institutional, and recreational land uses located within the planned municipal water supply service areas would be connected to municipal systems by the plan design year 2035. Under the plan, a number of private, self-supplied water supply systems generally located beyond planned municipal water supply service areas would remain. These include self-supplied residential, industrial, commercial, institutional, recreational, agricultural, irrigation, and electric-power-generation uses.

- The plan recommends the implementation of comprehensive water conservation programs, including both supply side water supply efficiency measures and demand side water conservation measures. The scope and content of these conservation programs are recommended on a utility-specific basis to reflect the source of supply and existing infrastructure. Expected reductions in demand vary from 4 to 10 percent on an average daily demand basis and from 6 to 18 percent on a maximum daily demand basis.

- The plan includes a groundwater recharge area protection component directed at preserving existing groundwater recharge areas classified as having a high or very high recharge potential. This component may be expected to be largely achieved through the implementation of the adopted design year 2035 regional land use plan, since that plan recommends preservation of the environmental corridors, isolated natural resource areas, and prime and other agricultural areas of the Region that facilitate recharge. About 75 percent of the highly rated, and about 78 percent, of the very highly rated recharge areas may be expected to be preserved by inclusion in the environmental corridors, isolated natural resource areas, and prime and other agricultural areas identified for preservation in the adopted regional land use plan. Careful design of new residential development and the use of selected stormwater management practices would be expected to further increase the amount of recharge.

- The plan includes a stormwater management component which recommends the implementation of available stormwater management practices, including treatment and infiltrations systems, which—to the extent practicable—will maintain the natural recharge of new residential and selected nonresidential land use developments.

- The plan includes provisions related to the siting of all new high-capacity wells and for the analysis and monitoring of impacts of such wells in the shallow aquifer. These provisions specify the measures that should be taken in the early stages of locating sites for high-capacity wells in the shallow aquifer to develop the necessary understanding of the hydrogeological system associated with each candidate site and its surrounding area and to assess the likelihood of impacts of proposed wells upon nearby existing wells and surface waterbodies. These components also provide for monitoring of water levels in the vicinity of new high-capacity wells in the shallow aquifer, both during the test well phase of placement and during operation of these wells.

- The plan includes a provision encouraging the installation of enhanced rainfall infiltration systems in areas where evaluations conducted in conjunction with siting of high-capacity wells in the shallow aquifer indicate probable reductions in baseflow to nearby surface waterbodies that are likely to affect streamflows or water levels in lakes or wetlands due to installation and operations of these wells.

These last four components of the preliminary recommended plan are intended to form the basis of a process to minimize the negative impacts to surface water systems associated with high-capacity well development.

Map 116 illustrates the areas served by municipal utilities and the sources of supply for those utilities under the preliminary recommended plan. The new sources of supply and attendant facilities for each water utility in the Region, and the costs of those facilities under the preliminary recommended plan, are listed in Table 167. The levels of water conservation recommended in the initially preferred plan are utility-specific, based upon the utility source of supply and infrastructure needs. Measures are included to be considered as a guide for development of the utility-specific programs.

Chapter X

RECOMMENDED WATER SUPPLY PLAN

INTRODUCTION

As noted in Chapter I, the primary purpose of the regional water supply planning program was to develop a long-range water supply plan for the Southeastern Wisconsin Region. The plan was to 1) meet the water supply objectives and supporting standards set forth in Chapter V of this report; 2) identify measures needed to abate existing and probable future water supply problems; and 3) preserve and protect the sources of supply. Chapter VII of this report describes the water supply problems and issues identified and addressed in the planning process. Chapter VIII of this report describes a set of four alternative water supply plans that were developed as candidates for adoption as a regional water supply plan, and identifies the technical, economic, and environmental performance of each of these alternative plans. Chapter IX presents the findings of a comparative evaluation of the four alternative water supply plans considered, and identifies the extent to which each of the plans may be expected to achieve the agreed-upon water supply objectives. The findings of the comparative evaluation indicated that each alternative plan considered contained some components that merited consideration for inclusion in a recommended plan. It was, therefore, concluded that a composite plan incorporating the best components of each of the alternative plans would be capable of meeting the water supply objectives more fully than any of the four alternative plans initially considered.

As described in Chapter IV, the adopted design year 2035 regional land use plan served as the basis for the necessary forecasts of employment, population, and land use development on which the alternative and preliminary recommended regional water supply plans were based. Chapter IX presents a preliminary recommended plan consisting of a composite of the best elements of the alternative plans considered. That preliminary recommended plan is graphically summarized on Map 116.

PUBLIC REACTION TO THE PRELIMINARY RECOMMENDED PLAN AND SUBSEQUENT ACTION OF THE TECHNICAL ADVISORY COMMITTEE

Introduction

Extensive public informational activities were conducted throughout the conduct of the regional water supply planning program to facilitate public participation in the planning effort. Those activities included, but were not limited to:

- Inclusion of descriptive material and preliminary draft chapters of this report, of SEWRPC Technical Report No. 43, *State-of-the-Art Water Supply Practices,* and of SEWRPC Technical Report No. 44, *Water Supply Law,* on the SEWRPC website, along with contact information to facilitate the submission of questions and the filing of comments as the work proceeded;

- Thirty-three presentations to local elected officials from throughout the seven-county Region;

- Ninety-one presentations to interested business, civic, and environmental groups and organizations from within the Region;

- Publication and distribution to about 2,000 elected and appointed public officials and interested citizens of three newsletters summarizing progress of the water supply planning program. The third newsletter included notice of the public informational meetings scheduled to be held to present and receive comments on a preliminary recommended plan. The newsletter distribution included the chief elected officials and clerks of all 147 cities, villages, and towns within the Region, as well as all county executives, administrators, and county board members; and

- Publication of paid newspaper advertisements announcing the public informational meetings scheduled to be held on the preliminary recommended plan in the CSI Community Shoppers (Walworth County), Daily News (West Bend area), El Conquistador (Milwaukee area), Freeman (Waukesha area), Fronteras de la Noticia (Kenosha area), Insider News (Racine area), Journal Times (Racine area), Kenosha News (Kenosha area), Milwaukee Journal Sentinel (Region), Milwaukee Times (Milwaukee area), News Graphic (Ozaukee County),Oconomowoc Enterprise (Oconomowoc area); and Weekend Freeman Lake Country (Waukesha County).

A series of public information meetings and hearings were held within the Region beginning in January 2009, at which the preliminary recommended plan was presented and comments on the plan solicited. The series consisted of the following meetings:

- January 12, 2009, at HeartLove Place in the City of Milwaukee, Milwaukee County;

- January 13, 2009, at the United Community Center in the City of Milwaukee, Milwaukee County;

- January 14, 2009, at the Wauwatosa Public Library in the City of Wauwatosa, Milwaukee County;

- January 20, 2009, at the Rotary Building in Frame Park in the City of Waukesha, Waukesha County;

- January 21, 2009, at the Washington County Fair Park Pavilion in the Town of Polk, Washington County;

- January 22, 2009, at the Government Center in the City of Elkhorn, Walworth County;

- January 26, 2009, at the Ozaukee County Administration Center in the City of Port Washington, Ozaukee County;

- January 27, 2009, at the Kenosha County Office Building in the Town of Bristol, Kenosha County; and

- February 2, 2009 at the Ives Groves Office Complex in the Village of Sturtevant, Racine County.

As already noted, the purpose of these informational meetings and hearings was to: present the preliminary recommended water supply plan for public review and evaluation; answer any questions that local public officials and interested citizens may have had about the plan; and solicit comments on, and criticisms of, the plan. Each meeting consisted of an open house from 5:00 to 6:00 p.m. at which the public was afforded the opportunity to meet with Regional Planning Commission staff to receive information and ask questions about the proposed plan, and to provide comment on the plan. Each open house was followed from 6:00 to 6:30 p.m. by a Commission staff presentation describing the planning process and the proposed plan. Commission staff were available throughout the entire meeting to receive written comments, including via personal dictation to a court reporter. The meetings were scheduled to end by 7:00 p.m., or later, as necessary.

In addition to the nine public informational meetings noted above, two sessions of the “Water-Wise Conference” held in the City of Waukesha on March 7, 2009, were devoted to obtaining public reaction to the proposed plan. This conference was sponsored by the Waukesha County Environmental Action League, a citizen organization based in Waukesha County. One session included a presentation on the proposed plan and one session was devoted to obtaining public comments on the plan.

At the specific request of the SEWRPC Environmental Justice Task Force (EJTF), the organizers of the Water-Wise Conference held in Waukesha on March 7, 2009, and citizens attending the Kenosha County public information meeting held on January 29, 2009, the comment period on the preliminary recommended plan, which was originally scheduled to end on February 9, 2009, was extended through March 16, 2009. Comments were accepted via United States mail, electronic facsimile (fax) communications, electronic mail (e-mail), and messages addressed to a comments page on the Commission website.

Summary of Public Comment

Attendance at the nine public information meetings and hearings, and at the informational sessions held at the Water-Wise Conference, totaled 181 persons. Comments on the plan were received from 160 persons, agencies, municipalities, utilities, and organizations; including written comments received at the meetings, comments dictated to the court reporter at the meetings, and comments received via United States mail, fax, e-mail, and the comments page of the Commission website. The comments received are fully documented in the *Record of Public Comments: A Regional Water Supply Plan for Southeastern Wisconsin*, October 2009.

Four of the 160 comments received indicated general support for the preliminary recommended regional water supply plan. Among the written comments generally supporting the plan were letters from the City of Waukesha Water Utility and the Public Service Commission of Wisconsin. Seventeen of the comments received were not relevant to the regional water supply plan, but rather related to such matters as other planned infrastructure improvement proposals, such as highway and sewerage system improvements, and were judged as not requiring response. The remaining 139 comments were related to suggested changes or additions to the plan, support for specific aspects of the plan, or otherwise indicated specific concerns or issues regarding the plan and were considered to require careful consideration and response. These comments are summarized and responded to in the following text. In some instances, related comments are grouped together in the text and given a common response.

Comments in Support of the Preliminary Recommended Water Supply Plan or Specific Components of the Plan

Comments were received that expressed general support for the preliminary recommended plan. Some comments also expressed qualified support for the plan. In addition, comments were received that expressed support for specific aspects of the plan including the recommended provision of a Lake Michigan water supply to straddling communities and the City of Waukesha water utility, preservation of groundwater recharge areas, the proposed siting procedure for high-capacity wells in the shallow aquifer, and the water conservation component of the plan.

General Comments in Opposition to the Plan

Comments were received that expressed opposition to the preliminary recommended plan without specifying the components of the plan that the commentators opposed. In addition, the following comment was received that expressed general opposition to the plan on the basis of economic viability:

- **Comment:** The current recession makes the plan unaffordable.

  Response: This comment was made specifically with respect to the proposed provision of municipal water supply to an urban area of the Region currently served by private wells, the expressed concern being over the cost of conversion from private wells to a municipal water utility. The design year of the preliminary recommended plan is 2035. It is unlikely that the current recession will last until then. In addition, experience has shown, that financial assistance for public infrastructure development may be expected to be available in the form of State and Federal loans and grants, particularly during periods of economic recession. Thus, the current economic recession should not determine the structure of a long-term plan.

Moreover, the plan does not specifically recommend that the areas concerned convert from private wells to a municipal water utility source relying on groundwater, but rather identifies these areas as having the potential, based upon their development density, to convert to service provided by a municipal water utility should water quality or quantity problems develop in these areas. If such problems do not surface, the areas concerned would continue to utilize individual private wells.

Comments Regarding the Planning Process and/or Factors Examined in the Water Supply Study

A number of comments were received which related to the process used in developing the plan and/or the factors considered in the planning process.

- **Comment:** The water supply study and any adoption and implementation of a water supply plan should be suspended until water supply planning is coordinated with housing, transit, and highway development and with job creation public policies.

- **Comment:** The plan selected should recognize other issues that may be impacted by the water supply plan such as land use, transportation, and housing development.

  Response: The design year 2035 regional land use plan serves as the basis for the regional water supply plan, provides the means for coordinating the design of the water supply plan with all of the other elements of the comprehensive regional plan, such as transportation, sanitary sewerage, stormwater management and flood control, and park and open space development, which are also based upon the land use plan.

  The Commission has always recognized the relationship that exists between land use planning and water supply planning, and indicated at the very beginning of the regional water supply planning effort that, should that planning effort identify any water resource constraints on the development pattern envisioned in the adopted regional land use plan, the Commission would initiate a process to amend the land use plan in an appropriate manner. The regional water supply planning effort has found that water supply is not a limiting factor within this Region with respect to the location of urban development located either east or west of the subcontinental divide. Indeed, the studies concerned have shown that the patterns and intensities of development envisioned in the regional land use plan—which represent a departure from development activity trends over the past 30 years and a return to a more centralized development pattern—could be supported by the available groundwater systems in the areas concerned, even if none of the proposed extensions of Lake Michigan water to areas located west of the subcontinental divide were to be implemented.

- **Comment:** Identifying the support of existing land use patterns and support of planned land use patterns as an objective, and giving it highest priority in the evaluation of alternative plans, rewards bad land use planning.

  Response: The ordering of water supply planning objectives in the evaluation of alternative plans in Chapter IX does not indicate a prioritization of the objectives. The five objectives were given equal weight in the evaluation. Clearly, any water supply plan must recognize the existing land use pattern. As noted above, the planned patterns of development envisioned in the regional land use plan represents good, not bad, land use planning. The regional land use plan envisions a more centralized land use pattern that can be economically provided with essential public services, including sanitary sewerage, water supply, and mass transit; that seeks to preserve the environmental corridors and isolated natural resource areas of the Region in natural, open uses; and that seeks to maintain the prime agricultural areas of the Region in agricultural use.

- **Comment:** A socioeconomic impact analysis should be included as a part of the plan.

  Response: Given the expressed interest in the potential socioeconomic impacts of the regional water supply plan, this issue was referred to the Commission Environmental Justice Task Force at its March 24, 2009, meeting. At that meeting, it was concluded that a socioeconomic impact analysis should be prepared for the regional water supply plan. Selection and adoption of a final regional water supply plan should be held in abeyance until completion of that analysis. The desired socioeconomic impact analysis was conducted by the University of Wisconsin Center for Economic Development (UWM-CED) and the findings of the analysis as set forth in a University report, are summarized in this planning report.

- **Comment:** The population growth estimates used for the plan are too high.

  Response: The population forecasts used to develop the regional water supply plan were the forecasts used to develop the design year 2035 regional land use plan and are set forth in SEWRPC Planning Report No. 48, *A Regional Land Use Plan for Southeastern Wisconsin: 2035*, June 2006, and in SEWRPC Technical Report No. 11, 4th Edition, *The Population of Southeastern Wisconsin*, July 2004. For the purposes of developing population forecast and alternative projections, the Commission employed the cohort-survival technique—a technique regarded as the "gold standard" by demographers. The assumptions made regarding probable future birth, death, and migration rates were based upon careful consideration by an advisory committee of knowledgeable professionals of past and current trends and available indicators of probable future trends at the county, regional, State, and national levels and—with respect to migration rates—the strength of the national and regional economies and changes in the civilian labor force of the Region. It is important to note that if with time the population forecasts used to develop the recommended water supply plan should prove to be too high, then the useful life of the plan would exceed the design year of the plan—a not necessarily undesirable event.

  The Commission does recognize that the preparation of population projections and forecasts involves uncertainties. Because of this, it is the Commission's practice to periodically review and revise its demographic and economic projections and forecasts. Past experience has shown that the Commission forecasts have consistently proven to be accurate at the regional level within about plus or minus 10 percent per decade. Such review indicates that the Commission population forecasts were, in 2007, within 1 percent of the actual population at the regional level, and within 1 percent or less at the county level.

- **Comment:** In the cost analyses, the cost savings from reduced use of salt for softening should be offset by the value of water softening plant loss experienced by residents abandoning their water softeners.

  Response: The investment in onsite water treatment equipment, such as water softeners, constitutes a sunk cost, that is, it represents an expense that has already been incurred and cannot be recovered regardless of which plan alternative is chosen. Previously expended, unrecoverable monies such as this are not considered in any accepted method of economic analyses of alternative plans; nor would such sunk costs typically be considered as a negative factor for a homeowner who could reduce his or her monthly costs through abandonment of a water softener.

- **Comment:** The municipal utility water loss estimates assumed in the plan are too low; they should be about 33 percent of water pumped.

  Response: The estimates of municipal utility water losses used in the planning process are based upon the unaccounted-for water reported by the municipal water utilities of the Southeastern Wisconsin Region in their annual reports which document water losses to the Public Service Commission of Wisconsin. While the percentage of water pumped that was unaccounted-for varied among the utilities concerned, the average percentage loss reported in 2000 was 11 percent. In subsequent years, the average was slightly less. As part of the water conservation component, the proposed plan recommends that municipal water utilities establish water system efficiency programs, including meter testing, leak detection and repair, water main maintenance and replacement, water system audits, and water production system refinement in order to reduce the percentage of unaccounted-for water in the operation of their transmission, storage, and distribution systems. These programs should assist in maintaining, or lowering, the currently experienced losses.

- **Comment:** The plan should identify secondary sources of water supply that could be used in the event of a terrorist attack.

  Response: The need for secondary sources of supply was considered and addressed in the design of the alternative and proposed plans. As an integral part of the planning effort, the reliable capacities of the water utilities operating in the Region were assessed. For utilities utilizing groundwater as a source of supply, reliable capacity was defined as adequate capacity to supply the needed maximum daily pumpage with the largest capacity well out of service. For utilities utilizing surface water as a source of supply, reliable capacity was defined as the capacity remaining with the most critical unit of the production process out of service. In the design of the alternative and recommended plans, facilities were then added to each water supply system to provide a reliable capacity equal to the anticipated 2035 maximum daily pumpage demand. The resulting systems then have a reliable capacity that provides significant protection for the continuity of supply in the event of a terrorist attack.

  Interconnections among municipal systems using similar sources of water supply for the purpose of providing water in the event of an emergency exist in many instances and consideration of others is also recommended in the plan. Such interconnections would provide secondary sources of water supply that could be used in the event of a terrorist attack. It should also be noted that all water supply utilities within the Region have been involved in security planning, with guidance provided by the U.S. Environmental Protection Agency (USEPA), the Wisconsin Department of Natural Resources (WDNR), and water utility organizations. Such local level planning is considered the most effective means of preventing and mitigating acts of terrorism.

- **Comment:** The plan does not address environmental impacts on water-dependent natural resources. An analysis of such environmental impacts is needed if the alternatives may be reasonably expected to have an impact on fish and wildlife species; endangered or threatened species; or critical species habitat.

  Response: The planning effort specifically included an evaluation of the potential environmental impacts of the alternative and recommended plans. The objectives and associated standards upon which the alternative and preliminary recommended plans are based specifically address the need for environmental protection. The alternative plans were comparatively evaluated based upon those objectives and standards. Specific information on all of the alternative water supply plans was developed relating to the potential impacts on the quantity of the surface waters as expressed by changes in groundwater-derived baseflows. These impacts, and the attendant impacts on wildlife, were carefully considered in the comparative evaluation of the alternative plans and selection of the preliminary recommended plan. Moreover, the regional land use plan on which the water supply plan is based recommends the preservation in essentially open, natural uses of all the remaining environmental corridors and critical species habitat areas of the Region. Thus, the water supply plans by their very nature included an environmental assessment procedure applicable at the systems level of planning. Implementation of specific elements of the plan may, or may not, require preparation of an environmental assessment or an environmental impact statement. However, this is a determination that will need to be made on a case-by-case basis during plan implementation.

Comments and Questions Regarding Potential Impacts of Specific Facilities or Actions

- **Comment:** Concern was expressed that new municipal wells constructed by the City of Hartford may adversely affect private wells currently used by Town of Hartford residents.

  Response: Under the preliminary recommended regional water supply plan, there should be no need for the City of Hartford to develop any new wells through the plan design year 2035, beyond the well under construction in 2009. If the forecast conditions on which the recommended plan is based should change, and additional municipal wells be required in the area, the plan includes recommendations related to the siting of all new high-capacity wells, and for the analysis and monitoring of the impacts of such wells finished in the shallow aquifer.

- **Comment:** The Town of Salem provided information on an investigation for the siting of a potential well to serve a planned municipal building in the south-central portion of the Town. The investigation indicated that a deep aquifer well may be more practical, given the groundwater quality conditions in that area. The preliminary recommended water supply plan envisions shallow aquifer wells to serve any municipal water supply systems developed in the Town.

  Response: If a need for public water supply systems to serve portions of the Town of Salem area develops in the future, the proposed plan envisions the use of shallow aquifer wells as a potential source of supply. The proposed plan recommends the conduct of more-detailed, site-specific evaluations of well locations and attendant hydrogeologic conditions to determine the best aquifer as a source for each well to be developed. Such analyses would be carried out as part of plan implementation and may result in some wells in the area concerned being finished in the deep aquifer. While such a change would result in some increase in costs, the increase in the overall plan costs would not be significant. The text of this report has been refined to indicate this possibility.

- **Comment:** Concern was expressed about the impacts of the HOD Landfill Superfund site in Antioch, Illinois, upon groundwater quality and proposed municipal wells in the Town of Salem.

  Response: According to the U.S. Environmental Protection Agency, remediation activities were completed at this site in 2001. As part of this remediation, leachate from the landfill continues to be collected for offsite treatment and disposal. This minimizes the risk of leachate leaking out of the landfill. The general direction of groundwater flow in the Antioch, Illinois, area is from west to east, making it unlikely that any contaminants from this site would be transported to locations in the Town of Salem area. In addition, as part of the proposed siting procedure for high-capacity wells, factors such as groundwater contamination would have to be examined and taken into account.

- **Comment:** The impacts of the proposed Thelen sand and gravel pit in the Village of Twin Lakes and Town of Randall area upon the shallow aquifer should be examined and included in the study.

  Response: It is anticipated that the impacts of this sand and gravel mining operation on the shallow aquifer may be expected to be localized. If serious cause for local concern can be shown, the Village of Twin Lakes, in which the proposed sand and gravel operation is to be located, should require the operator of the proposed operation to perform the hydrogeological analyses required to determine the local impacts of the mine on the shallow aquifer and on local surface waterbodies. The required analyses would be similar to those described in the preliminary recommended plan for siting new high-capacity wells. If these analyses were to indicate that significant local impacts to the shallow aquifer or to surface waterbodies may be expected to occur, appropriate mitigative measures could then be designed and implemented.

- **Comment:** Will the projected average 4.5 percent reduction in groundwater baseflow in Washington County lower water levels in Pike Lake?

  Response: The major inflows to Pike Lake consist of the inflow from the Rubicon River and direct precipitation onto the surface of the Lake. A water budget constructed for Pike Lake as a part of a lake management planning effort carried out by the Commission and the U.S. Geological Survey, estimated that inputs from groundwater baseflow represent about 7 percent of the inflow into Pike Lake.[1] Because inputs of groundwater baseflow represent a small portion of the water budget of Pike Lake, it is likely that any impacts from baseflow reductions associated with the recommended water supply plan would be within the range of normal interannual variation. Furthermore, there are no new wells planned to be located in the immediate vicinity of Pike Lake.

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[1]*SEWRPC Community Assistance Planning Report No. 273,* A Lake Management Plan for Pike Lake, Washington County, Wisconsin, *December 2005.*

Comments Regarding Provision of Lake Michigan Water to Communities Not Currently Utilizing Lake Michigan as a Source of Water Supply

- **Comment:** The pipeline used to provide Lake Michigan water to the City of Waukesha should be a double pipeline.

  Response: The issue of whether the supply pipeline required for the delivery of Lake Michigan water to the City of Waukesha should consist of one or two pipes should be determined in the next level of planning, i.e., preliminary engineering. It is unlikely, however, that a double pipeline would be required. In most places where a new Lake Michigan supply has been developed, only a single pipe transmission line has been used. Moreover, the existing Waukesha wells could be kept as a backup source of supply for use under emergency conditions.

- **Comment:** An alternative for providing the City of Cedarburg and the Village of Grafton with Lake Michigan water from the City of Port Washington via a pipeline through the Village of Saukville along CTH O should be considered.

  Response: An additional option was examined under the planning effort for the provision of a Lake Michigan water supply to the City of Cedarburg and the Village of Grafton via the Village of Saukville. This option is shown on Map 122. Under this option, the City of Port Washington would, by a direct connection through the Village of Saukville along CTH O, provide Lake Michigan water to the City of Cedarburg Light & Water Commission and the Village of Grafton Water and Wastewater Commission. The costs associated with this option are provided in Table 184, and would be similar for the utilities concerned to the costs of the option included in the preliminary recommended plan—the construction of a new Lake Michigan water and treatment facility to serve the City of Cedarburg and Village of Grafton area. The option of providing water supply to the City of Cedarburg and the Village of Grafton from the City of Port Washington water supply system would have a potential advantage of best meeting the planning standard relating to maximizing the use of existing water supply facilities. Either option would constitute an acceptable means of providing these communities with a Lake Michigan source of supply.

- **Comment:** The communities utilizing Lake Michigan as a source of water supply should include the City of West Bend and the Village of Newburg.

  Response: Based upon the environmental analyses and cost comparisons conducted as part of the planning effort, it was concluded that providing the City of West Bend and the Village of Newburg with a Lake Michigan water supply would not be a necessary or cost-effective option. The City of West Bend has adequate well capacity to meet current needs, and only modest additional supply would need to be developed to meet anticipated 2035 demand.

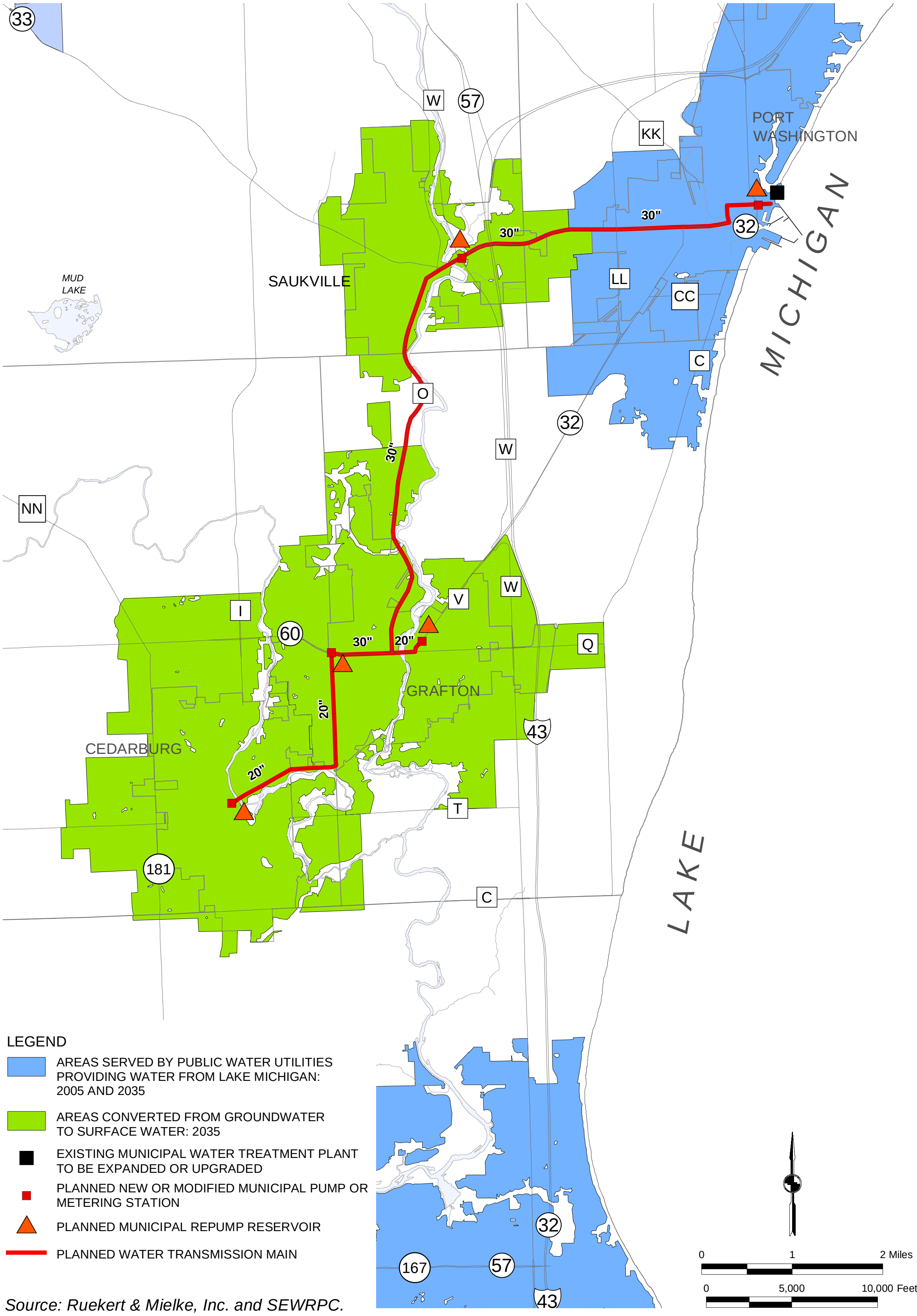
Comments Regarding Return Flow Options for the City of Waukesha Water Utility

- **Comment:** Any diversion of Lake Michigan water outside the Great Lakes watershed should require return flow.

  Response: The preliminary recommended plan proposes the provision of Lake Michigan water outside the Great Lakes watershed to three communities: the central and western portions of the City of Muskego, the central portion of the City of New Berlin; and the City of Waukesha. The first two are communities that straddle the subcontinental divide, are located within the Milwaukee Metropolitan Sewerage District (MMSD) sanitary sewer service area and, therefore, have existing return flow to the Great Lakes watershed. For the City of Waukesha, the preliminary recommended plan does envision return flow of any diverted water to the Great Lakes watershed.

Map 122

OPTION FOR PROVIDING THE CITY OF CEDARBURG AND VILLAGE OF GRAFTON WITH LAKE MICHIGAN WATER FROM THE CITY OF PORT WASHINGTON ALONG CTH O



Source: Ruekert & Mielke, Inc. and SEWRPC.

Table 184

PRINCIPAL FEATURES AND COSTS OF FACILITIES FOR OPTIONAL PORT WASHINGTON, SAUKVILLE, CEDARBURG, AND GRAFTON WATER SUPPLY SERVICE AREAS USING CTH O SAUKVILLE TO GRAFTON WATER TRANSMISSION MAIN ROUTE

Utility	Project Description	Project Location	Capacity	Units	Unit Cost	Number of Units	Capital Cost	Total Capital Cost
Port Washington	Treatment plant expansion	Port Washington	10.00	mgd	$23,700,000	1	$23,700,000	
	Repump reservoir (clearwell)	Port Washington	1.80	MG	2,033,000	1	2,033,000	- -
	Pumping station	Port Washington	10.00	mgd	1,748,000	1	1,748,000	
	30-inch mains	Port Washington to Saukville	- -	L.F.	257	16,500	4,240,500	
- -	- -	- -	- -	- -	- -	- -	$31,721,500	$31,721,500
Saukville	30-inch mains	Port Washington to Saukville	- -	L.F.	$ 257	5,500	$ 1,413,500	
	Pumping station	Saukville	2.10	mgd	957,000	1	957,000	- -
	Repump reservoir	Saukville	1.60	MG	1,961,000	1	1,961,000	
- -	- -	- -	- -	- -	- -	- -	$ 4,331,500	$ 4,331,500
Grafton/ Cedarburg	30-inch mains	Saukville to Grafton	- -	L.F.	$ 257	30,800	$ 7,915,600	
	20-inch mains	Grafton to Cedarburg		L.F.	184	13,200	2,428,800	
	Pumping Station	Grafton - East	2.00	mgd	936,000	1	936,000	
	Repump Reservoir	Grafton - East	3.50	MG	3,448,000	1	3,448,000	- -
	Pumping Station	Grafton - West	2.00	mgd	936,000	1	936,000	
	Repump Reservoir	Grafton - West	3.50	MG	3,448,000	1	3,448,000	
	Pumping Station	Cedarburg	3.00	mgd	1,124,000	1	1,124,000	
	Repump Reservoir	Cedarburg	5.80	MG	3,650,000	1	3,650,000	
- -	- -	- -	- -	- -	- -	- -	$23,886,400	$23,886,400
- -	- -	- -	- -	- -	- -	- -	- -	$59,939,400

Present Worth of Capital Cost	$68,509,000
Total O&M Cost	-$ 2,413,900[a]
Present Worth of Total O&M Cost	-$38,043,000
Total Present Worth Cost	$30,466,000
Equivalent Annual Cost	$ 1,933,000

[a]*Includes the sum of the estimated and new water supply operation and maintenance cost of $524,100 and a reduction in cost of $2,938,000 for savings associated with residences which would be able to discontinue their point-of-entry water treatment devices.*

Source: Ruekert & Mielke, Inc., and SEWRPC.

- **Comment:** The plan should include a specific return flow option as a part of the recommended provision of Lake Michigan water to the City of Waukesha; that option should consist of a direct discharge to Lake Michigan and not to a stream tributary to the Lake.

  Response: Four alternatives were considered with regard to the means of returning spent Lake Michigan water delivered to the City of Waukesha Water Utility. The conclusion of the analyses of these alternatives was that further more-detailed environmental assessment would be necessary in order to recommend a specific return flow option. While substantial analytical data were developed with respect to the potential impacts on stream flooding and Lake Michigan water quality, it was judged that the level of analysis required to determine the impacts on stream water quality and on stream channel erosion was beyond the scope of the regional water supply planning effort, and, moreover, would be duplicative of ongoing work activities being undertaken by the City of Waukesha. Thus, it was determined to maintain the recommendation to leave the selection of the specific form of the required return flow open pending the completion of the more-detailed environmental assessments that would be required during the plan implementation phase.

- **Comment:** Water returned to Lake Michigan should not create a water quality problem.

  Response: As part of the analysis of return flow options conducted under the planning effort, consideration was given to the impact of pollutant loadings on Lake Michigan; including consideration of the average concentrations of the major conventional pollutants in effluent discharged from the City of Waukesha wastewater treatment plant; and the ambient concentrations of those pollutants in Underwood Creek and the Menomonee River, streams considered for receipt of return flow. The average concentrations of ammonia-nitrogen, biochemical oxygen demand, total phosphorus, and total suspended solids in the treated effluent concerned were all found to be approximately equal to, or less than, the average ambient concentrations of these pollutants in the streams concerned. Average concentrations of chlorides in the treated effluent discharge by the Waukesha plant were found to be higher than the average ambient concentrations in these streams; however, the use of Lake Michigan water as a source of water supply by Waukesha would result in a significant reduction in the hardness of the water provided by this utility and would, therefore, eliminate the need for water softening by the users, as is currently necessary. This should result in a reduction in the concentration of chlorides discharged by the Waukesha wastewater plant into receiving waters.

  The State imposed effluent limitations that the Waukesha wastewater treatment plant is subject to are more stringent than those that plants discharging to Lake Michigan are subject to. For example, the weekly average concentration of total suspended solids discharged by the Waukesha wastewater treatment plant is not to exceed 10 milligrams per liter (mg/l). By contrast, the weekly average concentrations of total suspended solids discharged by the MMSD Jones Island and Southshore wastewater treatment plants are not to exceed 45 mg/l. The Jones Island and Southshore treatment plants are subject to an additional effluent limitation under which the monthly average concentration of total suspended solids is not to exceed 30 mg/l. Similarly, depending on the month of the year, the weekly average concentration of biochemical oxygen demand discharged by the Waukesha wastewater treatment plant is not to exceed levels in the range of 8.2 to 10.0 mg/l. The weekly average concentrations of biochemical oxygen demand discharged by the MMSD Jones Island and Southshore wastewater treatment plants are not to exceed 45 mg/l. The Jones Island and Southshore treatment plants are subject to an additional effluent limitation in which the monthly average concentration of biochemical oxygen demand is not to exceed 30 mg/l. Moreover, the actual concentrations of biochemical oxygen demand and suspended solids in the Waukesha wastewater treatment plant effluent are typically between 1.0 and 3.0 mg/l. In addition, the analyses recognized the potential impacts of the return flow on pollutant loadings to Lake Michigan. However, the increase in loadings was estimated to be insignificant—less than 1 percent—of the total loadings from the other sources of pollution—point and nonpoint—from the Region. Consequently, review of the findings of the system-level analyses concluded that the return flow concerned should not have a significant adverse effect on Lake Michigan. However, as previously noted, additional environmental analyses of the return flow component is expected to be carried out under second-level local planning and engineering by the City of Waukesha should it move forward with a diversion application.

Comments Regarding Potential New Municipal Water Utilities

- **Comment:** The new municipal water utilities proposed for the Village of Silver Lake, Village of Twin Lakes, Town of Randall, and Town of Salem in Kenosha County and the associated proposed municipal service areas and wells are unnecessary. In addition, some comments expressed opposition to creating new municipal water utilities without specifying a proposed utility.

  Response: The proposed plan calls for the provision of municipal water supply to certain areas of the Region that are currently served by private, onsite wells only if and when a need is demonstrated, and then at the option of the affected residents and local units of government concerned. Absent a demonstrated need and local initiative, residents and businesses of the areas would remain on individual wells.

  Additional text has been added to the report to clarify and emphasize these points.

- **Comment:** Where practical, the plan should favor expanding the service areas of existing water utilities over the creation of new utilities in order to achieve economies of scale. This comment was made in a letter from the Public Service Commission of Wisconsin.

  Response: Two auxiliary recommendations have been added to the recommended plan. The first identifies alternative means for providing public water supply to areas of existing and proposed urban development that transcend municipal boundaries and that are not currently served by municipal water supply facilities. The second identifies opportunities for integration among existing municipal utility systems. The revised text includes a preference for the expansion of existing utility systems rather than the creation of new utilities.

- **Comment:** Concern was expressed about water from any wells drilled in the Town of Salem being provided to other communities. Concern was also expressed about the Town of Salem being provided with water by the City of Kenosha Water Utility.

  Response: The number of wells planned, and the quantity of water estimated to be required, by the proposed Town of Salem Water Utility under the preliminary recommended regional water supply plan are based upon population, employment, and land use demand forecasts set forth in the adopted design year 2035 regional land use plan. The proposed water supply plan does not envision the provision of water by the Town of Salem Water Utility, should such a utility be created, to any other communities. The proposed plan also does not envision the expansion of the Kenosha Water Utility service area to those areas indicated to be served by municipal systems relying on groundwater water supply shown on Map 53. It should be noted that expansion of the City of Kenosha Water Utility service area into the Town of Salem would require approval under the Great Lakes-St. Lawrence River Basin Water Resources Compact. It is recognized, however, that should a Town of Salem Water Utility be created, it would be logical to consider interconnection to adjacent groundwater-supplied utilities for purposes of ensuring the provision of water in the event of emergencies.

- **Comment:** The proposed new municipal water utilities will spur development throughout Walworth County, because developers will build where the development can be connected to a municipal system.

  Response: The plan actually envisions the restriction of new urban development to areas around the periphery of existing urban development. The plan identifies only three potential new municipal utility areas within Walworth County: the Potter Lake area in the Town of East Troy and the Town of Lyons Sanitary District No. 2 area, and the existing urban-density development in the Delavan Lake

Sanitary District. The areas are all currently developed. In addition, the plan identifies limited areas immediately adjacent to existing municipal water supply service areas, which are currently served by private wells, as potential future municipal service areas. These areas currently contain urban-density development. In total the areas concerned encompass fewer than five square miles, or about 1 percent, of the County. The recommendations in the plan provide for the potential conversion of existing development from private to public water supply. However, the plan envisions such conversions only if and when there is a need demonstrated, and then at the option of the affected residents and local units of government concerned. Absent a demonstrated need and local initiative, residents and businesses would remain on individual wells. The vast majority of the area of Walworth County is envisioned to continue to rely on private wells.

- **Comment:** The report should contain a more prominent statement that the plan recommends that new municipal water utilities be formed only in the case of a demonstrated local need and if a local initiative is undertaken.

  Response: Additional text has been added to the report to clarify and emphasize these points.

Comments Regarding Proposed 2035 Water Supply Service Areas

- **Comment:** The proposed expanded municipal water supply service area for the Delavan Water and Sewerage Commission and the Williams Bay Municipal Water Utility in Walworth County and the associated proposed wells are unnecessary.

  Response: The plan calls for the provision of municipal water supply to certain areas that are currently served by private, onsite wells only if and when a need is demonstrated and then at the option of the affected residents and local units of government concerned. Absent a demonstrated need and local initiative, residents and businesses of the areas would remain on individual wells.

  Additional text has been added to the report to clarify and emphasize these points.

- **Comment:** The plan should address the need to limit the potential future expansion of the City of Waukesha.

  Response: As part of an application for a diversion of water from Lake Michigan under the Great Lakes Compact, the community applying for the diversion will have to submit an estimate of the proposed volume of water to be diverted and a map showing its proposed water supply service area. The water supply service area approved as part of any diversion request would limit provision of Lake Michigan water to that service area. No expansion beyond the Waukesha Water Utility service area as delineated in Chapter IV is envisioned in the preliminary recommended regional water supply plan.

- **Comment:** Since the Village of Richfield has incorporated, the inclusion of a portion of the unincorporated area in the Village of Germantown Water Utility planned year 2035 service area, as shown on Map 63, should be reconsidered.

  Response: While Map 63 shows the area that is referred to in the comment as being in the recommended 2035 service area of the Village of Germantown Water Utility, the legend to the map does indicate that this area could be served by a new utility. Several options are available for providing municipal water service to this area and similar areas where the proposed expansion of an existing utility's service area would transcend municipal boundaries. In the case of Richfield, one option would be to form a Village of Richfield utility district which would then contract with the existing Village of Germantown utility for the purchase of water to distribute within its service area. A second option would be to form a village utility district which would develop its own sources of water supply. Another option would be to contract for retail service from an existing utility. Although any of these forms of organization appear viable under the preliminary recommended plan, as noted in a previous comment, the State Public Service Commission encourages the regionalization of water supply systems in order to achieve economies of scale, and has found that expanding existing utility service area boundaries is more favorable for rate payers and less costly for utilities than the creation of new utilities. Additional text has been added to the report to clarify this point.

Comments Regarding the Recommended Water Conservation Program Component of the Plan

- **Comment:** The plan should provide more specifics regarding the recommended water conservation programs.

  Response: The proposed plan recommends that the scope and content of the water conservation programs be determined on a utility-specific basis, reflecting the type and sustainability of the source of supply and existing infrastructure conditions. Details regarding the kinds of measures recommended for these programs are set forth in Chapter IX of this report; while recommended levels of water conservation for individual utilities are set forth in Appendix K of this report. The types of measures to be considered and the levels of conservation to be achieved are based upon the information provided in SEWRPC Technical Report No. 43, *State-of-the-Art Water Supply Practices*, July 2007. The recommended measures are intended to constitute a guide to be used by local utilities in developing utility-specific programs. Implementation of these programs will require selection of measures and refining of program details in subsequent planning conducted by the individual utilities.

  The water conservation programs developed by the water utilities will have to be designed to meet the requirements of the Wisconsin Department of Natural Resources rulemaking process. This rulemaking process is being carried out to meet the requirements of the Great Lakes-St. Lawrence River Basin Water Resources Compact and Wisconsin Act 227, related groundwater protection legislation, and the September 2006 Report to the Governor on Water Conservation. The Wisconsin Act 227 requires that the WDNR establish statewide water conservation and efficiency goals and objectives and to establish rules specifying the requirements for water conservation and efficiency for applicants for new or increased diversions. The WDNR intends to initiate the water conservation rulemaking process during 2009, with completion expected on or about the end of 2010. The Public Service Commission of Wisconsin also considers any proposed water conservation measures during its review of water utility budgets and rates.

- **Comment:** Water conservation education is important.

  Response: As noted above, the proposed plan recommends that the scope and content of the water conservation programs be determined on a utility-specific basis, reflecting the type and sustainability of the source of supply and existing infrastructure conditions. Details regarding the kinds of measures recommended for these programs are set forth in Chapter IX of this report; while recommended levels of water conservation for individual utilities are set forth in Appendix K of this report. Public information and education programming is specifically identified as an element of each recommended level of water conservation program. As noted above, the Public Service Commission of Wisconsin and the Wisconsin Department of Natural Resources have important roles in establishing water conservation programs.

Comments Regarding the Placement of High-Capacity Wells

- **Comment:** Groundwater monitoring needs to be conducted in the area where a high-capacity well is proposed before the well is drilled and commissioned.

- **Comment:** An evaluation regarding the impacts of proposed high-capacity wells on surface waters and private wells should be required.

  Response: The plan includes provisions related to the siting of all new high-capacity wells and for the analysis and monitoring of impacts of such wells on the shallow aquifer. These provisions specify the measures that should be taken in the early stages of locating sites for high-capacity wells in the shallow aquifer to develop the necessary understanding of the hydrogeological system associated with each candidate site and its surrounding area and to assess the likelihood of impacts of proposed wells upon nearby existing wells and surface waterbodies. These provisions also recommend monitoring of water levels in the vicinity of new high-capacity wells in the shallow aquifer, both prior to and during the test well phase of placement and during operation of the well. The recommendations for well monitoring have been expanded to include baseline monitoring of private individual wells anticipated to be maintained in the vicinity of a new large-capacity well.

Comments Suggesting Additional Recommendations to be Considered for Inclusion in the Plan

- **Comment:** Additional recommended activities to reduce the reliance within Ozaukee County on shallow groundwater withdrawals are needed in the plan.

  Response: Under the preliminary recommended plan, groundwater withdrawals in Ozaukee County would substantially decrease. For example, the amount of water withdrawn by municipal water utilities would, between 2000 and 2035, decrease from about 4.3 million gallons per day to about 0.9 million gallons per day, the remaining withdrawals being attributed to the utilities serving the Villages of Belgium, Fredonia, and a portion of the Village of Newburg. Total withdrawals would decrease from about 9.0 million gallons per day to about 4.0 million gallons per day, including by private onsite wells and other self-supplied systems. This represents the greatest forecast decrease in withdrawals within any county in the seven-county Region. Under the conditions associated with the preliminary recommended plan, streams and watercourses in Ozaukee County would experience an average augmentation in baseflow of about 15 percent. The regional water supply plan also includes recommendations related to the siting of all new high-capacity wells and for the analysis and monitoring of impacts of such wells in the shallow aquifer. In the event that potential impacts to surface waterbodies are determined to be likely during this siting process, the plan recommends adoption of mitigative measures, such as relocation of proposed high-capacity wells and enhancement of groundwater recharge.

- **Comment:** Additional shallow aquifer recharge facilities should be incorporated into long-term stormwater management planning.

  Response: Map 108 shows the location of the sites for recharge facilities that were used in the application of the aquifer simulation model to help analyze the effects of the recharge facilities. The determination of the actual number of facilities, their capacities, their locations, and their appropriate design will need to be determined on a case-by-case basis during subsequent local planning and plan implementation efforts. The water supply plan recommends that these facilities be constructed where evaluations conducted in conjunction with the siting of high-capacity wells in the shallow aquifer indicate probable reductions in baseflows of streams or of water levels in lakes or wetlands due to installation and operations of the wells. In addition, the plan recommends preservation of existing recharge areas and the implementation of stormwater management practices designed to maintain recharge will help to maintain recharge to the shallow aquifer.

- **Comment:** The final plan should include a recommendation to study and formulate a road salt management plan to deal with increases in concentrations of chloride in shallow wells.

  Response: The recent update of the regional water quality management plan for the greater Milwaukee area watersheds included several recommendations regarding reductions of chloride contributions to surface waters.[2] These included recommendations that municipalities and counties within the planning area consider alternatives to current ice and snow control programs that would result in a reduction in the amount of chlorides introduced into the environment. For the purpose of groundwater quality protection, these recommendations will be incorporated into the regional water supply plan as an auxiliary recommendation.

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[2]*SEWRPC Planning Report No. 50,* A Regional Water Quality Management Plan Update for the Greater Milwaukee Watersheds, *December 2007.*

- **Comment:** The final plan should include a recommendation to formulate a management plan for the protection of the quality of water in shallow wells during major rainfall events.

  Response: Design standards governing the placement of wells are intended to protect the water quality of shallow wells in the event of flooding accompanying a major rainfall event. The current state-of-the-art design practices for wells should ensure the quality of water in new shallow wells in the event of flooding or stormwater impoundment accompanying a major rainfall event. These practices include watertight construction and terminating wells at elevations above the flood elevation.

- **Comment:** The remaining open space in Waukesha County, especially the high-recharge and very high-recharge areas, should be preserved for groundwater recharge.

  Response: The plan includes a groundwater recharge area protection component directed at preserving existing groundwater recharge areas classified as having a high or very high recharge potential. This component may be expected to be largely achieved through the implementation of the adopted design year 2035 regional land use plan, since that plan recommends preservation of the environmental corridors, isolated natural resource areas, and prime and other agricultural areas of the Region that facilitate recharge. About 74 percent of the high rated and the very high rated recharge areas may be expected to be preserved by inclusion in the environmental corridors, isolated natural resource areas, and prime and other agricultural areas identified for preservation in the adopted land use plan. Careful design of new urban development and the use of selected stormwater management practices is also recommended to increase the level of preservation of the highly rated and very highly rated recharge areas.

Comments and Questions Regarding Implementation of the Plan

- **Comment:** What are the exact locations of the wells planned or proposed for Kenosha County and how were these locations determined?

- **Comment:** Maps should be included that show the proposed staging of the plan recommendations in five- to 10-year increments.

  Response: The level of detail requested in this comment is beyond the scope of systems-level planning. The planning process used to prepare the regional water supply plan constitutes the first phase—the systems planning phase—of what is a three-phase public works development process. Second-level local planning and preliminary engineering constitutes the second phase in this sequential process, with final design constituting the third phase. The systems planning phase concentrates on the definition of the problems to be addressed and on the development and evaluation of alternative measures for resolution of these problems on an areawide basis. Systems planning is intended to permit the selection, from among available alternatives, of the most effective means to resolve the identified problems, in accordance with agreed upon objectives and supporting standards. In this initial planning phase, each alternative plan element is developed to sufficient detail to permit a sound, consistent comparison of the technical practicality and economic feasibility of each alternative and a proper evaluation of its potential environmental impacts. The identified areawide plan elements are carried into greater detail and depth in the next phase—second-level planning and preliminary engineering. The specific location of wells and the staging of water supply facility development will depend upon more detailed local planning and engineering.

- **Comment:** Future developers should be required to pay for and implement recommendations of the plan.

  Response: For some elements of the plan, this may be an option to be considered by the local units of government concerned during plan implementation. It is a common practice for municipalities within the Region to require developers to pay for, or to construct, some elements of the water supply infrastructure required to serve newly developing areas.

- **Comment:** The plan recommends that City of Hartford Utilities place greater reliance on the shallow aquifer as a source of water supply. The utility's last deep aquifer well was shut down in 2006 and is planned to be abandoned in 2009 at which time the utility plans to have a new large capacity shallow aquifer well and elevated storage tank operational.

  Response: Appropriate changes to the alternative and the recommended plan chapters of this report were made in response to this comment. The revised text now documents the recent City of Hartford water supply facility development and the abandonment of its existing deep aquifer well.

- **Comment:** SEWRPC should establish benchmarks which communities should meet with respect to water conservation, housing, and transportation. If the communities do not meet these benchmarks, SEWRPC should not assist them in planning water system expansion, new wells, water treatment plants, or in other efforts.

  Response: Upon completion of the regional water supply plan, the Commission's role in water supply planning will be limited to supporting implementation efforts by the local units of government involved. The Commission will have no direct role in those plan implementation actions. The powers and duties of regional planning commissions are set forth in Chapter 66.0309 of the *Wisconsin Statutes*, and the work of such commissions is clearly entirely advisory to plan implementation agencies. Withholding its services to constituent counties and municipalities to coerce compliance with its plans would be inconsistent with the Commission's advisory role in governmental practices and procedures.

- **Comment:** The Village Board of the Village of Germantown adopted a resolution indicating that, at this time, it declined to adopt any plan that would commit the Village of Germantown water utility to connect to Lake Michigan as a source of supply.

  Response: It is anticipated that implementation of a Lake Michigan water supply for the Village of Germantown would most likely occur late in the plan implementation period. The plan recommends conversion to a Lake Michigan water supply for most of the communities located east of the subcontinental divide traversing the Region, albeit late in the planning period for the following reasons: 1) the favorable environmental impacts attendant to the recovery of the deep aquifer; 2) the reduction in chloride discharges to surface waters; 3) the favorable impacts on stream flows; 4) the ability to preserve the groundwater sources for other uses, such as agricultural; and 5) the opportunity to use available excess production capacity at the Milwaukee Water Works. In any case, the regional water supply plan is an advisory plan, and its adoption cannot commit a local unit of government to any action recommended in the plan.

Questions Regarding the Status of the Plan

- **Comment:** Who asked for the study and where can the scope of work be found?

  Response: The regional water supply planning program was undertaken by the Commission in response to formal requests received from Kenosha, Racine, and Waukesha Counties, and from the City of Waukesha, the Villages of Hartland and Wales, and the Town of Genesee. The scope of work for the regional water supply planning program is described in the document entitled *Regional Water Supply Planning Program Prospectus*, published by the Commission in September 2002. Importantly, Wisconsin's groundwater management law—Wisconsin 2003 Act 310—requires the preparation of a water supply plan for southeastern Wisconsin. The regional plan documented herein is intended to fulfill that requirement.

- **Comment:** What if the elected officials of a municipality choose not to adopt and implement the recommended plan?

  Response: The recommended regional water supply plan, like all of the Commission's plans, will be an entirely advisory plan. After adoption by the Commission, it will be certified to the constituent

Counties and to the municipal units of government within the Region, and to concerned State and Federal agencies, for consideration, endorsement, and implementation. The Commission has no authority to require the adoption or implementation of its plans. Should a municipality or utility choose not to follow the plan recommendations, the impact of such decisions will have to be evaluated by the Commission in subsequent plan updates or amendments.

Comments Regarding the Presentation of Information in the Draft Planning Report

- **Comment:** The overlays of urban development should be removed from the recharge potential maps shown at the public information meetings. Infiltration will continue to occur in low- and medium-density residential areas.

  Response: The maps were altered as suggested to show the recharge potential in areas of urban development.

Comments and Questions Regarding the Public Information Meetings

- **Comment:** Every landowner should have been notified of the public information meetings by mail or phone call.

  Response: The public information meetings were announced through a newsletter describing the preliminary recommended plan which was sent to about 2,000 interested parties, including elected and appointed officials of all the county and municipal governments within the Region. The hearings were also advertised in 13 newspapers which serve the Region. Notification of such meetings to individual landowners in a 2,700-square-mile Region of over 1.9 million residents cannot reasonably be expected at the areawide, systems level of planning, the cost entailed being beyond the limited funding provided for the planning effort.

- **Comment:** Were local government officials given information about the plan prior to involving their electors in public comment?

  Response: Over the course or the planning program, interested parties—including county and municipal elected and appointed officials—were kept apprised of the progress and results of the planning program through a series of three newsletters, and in many cases, personal briefings. Each newsletter was sent to about 2,000 interested parties, including representatives of all the county and municipal units of government within the Region. The Commission staff has also made 124 informational presentations to groups on the plan, including groups of county and municipal officials.

Comments Included in Letters Received on the Preliminary Recommended Water Supply Plan Which Were Judged to Require Formal Letter Responses

Seven letters commenting on the preliminary recommended plan were received from the City of Milwaukee, interested organizations, and two faculty members of the University of Wisconsin. These comment letters were multifaceted and raised a number of issues which were judged so important as to warrant letter response. Copies of the comment letters and the responses are included in Appendix O.

A number of comments were received related to the adopted regional land use plan—the primary foundational element of the regional water supply plan. In response to those comments, it was noted that the adopted regional land use plan was not based upon projections of population, employment, and existing land use development trends, as assumed in the comments. Rather, the plan is based upon a set of carefully crafted regional development objectives which seek to reverse historic trends. The population of Milwaukee County declined by almost 113,000 persons over the approximately 30-year period from 1970 to 2003. Despite that trend, the regional land use plan envisions an increase in Milwaukee County population of almost 66,000 persons over the next 30 years. Similarly, employment levels in Milwaukee County declined by about 20,000 jobs from 1990 to 2003. The regional land use plan envisions an increase of over 39,000 jobs in Milwaukee County from 2003 to 2035. This reversal of the decline in population and employment levels in the central county of the Region are, in the plan, attended by major reductions in the historic growth levels of the outlying counties. For example, from 1970 to 2003 the population of Waukesha County increased by about 140,000 persons. The regional plan, however, envisions that from 2003 to 2035 Waukesha County's population would increase by about 76,000 persons. The plan envisions similar reductions in the historic growth levels of the other collar counties. The regional land use plan, then, seeks to recentralize development within the Region on the Kenosha, Racine, and Milwaukee urbanized areas as much as possible, encouraging redevelopment and new development to occur at higher densities in neighborhoods located in areas that either are already served by, or can readily be served by sanitary sewerage, public water supply, mass transit, and police and fire protection services.

In a related response, it was also indicated that many factors must be taken into account in the development of an advisory land use plan that attempts to influence the land use pattern of a large region. In addition to the availability of water supply, such factors include provision of transportation, sanitary sewerage, stormwater management and flood control, and park and open space facilities; the maintenance of a productive agricultural base; protection of air and water quality conditions; and protection of environmentally sensitive areas found throughout the regional landscape.

The Commission has long subscribed to principles which recognize that natural resource base factors should influence the placement and intensity of urban development. This is why, for example, the Commission land use plan seeks to protect the floodlands, wetlands, woodlands, and other environmentally sensitive lands found within and beyond the Commission-identified environmental corridors. This is also why the Commission land use plan seeks to protect the most productive agricultural soils of the Region. Groundwater and surface water resources used for water supply are also important considerations in land use planning, and recognition of this importance was one of the fundamental reasons why the Commission has long sought to prepare a regional water supply plan. The Commission has always recognized the relationship that exists between land use planning and water supply planning, and indicated at the very beginning of the water supply study effort that, should that planning effort identify any water resource constraints on the development pattern envisioned in the adopted regional land use plan, the Commission would initiate a process to amend the land use plan in an appropriate manner. This issue was specifically discussed in a collegial manner during two of the Regional Water Supply Plan Advisory Committee meetings. A cyclical approach of basing the regional water supply plan on the regional land use plan and considering the need to amend the regional land use plan if a water supply sustainability issue was demonstrated, was agreed upon.

Analyses conducted under the regional water supply study indicate that the patterns and intensities of development envisioned in the 2035 regional land use plan can be supported in a sustainable manner under the recommended water supply plan. Moreover, the analyses concluded there would be an adequate water supply through the year 2035 from a combination of deep and shallow groundwater aquifers for those communities from outside the Lake Michigan basin proposed under the plan to receive Lake Michigan water, should these communities instead continue to rely on groundwater for water supply. Accordingly, there is no basis for a change in the regional land use plan based upon water supply considerations.

It was also noted that State law requires counties and municipalities to adopt "smart growth" plans if the counties and municipalities are to exercise zoning, land subdivision control, or official map regulation. Within southeastern Wisconsin, as of May 1, 2010, six of the seven counties adopted such plans. These county plans essentially incorporate the adopted regional land use plan. In addition to the county plans, 146 of the 147 municipalities within the Region have prepared, or are in the process of preparing, such "smart growth" plans. Again, with some exceptions, these local plans substantially incorporate the regional land use plan.

The comment letters and written responses also covered topics related directly to the preliminary regional water supply plan. These comments and responses are contained in Appendix O.

Based upon the comments received and the responses thereto, the following actions regarding modifications to the preliminary regional water supply plan were made.

- The recommended water supply plan includes a specific recommendation for application of a high-capacity well siting procedure that incorporates hydrologic analyses, performance monitoring, and mitigation steps for siting of high-capacity wells. Chapter XI, "Plan Implementation," includes a recommendation for incorporating such procedures into State regulations.

- Chapter XI, "Plan Implementation," includes a recommendation that the environmental corridors delineated on the adopted regional land use plan be expanded to include selected additional lands categorized as having high or very high recharge characteristics.

- The recommended water supply plan and plan implementation recommendations includes a specific recommendation for the conduct of additional planning, engineering, legal, and environmental analyses to meet the requirements of the Great Lakes-St. Lawrence River Basin Water Resources Compact when a diversion of Lake Michigan water is involved in a plan implementation action. The conduct of the analyses will be recommended as an essential part of the second-level local planning and preliminary engineering and diversion permit application plan implementation activities.

- The importance of the well siting procedure, water conservation, and groundwater recharge measures has been highlighted for areas of the Region expected to rely on shallow aquifer water supplies.

SOCIOECONOMIC ANALYSIS

In 2007, the Regional Planning Commission created an Environmental Justice Task Force to more directly involve the minority and low-income communities in its planning process. Given the expressed interest of the Task Force in the potential socioeconomic impacts of the regional water supply plan, it was determined to have a consultant conduct a socioeconomic analysis of the preliminary recommended regional water supply plan. In response to a request for proposals, four consultants submitted proposals to carry out the desired socioeconomic analysis. A consultant selection committee was formed and determined to select two of the consultant teams for personal interview, after which the committee recommended retention of the University of Wisconsin-Milwaukee Center for Economic Development to carry out the desired analysis. The findings of the completed socioeconomic analysis are documented in the report entitled *Socio-Economic Impact Analysis of the Regional Water Supply Plan for Southeastern Wisconsin*, dated July 31, 2010, prepared by the University Center.

The summary and conclusions of the socioeconomic analysis are summarized in Appendix P. The analysis concluded that probable future population growth, racial and ethnic population patterns, and job growth would not be significantly affected by implementation of the recommendations in the proposed plan concerning the continued use of the existing sources of supply. In addition, the analysis concluded that little or no adverse environmental impacts were to be expected in communities served by the utilities concerned. The analysis concluded that past trends regarding the number and percentage of low-income persons are likely to continue in the communities which are proposed to change to a Lake Michigan supply or be a provider of such supply. The study notes that intergovernmental agreements between provider and customer water supply utilities and communities could offer opportunities to offset any potential socioeconomic impacts. It was further concluded that the potential new utility service areas identified in the plan would not have a significant impact on existing or planned urban development patterns. The analysis, however, recommended that the regional water supply plan contain information on any cost-sharing assistance that may be available to low- and moderate-income residents in such new service areas to offset the capital costs entailed.

The analysis also concluded that the recommendations contained in the preliminary regional water supply plan relating to water conservation, stormwater management practices, well siting, and enhanced rainfall infiltration systems would either have no significant impact on low-income, minority, ethnic, or disabled persons; or that there was no clear linkage between plan implementation and such impacts. It was also concluded that it was unlikely that these plan elements would have an adverse impact on the environment or cause disproportionate environmental impacts on low- and moderate-income residents.

The analysis recommended that implementation measures concerning the recharge areas designated in the plan for protection should include an inventory of the population and land uses involved. In addition, it was recommended that any State, county, or local regulations regarding the protection of the recharge areas should take into consideration any potential impacts on the affected populations.

The analysis also made two recommendations directed toward the Regional Planning Commission when future updates of the regional water supply plan are carried out. One recommendation related to providing representation of the environmental justice communities on the planning advisory committee. The other recommendation related to the preparation of a formal public participation plan be prepared for any future updates of the regional water supply plan. All of the recommendations set forth in the study have been incorporated into the final regional water supply plan and implementation recommendations or have been taken into account by Regional Planning Commission policies.

At its September 2, 2010, meeting, the EJTF acted to accept the UWM-CED socioeconomic impact analysis report for transmittal to the Southeastern Wisconsin Regional Planning Commission; and recommended that comments made by members of the public present at the September 2, 2010, meeting, as well as comments made by members of the Task Force itself, be transmitted to the Southeastern Wisconsin Regional Planning Commission, with possible amendments. The comments and concerns raised and transmitted to the Southeastern Wisconsin Regional Planning Commission have been documented in the minutes of the September 2, 2010 Environmental Justice Task Force meeting, and were provided to the Regional Water Supply Planning Advisory Committee and the Regional Planning Commission. Based upon careful consideration of the comments received and the fact that a greater part of the EJTF and public comments to the EJTF relate to the validity of assumptions related to future conditions that were used in the socioeconomic impact study, no changes were made to the UWM-CED socioeconomic analysis. For the same reason, no changes were made to the regional water supply plan or plan report by the Regional Water Supply Planning Advisory Committee, recognizing that the plan currently recommends that population, employment, land use, and water demand and supply conditions within the Region be monitored, and that the plan be periodically reevaluated and revised as may be necessary or desirable.

RECOMMENDED REGIONAL WATER SUPPLY PLAN

Land Use Basis for Regional Water Supply Plan

The adopted design year 2035 regional land use plan[3] serves as the basis for the preparation of the regional water supply plan. The regional land use plan was designed to accommodate the regional employment, population, and household forecasts described in Chapter IV. The plan seeks to encourage infill development and redevelopment in existing urban centers, and the location of new urban development adjacent to and outward from existing urban centers in areas which can be readily served by sanitary sewerage and water supply systems and by mass transit facilities. The plan seeks to preserve the environmental corridors and isolated natural resource areas within the Region in essentially natural open uses, and to preserve the best remaining agricultural areas of the Region in agricultural uses.

It should be noted that, pursuant to State law, six of the seven counties comprising the Region have recently adopted “smart growth” plans. The land use elements of those plans are generally in substantial conformance with the adopted regional land use plan, the exceptions largely being associated with some rural communities not preserving prime agricultural lands as recommended in the regional plan, and proposing very low-density urban development, and with some urban communities which envision more substantial growth by the year 2035 than does the regional plan. By State law, adoption of the smart growth plans must be by ordinance, and the exercise of certain plan implementation powers, such as zoning and land subdivision control, must be in conformance with the adopted plans. These plan adoption actions indicate strong support by the County Boards for the regional plan. It should be further noted that only Milwaukee County has not prepared a county level smart growth plan, there being little perceived need to do so since the entire county is included within incorporated municipalities.

A number of alternative means were identified to provide for a sustainable water supply to support the development envisioned in the regional land use plan. The recommended regional water supply plan set forth herein was judged to be the best alternative in meeting the water supply planning objectives set forth in Chapter V, including consideration of costs and environmental impacts. The recommended water supply plan set forth herein also takes into consideration the substantial comments received during the extensive public hearings conducted as a part of the planning program.

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[3]*SEWRPC Planning Report No. 48*, A Regional Land Use Plan for Southeastern Wisconsin: 2035*, June 2006.*

Plan Elements

Based upon careful consideration of the comments received at the public hearings held on the preliminary regional water supply plan, that plan was refined to form the recommended regional water supply plan. The sources of water supply envisioned under the recommended plan for the various existing and proposed service areas are shown on Map 123. The number of utilities proposed to utilize the various sources of supply, together with the estimated design year 2035 population served and average daily pumpage are given in Table 185. Map 124 illustrates the primary facilities envisioned to be used to provide the sources of supply. The elements of the recommended water supply plan, as well as the changes made to the preliminary recommended water supply plan described in Chapter IX, may be summarized as follows:

- There are 60 water utilities or portions of utilities which would serve about 1.67 million persons by the design year 2035—or about 75 percent of the forecast regional population—and which have been determined to have adequate existing sources of supply. These utilities are recommended to continue to use their existing sources of supply. Of these utilities, 27 utilities, serving about 1.41 million persons rely on Lake Michigan supply; while 33 utilities serving about 254,000 persons rely on groundwater supplies. These 60 utilities, may be expected to require infrastructure expansion in most cases to serve the forecast demand in their existing and expanded service areas. However, the existing sources of supply are considered adequate. These utilities are listed in Table 186 and represent the majority of the existing water utilities within the Region. Table 187 summarizes the number of utilities with existing sources of supply that are considered adequate and the associated plan year population and average daily pumpage by county. For three of the utilities—the Village of Fredonia Municipal Water Utility, the western portion of the Village of Menomonee Falls Water Utility, and the Town of Brookfield Sanitary District No. 4—the alternative plans considered a Lake Michigan supply option. However, upon evaluation, the continued use of the existing groundwater supplies was recommended.

  The preliminary recommended plan was refined to reflect current information on the most recent expansion of the City of Oak Creek Water Utility water treatment plant and its associated costs. The recommended plan now recognizes the capacity provided by the expansion under construction in 2010 and attendant construction costs.

  With regard to the Village of Caledonia West Utility District, the water supply service area attendant to that District has been adjusted to include a new larger western Caledonia area to be consistent with the Racine County "smart growth" comprehensive plan[4] and the City of Racine and Village of Caledonia sewer service area plan.[5] All of the planned water supply service areas concerned are recommended to be served by a Lake Michigan supply from the City of Racine Water and Wastewater Utility and the City of Oak Creek Water Utility. A portion of the expanded western service area for the Village of Caledonia West Utility District was previously identified as the Northwest Caledonia Planned Utility District in earlier chapters. However, that name has been eliminated, and the area concerned has been included in the expanded Village of Caledonia West Utility District. A portion of the West Utility District is currently served by purchasing Lake Michigan supply from the City of Racine Water and Wastewater Utility, and a portion is served using purchased Lake water from the City of Oak Creek Water Utility. It is recommended that the best means to provide the Lake Michigan supply to the expanded western portions of the water supply service area considering the sources noted above be determined as part of the second-level planning and engineering phase of plan implementation.

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[4]*SEWRPC Community Assistance Planning Report No. 301,* A Multi-Jurisdictional Comprehensive Plan for Racine County: 2035, *November 2009.*

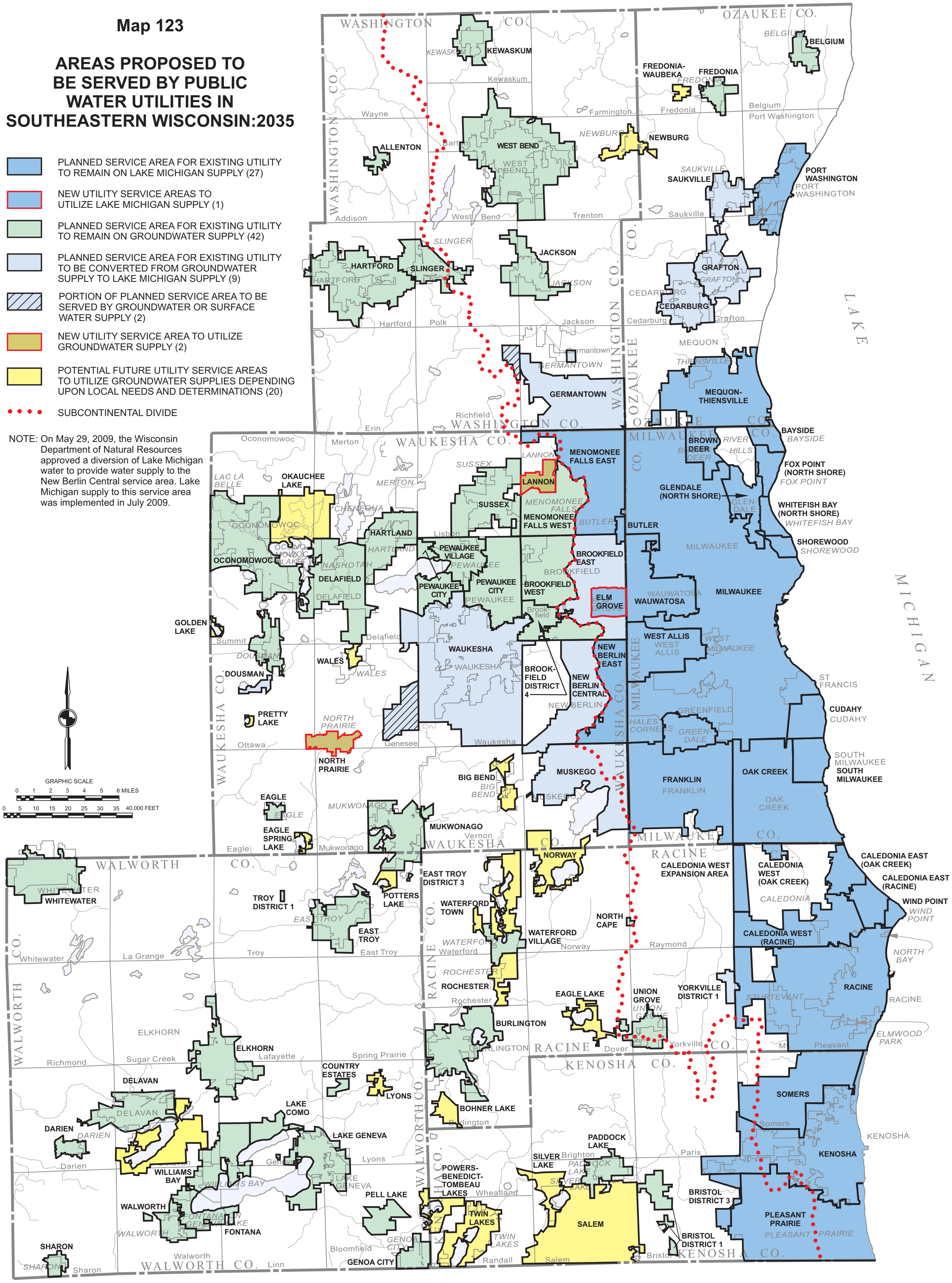
[5]*SEWRPC* Amendment to the Regional Water Quality Management Plan, Village of Caledonia, *June 2009.*

Map 123

AREAS PROPOSED TO BE SERVED BY PUBLIC WATER UTILITIES IN SOUTHEASTERN WISCONSIN:2035

- PLANNED SERVICE AREA FOR EXISTING UTILITY TO REMAIN ON LAKE MICHIGAN SUPPLY (27)
- NEW UTILITY SERVICE AREAS TO UTILIZE LAKE MICHIGAN SUPPLY (1)
- PLANNED SERVICE AREA FOR EXISTING UTILITY TO REMAIN ON GROUNDWATER SUPPLY (42)
- PLANNED SERVICE AREA FOR EXISTING UTILITY TO BE CONVERTED FROM GROUNDWATER SUPPLY TO LAKE MICHIGAN SUPPLY (9)
- PORTION OF PLANNED SERVICE AREA TO BE SERVED BY GROUNDWATER OR SURFACE WATER SUPPLY (2)
- NEW UTILITY SERVICE AREA TO UTILIZE GROUNDWATER SUPPLY (2)
- POTENTIAL FUTURE UTILITY SERVICE AREAS TO UTILIZE GROUNDWATER SUPPLIES DEPENDING UPON LOCAL NEEDS AND DETERMINATIONS (20)
- SUBCONTINENTAL DIVIDE

NOTE: On May 29, 2009, the Wisconsin Department of Natural Resources approved a diversion of Lake Michigan water to provide water supply to the New Berlin Central service area. Lake Michigan supply to this service area was implemented in July 2009.



Source: SEWRPC.

Table 185

RECOMMENDED SOURCES OF WATER SUPPLY FOR EXISTING AND POTENTIAL NEW UTILITIES WITHIN SOUTHEASTERN WISCONSIN: 2035

Recommendation	Number of Utilities	2035 Population in Service Area	2035 Average Daily Pumpage (gallons per day X 1,000)
Existing Utilities with Adequate Lake Michigan Supply	27	1,411,200	213,903
Existing Utilities with Adequate Groundwater Supplies	33	254,100[a]	33,323
Existing Groundwater Utilities to Place More Reliance on Shallow Aquifer	5	58,600	8,619
Existing Groundwater Utilities Considered for a Lake Michigan Supply, But Recommended to Remain on a Groundwater Supply	4	65,900	8,848
Existing Utilities Recommended to Be Converted from Groundwater to Lake Michigan Supply	9	219,000	27,779
New Utilities Recommended to Utilize Lake Michigan Supply	1	6,600	769
Potential New Utilities Recommended to Utilize Groundwater Supplies	22	83,100	10,014
Subtotal	101	2,098,500	303,255
Population Recommended to Be Served by Private Residential Other-than-Municipal Systems and Private Onsite Wells Groundwater Supplies	- -	180,100	11,706
Total	101[a]	2,278,600[b]	314,961

[a]*Includes two portions of three utilities which are envisioned to utilize different sources of supply, thus, there are expected to be 98 utilities.*

[b]*Includes 2,600 persons in Jefferson County served by the City of Whitewater Utility.*

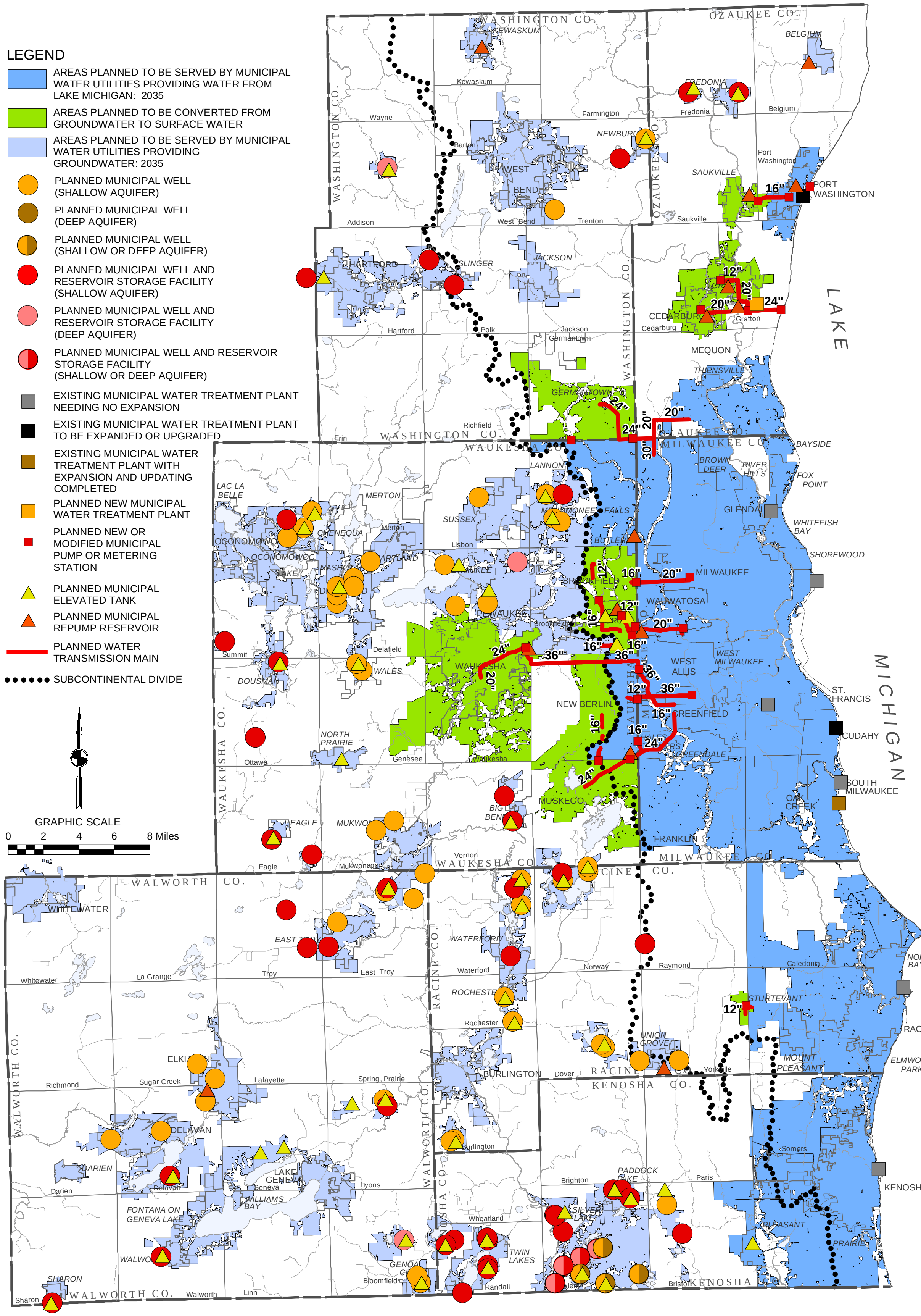
Source: SEWRPC.

- The recommended plan envisions an increased reliance on the shallow aquifer and decreased reliance on the deep aquifer as sources of supply over time for four utilities—the City of Delavan Water and Sewage Utility, the City of Elkhorn Water Utility, the Village of Union Grove Utility, and the Town of Bristol Utility District No. 1. In addition, the plan recognizes that the City of Hartford Water Utility, in 2009, had a new shallow aquifer well and associated elevated storage tank under development. The well and storage tank are expected to be in service in 2010. With the completion of the new well, the utility plans to abandon its one existing deep aquifer well, so that its water supply will be provided entirely by the existing compliant shallow aquifer wells and the new shallow aquifer well, as recommended in the preliminary and final recommended regional plan. Together these five utilities would serve about 59,000 persons by the design year 2035, or about 3 percent of the regional population.

  There are four utilities for which an increased reliance on the shallow aquifer source and the treatment of the existing deep aquifer sources is recommended following an evaluation of the potential for connection to a Lake Michigan supply. These utilities include the western portion of the City of Brookfield Water Utility, City of Pewaukee Water Utility, Village of Pewaukee Water Utility, and Village of Sussex Water Utility. Together these four utilities would serve about 66,000 persons by the design year 2035, or about 3 percent of the regional population. With regard to the City of Pewaukee Water Utility and the Village of Pewaukee Water Utility, the facilities envisioned have been revised from those included under the preliminary recommended plan based upon local facility planning documented in the report entitled, *City and Village of Pewaukee Water Utility Consolidation Study; City and Village of Pewaukee, Waukesha County, Wisconsin*, August 2009.

Map 124

RECOMMENDED REGIONAL WATER SUPPLY PLAN FACILITIES: 2035



NOTES: The City of Oak Creek Sewer and Water Utility completed expansion and upgrading of its water treatment plant in 2010.
The City of Hartford completed the recommended new well and storage tank in 2010.
This map does not indicate the return flow options of the recommended plan. See Map 125 for these return flow options.

Source: Ruekert & Mielke, Inc. and SEWRPC.

Table 186

UTILITIES CONSIDERED TO HAVE ADEQUATE SOURCES OF WATER SUPPLY UNDER THE PRELIMINARY RECOMMENDED REGIONAL WATER SUPPLY PLAN: 2035

County and Utility	Source of Supply
Kenosha County	
City of Kenosha Water Utility	Lake Michigan self-supplied
Village of Paddock Lake Municipal Water Utility	Groundwater shallow aquifer
Village of Pleasant Prairie Water Utility	Lake Michigan purchased supply
Town of Bristol Utility District No. 3	Lake Michigan purchased supply
Town of Somers Water Utility	Lake Michigan purchased supply
Milwaukee County	
City of Cudahy Water Utility	Lake Michigan self-supplied
City of Franklin Water Utility	Lake Michigan purchased supply
City of Glendale Water Utility[a]	Lake Michigan purchased supply
City of Milwaukee Water Utility	Lake Michigan self-supplied
City of Oak Creek Water and Sewer Utility	Lake Michigan self-supplied
City of South Milwaukee Water Utility	Lake Michigan self-supplied
City of Wauwatosa Water Utility	Lake Michigan purchased supply
City of West Allis Water Utility	Lake Michigan purchased supply
Village of Brown Deer Public Water Utility	Lake Michigan purchased supply
Village of Fox Point Water Utility[a]	Lake Michigan purchased supply
Village of Greendale Water Utility	Lake Michigan purchased supply
Village of Shorewood Municipal Water Utility	Lake Michigan purchased supply
Village of Whitefish Bay Water Utility[a]	Lake Michigan purchased supply
We Energies-Water Services[a]	Lake Michigan purchased supply
Ozaukee County	
City of Port Washington	Lake Michigan self-supplied
Village of Belgium Municipal Water Utility	Groundwater shallow aquifer
Village of Fredonia Municipal Water Utility	Groundwater shallow aquifer
We Energies-Water Services	Lake Michigan purchased supply
Racine County	
City of Burlington Municipal Waterworks	Groundwater deep Aquifer
City of Racine Water and Wastewater Utility[b]	Lake Michigan self-supplied
Village of Caledonia West Utility District[c] Oak Creek	Lake Michigan purchased supply
Village of Caledonia West Utility District[c] Racine	Lake Michigan purchased supply
Village of Caledonia East Utility District[d] Oak Creek	Lake Michigan purchased supply
Village of Caledonia East Utility District[d] Racine	Lake Michigan purchased supply
Village of Waterford Water and Sewer Utility	Groundwater deep and shallow aquifers
Village of Wind Point Municipal Water Utility	Lake Michigan purchased supply
North Cape Sanitary District	Groundwater shallow aquifer
Walworth County	
City of Lake Geneva Municipal Water Utility	Groundwater shallow aquifer
City of Whitewater Municipal Water Utility	Groundwater deep aquifer
Village of Darien Water Works and Sewer System	Groundwater deep and shallow aquifers
Village of East Troy Municipal Water Utility	Groundwater deep and shallow aquifers
Village of Fontana Municipal Water Utility	Groundwater deep and shallow aquifers
Village of Genoa City Municipal Water Utility	Groundwater deep and shallow aquifers
Village of Sharon Waterworks and Sewer System	Groundwater deep and shallow aquifers
Village of Walworth Municipal Water and Sewer Utility	Groundwater shallow aquifer
Village of Williams Bay Municipal Water Utility	Groundwater deep and shallow aquifers
Country Estates Sanitary District	Groundwater deep aquifer
Town of Bloomfield Pell Lake Sanitary District No. 1	Groundwater deep aquifer
Town of East Troy Sanitary District No. 3	Groundwater deep and shallow aquifers
Town of Geneva Lake Como Sanitary District No. 1	Groundwater deep aquifer
Town of Troy Sanitary District No. 1	Groundwater shallow aquifer
Washington County	
City of West Bend Water Utility	Groundwater shallow aquifer
Village of Jackson Water Utility	Groundwater shallow aquifer
Village of Kewaskum Municipal Water Utility	Groundwater shallow aquifer
Village of Slinger Utilities	Groundwater shallow aquifer
Allenton Sanitary District No. 1	Groundwater deep aquifer
Waukesha County	
City of Delafield Municipal Water Utility	Groundwater deep and shallow aquifers
City of New Berlin Water Utility (east)	Lake Michigan purchased supply
City of Oconomowoc Utilities	Groundwater deep and shallow aquifers
Village of Butler Public Water Utility	Lake Michigan purchased supply
Village of Dousman Water Utility	Groundwater deep and shallow aquifers
Village of Eagle Municipal Water Utility	Groundwater shallow aquifer
Village of Hartland Municipal Water Utility	Groundwater shallow aquifer
Village of Menomonee Falls Water Utility (east)	Lake Michigan purchased supply
Village of Menomonee Falls Water Utility (west)	Groundwater shallow aquifer
Village of Mukwonago Municipal Water Utility	Groundwater deep and shallow aquifers
Town of Brookfield Sanitary District No. 4	Groundwater shallow aquifer

[a]The North Shore Water Commission provides water to the City of Glendale Water Utility, the Village of Fox Point Water Utility, the Village of Whitefish Bay Water Utility, and a portion of the Village of Bayside served by We Energies-Water Services.

[b]Includes the Village of Sturtevant Water Utility which was purchased by the City of Racine Water and Wastewater Utility in 2007 and is now served by the City Utility on a retail basis.

[c]Includes the former Caddy Vista Sanitary District and the former Caledonia Sanitary District No. 1 which were consolidated in 2007 to form the Caledonia West Utility District.

[d]Includes the former Crestview Sanitary District and the former North Park Sanitary Districts which were consolidated in 2007 to form the Caledonia East Utility District.

Source: SEWRPC.

Table 187

SUMMARY POPULATION AND PUMPAGE DATA FOR UTILITIES CONSIDERED TO HAVE ADEQUATE SOURCES OF SUPPLY UNDER THE RECOMMENDED REGIONAL WATER SUPPLY PLAN: 2035

	Lake Michigan-Supplied Utilities			Groundwater-Supplied Utilities		
County	Number of Utilities	2035 Service Area Population	Year 2035 Average Daily Pumpage (gallons per day X 1,000)	Number of Utilities	2035 Service Area Population	Year 2035 Average Daily Pumpage (gallons per day X 1,000)
Kenosha	4	156,000	22,229	1	5,000	535
Milwaukee	14	1,004,200	147,277	- -	- -	- -
Ozaukee	2	43,800	6,494	2	5,300	781
Racine	4	149,800	29,850	3	20,900	3,186
Walworth	- -	- -	- -	14	74,200	10,288
Washington	- -	- -	- -	5	69,700	7,776
Waukesha	3	57,400	7,958	8	79,000	10,757
Total	27	1,411,200	213,808	33	254,100	33,323

Source: SEWRPC.

- For eight utilities which currently have provision for return flow to Lake Michigan, the plan recommends conversion to Lake Michigan as the source of water supply. Six of the service areas concerned—the eastern portion of the City of Brookfield Municipal Water Utility service area; the City of Cedarburg Light & Water Commission; the Village of Germantown Water Utility; the Village of Grafton Water and Wastewater Commission; the Village of Saukville Municipal Water Utility; and the Town of Yorkville Utility District No. 1—are located east of the subcontinental divide. Two of the areas—the central portion of the City of New Berlin Water Utility service area, and the City of Muskego Public Water Utility—are located within communities that straddle the subcontinental divide, but are located within the MMSD sanitary sewer service area and, therefore, have provisions in place for return flow. Together these eight utilities would serve about 130,500 persons by the design year 2035, or about 6 percent of the regional population.

  With regard to the conversion of the Village of Germantown Water Utility to a Lake Michigan supply, the plan recognizes that the Utility is in 2009 developing a new deep aquifer well and that conversion to a Lake Michigan supply is currently not envisioned. The plan, never-the-less, continues to recommend the eventual conversion of the Utility's source of supply to Lake Michigan, albeit later in the planning period. This recommendation is made because of the environmental benefits associated with the conversion to a Lake Michigan supply, including a stabilization and recovery of the drawdown in the deep aquifer, the reduction in chloride discharges attendant to the expected reduced water softening, and the expected improvement in groundwater-derived surface water base flows. Conversion from groundwater supplies to a Lake Michigan supply is envisioned only if the local utility undertakes the initiative to implement the change. Absent such an initiative, the Village of Germantown Water Utility would continue to utilize groundwater as a source of water supply.

  A portion of the Village of Germantown Water Utility service area extends into the east-central portion of the Village of Richfield. During 2008, the former Town of Richfield was incorporated as a village. Given this new municipal status, this portion of the planned water supply service area is expected to be served by a newly created water utility in the Village of Richfield. That utility could be served by a separate groundwater-supplied water system, or through a connection to the Village of Germantown Water Utility system. The water supply service area in the Village of Richfield lies east of the subcontinental divide. Thus, no diversion issue would be involved if a connection to the Village of Germantown system were implemented, and that system was converted to Lake Michigan as a source.

With regard to the conversion of the City of Cedarburg Light & Water Commission and the Village of Grafton Water and Wastewater Utility to a Lake Michigan supply, the cost data included in the recommended plan are based upon the development of a new water treatment plant and associated transmission and storage facilities to serve these two utilities. It should be noted, however, that the analyses made for Alternative Plan 4, and the analyses made in response to comments received on the preliminary plan, indicate that there are two other viable options available for providing a Lake Michigan supply to these two utilities—one by connection to the City of Port Washington Utility water supply system upon expansion of that Utility's water treatment plant; and the other by connection to the City of Milwaukee Water Works water supply system. All three options were estimated to have similar costs. Accordingly, the plan recommends that the three options be considered in greater detail in a second-level plan implementation planning and engineering phase.

With regard to the connection of the eastern portion of the City of Brookfield Water Utility service area and the Village of Elm Grove proposed utility service area to a Lake Michigan supply, the cost data included in the recommended plan are based upon direct connections to the Milwaukee Water Works. However, there are two other viable options available for providing a Lake Michigan supply to these two service areas: one by connection through the City of Wauwatosa and City of West Allis water supply systems; and the other by connection to a new transmission system for the City of Waukesha connection to the Milwaukee Water Works, the City of Oak Creek Water and Sewer Utility, or the City of Racine Water and Wastewater Utility water supply systems. A similar situation exists with respect to the City of Muskego Water Utility with potential connections to the Milwaukee Water Works, the City of Oak Creek Water and Sewer Utility, and the City of Racine Water and Wastewater Utility systems. Accordingly, the plan recommends that the options be considered in greater detail in a second-level plan implementation planning and engineering phase.

With regard to the City of Muskego Water Utility Lake Michigan supply recommendation, the regional plan recognizes that more-detailed engineering, legal, and environmental supporting information will be required to support any application for a Lake Michigan water supply and to meet the requirement of the Great Lakes-St. Lawrence River Basin Water Resources Compact and 2007 Wisconsin Act 227.

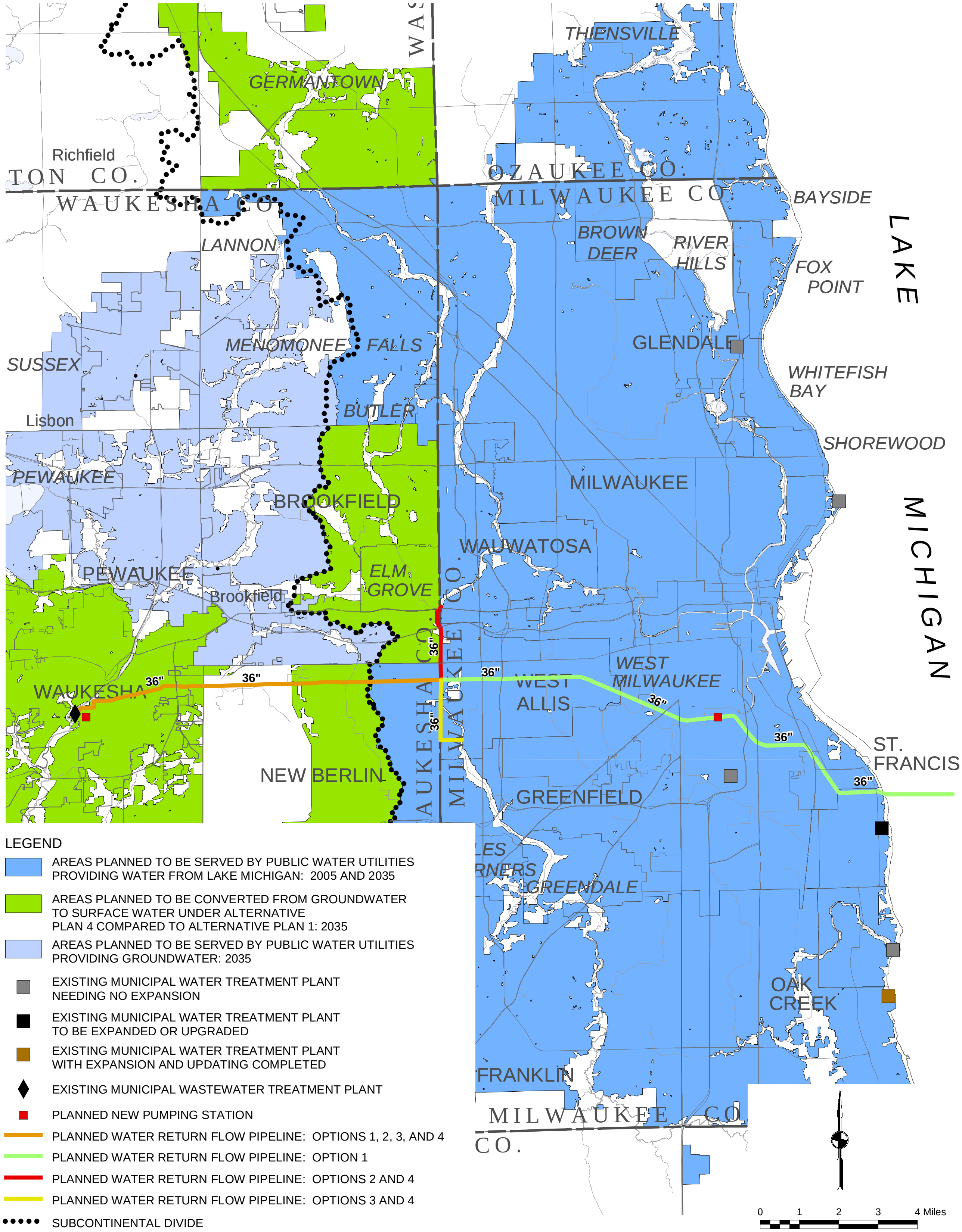
- For the City of Waukesha Water Utility, the plan recommends the conversion to Lake Michigan as the source of supply with the provision of return flow to Lake Michigan. This utility service area could potentially serve 88,500 people by the design year 2035, or about 4 percent of the regional population. Return flow could be provided by returning treated wastewater either directly by pipeline to Lake Michigan, or to streams tributary to Lake Michigan. Examples of return flow options are shown on Map 125 and the return flow options are described in more detail in Chapter IX.

  With regard to the City of Waukesha Water Utility Lake Michigan supply recommendation, including the return flow component, the regional plan recognizes that more-detailed engineering, legal, and environmental information will be required to support any application for a Lake Michigan water supply, and to meet the requirements of the Great Lakes-St. Lawrence River Basin Water Resources Compact and 2007 Wisconsin Act 227. Such information should be assembled under the necessary preliminary engineering and planning required for plan implementation. The more-detailed environmental analyses related to the return flow option should include assessment of the potential impacts on flooding, water quality, stream channel erosion, and stream habitat. Because of the need for further assessment, no final recommendations relating to specific return flow component is included in the recommended plan. Rather, the selection of the best return flow option is left open until completion of the required more-detailed assessments. For purposes of developing the cost of the recommended regional water supply plan, a range of costs was used to represent the potential costs of the return flow options.

  With regard to the Waukesha Water Utility Lake Michigan supply return flow component, it is recognized that the environmental analysis process as set forth in Chapter NR 150 of the *Wisconsin Administrative Code*, will also have to be followed as deemed appropriate by the WDNR. This process is designed to insure proper environmental analysis of specific projects, and, as deemed

Map 125

RETURN FLOW OPTIONS FOR THE RECOMMENDED WATER SUPPLY PLAN: RETURN FLOW PIPELINES TO LAKE MICHIGAN, THE ROOT RIVER, AND UNDERWOOD CREEK



NOTE: The City of Oak Creek Sewer and Water Utility completed expansion and upgrading of its water treatment plant in 2010.

Source: Ruekert & Mielke, Inc. and SEWRPC.

appropriate by the WDNR, may include the preparation of a full environmental impact statement. Based upon the WDNR understanding of the potential Waukesha diversion project, an initial listing of topics to be addressed under the environmental analyses process was developed in February 2010. That listing includes required assessment of the potential impacts on surface water, wetland, and groundwater resources on geomorphology and soils; on terrestrial and aquatic flora and fauna; on air quality; on socioeconomic conditions; on land use; on energy use; on archaeological and historical resources; on public water supplies and uses; and on geographically scarce resources.

The potential impacts of a City of Waukesha Water Utility return flow component was an issue raised and commented upon in the public review of the preliminary recommended plan and of the alternatives thereto. The comments focused concern on the potential impacts on Underwood Creek and the Menomonee River and on the Root River should the return flow be discharged to and conveyed by those streams to Lake Michigan. Potential impacts on those streams, both positive and negative, based upon the system level analysis conducted under the regional water supply planning program are described in Chapter IX. This analysis assumed active management of the return flows to eliminate flow impacts during high flow periods. It was determined that more detailed engineering, legal, and environmental information should be developed under the subsequent preliminary engineering required for plan implementation and for review of the Lake Michigan diversion application should the City of Waukesha determine to proceed with an effort to obtain a Lake Michigan supply. Accordingly, the Advisory Committee for the regional water supply planning program recommended that identification of the best option for a return flow be left open in the regional plan. Subsequently, the WDNR has concluded that an environmental impact statement would have to be prepared to evaluate the return flow options should the City decide to proceed. The preparation of an environmental impact statement would be intended to insure that the environmental impacts of the return flow options are identified and considered during the project development and review phases. The environmental impact statement process includes a public comment period and a public hearing.

In addition to the required preparation of an environmental impact statement, other steps in the plan implementation process will ensure the environmental soundness of the return flow option selected. These steps include: the WDNR permitting process and the related review of the return flow proposal for conformance with the regional water quality management plan by the Southeastern Wisconsin Regional Planning Commission (SEWRPC) and the WDNR; County and other local government permitting for construction of facilities in public rights-of-way; and intergovernmental agreements between a Lake Michigan water supplier and the purchaser of that water.

With regard to the WDNR permitting process, it is particularly important to note that the development of a new discharge for return flow will require a finding of conformance with the regional water quality management plan. This will require the processing and approval by SEWRPC and the WDNR of a formal amendment to the regional water quality management plan. Such processing and approval includes a collegial involvement of the affected local units of government and public informational meetings, as well as detailed consideration of the environmental and other impacts associated with the proposed action. Such collegial involvement in the review process would assure careful consideration of county and municipal interests and concerns. Accordingly, it may be concluded that adequate means are available to ensure a thorough review of any return flow proposals and to ensure that a sound decision is reached regarding proposals.

To ensure an orderly and timely evaluation of any return flow project that might be put forth, it is recommended that the City of Waukesha Water Utility and the WDNR directly involve and work cooperatively with SEWRPC, MMSD, the Counties, and the other local units of government potentially impacted in conducting the required analyses of any return flow proposals should obtaining a Lake Michigan supply be pursued by the City of Waukesha. In this regard, it is recommended that an oversight committee be formed of all units and agencies of government concerned as described in Chapter XI. It is further recommended that concurrence of the Counties and other local units of government directly affected be obtained for the return flow system deemed to be the best option.

The source of the Lake Michigan supply for the City of Waukesha Water Utility could be potentially provided by the City of Milwaukee Water Works, the City of Oak Creek Water and Sewer Utility, or the City of Racine Water and Wastewater Utility, as described in Chapter VIII. For purposes of developing the cost of the recommended regional water supply plan, the source of the supply was assumed to be the City of Milwaukee Water Works. Other options for the provision of a Lake Michigan supply to the City of Waukesha Water Utility and other adjacent utilities were developed and evaluated under the alternative plan design process documented in Chapters VIII and IX. The alternatives so developed and evaluated are also considered viable options which could be further considered during plan implementation.

- The plan recommends the development of a new water utility to serve the Village of Elm Grove. In the plan design both groundwater and Lake Michigan supply options were considered for this utility. Upon evaluation, the Lake Michigan supply option is recommended as the best long-term option. The new utility would serve about 6,600 persons by the design year 2035, or less than 1 percent of the regional population.

  In the design of alternative plans, a new service area was envisioned for a small area of eastern Racine County identified as the "Northwest Caledonia Planned Utility District." This area is now proposed to be included in an expansion of the Village of Caledonia West Utility District in order to be consistent with the Racine County comprehensive "smart growth" plan and local sanitary sewer service area plans. The entire Village of Caledonia West Utility District is recommended to be served by a Lake Michigan supply. Both the City of Oak Creek Water Utility and the City of Racine Water and Wastewater Utility currently provide service to portions of the Village of Caledonia West Utility District. It is recommended that the best means to provide the Lake Michigan supply to the expanded western portions of the water supply service area be determined as part of the second-level planning and engineering phase of plan implementation.

- There are 20 areas of existing urban-density development that are currently served by private, onsite wells, which are considered as potential areas for service by municipal groundwater supplies, either through the creation of new utilities which would be served by extension of service from existing utilities; or, in some cases, by the creation of new utilities, with separate sources of supply. These areas include an area designated as "Town of Delavan-Delavan Lake Area," which is designated as a "potential water supply service area," rather than being included in the expansion area for the City of Delavan Water and Sewerage Commission service area. This revised designation was made in response to comments made at the public hearings on the preliminary recommended plan. Those comments suggested that the private wells in the Delavan Lake area were currently functioning adequately and could continue to supply the area into the future. The designation as a "potential water supply service area" includes specific recommendations which constrain the conversion to a municipal water supply system based upon local need and initiatives as described below. These 20 areas are designated as potential future municipal water supply service areas in order to assess the demands, added supply sources needed, and the effectiveness of the regional water supply system if such municipal systems were developed. The development of municipal water supply systems in the areas concerned is envisioned only if a local demonstrated need were to arise based upon groundwater quality or quantity issues and, if a local initiative was then undertaken to implement a municipal system. In the absence of such a need and initiative, the residents and businesses in these areas would be expected to continue to rely on private wells.

  If conversion to a public supply takes place in accordance with local actions, it is recommended that, to the extent practicable, the areas be served by the extension of service by existing utilities. The Public Service Commission of Wisconsin has found that such extensions offer economies of scale and are often more favorable to rate payers.

  In addition to these 20 areas, the Village of Lannon proposed utility is recommended to be served by groundwater supplies following evaluation of alternatives providing for use of a Lake Michigan

Table 188

POTENTIAL NEW MUNICIPAL WATER UTILITIES ENVISIONED TO USE GROUNDWATER SUPPLIES: 2035

County and Utility[a]
Kenosha County
Village of Silver Lake Potential Utility
Village of Twin Lakes Potential Utility
Town of Salem Potential Utility
Powers-Benedict-Tombeau Lakes Area Potential Utility
Ozaukee County
Town of Fredonia-Waubeka Area Potential Utility
Racine County
Town of Burlington-Bohner Lake Area Potential Utility District
Town of Dover-Eagle Lake Area Potential Utility District
Town of Norway Area Potential Utility
Village of Rochester Area Potential Utility[b]
Town of Waterford Area Potential Utility
Walworth County
Town of Delavan-Delavan Lake Sanitary District[c]
Town of East Troy-Potter Lake Area Potential Utility
Town of Lyons Area Potential Utility
Washington County
Village of Newburg Area Potential Utility
Waukesha County
Village of Big Bend Potential Utility
Village of Lannon Potential Utility
Village of North Prairie Potential Utility (conversion of the Prairie Village Trust)
Village of Wales Potential Utility
Town of Eagle-Eagle Spring Lake Area Potential Utility
Town of Oconomowoc-Okauchee Lake Area Potential Utility
Town of Ottawa-Pretty Lake Area Potential Utility
Town of Summit-Golden Lake Area Potential Utility

[a]*The projected 2035 service areas for municipal water systems are shown on Map 123.*

[b]*Includes the former Town of Rochester and Village of Rochester service areas as delineated in Chapter IV of this report.*

[c]*Includes the Delavan Lake Sanitary District portion of the City of Delavan Water and Sewer Commission water supply service area as delineated in Chapter IV of this report.*

Source: SEWRPC.

supply and others providing for use of groundwater supplies. In addition, it is recommended that the existing Prairie Village Water Trust serving the Village of North Prairie be converted to a municipal water supply utility and serve the Village of North Prairie water supply service area. The Village of Lannon and the Village of North Prairie proposed utilities, both recommended to utilize a groundwater supply, would serve about 4,600 persons by the design year 2035, or less than 1 percent of the regional population.

The potential municipal water supply service areas are shown on Map 123 and are listed in Table 188. Together these 22 areas are expected to include about 83,100 persons by the design year 2035, or about 4 percent of the regional population.

With regard to the potential development of a municipal water supply system in the Town of Salem, the preliminary recommended plan envisioned the potential future development of up to eight new shallow aquifer wells. The actual number of such wells required will depend upon the individual well capacities achieved and which areas, if any, are converted from private wells to a municipal system, based upon local needs and implementation initiatives. Information provided by the Town indicates that an analysis conducted for the location of a potential new well to serve a municipal complex found that a deep aquifer well may be more feasible than a shallow aquifer well. In addition, Town residents have indicated a concern that the use of shallow aquifer wells would adversely impact private wells and surface waters. The plan recognizes that there will be a need for detailed well siting evaluations as part of any plan implementation effort. Decisions concerning well locations and depths and the aquifer actually to be utilized will be dependent upon those more-detailed evaluations. Accordingly, the plan recognizes that there is a potential for some potential municipal wells to be finished in the deep aquifer, as well as in the shallow aquifer in the Town of Salem.

- The plan recommends connection of the existing, self-supplied water systems serving residential communities, and most of self-supplied systems serving commercial, institutional, and recreational land uses, located within the planned municipal water supply service areas of municipal systems by the plan design year 2035. Under the plan, a number of private, self-supplied water supply systems generally located beyond planned municipal water supply service areas would remain, as would selected systems located within the municipal services area, but serving specialized uses, such as golf course irrigation or certain industrial uses. The number of such systems is enumerated by the type of land used involved in Chapter IX. The residential community systems envisioned to remain on self-supplied systems are envisioned to serve about 4,200 persons by the design year 2035, or less than 1 percent of the regional population.

- The plan recommends continued use of private domestic wells in areas beyond the planned water supply service areas. About 1,843 square miles of the Region are located outside the planned 2035 municipal water service areas. In addition, there are about 63 square miles located in the 20 areas where potential new water utilities are envisioned. Private domestic wells are envisioned to be used by from 175,900 to 254,400 persons—or by about 8 to 11 percent of the regional population—by the design year 2035, depending upon the number of new municipal facilities found to be needed to serve existing development based upon local needs and determinations.

- The plan recommends implementation of comprehensive water conservation programs, including both supply side efficiency measures and demand side conservation measures. The scope and content of these conservation programs are to be determined on a utility-specific basis to reflect the type and sustainability of the source of supply and the probable future water supply infrastructure requirements.

  Three levels of conservation programs are recommended for application in the Region: a base-level program which would provide a reduction of about 4 percent in average daily demand, and a reduction of about 6 to 10 percent in maximum daily demand; an intermediate-level program which would provide a reduction of about 6 to 8 percent in average daily demand, and a reduction of about 12 to 16 percent in maximum daily demand; and an advanced-level program which would provide a reduction of about 10 percent in average daily demand, and a reduction of about 18 percent in maximum daily demand. In addition, an optional higher level water conservation program could be considered by local utilities or individual water users. This program would provide a reduction of about 25 to 35 percent in average daily demand, and a reduction of about 30 to 50 percent in maximum daily demand. The measures included in each level of program are summarized in Table 189 and are described in Chapter IX of this report.

  Recommended program levels of water conservation for individual utilities are summarized on Map 126. The recommended water conservation measures are primarily intended to apply to municipal water utilities; however, the plan envisions that the base-level water conservation measures would also apply to private individual, self-supplied systems. Under the recommended plan, the base-level program is envisioned to be utilized by about 1.6 million persons, or about 70 percent of the year 2035 service area population. The intermediate-level program is envisioned to be utilized by an additional about 0.5 million persons, or about 22 percent of the year 2035 service area population. The advanced-level program is envisioned to be utilized by an additional about 0.1 million persons, or about 4 percent of the year 2035 service area population. Areas of existing development served by private individual wells are recommended to utilize a base level of water conservation. An advanced level of water conservation is envisioned to be used in those areas when converted to municipal service based upon local needs and initiatives. This recommendation is made in recognition of the potential value of conservation measures in reducing infrastructure costs associated with the development of new water supply systems. These recommendations apply to about 78,000 persons, or about 3 percent of the year 2035 service area population. The recommended water conservation measures together are expected to reduce the plan design year 2035 water demand in the Region by about 6.0 million gallons per day on an average daily demand basis and by about 15 million gallons per day on a maximum daily basis. The WDNR has drafted Chapter NR 852 of the *Wisconsin Administrative Code* which sets forth rules and guidelines related to water conservation pursuant to the requirements of the Great Lakes-St. Lawrence River Basin Water Resources Compact and Wisconsin Acts 227 and 310. As of September 1, 2010, this proposed rule had been approved by the Wisconsin Natural Resources Board, and was submitted to the State Legislature for review.

  As noted in Chapter IX of this report, under planned conditions some very modest drawdowns may be expected in the deep aquifer underlying portions of Walworth County and very small portions of Kenosha, Washington, and Waukesha Counties. Under these circumstances, it would be prudent for the utilities utilizing the deep aquifer in these areas to periodically revaluate their water conservation programs in light of observed trends in water levels in the deep aquifer. Accordingly, it is recommended that the City of Elkhorn Light and Water Utility, the City of Whitewater Municipal

Table 189

ANTICIPATED REDUCTIONS IN DEMAND AND POTENTIAL PROGRAM COMPONENTS FOR RECOMMENDED WATER CONSERVATION PROGRAMS

Program Level[a]	Reduction in Daily Demand (percent)		Potential Program Components[b]
	Average	Maximum	
Base	4	6 to 10	Water supply system efficiency actions Meter testing Leak detection and repair Water main maintenance and replacement Water system audits Water production system refinement Evaluation of new water metering technologies
			Moderate level of public information and education Redesign of water bills Collation and distribution of educational materials Presentation to school and civic groups
			Outdoor watering reduction measures Rain barrels Limited lawn and landscape watering restrictions
Intermediate	6 to 8	12 to 16	All of the components of the base-level program
			Higher levels of public information and education Development of school curricula Broader informational program in websites, newspapers, and flyers
			Plumbing retrofits, including provision of low-volume shower heads and toilet displacement device kits
			Water conservation rate structures
			More aggressive outdoor watering restrictions
Advanced	10	18	All of the components of the intermediate-level program
			Fixture and plumbing management Toilet replacement rebate programs Water softener replacement rebate programs Clothes washing machine replacement rebate programs
			More aggressive conservation rate structures
			Additional outdoor watering restrictions

[a] *Recommended program levels of water conservation for individual utilities are summarized on Map 126. The plan also envisions that the base-level conservation measures would apply to private individual, self-supplied systems.*

[b] *The scope and content of the water conservation programs are to be determined on a utility-specific basis to reflect the type and sustainability of the source of supply and the probable future water supply infrastructure requirements.*

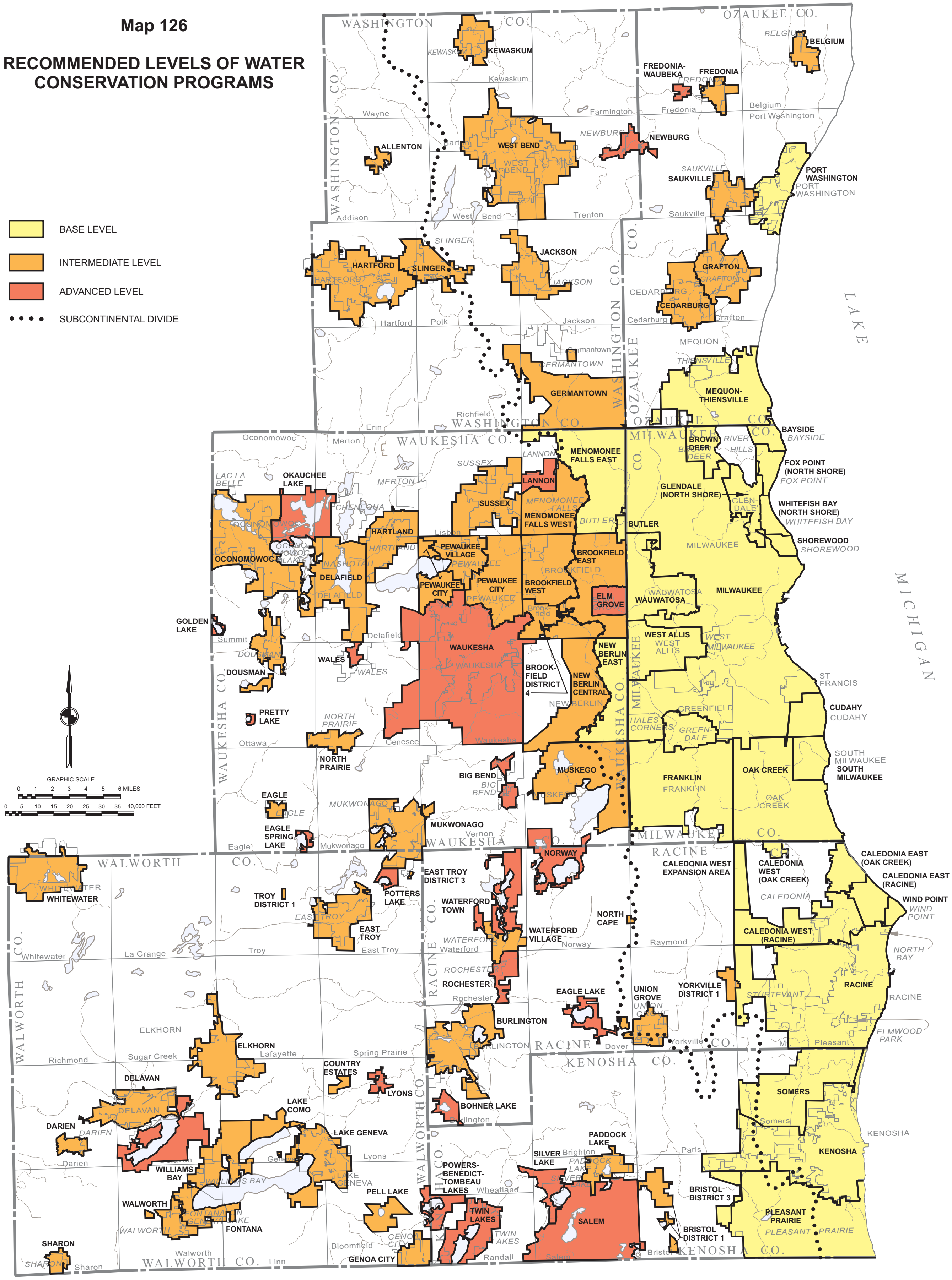
Source: SEWRPC.

Water Utility, the Village of Darien Water Works and Sewer System, the Village of Genoa City Municipal Water Utility, the Village of Williams Bay Municipal Water Utility, and the Lake Como Sanitary District No. 1 in Walworth County; the Allenton Sanitary District No. 1 in Washington County; and the City of Oconomowoc Utility in Waukesha County monitor water-levels in their deep aquifer wells and periodically reevaluate their water supply management program, including the level of water conservation program required.

- The plan recommends the protection and preservation of groundwater recharge areas classified as having a high or very high recharge potential. These recharge areas are shown on Map 127. Such protection may be largely achieved through the implementation of the adopted design year 2035

Map 126

RECOMMENDED LEVELS OF WATER CONSERVATION PROGRAMS



Source: SEWRPC.

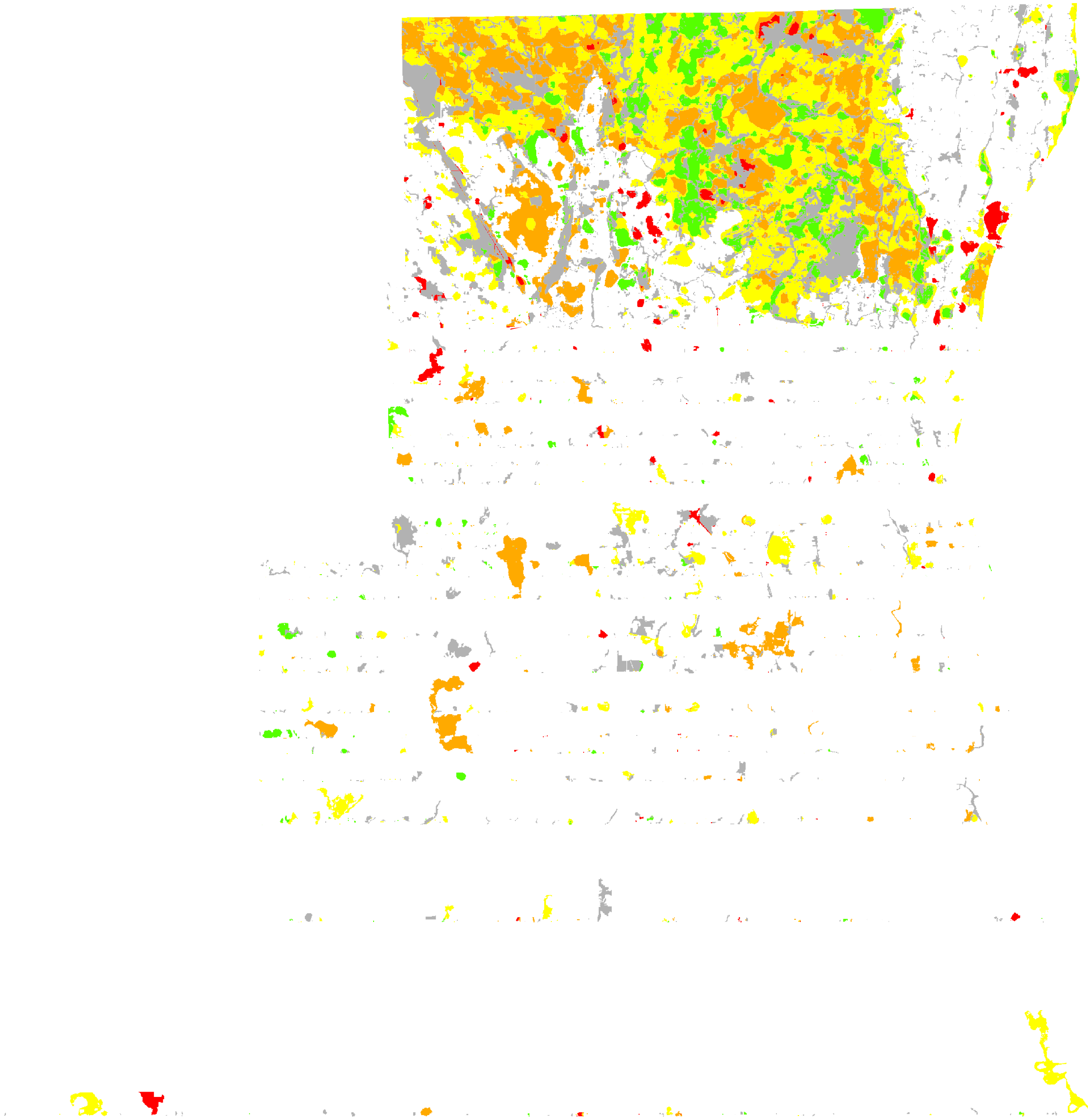


Table 190

AREAS OF HIGH AND VERY HIGH GROUNDWATER RECHARGE POTENTIAL TO REMAIN IN OPEN SPACE USES IN THE SOUTHEASTERN WISCONSIN REGION BASED UPON THE YEAR 2035 REGIONAL LAND USE PLAN FOR SOUTHEASTERN WISCONSIN

	High Groundwater Recharge Potential		Very High Groundwater Recharge Potential	
Land Use Plan Category[a]	Square Miles	Percent[b]	Square Miles	Percent[c]
Primary Environmental Corridor	120.1	18.4	28.9	20.2
Secondary Environmental Corridor	14.5	2.2	1.8	1.3
Isolated Natural Resource Area	17.4	2.7	2.1	1.5
Agricultural and Rural Residential	327.6	50.3	73.3	51.4
Dedicated Recreational Land	9.0	1.4	4.7	3.3
Subtotal	488.6	75.0	110.8	77.7
Sub-Urban-Density Residential	11.5	1.8	2.3	1.6
Low-Density Residential	61.2	9.4	12.1	8.5
Subtotal	561.3	86.2	125.2	87.8
Unprotected	89.9	13.8	17.4	12.2
Total	651.2	100.0	142.6	100.0

[a]*Planned land use category in the 2035 regional land use plan.*

[b]*Percent of high water recharge areas located in each land use plan category.*

[c]*Percent of very high water recharge areas located in each land use plan category.*

Source: SEWRPC.

regional land use plan and supporting county comprehensive plans, since these plans recommend preservation of the environmental corridors, isolated natural areas, prime and other agricultural areas of the Region that facilitate recharge. As shown on Map 128 and as quantified in Table 190, about 76 percent of the highly rated and very highly rated recharge areas may be expected to be preserved by inclusion in the environmental corridors, isolated natural resource areas, and prime and other agricultural areas identified for preservation in the adopted regional land use plan.

Depending on the zoning and development practices utilized, additional highly rated and very highly rated recharge areas may also be substantially protected through inclusion into suburban-density and low-density residential areas. In these areas, it is recommended that careful site design and the use of stormwater management practices designed to maintain the natural hydrology and maintain recharge be applied.[6] This will increase the level of protection for the important recharge areas. It is also recommended that the recharge areas be considered for protection and preservation by agencies and organizations involved in land conservancy activities.

Importantly, the plan recommends that consideration be given to expanding the currently delineated primary and secondary environmental corridors as delineated on the regional land use plan to include selected recharge areas classified as having high or very high recharge characteristics. The procedure historically utilized for environmental corridor delineation have been well accepted and consider the location of natural resource features and the extent of the areas occupied by such features. Recharge characteristics could be considered for integration into the current procedure. Such integration should be done on a comprehensive basis as part of the regional land use planning program the next time the corridor delineations are updated, and should be accomplished under the guidance of the Commission Advisory Committee on Regional Land Use Planning.

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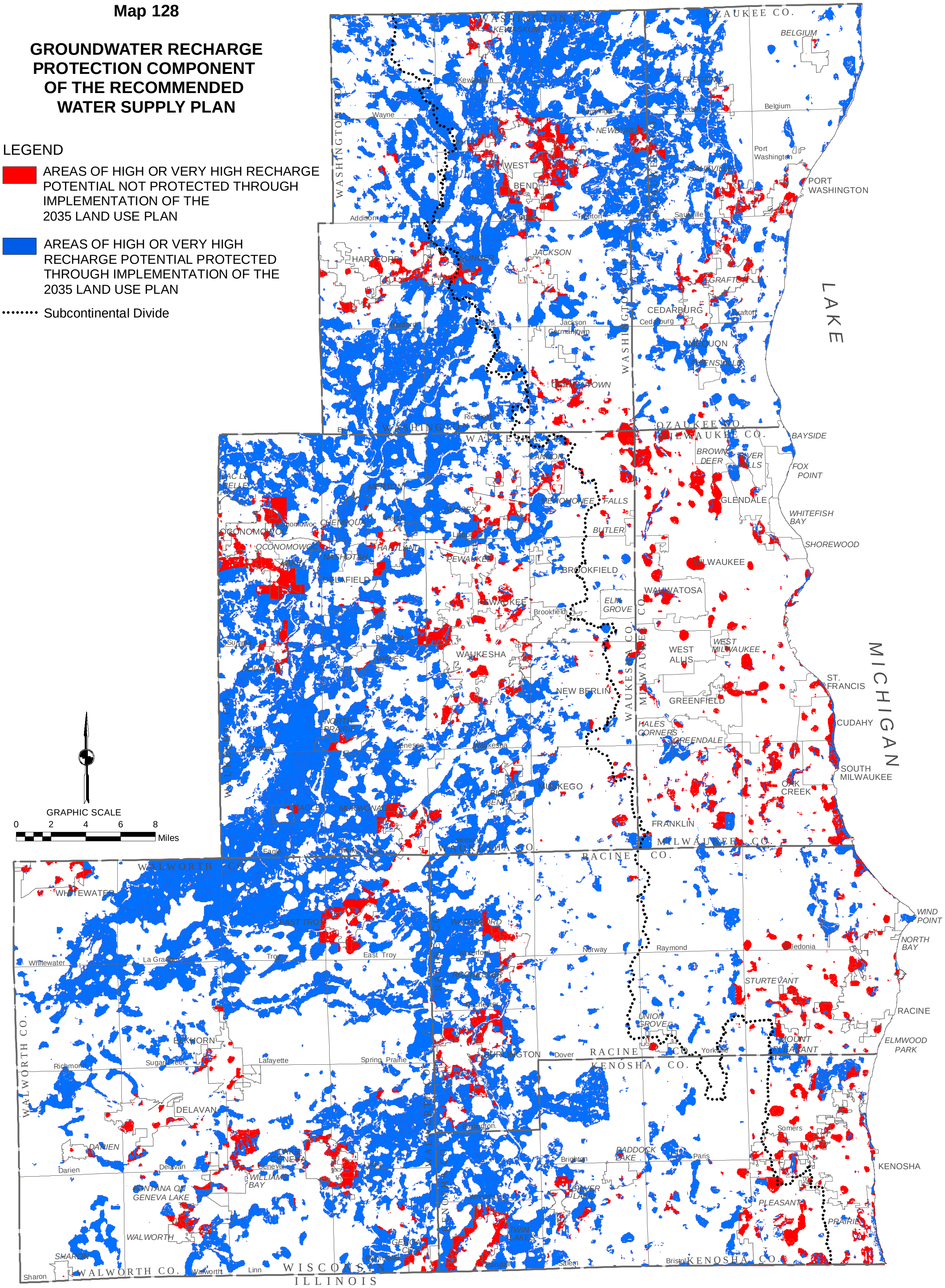
[6]*Examples of potential site design and stormwater management practices which could be considered, include the use of permeable pavement; set-aside open space; infiltration basins and trenches' landscaping with drought resistant plants; landscape mulch versus turf grass; conservation subdivision design; and the integration of rain gardens, bioswales, and other groundwater recharge features into site design. However, care must be taken on a site-specific basis to avoid increased potential for groundwater contamination.*

Map 128

GROUNDWATER RECHARGE PROTECTION COMPONENT OF THE RECOMMENDED WATER SUPPLY PLAN

LEGEND

- AREAS OF HIGH OR VERY HIGH RECHARGE POTENTIAL NOT PROTECTED THROUGH IMPLEMENTATION OF THE 2035 LAND USE PLAN
- AREAS OF HIGH OR VERY HIGH RECHARGE POTENTIAL PROTECTED THROUGH IMPLEMENTATION OF THE 2035 LAND USE PLAN
- Subcontinental Divide



Source: SEWRPC.

The groundwater recharge area protection plan element envisions that selected areas with high or very high recharge characteristics be added to the Commission-delineated environmental corridors for preservation in open space uses. The plan element also envisions that land development practices be revised to preserve to the extent practicable the natural hydrology of areas proposed for development. As such plan implementation actions are undertaken, it is recommended that the population and land uses in, and adjacent to, the concerned areas be inventoried, and any regulations or other actions to preserve the recharge area or characteristics consider the impacts on the population in, or adjacent to, these areas.

- The plan recommends implementation of state-of-the-art stormwater management practices, including application of treatment and infiltration systems, which, to the extent practicable, will maintain the natural recharge of areas committed to urban land use development. This component is intended to apply to residential and some nonresidential developments served by both municipal and private water supply systems in order to contribute to a sustainable groundwater supply, as well as for related stormwater management purposes. Such practices are considered important, even in areas served by individual wells and onsite sewage disposal systems where the majority of the water used is returned to the aquifer. Such areas do experience some losses in water used and stormwater infiltration practices contribute to broader aquifer recharge objectives. This recommendation may be expected to be largely implemented through the provisions of Chapter NR 151 of the *Wisconsin Administrative Code*, and through county and municipal stormwater management ordinances adopted in accordance with Chapter 216 of the *Wisconsin Administrative Code*.[7] In particular, the application of practices in accordance with the WDNR stormwater management technical standards is recommended. Consideration of the application of conservation subdivision design to enhance infiltration is recommended, particularly in areas where groundwater analyses associated with well siting identifies potential negative impacts on surface waters as a result of well siting.

- The plan recommends that studies related to the siting of all new high-capacity wells include analyses of potential, and subsequent monitoring of the actual impacts of such wells on the shallow aquifer, existing wells, and surface waters. The siting studies should be designed to develop the necessary understanding of the hydrogeological system associated with each candidate site and to assess the likelihood of impacts of proposed wells upon nearby existing wells and surface waterbodies. The studies should include identification of significant potential negative impacts, needed mitigative actions, or site location revisions. Water levels in the vicinity of new high-capacity wells in the shallow aquifer should be monitored before and after wells are constructed and placed into operation to establish a baseline including levels expected to be maintained in private wells and to develop performance and impact data during the test well phase of well development and during the subsequent operation of the well over time.

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[7]*The WDNR has proposed several revisions to Chapter NR 151 of the* Wisconsin Administrative Code*. The proposed revisions add new, and modify existing, performance standards that address stormwater runoff pollution from both agricultural and nonagricultural sources, including transportation facilities. The proposed revisions make modifications to the agricultural performance standards addressing cropland soil erosion control, nutrient management, and manure storage. The proposed revisions would also change nonagricultural performance standards that address construction site erosion control, post-construction stormwater management, and runoff from developed urban areas. Among the proposed revisions to the post-construction performance standards are a removal of the exemption from the total suspended solids performance standards applicable to redevelopment sites with no increase in expanded parking or roads, and the addition of a midlevel infiltration performance standard for sites with a moderate amount of impervious area development. As of September 1, 2010, the proposed revisions had been approved by the Wisconsin Natural Resources Board and have been submitted to the State Legislature for review.*

While it is recognized that siting wells in the shallow aquifer is dependent upon locating productive areas, some additional factors should be considered when siting wells constructed in this aquifer. Preference should be given to site locations that are less likely to produce adverse impacts upon surface waterbodies and existing wells. In addition, preference should be given to sites adjacent to major rivers receiving treated effluent from municipal wastewater treatment plants downstream from their treatment plants. Such application of riverbank filtration has the potential to increase available water supplies without degrading the environment.

- The plan recommends that measures be taken to enhance rainfall infiltration particularly in areas where evaluations conducted in conjunction with the siting of high-capacity wells in the shallow aquifer indicate probable reductions in baseflow on nearby streams and in water levels in lakes and wetlands due to installation and operation of these wells. Two means of achieving the desired enhancement are envisioned. One involves the construction of rainfall infiltration systems in areas where adverse impacts of new wells on surface water features may be anticipated. Locating these systems will require site-specific analyses to ensure that the systems are located in the recharge areas of the waterbodies expected to be impacted and in areas well suited for shallow groundwater recharge. The specific measures comprising the systems must be selected and designed on a case-by-case, site-specific basis. The systems include measures such as rain gardens, larger bioretention basins, infiltration ponds, infiltration ditches, and subsurface storage and infiltration galleries. Information on the available artificial recharge methodologies is presented in SEWRPC Technical Report No. 43, *State-of-the-Art of Water Supply Practices*, July 2007. It is envisioned that there would be a total of 32 of these rainfall infiltration systems installed under the recommended plan. It is recommended that consideration be given to developing a groundwater monitoring program in conjunction with each of the rainfall infiltration systems. The monitoring program would be based upon site-specific considerations, such as size of the system, relationship to wells, and tributary land uses. The general locations of the rainfall infiltrations systems that are envisioned are shown on Map 129.

  The second means of providing for additional groundwater recharge is through applications of farming practices that reduce or eliminate tillage of fields. This means has potential to be applied on an areawide basis, as well as in areas potentially affected by new high capacity wells. Infiltration of water into soils is directly related to a number of soil properties, including structural stability[8], bulk density[9], and pore structure.[10] Long-term applications of different tillage regimes can alter these properties resulting in an alteration of soil structure and the various soil factors affecting the water storage capacity and water transmission properties of the soil.[11] Tillage systems that significantly

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[8]*J.M. Tisdall and H.H. Adem, "Effect of Water Content of Soil at Tillage on Size-Distribution of Aggregates and Infiltration,"* Australian Journal of Experimental Agriculture*, Volume 26, 1986.*

[9]*M.S. Patel and N.T. Singh, "Changes in Bulk Density and Water Intake Rate of a Coarse Textured Soil in Relation to Different Levels of Compaction,"* Journal of the Indian Society of Soil Science*, Volume 29, 1981.*

[10]*M.D. Ankeny, T.C. Kaspar, and R. Horton, "Characterization of Tillage and Traffic Effects on Unconfined Infiltration Measurements,"* Soil Science Society of America Journal*, Volume 54, 1990.*

[11]*L.R. Drees and others, "Micromorphological Characteristics of Long-Term No-Tillage and Conventionally Tilled Soils,"* Soil Science Society of America Journal*, Volume 58, 1994.*

Map 129

GROUNDWATER RECHARGE FACILITIES UNDER THE RECOMMENDED REGIONAL WATER SUPPLY PLAN

LEGEND

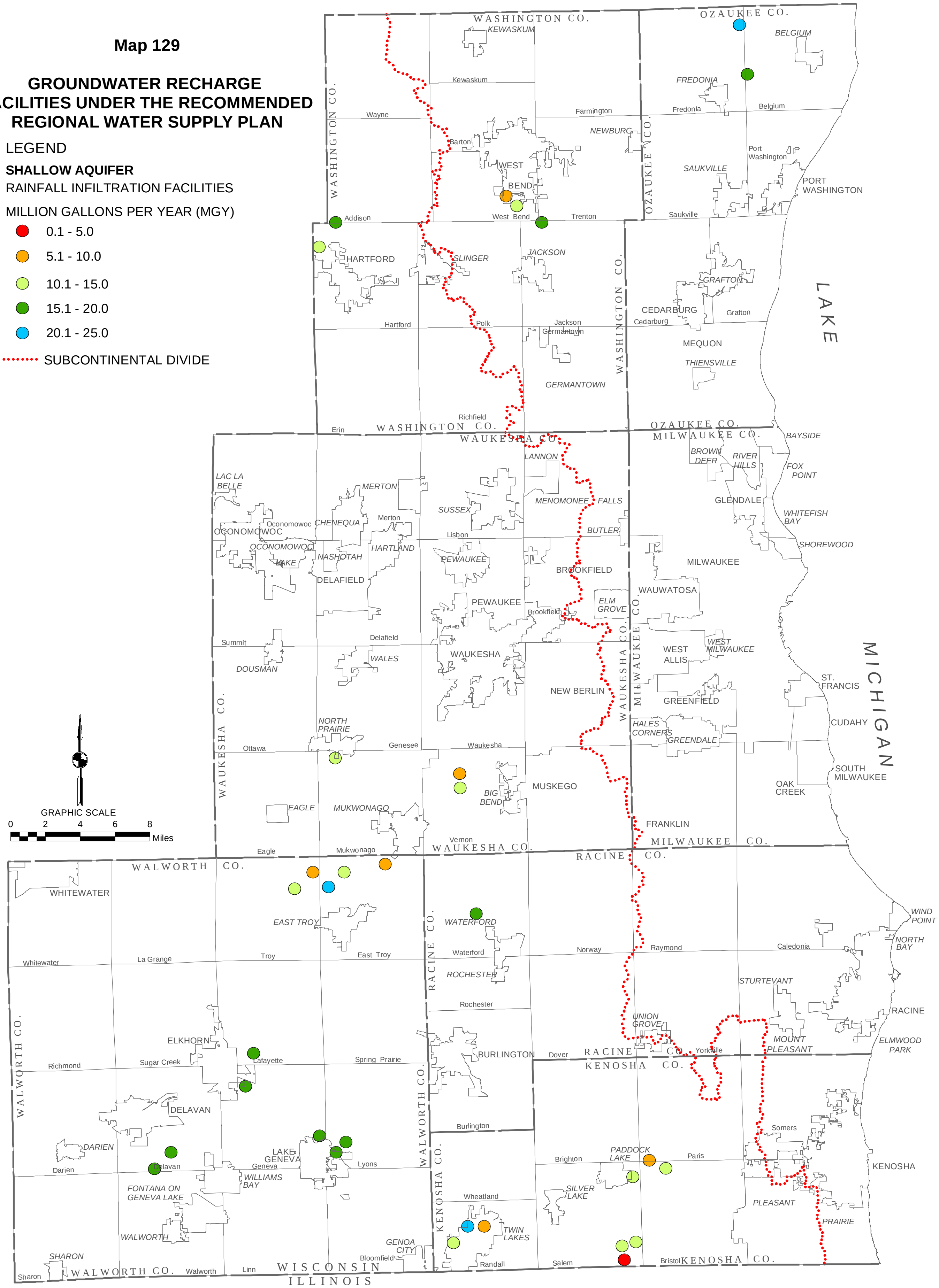
SHALLOW AQUIFER

RAINFALL INFILTRATION FACILITIES

MILLION GALLONS PER YEAR (MGY)

- 0.1 - 5.0
- 5.1 - 10.0
- 10.1 - 15.0
- 15.1 - 20.0
- 20.1 - 25.0

SUBCONTINENTAL DIVIDE



Source: SEWRPC.

disturb the soil can result in progressively lower infiltration rates as the growing season progresses, as a result of the loss of aggregate stability.[12] In some soil systems, long-term application of no-till systems has been found to result in higher infiltration rates and higher saturated hydraulic conductivity values than long-term application of conventional tillage.[13] Several factors appear to account for this. Tilling operations tend to compact the soil below the tilled zone, disrupt surface-vented soil pores, and increase the decomposition of crop residues.[14] The presence and maintenance of residue in no-till systems reduces the formation of surface crusts by absorbing the energy from raindrop impact.[15] No-till soils also tend to have more continuous channels for infiltration than conventionally-tilled soils, in part due to the activities of soil organisms such as earthworms.[16] These results indicate that applications of no-till practices on areas with suitable soils may be expected to increase infiltration and groundwater recharge. These practices also have other benefits such as reduced erosion which are often the primary purpose for application of the practice. When applying low- or no-till practices for enhancing groundwater recharge, it will be important to consider additional factors including the potential impact of nutrient management and agricultural chemical management practices on groundwater quality. Information on the benefits of no-till practices is available from the University of Wisconsin-Extension Discovery Farms program which develops on-farm and related research to determine the economic and environmental effects of agricultural practices on a diverse group of Wisconsin farms.[17]

The use of farming practices with reduced or no tillage is recommended to be promoted for the potential enhanced rainfall infiltration as well as its more commonly accepted purposes. For groundwater infiltration purposes the practice would be most applicable in the vicinity of the locations where there are potential negative impacts to surface waters due to reduced baseflows as described previously. In those areas, the practices may offer an attractive alternative to, or supplement of, the constructed systems described above. In addition, it is recommended that the practice be promoted on a broader basis due to the potential for multiple benefits including substantial groundwater recharge. As an example, in 2009, there were approximately 450,000 acres of land devoted to corn and soybean production in the Southeastern Wisconsin Region. If rainfall infiltration to the groundwater system on 20 percent of that land could be increased by one inch per year that would equate to about 2.4 billion gallons per year or about 6.7 million gallons per day. This amount is significantly more than the added groundwater recharge expected from the 32 constructed systems

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[12] *P.W. Unger, "Infiltration of Simulated Rainfall: Tillage Systems and Crop Residue Effects,"* Soil Science Society of America Journal, *Volume 56, 1992.*

[13] *R.H. Azooz and M.A. Arshad, "Soil Infiltration and Hydraulic Conductivity Under Long-Term No-Tillage and Conventional Tillage Systems,"* Canadian Journal of Soil Science, *Volume 76, 1996; T.J. Sauer, B.E. Clothier, and T.C. Daniel, "Surface Measurements of the Hydraulic Character of Tilled and Untilled Soil,"* Soil Tillage Research, *Volume 15, 1990.*

[14] *L.M. Carter and R.F Colwick, "Evaluation of Tillage Systems for Cotton Production Systems,"* Transactions of the American Society of Agricultural Engineers, *Volume 14, 1971.*

[15] *C.H. Roth and others, "Effect of Mulch Rates and Tillage Systems on Infiltrability and Other Soil Physical Properties of an Oxisol in Parana, Brazil,"* Soil Tillage Research, *Volume 11, 1988.*

[16] *Sauer, Clothier, and Daniel,* Soil Tillage Research, op. cit.

[17] *Information on Discovery Farms is available at http://www.uwdiscoveryfarms.org/Home.aspx.*

noted above. Accordingly, no- or low-tillage practices could offset potential baseflow reductions, or, in some cases, enhance baseflow if strategically located. Thus, it is recommended that both the enhanced agricultural land infiltration and the constructed rainfall infiltration systems be promoted and evaluated. In this regard, it is recognized that agricultural land operators must make decisions on tillage practices based upon a number of variables which are often more directly tied to crop production. However, it is possible that utilities or other high capacity well developers could provide incentives for changes in cropping practices if it is deemed important to well siting situations.

Special Consideration in Areas with Increased Reliance on Shallow Aquifer Supplies

The recommended stormwater management, high-capacity well siting, and rainfall infiltration practices are intended to form the basis of a procedure intended to abate the negative impacts on surface water systems associated with high-capacity well development. The procedure would provide for initial analyses of potential alternative well sites in order to select sites which minimize adverse impacts on the groundwater and surface water systems. These initial siting analyses would guide the selection of well sites and would be followed by more-detailed analyses of the potential impacts associated with each of the selected sites. Initial monitoring of water levels in private wells to establish a baseline condition is recommended. Where significant potential negative impacts to surface water systems or to existing wells are identified, a mitigation plan would be developed incorporating enhanced recharge based upon stormwater management and infiltration measures. In addition, other mitigation measures, such as pumping protocols and impacted well compensation measures, could be considered. Measures to mitigate impacts on surface waterbodies would include provision of artificial recharge designed to offset the losses in baseflow to the extent practical.

There are significant areas of the Region in which the plan recommends increased reliance on the use of the shallow aquifer as a source of supply. This is particularly true in the western and southwestern portions of the Region. As previously noted, such water use has the potential to impact surface water features, as well as the groundwater aquifer concerned. Review of the potential surface water impacts of the recommended plan—and of alternatives thereto—indicate that potential groundwater-derived baseflow reductions may be expected to range from 1.5 to 4.5 percent on a countywide basis in the outlying counties over the period 2005 to 2035. These impacts may be severe on a localized basis. Such localized impacts would represent worst case situations, since the analyses assume the conversion to municipal systems in 20 areas currently served by private wells. Such conversion is a potential future condition which the plan recommendations recognizes may be needed in only some of these areas. In some of the areas, individual wells may continue to function adequately to support the existing urban development. In many of the areas with the highest potential for surface water impacts, it is expected that some of the potential municipal water supply service areas will remain on private wells through the planning period. In those cases, the result would be a reduction in the indicated surface water impacts because of the lower pumping rates and distribution of the individual wells.

For areas where an increased reliance on shallow aquifer wells is expected, it is recommended that special consideration be given to implementation of the recommended water conservation measures; groundwater recharge protection and enhancement measures; and to implementation of the high-capacity well development siting, monitoring, and impact mitigation recommendations set forth above. Mitigative action may include limiting municipal service area expansion to areas with specific needs, careful well siting, well operating protocols, groundwater recharge protection and enhancements, artificial groundwater recharge, infiltration-based stormwater management practices, and groundwater monitoring.

As noted in Chapter IX of this report, under planned conditions some reductions in baseflow may be expected in surface waters in the Region related to the envisioned use of the shallow aquifer as a source of water supply. Although these impacts may be mitigated in several streams by contributions of treated effluent from wastewater treatment plants, it would be prudent for the utilities utilizing the shallow aquifer to periodically reevaluate their water conservation programs in light of their water usage. Therefore it is recommended that water utilities utilizing the shallow aquifer as a source of supply monitor their water usage and periodically reevaluate their water supply management program, including the scope and level of their water conservation programs.

Auxiliary Water Supply Plan Recommendations

Chloride Reduction Programs

Surface water quality monitoring data documented in various Commission and other agency reports indicate that chloride concentrations in streams and lakes of the Southeastern Wisconsin Region have been steadily increasing over time.[18] The increase in chloride concentrations may be attributed to multiple sources, including: sodium chloride and calcium chloride applied for ice and snow control on land access, collector, and arterial streets and highways, and public and private parking lots; and discharges from water softener systems to either private onsite wastewater treatment systems which discharge to groundwater and thereby ultimately to streams, lakes, and wetlands as baseflow; or which discharge to public wastewater treatment plants which do not remove chlorides and which discharge directly to surface waters. While adequate data are not available to assess trends in chloride concentrations in groundwater, the trends in surface waters and the high solubility of chloride in water suggest that chloride concentrations in groundwater may also be increasing. Overall, the increasing chloride concentrations in surface waters and the potential for increasing concentrations in groundwater should be a cause for concern.

Thus, it is recommended that the municipalities and counties in the Region continue to reevaluate their practices regarding the application of chlorides for street and highway ice and snow control and strive to achieve minimum application rates consistent with safe operation. It is also recommended that municipalities continue to consider alternatives to current ice and snow control programs, such as the program adopted by the City of Brookfield, which calls for applying a sand-salt mix to land access and collector facilities with enhanced street sweeping in the spring of the year to remove accumulated sand; or the program initiated in the City of Franklin which involves application of a salt brine, sometimes along with a liquid derived from sugar beet juice, depending on weather conditions. These programs can serve as models for other municipalities.

As noted above, chlorides used in water softeners can also increase chloride contributions to surface water and groundwater. It may be expected that under the recommended water supply plan, the reduction in hardness in the water provided by those utilities shifting from groundwater to Lake Michigan as a source of supply will eliminate the need for water softening by most users with a resulting decrease in chloride discharges. For those municipalities continuing to use groundwater as a source of water supply, it is recommended that education programs be implemented to provide information about alternative water softening media and the use of more-efficient softeners which are regenerated based upon the amount of water used and the quality of the water.

Stormwater Management Measures Affecting Groundwater Quality

Chlorides that are applied to streets and highways for ice and snow control are conservative constituents that are often dissolved in stormwater runoff. Stormwater infiltration practices do not treat and remove chlorides dissolved in runoff. Thus, special safeguards must be applied to avoid adverse effects of chlorides on groundwater quality. It is, therefore, recommended that the design of stormwater management facilities that directly or indirectly involve infiltration of stormwater consider the potential impacts on groundwater quality. Those effects should be a consideration in the design of infiltration facilities such as infiltration trenches, infiltration basins, bioretention facilities, rain gardens, grassed swales, and subsurface storage and infiltration galleries; and in the design of stormwater detention basins. The WDNR has developed post-construction stormwater management technical standards for site-specific evaluation of stormwater infiltration, infiltration basins, bioretention facilities, and wet

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[18]*See, for example, SEWRPC Technical Report No. 39,* Water Quality Conditions and Sources of Pollution in the Greater Milwaukee Watersheds, *November 2007; SEWRPC Community Assistance Planning Report No. 273,* A Lake Management Plan for Pike Lake, Washington County, Wisconsin, *December 2005; SEWRPC Community Assistance Planning Report No. 283,* A Lake Management Plan for the Waterford Impoundment, Racine County, Wisconsin, *Volume One*, Inventory Findings, *October 2007; SEWRPC Community Assistance Planning Report No. 300,* A Lake Management Plan for George Lake, Kenosha County, Wisconsin, *August 2007.*

detention basins.[19] Those standards include provisions intended to protect groundwater quality, and it is recommended that the standards continue to be refined and be applied in the design of stormwater management facilities.

Disposal of Emerging and Unregulated Contaminants

Water quality contaminants of emerging concern include pharmaceuticals, personal care products, and endocrine disrupting compounds. Recent research shows that these contaminants are entering surface and groundwater and may be producing adverse effects on fish and other aquatic organisms. These compounds may enter the environment in a number of ways, including disposal of pharmaceuticals and personal care products through flushing down the toilet or pouring down sink drains; excretion of medications by humans, pets, or farm animals; and disposal of medications or products in improperly designed or maintained landfills. The extent of the threat posed to human health and to the integrity of surface waters and groundwaters by the presence of these compounds is not currently known. Several factors account for this lack of knowledge. These categories represent a large number of chemical compounds, and the concentrations of most of these compounds in surface waters and groundwaters have not been determined. The biological and toxicological effects of many of these compounds on human health have not been characterized, especially at environmentally relevant concentrations and under long-term conditions. Few data are available on the effect of these compounds in the environment. Studies examining the presence of these compounds in the environment, and the toxicological properties of these compounds, have generally not examined their metabolites and transformation products, which may be biologically active.

Given the uncertainty regarding the threat posed by these substances, it would be prudent and protective of human health and the integrity of surface waters and groundwaters to reduce inputs of these materials into the environment. Therefore, it is recommended that public informational and educational programs be carried out, and that periodic collections of expired and unused medications be conducted. The WDNR has issued guidance on regulatory aspects of collecting unwanted household pharmaceuticals.[20] For those portions of the Region served by the MMSD, the MMSD 2020 facilities plan recommends that MMSD continue to support the periodical collection of pharmaceuticals as part of its Household Hazardous Waste Collection program. Because some of these compounds are considered controlled substances and are strictly regulated by the U.S. Drug Enforcement Administration, such collections require the participation of local law enforcement agencies. In addition, Wisconsin allows some unused cancer and chronic disease drugs and supplies to be donated to participating pharmacies or medical facilities for use by other patients. Rules governing this are set forth in Chapter DHS 148 of the *Wisconsin Administrative Code.* Consideration could also be given to establishing collection centers for pharmaceuticals at law enforcement offices. It is important to note that under current Wisconsin hazardous waste rules, unless the pharmaceuticals are screened to exclude those that are also considered hazardous waste under the Federal Resource Conservation and Recovery Act, law enforcement agencies participating in this sort of collection would be regulated as permanent household hazardous waste collection facilities. The inability, or reluctance, of law enforcement agencies to comply with hazardous waste requirements may discourage participation in this type of collection option.[21]

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[19] *The technical standards are set forth in a series of documents that can be found on the Wisconsin Department of Natural Resources website at* http://dnr.state.wi.us/runoff/stormwater/techstds.htm*.*

[20] *Wisconsin Department of Natural Resources,* Collecting Unwanted Household Pharmaceuticals: Regulatory Guidance for Organizers of Household Pharmaceutical Collection Events, *Pub. WA-1025-2006, August 9, 2006.*

[21] *Effective June 27, 2006, the WDNR developed an enforcement discretion memorandum, effective for one year, that conditionally exempted from the State's hazardous waste and solid waste rules household pharmaceutical waste collected by law enforcement officials or collected at household pharmaceutical waste collection facilities or events. This enforcement discretion memorandum was extended for an additional two-year period (to June 27, 2009), during which time the WDNR was to evaluate both the impacts of the policy and the possibility of revising the Department solid and hazardous waste rules. In June 2009, this enforcement discretion memorandum was extended for an additional two-year period (to June 18, 2011).*

With regard to the emerging and unregulated contaminants, it should be noted that the U.S. Environmental Protection Agency and the Wisconsin Department of Natural Resources, in conjunction with water utility organizations, are continually working to improve water supply monitoring and treatment protocols designed to protect the public health and welfare. In this regard, the regional water supply plan assumes these continuing activities will lead to sound measures to address these contaminants as the science to do so evolves.

Water Supply Quality Monitoring and Enforcement

The regional water supply plan recommendation for source water quality monitoring and enforcement envisions continuation, and expansion as needed, of existing regulations and programs. The USEPA and the WDNR, in conjunction with water utilities and utility organizations, are continually working to improve water supply monitoring and treatment protocols designed to protect the public health and welfare. Ongoing programs related to drinking water supply administered by the WDNR include wellhead protection, source water protection, local public water system capacity development, and water system operator certification. The USEPA has the responsibility for setting national drinking water standards for public water systems. The USEPA and the WDNR have established standards for drinking water in Wisconsin designed to protect the public health, safety, and welfare. Standards have also been established for surface and groundwater quality. Additionally, plans for construction of new public water supply facilities or improvements to existing facilities are reviewed and approved by the WDNR. The WDNR has also established sampling and analytical requirements to accompany the drinking water standards. In addition, the WDNR, and in some cases counties, namely Waukesha County in southeastern Wisconsin, regulates private well construction, pump installation standards, and well driller and pump installer licensing. Municipal utilities, however, have the primary responsibility for providing safe drinking water.

Water utilities within Wisconsin, working with the regulatory agencies concerned, generally have an enviable record of successfully providing safe drinking water. Over a period of about 120 years there have been few incidences of severe municipal drinking water contamination. Those incidences that did occur were properly corrected. These ongoing operations designed to provide safe drinking water are described in more detail in Chapter XI. These operations, when supplemented by expanded, or additional, measures needed to control emerging and unregulated contaminants, as noted above, provide the basis for water supply quality monitoring and enforcement under the recommended regional water supply plan.

Options for Providing Water Supply to Unincorporated Areas Adjacent to Incorporated Areas Served by Water Supply Utilities

As already noted, the plan identifies certain areas of existing, or of a mix of existing and proposed, urban development that are currently served by private, onsite wells and recommends that these areas be provided with a municipal water supply either through the extension of service by existing utilities, or in some cases by the creation of new utilities. Such extension of service is envisioned to occur only when a need is demonstrated and at the option of the communities concerned. Alternative arrangements are available for providing water supply to such areas within the context of the sources recommended in the plan. The alternatives include formation of a separate utility which would develop its own sources of supply, supplying a separate utility through a cooperative arrangement with an adjacent utility, or extending service from an existing utility into the area concerned. Potential options for the various service areas concerned are set forth in Table 191. These options should be considered by the communities and utilities involved in considering the provision of the needed additional service. However, the Public Service Commission of Wisconsin has found that expansion of existing facilities offers economies of scale and are often more favorable to rate payers. Accordingly, it is recommended that expansion of existing utilities be considered carefully in the evaluation of options.

In a recent development, the Town of Cedarburg in Ozaukee County completed a study of the type herein envisioned concerning the need for, and feasibility of, creating a water utility. The study found that an adequate groundwater supply source was available in the area, and the creation of a water utility was a feasible option. The Town expressed its willingness to work with neighboring communities to study the feasibility of creating a cooperative water utility. However, that option was not agreed upon at that time. The Town also expressed a willingness to consider purchasing water from neighboring water utilities—the City of Cedarburg and the Village of Grafton—that utilized groundwater or surface water sources, such as Lake Michigan.

Monitoring of Water Supply Activities in Areas Beyond the Region

Chapter VII identified the interrelationship of groundwater recharge and use in areas located adjacent to the seven-county Southeastern Wisconsin Region. Analyses of simulation modeling conducted under the regional water supply planning effort indicated that groundwater pumping in pumping centers located outside the Region may have the potential to adversely impact water levels in the deep sandstone aquifer underlying the planning area. It was also determined that recharge of this aquifer from outside the Region will continue to be a factor in the level of sustainability of the deep aquifer. Groundwater withdrawal and recharge in areas located outside the Region were found not to be significant factors in the sustainability of the shallow aquifer within the Region. Based upon the findings of the analyses conducted, it was concluded that the inclusion of specific plan recommendations applicable to areas located adjacent to the Southeastern Wisconsin Region was not warranted. The plan, however, recommends the continued monitoring of the conditions related to water use and recharge in areas located immediately to the west and south of the Region. It is further recommended that the assumptions with regard to use and recharge in these adjacent areas which were used in the simulation modeling analyses concerned be compared to actual conditions on about a five-year cycle beginning in 2015. Should significant variation be found between the assumptions used in the modeling analyses and actual conditions, further simulation modeling and analyses may be warranted to determine if the variations found may be expected to result in adverse impacts within the Region which would need to be addressed.

Cooperative Development and Systems Integration of Water Utilities

Where opportunities exist, it is recommended that municipal water utilities in the Southeastern Wisconsin Region give consideration to cooperative facility development, systems integration, and consolidation of activities. Such activities may ensure provision of water in the event of an emergency such as a breakdown in the utilities facilities, a fire emergency, or a terrorist attack. In addition, these activities may allow for the achievement of economies of scale that allow for less costly operation of the utilities and more favorable rates for utility customers. The range of activities contemplated includes interconnections among adjacent utilities; cooperative development of utility infrastructure, such as supply, treatment, and distribution infrastructure; or integration and consolidation of existing systems. The scope and extent of the activities implemented is most appropriately determined by the utilities and affected communities. Table 192 lists specific utilities where such activities could potentially be viable and result in system efficiencies.

Plan Costs

The principal features of the recommended plan, including the new sources of supply and attendant facilities for each water utility in the Region, and the estimated costs of those facilities are listed in Table 193. The recommended plan has an estimated capital cost which ranges from about $333.8 million to about $361.4 million, depending upon the return flow alternative included. The annual operation and maintenance costs associated with the proposed new water utility water supply facilities and programs is estimated to range from about $11.0 million to about $11.5 million, also depending upon the return flow alternative included. The annual savings in costs associated with the elimination of individual point-of-entry treatment devices is estimated to be $16.8 million. The annual operation and maintenance costs for existing water supply facilities envisioned to be maintained is estimated to be about $107.1 million. Thus, the total annual operation and maintenance cost of the regional water supply plan for existing and new facilities is estimated to range from about $101.3 million to about $101.8 million depending upon the return flow alternative included.

The data used to develop the cost estimates for the recommended plan are based upon 2005 costs with an *Engineering News Record* construction cost index value of 9,563 which is the December 2005 average of the Chicago and Minneapolis indices. In order to update the costs to 2010, the capital costs were adjusted to an *Engineering News Record* construction cost value of 11,197 which is the March 2010 average of the Chicago and Minneapolis indices. The annual operation and maintenance costs were adjusted to reflect a U.S. Bureau of Labor Statistics consumer price index of 214.5. The updated 2010 costs are set forth in Table 194. The updated capital cost ranges from about $388.8 million to $421.1 million depending upon the return flow alternative included. The updated annual operation and maintenance cost is estimated to range from about $111.4 million to about $112.0 million depending upon the return flow alternative included.

Table 191

OPTIONS FOR PROVIDING WATER SUPPLY TO SELECTED POTENTIAL NEW MUNICIPAL WATER UTILITIES AND SELECTED PORTIONS OF EXISTING 2035 MUNICIPAL WATER UTILITY SERVICE AREAS NOT CURRENTLY SERVED

Service Area	Options for Providing Water Supply
Kenosha County	
Village of Silver Lake Potential Utility	1. Separate utility supply utilizing groundwater 2. Cooperative supply with the Town of Salem Proposed Utility[a]
Village of Twin Lakes Potential Utility	1. Separate utility supply utilizing groundwater 2. Cooperative supply with the Powers-Benedict-Tombeau Lakes Area Proposed Utility
Town of Salem Potential Utility	1. Separate utility supply utilizing groundwater 2. Partial cooperative supply with the Paddock Lake Municipal Water Utility[a] 3. Partial cooperative supply with the Village of Silver Lake Proposed Utility[a]
Powers-Benedict-Tombeau Lakes Area Potential Utility	1. Separate utility supply utilizing groundwater 2. Cooperative supply with the Village of Twin Lakes Proposed Utility
Ozaukee County	
Town of Cedarburg Area	1. Cooperative supply with the City of Cedarburg 2. Cooperative supply with the Village of Grafton 3. Separate utility supply utilizing groundwater
Town of Fredonia-Waubeka Area Potential Utility	1. Cooperative supply with the Village of Fredonia 2. Separate utility supply utilizing groundwater
Racine County	
Village of Rochester Area Potential Utility	1. Separate utility supply utilizing groundwater 2. Cooperative supply with the Village of Waterford Water Utility[b]
Town of Waterford Area Potential Utility	1. Separate utility supply utilizing groundwater 2. Cooperative supply with the Village of Waterford Water Utility[b]
Walworth County	
Delavan Lake Sanitary District Area	1. Separate utility supply utilizing groundwater 2. Cooperative supply with the Delavan Water and Sewerage Commission[c]
Town of East Troy-Potter Lake Area Potential Utility	1. Separate utility supply utilizing groundwater 2. Cooperative supply with the Village of East Troy Municipal Water Utility[d] 3. Cooperative supply with the Village of Mukwonago Municipal Water Utility 4. Cooperative supply with the East Troy Sanitary District No. 3
Town of Lyons Area Potential Utility	1. Separate utility supply utilizing groundwater 2. Cooperative supply with the Country Estates Sanitary District[e]
Washington County	
Town of Hartford Areas Adjacent to the City of Hartford Water Utilities' Projected 2035 Service Area	1. Separate utility supply utilizing groundwater 2. Cooperative supply with the City of Hartford Water Utilities[f]
Village of Richfield Areas Adjacent to the Village of Germantown Water Utility's Projected 2035 Service Area	1. Separate utility supply utilizing groundwater 2. Cooperative supply with the Village of Germantown Water Utility[g]
Waukesha County	
Village of Elm Grove Potential Utility	1. Cooperative supply with the City of Brookfield Municipal Water Utility[h] 2. Cooperative supply with the City of Milwaukee Water Works 3. Cooperative supply with the City of Wauwatosa Water Utility
Village of Lannon Potential Utility	1. Separate utility supply utilizing groundwater 2. Cooperative supply with the Village of Menomonee Falls
Town of Delafield Areas Adjacent to the City of Waukesha Water Utility's Projected 2035 Service Area	1. Separate utility supply utilizing groundwater 2. Cooperative supply with the City of Waukesha Water Utility[i]

Table 191 (continued)

Service Area	Options for Providing Water Supply
Waukesha County (continued)	
Town of Delafield Areas Adjacent to the Delafield Municipal Water Utility's Projected 2035 Service Area	1. Separate utility supply utilizing groundwater 2. Cooperative supply with the Delafield Municipal Water Utility[j]
Town of Genesee Areas Adjacent to the City of Waukesha Water Utility's Projected 2035 Service Area	1. Separate utility supply utilizing groundwater 2. Cooperative supply with the City of Waukesha Water Utility
Town of Lisbon Areas Adjacent to the Sussex Water Utility's Projected 2035 Service Area	1. Separate utility supply utilizing groundwater 2. Cooperative supply with the City of Pewaukee Water Utility 3. Cooperative supply with the Sussex Water Utility[k]
Town of Oconomowoc-Okauchee Lake Area Potential Utility	1. Separate utility supply utilizing groundwater 2. Cooperative supply with the City of Oconomowoc Utilities[l]

[a]*In addition, there is potential of a cooperative supply between the Paddock Lake Municipal Water Utility and the proposed utilities for the Village of Silver Lake and the Town of Salem.*

[b]*For the purposes of sanitary sewer service, the projected 2035 municipal water supply service areas for the Village of Waterford Water Utility and the proposed Village of Rochester and Town of Waterford water utilities are within the Waterford/Rochester planned sewer service area and are served by the Western Racine County Wastewater Treatment Plant.*

[c]*For the purposes of sanitary sewer service, the portions of the projected 2035 municipal water supply service area in the Delavan Lake Sanitary District are served by the Delavan Lake Sanitary District.*

[d]*For the purposes of sanitary sewer service, the projected 2035 municipal water supply service area for the proposed Town of East Troy-Potter Lake Utility is within the East Troy planned sewer service area and is served by the East Troy Wastewater Treatment Plant.*

[e]*For the purposes of sanitary sewer service, the projected 2035 municipal water supply service area for the Country Estates Sanitary District and the proposed Town of Lyons Utility are within the Town of Lyons/Country Estates Sanitary District planned sewer service area and are served by the Town of Lyons Sanitary District No. 2 Wastewater Treatment Plant.*

[f]*For purposes of sanitary sewer service, the portion of the Town of Hartford that is adjacent to the projected 2035 municipal water supply service area of the City of Hartford Water Utilities is within the Hartford planned sewer service area and is served by the Hartford wastewater treatment plant.*

[g]*For purposes of sanitary sewer service, the portion of the Village of Richfield that is adjacent to the projected 2035 municipal water supply service area of the Village of Germantown Water Utility is within the Germantown planned sewer service area and is served by the Milwaukee Metropolitan Sewerage District's wastewater treatment plants.*

[h]*For the purposes of sanitary sewer service, the projected 2035 municipal water supply service area for the proposed Village of Elm Grove Utility is within the Brookfield East planned sewer service area and is served by the Milwaukee Metropolitan Sewerage District's wastewater treatment plants.*

[i]*For the purposes of sanitary sewer service, the portion of the Town of Delafield that is adjacent to the projected 2035 municipal water supply service area of the City of Waukesha Water Utility is within the Waukesha planned sewer service area and is served by the Waukesha wastewater treatment plant.*

[j]*For the purposes of sanitary sewer service, the portion of the Town of Delafield that is adjacent to the projected 2035 municipal water supply service area of the Delafield Municipal Water Utility is within the Delafield-Nashotah planned sewer service area and is served by the Delafield-Hartland Water Pollution Control Facility.*

[k]*For the purposes of sanitary sewer service, the portion of the Town of Lisbon that is adjacent to the projected 2035 municipal water supply service area of the Sussex Village Utility is within the Sussex planned sewer service area and is served by the Sussex wastewater treatment plant.*

[l]*For the purposes of sanitary sewer service, a portion of the proposed Okauchee Lake Area Water Utility is within the Oconomowoc planned sewer service area and is served by the Oconomowoc wastewater treatment plant.*

Source: SEWRPC.

The costs set forth herein are those estimated to be needed to develop or expand the water supply facilities for the municipal water utilities within the Region. Those facilities include: new or upgraded wells; water treatment facilities for both surface water and groundwater supplies; selected storage facilities; pumping and transmission facilities associated with connections between utilities for source water purposes; and return flow facilities where needed. The costs do not include provisions for the maintenance of the existing water transmission and distribution systems, the costs for construction of new distribution systems, or extending existing distribution systems.

Table 192

POTENTIAL COOPERATIVE DEVELOPMENT AND SYSTEMS INTEGRATION OR CONSOLIDATION ACTIVITIES AMONG SOUTHEASTERN WISCONSIN WATER UTILITIES

Utility	Potential Cooperating Entities
Kenosha County	
Kenosha Water Utility[a]	Pleasant Prairie Water Utility, Town of Bristol Utility District No. 3, Town of Somers Water Utility
Pleasant Prairie Water Utility[a]	Kenosha Water Utility, Town of Bristol Utility District No. 3, Town of Somers Water Utility
Town of Bristol Utility District No. 3[a]	Kenosha Water Utility, Pleasant Prairie Water Utility, Town of Somers Water Utility
Town of Somers Water Utility[a]	Kenosha Water Utility, Pleasant Prairie Water Utility, Town of Bristol Utility District No. 3[a]
Milwaukee County	
Milwaukee Water Works[a]	Other utilities with common boundaries[a]
Utilities with Common Boundaries with Milwaukee Water Works[a]	Milwaukee Water Works[a]
City of Milwaukee Water Works[a]	City of Cudahy Water Utility, City of South Milwaukee Water Utility
City of South Milwaukee Water Utility	City of Milwaukee Water Works
City of Cudahy Water Utility	City of Milwaukee Water Works
City of Oak Creek Water and Sewer Utility[a]	City of South Milwaukee Water Utility, City of Franklin Water Utility, Village of Caledonia West Utility District[a]
City of Franklin Water Utility[a]	City of Oak Creek Water and Sewer Utility
City of South Milwaukee Water Utility	City of Oak Creek Water and Sewer Utility
Village of Bayside	City of Mequon Water Utility, Village of Fox Point Water Utility
Village of Fox Point Water Utility	Village of Bayside
Ozaukee County	
City of Cedarburg Light and Water Commission	City of Port Washington Water Utility, Village of Grafton Water and Wastewater Commission
City of Mequon Water Utility	Village of Germantown Water Utility, Village of Bayside
City of Port Washington Water Utility	City of Cedarburg Light and Water Commission, Village of Grafton Water and Wastewater Commission, Village of Saukville Municipal Water Utility
Village of Grafton Water and Wastewater Commission	City of Cedarburg Light and Water Commission, Village of Saukville Municipal Water Utility
Village of Saukville Municipal Water Utility	City of Port Washington Water Utility, Village of Grafton Water and Wastewater Commission
Racine County	
City of Racine Water and Wastewater Utility[a]	Village of Caledonia East Utility District, Village of Caledonia West Utility District[a]
Village of Caledonia East Utility District[a]	City of Racine Water and Wastewater Utility[a]
Village of Caledonia West Utility District[a]	City of Racine Water and Wastewater Utility, City of Oak Creek Water and Sewer Utility[a]
Walworth County	
Fontana Municipal Water Utility	Lake Como Sanitary District No. 1, Walworth Municipal Water and Sewer Utility, Williams Bay Municipal Water Utility

Table 192 (continued)

Utility[a]	Potential Cooperating Entities
Walworth County (continued)	
Lake Como Sanitary District No. 1	Fontana Municipal Water Utility, Walworth Municipal Water and Sewer Utility, Williams Bay Municipal Water Utility
Walworth Municipal Water and Sewer Utility	Fontana Municipal Water Utility, Lake Como Sanitary District No. 1, Williams Bay Municipal Water Utility
Williams Bay Municipal Water Utility	Fontana Municipal Water Utility, Lake Como Sanitary District No. 1, Walworth Municipal Water and Sewer Utility
Washington County	
City of Hartford Water Utilities	Village of Slinger Utilities
Village of Germantown Water Utility	City of Mequon, Village of Menomonee Falls Water Utility
Village of Slinger Utilities	City of Hartford Water Utilities
Waukesha County	
City of Brookfield Municipal Water Utility	City of New Berlin Water Utility, City of Wauwatosa Water Utility, City of West Allis Water Utility, Village of Butler Public Water Utility, Village of Menomonee Falls Water Utility, Brookfield Sanitary District No. 4
Delafield Municipal Water Utility	Hartland Municipal Water Utility
City of Muskego Public Water Utility	City of Franklin Water Utility, City of New Berlin Water Utility
City of New Berlin Water Utility	City of Brookfield Municipal Water Utility, City of Muskego Public Water Utility, City of West Allis Water Utility
City of Pewaukee Water Utility	City of Waukesha Water Utility, Village of Sussex Water Utility, Village of Pewaukee Water Utility
Village of Butler Public Water Utility	City of Brookfield Municipal Water Utility, City of Wauwatosa Water Utility, Village of Menomonee Falls Water Utility
Hartland Municipal Water Utility	Delafield Municipal Water Utility
Village of Menomonee Falls Water Utility	City of Brookfield Municipal Water Utility, Village of Butler Public Water Utility ,Village of Germantown Water Utility, Village of Sussex Water Utility
Village of Pewaukee Water Utility	City of Pewaukee Water Utility
Village of Sussex Water Utility	City of Pewaukee Water Utility, Village of Menomonee Falls Water Utility
Brookfield Sanitary District No. 4	City of Brookfield Municipal Water Utility

[a]*It is recognized that significant integration of water is in place given the water supplier and customer agreements and interconnections.*

Source: SEWRPC.

ABILITY OF THE RECOMMENDED WATER SUPPLY PLAN TO MEET THE WATER SUPPLY PLANNING OBJECTIVES

The water supply development objectives and supporting principles and standards were formulated early in the regional water supply planning effort and constitute the overall goals of the regional water supply plan. These agreed-upon objectives and standards provide the basis for plan preparation, comparison of alternative plans, and evaluation. It is, therefore, appropriate to determine how well the recommended regional water supply plan meets these objectives and standards. Accordingly, an evaluation of the recommended plan was made on the basis of its ability to achieve the water supply development objectives and supporting standards. The results of the evaluation are presented in summary form in Table 195.

Table 193

PRINCIPAL FEATURES AND COSTS OF WATER SUPPLY FACILITIES AND PROGRAMS UNDER THE RECOMMENDED WATER SUPPLY PLAN, DESIGN YEAR 2035

			Annual Operation and Maintenance Costs				
			New, Expanded, or Upgraded Programs and Facilities[a,b]				
County and Utility	New, Expanded, or Upgraded Programs and Facilities Description[a]	Capital Cost for New, Expanded, or Upgraded Facilities ($ X 1,000)	Water Utility Costs ($ X 1,000)	Annual Savings in Private Individual Water Treatment Costs[c] ($ X 1,000)	Total Net O & M Costs ($ X 1,000)	Existing Facilities[d] ($ X 1,000)	Total ($ X 1,000)
Kenosha County							
City of Kenosha Water Utility	No additions	- -	41.7	- -	41.7	1,634.0[e]	1,675.7
Village of Paddock Lake Municipal Water Utility	Addition of two 0.25 MG elevated tanks, three shallow aquifer wells with 0.20 MG reservoir each	4,032	54.0	- -	54.0	65.1	119.1
Village of Pleasant Prairie Water Utility	Addition of 0.75 MG elevated tank	1,620	39.7	- -	39.7	2,887.5[e]	2,927.2
Town of Bristol Utility District No. 1	Addition of two shallow aquifer wells, 0.50 MG elevated tank, 0.40 MG reservoir	2,654	34.6	- -	34.6	240.6	275.2
Town of Bristol Utility District No. 3	No additions	- -	0.1	- -	0.1	668.5[e]	668.6
Town of Somers Water Utility	No additions	- -	3.5	- -	3.5	1,316.6[e]	1,320.1
Village of Silver Lake Potential Utility	Addition of three shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank	3,437	95.9	- -	95.9	- -	95.9
Village of Twin Lakes Potential Utility	Addition of five shallow aquifer wells with 0.1 MG reservoir each, two 0.3 MG elevated tanks	5,317	163.4	- -	163.4	- -	163.4
Town of Salem Potential Utility	Addition of eight wells,[f] four with 0.15 MG reservoirs, two 0.3 MG elevated tanks	7,294[f]	297.9[f]	- -	297.9[f]	- -	297.9
Powers-Benedict-Tombeau Lakes Area Planned Utility	Addition of two shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank	2,584	58.8	- -	58.8	- -	58.8
Land Acquisition for Wells and Storage Tanks	33 acres	2,310	- -	- -	- -	- -	- -
Countywide	Nine rainfall infiltration systems	5,509	41.2	- -	41.2	- -	41.2
Subtotal	23 Wells, 28 Storage Tanks, Nine Rainfall Infiltration Systems	34,757	830.8	- -	830.8	6,812.3	7,643.1
Milwaukee County							
City of Cudahy Water Utility	Duplicate rapid mix facility	100	7.5	- -	7.5	1,276.9	1,284.4
City of Franklin Water Utility	No additions	- -	13.4	- -	13.4	3,419.6[e]	3,433.0
City of Glendale Water Utility	No additions	- -	6.1	- -	6.1	1,282.0[e]	1,288.1
City of Milwaukee Water Works	No additions	- -	263.1	- -	263.1	34,070.7[e]	34,333.8

Table 193 (continued)

County and Utility	New, Expanded, or Upgraded Programs and Facilities Description[a]	Capital Cost for New, Expanded, or Upgraded Facilities ($ X 1,000)	Annual Operation and Maintenance Costs: New, Expanded, or Upgraded Programs and Facilities[a,b]: Water Utility Costs ($ X 1,000)	Annual Savings in Private Individual Water Treatment Costs[c] ($ X 1,000)	Total Net O & M Costs ($ X 1,000)	Existing Facilities[d] ($ X 1,000)	Total ($ X 1,000)
Milwaukee County (continued)							
City of Oak Creek Water and Sewer Utility	Addition of 16 mgd floc-sedimentation basins, 10 mgd multi-media filtration, and miscellaneous plant improvements, plus an analysis for rerating selected treatment unit capacities[g]	12,100[g]	547.4	- -[h]	547.4	947.0[e]	1,494.4
City of South Milwaukee Water Utility	No additions	- -	8.6	- -	8.6	1,193.5	1,202.1
City of Wauwatosa Water Utility	No additions	- -	19.6	- -	19.6	5,728.4[e]	5,748.0
City of West Allis Water Utility	No additions	- -	25.2	- -	25.2	4,645.0[e]	4,670.2
Village of Brown Deer Public Water Utility	No additions	- -	4.8	- -	4.8	1,030.3[e]	1,035.1
Village of Fox Point Water Utility	No additions	- -	2.6	- -	2.6	533.6[e]	536.2
Village of Greendale Water Utility	No additions	- -	5.6	- -	5.6	965.1[e]	970.7
Village of Shorewood Municipal Water Utility	No additions	- -	1.4	- -	1.4	821.5[e]	822.9
Village of Whitefish Bay Water Utility	No additions	- -	5.8	- -	5.8	711.6[e]	717.4
We Energies-Water Services[i]	No additions	- -	1.0	- -	1.0	177.2[e]	178.2
Subtotal	0 Wells, 0 Storage Tanks, Two Treatment Plant Upgrades	12,200	912.1	- -	912.1	56,802.4	57,714.5
Ozaukee County							
City of Cedarburg Light and Water Commission/ Village of Grafton Water and Wastewater Commission	New 9.0 MGD Lake Michigan intake and water treatment plant, connecting transmission mains[j]	47,048	824.2	2,483.0	-1,658.8	792.8	-866.0
City of Port Washington Water Utility	Addition of 3.0 MGD coag-floc-sed, filtration, 3.0 MGD pumping	6,895	86.2	- -	86.2	1,340.3	1,426.5
Village of Belgium Municipal Water Utility	Addition of 0.45 MG reservoir at Well 3, service pumps at Wells 1 and 2	586	2.0	- -	2.0	198.1	200.1
Village of Fredonia Municipal Water Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.20 MG reservoir	1,417	23.5	- -	23.5	133.5	157.0
Village of Saukville Municipal Water Utility	Lake Michigan Supply Connection	3,870	198.3[k]	455.0	-256.7[k]	187.1	-69.6
We Energies-Water Services[i]	5,300 lineal feet of 30-inch main (shared with Village of Germantown) in 107th street, 16,100 lineal feet of 20-inch main in Granville Road and Donges Bay Road	3,300	231.8[l]	- -[m]	231.8[l]	1,673.2	1,905.0

Table 193 (continued)

County and Utility	New, Expanded, or Upgraded Programs and Facilities Description[a]	Capital Cost for New, Expanded, or Upgraded Facilities ($ X 1,000)	Annual Operation and Maintenance Costs: New, Expanded, or Upgraded Programs and Facilities[a,b]: Water Utility Costs ($ X 1,000)	Annual Operation and Maintenance Costs: New, Expanded, or Upgraded Programs and Facilities[a,b]: Annual Savings in Private Individual Water Treatment Costs[c] ($ X 1,000)	Annual Operation and Maintenance Costs: New, Expanded, or Upgraded Programs and Facilities[a,b]: Total Net O & M Costs ($ X 1,000)	Annual Operation and Maintenance Costs: Existing Facilities[d] ($ X 1,000)	Annual Operation and Maintenance Costs: Total ($ X 1,000)
Ozaukee County (continued)							
Town of Fredonia-Waubeka Area Potential Utility	Addition of one shallow aquifer well with 0.10 MG reservoir, 0.25 MG elevated tank	1,460	24.5	- -	24.5	- -	24.5
Land Acquisition for Wells, Storage Tanks and Water Treatment Plant	14 acres	980	- -	- -	- -	- -	- -
Countywide	Two rainfall infiltration systems	1,199	13.5	- -	13.5	- -	13.5
Subtotal	Two Wells, Five Storage Tanks, One Treatment Plant Upgrade, One New Treatment Plant, One Lake Michigan Supply, Two Rainfall Infiltration Systems	66,755	1,404.0	2,938.0	-1,534.0	4,325.0	2,791.0
Racine County							
City of Burlington Municipal Waterworks	Radium treatment at Well Nos. 9 and 10[n]	3,256	48.6	- -	48.6	776.8	825.4
City of Racine Water and Wastewater Utility[o]	No additions	- -	45.9	- -	45.9	7,875.5[e]	7,921.4
Village of Caledonia West Utility District[p] (Oak Creek)	No additions	- -	0.4	- -	0.4	167.5[e]	167.9
Village of Caledonia West Utility District[p] (Racine)	No additions	- -	3.1	- -	3.1	1,313.3[e]	1,316.4
Village of Caledonia East Utility District[q] (Oak Creek)	No additions	- -	1.9	- -	1.9	598.5[e]	600.4
Village of Caledonia East Utility District[q] (Racine)	No additions	- -	3.5	- -	3.5	749.9[e]	753.4
Village of Caledonia East Expansion Area	9,000 lineal feet of water transmission main	1,557	45.5[r]	- -	45.5[r]	- -	45.5
Village of Union Grove Municipal Water Utility	Addition of two shallow aquifer wells, 0.40 MG reservoir	1,776	27.1	- -	27.1	348.0	375.1
Village of Waterford Water and Sewer Utility	Addition of one shallow aquifer well with 0.40 MG reservoir	1,151	15.7	- -	15.7	228.8	244.5
Village of Wind Point Municipal Water Utility	No additions	- -	0.8	- -	0.8	281.1[e]	281.9
North Cape Sanitary District	Addition of one shallow aquifer well with reservoir	155	2.1	- -	2.1	7.4	9.5
Town of Yorkville Water Utility District 1	Lake Michigan supply connection	459	20.0[s]	28.0	-8.0[s]	39.1	31.1
Town of Burlington-Bohner Lake Area Planned Utility District	Addition of two shallow aquifer wells, 0.30 MG elevated tank	1,941	43.2	- -	43.2	- -	43.2
Town of Dover-Eagle Lake Area Planned Utility District	Addition of two shallow aquifer wells, 0.30 MG elevated tank	1,941	48.0	- -	48.0	- -	48.0

Table 193 (continued)

County and Utility	New, Expanded, or Upgraded Programs and Facilities Description[a]	Capital Cost for New, Expanded, or Upgraded Facilities ($ X 1,000)	Annual Operation and Maintenance Costs: New, Expanded, or Upgraded Programs and Facilities[a,b]: Water Utility Costs ($ X 1,000)	Annual Savings in Private Individual Water Treatment Costs[c] ($ X 1,000)	Total Net O & M Costs ($ X 1,000)	Existing Facilities[d] ($ X 1,000)	Total ($ X 1,000)
Racine County (continued)							
Town of Norway Area Potential Utility	Addition of four shallow aquifer wells, one with 0.15 MG reservoir, two 0.25 MG elevated tanks	4,024	115.8	- -	115.8	- -	115.8
Village of Rochester Area Potential Utility[t]	Addition of two shallow aquifer wells, two 0.10 MG elevated tanks	1,844	29.8	- -	29.8	- -	29.8
Town of Waterford Area Potential Utility	Addition of three shallow aquifer wells, one with 0.15 MG reservoir, two 0.3 MG elevated tanks	3,485	117.8	- -	117.8	- -	117.8
Land Acquisition for Wells and Storage Tanks	25 acres	1,750	- -	- -	- -	- -	- -
Countywide	One rainfall infiltration system	495	6.0	- -	6.0	- -	6.0
Subtotal	17 Wells, 13 Storage Tanks, One Lake Michigan Supply Connection, One Rainfall Infiltration System	23,834	575.2	28.0	547.2	12,385.9	12,933.1
Walworth County							
City of Delavan Water and Sewerage Commission	Addition of two shallow aquifer wells with iron removal treatment	2,050	51.5	- -	51.5	886.6	938.1
City of Elkhorn Light and Water	Addition of three shallow aquifer wells, 0.35 MG treated water reservoir	2,342	57.0	- -	57.0	1,118.1	1,175.1
City of Lake Geneva Municipal Water Utility	No additions	- -	11.3	- -	11.3	723.5	734.8
City of Whitewater Municipal Water Utility	No additions	- -	13.7	- -	13.7	600.0	613.7
Village of Darien Water Works and Sewer System	Increase Well 1 output from 325 to 425 gpm	30	15.2	- -	15.2	192.1	207.3
Village of East Troy Municipal Water Utility	Addition of three shallow aquifer wells, two with 0.10 MG reservoir each[u]	2,199	55.6	- -	55.6	278.4	334.0
Village of Fontana Municipal Water Utility	No additions	- -	2.0	- -	2.0	339.2	341.2
Village of Genoa City Municipal Water Utility	Addition of two shallow aquifer wells and 0.25 MG elevated tank	1,898	48.1	- -	48.1	364.8	412.9
Village of Sharon Waterworks and Sewer System	Addition of one shallow aquifer well with 0.30 MG reservoir, 0.20 MG elevated tank	1,512	17.1	- -	17.1	146.6	163.7
Village of Walworth Municipal Water and Sewer Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.15 MG reservoir	1,333	30.6	- -	30.6	177.3	207.9
Village of Williams Bay Municipal Water Utility	No additions	- -	4.3	- -	4.3	510.0	514.3

Table 193 (continued)

County and Utility	New, Expanded, or Upgraded Programs and Facilities Description[a]	Capital Cost for New, Expanded, or Upgraded Facilities ($ X 1,000)	Annual Operation and Maintenance Costs: New, Expanded, or Upgraded Programs and Facilities[a,b]: Water Utility Costs ($ X 1,000)	Annual Operation and Maintenance Costs: New, Expanded, or Upgraded Programs and Facilities[a,b]: Annual Savings in Private Individual Water Treatment Costs[c] ($ X 1,000)	Annual Operation and Maintenance Costs: New, Expanded, or Upgraded Programs and Facilities[a,b]: Total Net O & M Costs ($ X 1,000)	Annual Operation and Maintenance Costs: Existing Facilities[d] ($ X 1,000)	Annual Operation and Maintenance Costs: Total ($ X 1,000)
Walworth County (continued)							
Town of Bloomfield Pell Lake Sanitary District No. 1	Addition of 0.20 MG elevated tank, one deep aquifer well with radium treatment and with 0.4 MG reservoir	1,891	39.6	- -	39.6	296.0	335.6
Town of East Troy Sanitary District No. 3	Addition of one shallow aquifer well	130	0.1	- -	0.1	13.1	13.2
Town of Geneva Lake Como Sanitary District No. 1	Addition of 0.20 MG elevated tank and 0.45 MG reservoir	1,066	12.4	- -	12.4	232.3	244.7
Town of Troy Sanitary District No. 1	Addition of one shallow aquifer well with 0.01 MG reservoir	80	0.2	- -	0.2	6.5	6.7
Country Estates Sanitary District	Addition of 0.20 MG elevated tank	480	10.8	- -	10.8	106.2	117.0
Town of Delavan-DLSD Potential Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.30 MG reservoir	1,512	32.4	- -	32.4	- -	32.4
Town of Lyons Area Potential Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.3 MG elevated tank	2,169	39.7	- -	39.7	- -	39.7
Town of East Troy-Potter Lake Area Potential Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.3 MG elevated tank	2,169	35.2	- -	35.2	- -	35.2
Land Acquisition for Wells and Storage Tanks	29 acres	2,030	- -	- -	- -	- -	- -
Countywide	12 rainfall infiltration systems	6,207	66.0	- -	66.0	- -	66.0
Subtotal	20 Wells, 20 Storage Tanks, 12 Rainfall Infiltration Systems	29,098	542.8	- -	542.8	5,990.7	6,533.5
Washington County							
City of Hartford Utilities	Addition of one shallow aquifer well, treatment system, one 0.75 MG elevated tank, and interconnecting piping (these facilities are under construction and expected to be operational during 2009)	7,500	102.8	- -	102.8	1,123.0	1,225.8
City of West Bend Water Utility	Addition of one shallow aquifer well	625	58.4	- -	58.4	2,577.6	2,636.0
Village of Germantown Water Utility	Lake Michigan supply connection	8,404	335.0[v]	1,720.0	-1,385.0[v]	977.2	-407.8
Village of Jackson Water Utility	No additions	- -	7.4	- -	7.4	538.2	545.6
Village of Kewaskum Municipal Water Utility	Addition of 0.25 MG reservoir	351	4.4	- -	4.4	316.4	320.8
Village of Slinger Utilities	Addition of two shallow aquifer wells with 0.20 MG reservoir each	1,824	31.9	- -	31.9	268.6	300.5

Table 193 (continued)

County and Utility	New, Expanded, or Upgraded Programs and Facilities Description[a]	Capital Cost for New, Expanded, or Upgraded Facilities ($ X 1,000)	Annual Operation and Maintenance Costs				
			New, Expanded, or Upgraded Programs and Facilities[a,b]				
			Water Utility Costs ($ X 1,000)	Annual Savings in Private Individual Water Treatment Costs[c] ($ X 1,000)	Total Net O & M Costs ($ X 1,000)	Existing Facilities[d] ($ X 1,000)	Total ($ X 1,000)
Washington County (continued)							
Allenton Sanitary District No. 1	Addition of 0.20 MG elevated tank, one deep aquifer well with 0.30 MG reservoir	1,672	20.3	- -	20.3	128.7	149.0
Village of Newburg Area Potential Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.30 MG elevated tank	2,169	40.7	- -	40.7	- -	40.7
Land Acquisition for Wells and Storage Tanks	10 acres	700	- -	- -	- -	- -	- -
Countywide	Five rainfall infiltration systems	2,634	27.0	- -	27.0	- -	27.0
Subtotal	Seven Wells, Eight Storage Tanks, One Lake Michigan Supply Connection, Five Rainfall Infiltration Systems	25,879	627.9	1,720.0	-1,092.1	5,929.7	4,837.6
Waukesha County							
City of Brookfield Municipal Water Utility (east)	Lake Michigan supply connection	19,682	454.0[w]	1,440.0	-986.0[w]	626.2	-359.8
City of Brookfield Municipal Water Utility (west)	No additions	- -	17.0	- -	17.0	1,058.4	1,075.4
City of Delafield Municipal Water Utility	Addition of five shallow aquifer wells, 0.40 MG elevated tank	4,019	110.1	- -	110.1	325.3	435.4
City of Muskego Public Water Utility	Lake Michigan supply connection	12,675	197.0	1,519.0	-1,322.0[x]	611.9	-710.1
City of New Berlin Water Utility (east)	Addition of 0.40 MG reservoir	526	8.5	- -	8.5	1,105.2[e]	1,113.7
City of New Berlin Water Utility (central)	Lake Michigan supply connection[aa]	6,685	256.5	1,260.0	-1,003.5[z]	697.9	-305.6
City of Oconomowoc Utilities	No additions	- -	17.4	- -	17.4	921.7	939.1
City of Pewaukee Water and Sewer Utility	Addition of three shallow aquifer wells, one with reservoir, one deep well with radium treatment and reservoir, service pumps, one 0.50 MG elevated tank, and one 0.20 MG elevated tank[y]	5,209	438.6	- -	438.6	958.8	1,397.4
City of Waukesha Water Utility	Lake Michigan supply connection[bb]	60,752 to 88,331	3,826.5 to 4,327.0	7,268.0	-3,441.5 to -2,941.0[bb]	2,033.2	-1,408.3 to -907.8
Village of Butler Public Water Utility	Addition of 0.25 MG reservoir	351	0.8	- -	0.8	420.6[e]	421.4
Village of Dousman Water Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.40 MG reservoir	1,631	26.2	- -	26.2	173.8	200.0
Village of Eagle Municipal Water Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.40 MG reservoir	1,631	17.8	- -	17.8	109.3	127.1
Village of Hartland Municipal Water Utility	Addition of one shallow aquifer well	625	17.7	- -	17.7	589.7	607.4
Village of Menomonee Falls Water Utility (east)	No additions	- -	12.2	- -	12.2	2,852.9[e]	2,865.1

Table 193 (continued)

County and Utility	New, Expanded, or Upgraded Programs and Facilities Description[a]	Capital Cost for New, Expanded, or Upgraded Facilities ($ X 1,000)	Annual Operation and Maintenance Costs: New, Expanded, or Upgraded Programs and Facilities[a,b]: Water Utility Costs ($ X 1,000)	Annual Operation and Maintenance Costs: New, Expanded, or Upgraded Programs and Facilities[a,b]: Annual Savings in Private Individual Water Treatment Costs[c] ($ X 1,000)	Annual Operation and Maintenance Costs: New, Expanded, or Upgraded Programs and Facilities[a,b]: Total Net O & M Costs ($ X 1,000)	Annual Operation and Maintenance Costs: Existing Facilities[d] ($ X 1,000)	Annual Operation and Maintenance Costs: Total ($ X 1,000)
Waukesha County (continued)							
Village of Menomonee Falls Water Utility (west)	Addition of 0.20 MG elevated tank, two shallow aquifer wells	1,755	32.9	- -	32.9	186.3	219.2
Village of Mukwonago Municipal Water Utility	Addition of three shallow aquifer wells	2,195	77.7	- -	77.7	564.4	642.1
Village of Pewaukee Water Utility	Radium treatment facility for Well No. 5[cc]	671	19.5	- -	19.5	470.6	490.1
Village of Sussex Public Water Utility	Addition of one shallow aquifer well	625	42.9	- -	42.9	620.8	663.7
Town of Brookfield Sanitary District No. 4	Addition of 0.35 MG reservoir	467	6.0	- -	6.0	506.9	512.9
Village of Big Bend Potential Utility	Addition of two shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank	2,584	76.1	- -	76.1	- -	76.1
Village of Elm Grove Potential Utility	Lake Michigan supply connection[j]	2,797	129.3[dd]	596.0	-466.7[dd]	- -	-466.7
Village of Lannon Potential Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.75 MG elevated tank	3,098	118.7	- -	118.7	- -	118.7
Village of North Prairie Utility	Addition of 0.50 MG elevated tank	878	19.5	- -	19.5	- -	19.5
Village of Wales Potential Utility	Addition of two shallow aquifer wells, 0.30 MG elevated tank	1,941	42.5	- -	42.5	- -	42.5
Town of Eagle-Eagle Spring Lake Area Potential Utility	Addition of one shallow aquifer well with 0.15 MG reservoir	853	5.4	- -	5.4	- -	5.4
Town of Oconomowoc-Okauchee Lake Area Potential Utility	Addition of four shallow aquifer wells, one with 0.15 MG reservoir, two 0.30 MG elevated tanks	4,110	120.2	- -	120.2	- -	120.2
Town of Ottawa-Pretty Lake Area Potential Utility	Addition of one shallow aquifer well with 0.10 MG reservoir	787	3.2	- -	3.2	- -	3.2
Town of Summit-Golden Lake Area Potential Utility	Addition of one shallow aquifer well with 0.10 MG reservoir	787	2.2	- -	2.2	- -	2.2
Land Acquisition for Wells and Storage Tanks	43 acres	3,010	- -	- -	- -	- -	- -
Countywide	Two rainfall infiltration systems	938	7.5	- -	7.5	- -	7.5
Subtotal	31 Wells, 26 Storage Tanks, Five Lake Michigan Supply Connections, Two Rainfall Infiltration Systems	141,282 to 169,861	6,103.9 to 6,604.4	12,083.0	-5,979.1 to -5,478.6	14,833.9	8,854.8 to 9,355.3
Total	100 Wells, 100 Storage Tanks, Eight Lake Michigan Supply Connections, Three Treatment Plant Upgrades, One New Treatment Plant, 31 Rainfall Infiltration Systems	333,805 to 361,384	10,996.7 to 11,497.2	16,769.0	-5,777.3 to -5,271.8	107,079.9	101,307.6 to 101,808.1

Footnotes to Table 193

[a]All utilities' programs include water conservation programs as refined in Appendix K. Water distribution system costs are not included.

[b]The operation and maintenance costs are for increased incremental costs associated with new, expanded, or upgraded facilities and for water conservation measures. The estimated annual cost for water conservation is included as an operation and maintenance cost for all utilities.

[c]Cost savings associated with residences and businesses which would be able to discontinue or reduce uses of point-of-entry water treatment devices.

[d]Costs estimated from analysis of Public Service Commission of Wisconsin reports. Costs are estimated for water supply facilities to be retained. Costs do not include existing facility debt service.

[e]O&M costs for utilities which purchase water from water supplier are based upon 2005 unit costs to purchase water. The O&M costs for the water supplier reflect a credit representing the portion of the purchased water cost associated with existing facility fixed costs.

[f]The depth and aquifer of new wells to be developed in the Town of Salem will depend upon more-detailed hydrogeologic elevations. The costs included assume shallow aquifer wells. However, site-specific evaluations may indicate that some wells would be finished in the deep aquifer.

[g]Based upon plant expansion program for which construction was under way in 2009. Costs are based upon actual bid prices, plus 15 percent for engineering, legal, and contingencies. The City of Oak Creek Water and Sewer Utility plans to conduct a rerating analysis of its water plant once the ongoing plant expansion is completed late in 2010. The rerating analysis will be designed to demonstrate a plant capacity of 35 mgd, an increase of 7 mgd from the rating of 28 mgd, based upon the 2009 expansion.

[h]There is expected to be an estimated average reduction of $376,000 per year for savings associated with existing residences which would be able to discontinue their point-of-entry water treatment systems in the Cities of Oak Creek and Franklin. However, there is also an expected cost involved in developing local water distribution systems. The cost savings due to discontinuation of the point-of-entry water treatment system and the costs of the local distribution systems are common to all alternative plans and are not specifically accounted for in this table.

[i]The We Energies-Water Services water supply system serving portions of the City of Mequon and Villages of Bayside and Thiensville was acquired by the City of Mequon in 2009. The City of Mequon Water Utility contracts with City Water, LLC, to manage and operate the water supply system serving portions of the City of Mequon and Villages of Bayside and Thiensville.

[j]The recommended regional water supply plan includes viable options for the provision of Lake Michigan water supply to the Cedarburg Light and Water Commission and the Grafton Water and Wastewater Commission, which are recommended to be evaluated during implementation. These options include connections to the expanded City of Port Washington Water Utility system or to the Milwaukee Water Works.

[k]The annual O&M cost for the Village of Saukville Water Utility includes an estimated annual water production cost of $120,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The additional cost for water purchase would be offset by a corresponding decrease in the O&M cost for the water supplier. Based upon the magnitude of the additional water purchase costs, the projected savings in total new O&M costs and in total O&M costs may be reduced. If the additional costs were to be sufficiently high, it could result in a change from a negative total net to total O&M cost to a positive or increase in total net or total O&M cost.

[l]The annual O&M cost for the We Energies-Water Services Mequon and Thiensville service area includes an estimated average annual water production cost of $219,000 per year based upon the estimated incremental cost of $230 per million gallons for water production at the City of Milwaukee Water Works treatment facilities. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed cost and other costs. The additional cost for water purchase would be offset by a corresponding decrease in the O&M cost for the water supplier. Based upon the magnitude of the additional water purchase costs, the projected savings in total new O&M costs and in total O&M costs may be reduced. If the additional costs were to be sufficiently high, it could result in a change from a negative total net to total O&M cost to a positive or increase in total net or total O&M cost.

[m]There is expected to be an estimated average reduction of $1,520,000 per year for savings associated with existing residences which would be able to discontinue their point-of-entry water treatment systems. However, there are also expected costs involved in developing a local water distribution system. The cost savings due to discontinuation of the point-of-entry water treatment system and the cost of the local distribution system are common to all alternative plans and are not specifically accounted for in this table.

[n]The City of Burlington radium treatment facilities are included in the recommended plan based upon studies by the City conducted in 2009 and 2010. No treatment was envisioned under the alternative and preliminary recommended plans documented in Chapters VIII and IX.

[o]Includes the Village of Sturtevant Water Utility which was purchased by the City of Racine Water and Wastewater Utility in 2007 and is now served by the City Utility on a retail basis.

[p]Includes the former Caddy Vista Sanitary District and the former Caledonia Utility District No. 1 which were consolidated in 2006 to form the Caledonia West Utility District

[q]Includes the former Crestview Sanitary District and the former North Park Sanitary Districts which were consolidated in 2007 to form the Caledonia East Utility District.

Table 193 Footnotes (continued)

[r]The annual O&M cost for the Village of Caledonia East Utility District expansion area includes an estimated annual water production cost of $42,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The additional cost for water purchase would be offset by a corresponding decrease in the O&M cost for the water supplier.

[s]The annual O&M cost for the Town of Yorkville Utility District No. 1 includes an estimated annual water production cost of $17,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The additional cost for water purchase would be offset by a corresponding decrease in the O&M cost for the water supplier. Based upon the magnitude of the additional water purchase costs, the projected savings in total new O&M costs and in total O&M costs may be reduced. If the additional costs were to be sufficiently high, it could result in a change from a negative total net to total O&M cost to a positive or increase in total net or total O&M cost.

[t]Includes the former Town of Rochester and Village of Rochester service areas as delineated in Chapter IV of this report. In December 2008, the Village and Town of Rochester were consolidated as the Village of Rochester.

[u]One of the new Village of East Troy wells was in place and operational as of 2008.

[v]The annual O&M cost for the Village of Germantown Water Utility includes an estimated annual water production cost of $215,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The additional cost for water purchase would be offset by a corresponding decrease in the O&M cost for the water supplier. Based upon the magnitude of the additional water purchase costs, the projected savings in total new O&M costs and in total O&M costs may be reduced. If the additional costs were to be sufficiently high, it could result in a change from a negative total net to total O&M cost to a positive or increase in total net or total O&M cost.

[w]The annual O&M cost for the City of Brookfield Water Utility for the eastern portion of the City includes an estimated annual water production cost of $205,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The additional cost for water purchase would be offset by a corresponding decrease in the O&M cost for the water supplier. Based upon the magnitude of the additional water purchase costs, the projected savings in total new O&M costs and in total O&M costs may be reduced. If the additional costs were to be sufficiently high, it could result in a change from a negative total net to total O&M cost to a positive or increase in total net or total O&M cost.

[x]The annual O&M cost for the City of Muskego Water Utility includes an estimated annual water production cost of $133,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The additional cost for water purchase would be offset by a corresponding decrease in the O&M cost for the water supplier. Based upon the magnitude of the additional water purchase costs, the projected savings in total new O&M costs and in total O&M costs may be reduced. If the additional costs were to be sufficiently high, it could result in a change from a negative total net to total O&M cost to a positive or increase in total net or total O&M cost.

[y]The City of New Berlin central Lake Michigan supply connection was completed in 2009.

[z]The annual O&M cost for the City of New Berlin Water Utility for the central portion of the City includes an estimated annual water production cost of $185,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The additional cost for water purchase would be offset by a corresponding decrease in the O&M cost for the water supplier. Based upon the magnitude of the additional water purchase costs, the projected savings in total new O&M costs and in total O&M costs may be reduced. If the additional costs were to be sufficiently high, it could result in a change from a negative total net to total O&M cost to a positive or increase in total net or total O&M cost.

[aa]Based upon a locally developed plan, the City and Village of Pewaukee Water Utility consolidation study, August 2009, prepared by Ruekert & Mielke, Inc. Three of the four wells are assumed to be shallow wells, and one well is assumed to be a deep well. However, the local plan indicates there may be a need to use deep wells and radium treatment. The well depth and level of treatment will have to be determined on a site-specific basis.

[bb]The annual O&M cost for the City of Waukesha Water Utility includes an estimated annual water production cost of $739,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The additional cost for water purchase would be offset by a corresponding decrease in the O&M cost for the water supplier. Based upon the magnitude of the additional water purchase costs, the projected savings in total new O&M costs and in total O&M costs may be reduced. If the additional costs were to be sufficiently high, it could result in a change from a negative total net to total O&M cost to a positive or increase in total net or total O&M cost.

[cc]Based upon a locally developed plan, the City and Village of Pewaukee Water Utility consolidation study, August 2009, prepared by Ruekert & Mielke, Inc. The facilities needed for the Village of Pewaukee were revised to include radium treatment at Well No. 5, rather than replacement of Well No. 5, as set forth in the earlier chapters of this report.

[dd]The annual O&M cost for the Village of Elm Grove includes an estimated annual water production cost of $62,000 per year based upon an estimated incremental cost of $230 per million gallons for water production at the supplier utility. The cost to purchase that water would be expected to be much greater, as it would include consideration of fixed and other costs. The additional cost for water purchase would be offset by a corresponding decrease in the O&M cost for the water supplier. Based upon the magnitude of the additional water purchase costs, the projected savings in total new O&M costs and in total O&M costs may be reduced. If the additional costs were to be sufficiently high, it could result in a change from a negative total net to total O&M cost to a positive or increase in total net or total O&M cost.

Source: Ruekert & Mielke, Inc., and SEWRPC.

Table 194

PRINCIPAL FEATURES AND COSTS OF WATER SUPPLY FACILITIES AND PROGRAMS UNDER THE RECOMMENDED WATER SUPPLY PLAN, DESIGN YEAR 2035 UPDATED TO 2010 COSTS

County and Utility	New, Expanded, or Upgraded Programs and Facilities Description[a,b]	Capital Cost for New, Expanded, or Upgraded Facilities ($ X 1,000)		Annual Operation and Maintenance Costs ($ X 1,000)	
		2005 Costs	2010 Costs	2005 Costs	2010 Costs
Kenosha County					
City of Kenosha Water Utility	No additions	- -	- -	1,675.7	1,843.3
Village of Paddock Lake Municipal Water Utility	Addition of two 0.25 MG elevated tanks, three shallow aquifer wells with 0.20 MG reservoir each	4,032	4,717	119.1	131.0
Village of Pleasant Prairie Water Utility	Addition of 0.75 MG elevated tank	1,620	1,895	2,927.2	3,219.9
Town of Bristol Utility District No. 1	Addition of two shallow aquifer wells, 0.50 MG elevated tank, 0.40 MG reservoir	2,654	3,105	275.2	302.7
Town of Bristol Utility District No. 3	No additions	- -	- -	668.6	735.5
Town of Somers Water Utility	No additions	- -	- -	1,320.1	1,452.1
Village of Silver Lake Potential Utility	Addition of three shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank	3,437	4,021	95.9	105.5
Village of Twin Lakes Potential Utility	Addition of five shallow aquifer wells with 0.1 MG reservoir each, two 0.3 MG elevated tanks	5,317	6,221	163.4	179.7
Town of Salem Potential Utility	Addition of eight wells,[c] four with 0.15 MG reservoirs, two 0.3 MG elevated tanks	7,294	8,534	297.9	327.7
Powers-Benedict-Tombeau Lakes Area Planned Utility	Addition of two shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank	2,584	3,023	58.8	64.7
Land Acquisition for Wells and Storage Tanks	33 acres	2,310	2,703	- -	- -
Countywide	Nine rainfall infiltration systems	5,509	6,446	41.2	45.3
Subtotal	23 Wells, 28 Storage Tanks, Nine Rainfall Infiltration Systems	34,757	40,667	7,643.1	8,407.4
Milwaukee County					
City of Cudahy Water Utility	Duplicate rapid mix facility	100	117	1,284.4	1,412.8
City of Franklin Water Utility	No additions	- -	- -	3,433.0	3,776.3
City of Glendale Water Utility	No additions	- -	- -	1,288.1	1,416.9
City of Milwaukee Water Works	No additions	- -	- -	34,333.8	37,767.2
City of Oak Creek Water and Sewer Utility	Addition of 16 mgd floc-sedimentation basins, 10 mgd multi-media filtration, and miscellaneous plant improvements, plus an analysis for rerating selected treatment unit capacities[d]	12,100[g]	13,068	1,494.5	1,644.0
City of South Milwaukee Water Utility	No additions	- -	- -	1,202.1	1,322.3
City of Wauwatosa Water Utility	No additions	- -	- -	5,748.0	6,322.8
City of West Allis Water Utility	No additions	- -	- -	4,670.2	5,137.2

Table 194 (continued)

County and Utility	New, Expanded, or Upgraded Programs and Facilities Description[a,b]	Capital Cost for New, Expanded, or Upgraded Facilities ($ X 1,000)		Annual Operation and Maintenance Costs ($ X 1,000)	
		2005 Costs	2010 Costs	2005 Costs	2010 Costs
Milwaukee County (continued)					
Village of Brown Deer Public Water Utility	No additions	- -	- -	1,035.1	1,138.6
Village of Fox Point Water Utility	No additions	- -	- -	536.2	589.8
Village of Greendale Water Utility	No additions	- -	- -	970.7	1,067.8
Village of Shorewood Municipal Water Utility	No additions	- -	- -	822.9	905.2
Village of Whitefish Bay Water Utility	No additions	- -	- -	717.4	789.1
We Energies-Water Services[e]	No additions	- -	- -	178.2	196.0
Subtotal	0 Wells, 0 Storage Tanks, Two Treatment Plant Upgrades	12,200	13,185	57,714.6	63,485.9
Ozaukee County					
City of Cedarburg Light and Water Commission/ Village of Grafton Water and Wastewater Commission	New 9.0 MGD Lake Michigan intake and water treatment plant, connecting transmission mains[f]	47,048	55,046	-866.0	-952.6
City of Port Washington Water Utility	Addition of 3.0 MGD coag-floc-sed, filtration, 3.0 MGD pumping	6,895	8,067	1,426.5	1,569.2
Village of Belgium Municipal Water Utility	Addition of 0.45 MG reservoir at Well 3, service pumps at Wells 1 and 2	586	686	200.1	220.1
Village of Fredonia Municipal Water Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.20 MG reservoir	1,417	1,658	157.0	172.7
Village of Saukville Municipal Water Utility	Lake Michigan Supply Connection	3,870	4,528	-69.6	-76.6
We Energies-Water Services[e]	5,300 lineal feet of 30-inch main (shared with Village of Germantown) in 107th street, 16,100 lineal feet of 20-inch main in Granville Road and Donges Bay Road	3,300	3,861	1,905.0	2,095.5
Town of Fredonia-Waubeka Area Potential Utility	Addition of one shallow aquifer well with 0.10 MG reservoir, 0.25 MG elevated tank	1,460	1,708	24.5	27.0
Land Acquisition for Wells, Storage Tanks and Water Treatment Plant	14 acres	980	1,147	- -	- -
Countywide	Two rainfall infiltration systems	1,199	1,403	13.5	14.9
Subtotal	Two Wells, Five Storage Tanks, One Treatment Plant Upgrade, One New Treatment Plant, One Lake Michigan Supply, Two Rainfall Infiltration Systems	66,755	78,104	2,791.0	3,070.2
Racine County					
City of Burlington Municipal Waterworks	Radium treatment at Well Nos. 9 and 10[g]	3,256	3,810	825.4	907.9
City of Racine Water and Wastewater Utility[h]	No additions	- -	- -	7,921.4	8,713.5
Village of Caledonia West Utility District[i] (Oak Creek)	No additions	- -	- -	167.9	184.7
Village of Caledonia West Utility District[i] (Racine)	No additions	- -	- -	1,316.4	1,448.0
Village of Caledonia East Utility District[j] (Oak Creek)	No additions	- -	- -	600.4	660.4

Table 194 (continued)

County and Utility	New, Expanded, or Upgraded Programs and Facilities Description[a,b]	Capital Cost for New, Expanded, or Upgraded Facilities ($ X 1,000)		Annual Operation and Maintenance Costs ($ X 1,000)	
		2005 Costs	2010 Costs	2005 Costs	2010 Costs
Racine County (continued)					
Village of Caledonia East Utility District[j] (Racine)	No additions	- -	- -	753.4	828.7
Village of Caledonia East Expansion Area	9,000 lineal feet of water transmission main	1,557	1,822	45.5	50.1
Village of Union Grove Municipal Water Utility	Addition of two shallow aquifer wells, 0.40 MG reservoir	1,776	2,078	375.1	412.6
Village of Waterford Water and Sewer Utility	Addition of one shallow aquifer well with 0.40 MG reservoir	1,151	1,347	244.5	269.0
Village of Wind Point Municipal Water Utility	No additions	- -	- -	281.9	310.1
North Cape Sanitary District	Addition of one shallow aquifer well with reservoir	155	181	9.5	10.5
Town of Yorkville Water Utility District 1	Lake Michigan supply connection	459	537	31.1	34.2
Town of Burlington-Bohner Lake Area Planned Utility District	Addition of two shallow aquifer wells, 0.30 MG elevated tank	1,941	2,271	43.2	47.5
Town of Dover-Eagle Lake Area Planned Utility District	Addition of two shallow aquifer wells, 0.30 MG elevated tank	1,941	2,271	48.0	52.8
Town of Norway Area Potential Utility	Addition of four shallow aquifer wells, one with 0.15 MG reservoir, two 0.25 MG elevated tanks	4,024	4,708	115.8	127.4
Village of Rochester Area Potential Utility[k]	Addition of two shallow aquifer wells, two 0.10 MG elevated tanks	1,844	2,158	29.8	32.8
Town of Waterford Area Potential Utility	Addition of three shallow aquifer wells, one with 0.15 MG reservoir, two 0.3 MG elevated tanks	3,485	4,077	117.8	129.6
Land Acquisition for Wells and Storage Tanks	25 acres	1,750	2,048	- -	- -
Countywide	One rainfall infiltration system	495	579	6.0	6.6
Subtotal	17 Wells, 13 Storage Tanks, One Lake Michigan Supply Connection, One Rainfall Infiltration System	23,834	27,886	12,933.1	14,226.4
Walworth County					
City of Delavan Water and Sewerage Commission	Addition of two shallow aquifer wells with iron removal treatment	2,050	2,399	938.1	1,031.9
City of Elkhorn Light and Water	Addition of three shallow aquifer wells, 0.35 MG treated water reservoir	2,342	2,740	1,175.1	1,292.6
City of Lake Geneva Municipal Water Utility	No additions	- -	- -	734.8	808.3
City of Whitewater Municipal Water Utility	No additions	- -	- -	613.7	675.1
Village of Darien Water Works and Sewer System	Increase Well 1 output from 325 to 425 gpm	30	35	207.3	228.0
Village of East Troy Municipal Water Utility	Addition of three shallow aquifer wells, two with 0.10 MG reservoir each[l]	2,199	2,573	334.0	367.4
Village of Fontana Municipal Water Utility	No additions	- -	- -	341.2	375.3
Village of Genoa City Municipal Water Utility	Addition of two shallow aquifer wells and 0.25 MG elevated tank	1,898	2,221	412.9	454.2
Village of Sharon Waterworks and Sewer System	Addition of one shallow aquifer well with 0.30 MG reservoir, 0.20 MG elevated tank	1,512	1,769	163.7	180.1
Village of Walworth Municipal Water and Sewer Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.15 MG reservoir	1,333	1,560	207.9	228.7

Table 194 (continued)

County and Utility	New, Expanded, or Upgraded Programs and Facilities Description[a,b]	Capital Cost for New, Expanded, or Upgraded Facilities ($ X 1,000)		Annual Operation and Maintenance Costs ($ X 1,000)	
		2005 Costs	2010 Costs	2005 Costs	2010 Costs
Walworth County (continued)					
Village of Williams Bay Municipal Water Utility	No additions	- -	- -	514.3	565.7
Town of Bloomfield Pell Lake Sanitary District No. 1	Addition of 0.20 MG elevated tank, one deep aquifer well with radium treatment and with 0.4 MG reservoir	1,891	2,212	335.6	369.2
Town of East Troy Sanitary District No. 3	Addition of one shallow aquifer well	130	152	13.2	14.5
Town of Geneva Lake Como Sanitary District No. 1	Addition of 0.20 MG elevated tank and 0.45 MG reservoir	1,066	1,247	244.7	269.2
Town of Troy Sanitary District No. 1	Addition of one shallow aquifer well with 0.01 MG reservoir	80	94	6.7	7.4
Country Estates Sanitary District	Addition of 0.20 MG elevated tank	480	562	117.0	128.7
Town of Delavan-DLSD Potential Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.30 MG reservoir	1,512	1,769	32.4	35.6
Town of Lyons Area Potential Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.3 MG elevated tank	2,169	2,538	39.7	43.7
Town of East Troy-Potter Lake Area Potential Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.3 MG elevated tank	2,169	2,538	35.2	38.7
Land Acquisition for Wells and Storage Tanks	29 acres	2,030	2,375	- -	- -
Countywide	12 rainfall infiltration systems	6,207	7,262	66.0	72.6
Subtotal	20 Wells, 20 Storage Tanks, 12 Rainfall Infiltration Systems	29,098	34,046	6,533.5	7,186.9
Washington County					
City of Hartford Utilities	Addition of one shallow aquifer well, treatment system, one 0.75 MG elevated tank, and interconnecting piping (these facilities are under construction and expected to be operational during 2009)	7,500	8,100	1,225.8	1,348.4
City of West Bend Water Utility	Addition of one shallow aquifer well	625	731	2,636.0	2,899.6
Village of Germantown Water Utility	Lake Michigan supply connection	8,404	9,833	-407.8	-448.6
Village of Jackson Water Utility	No additions	- -	- -	545.6	600.2
Village of Kewaskum Municipal Water Utility	Addition of 0.25 MG reservoir	351	411	320.8	352.9
Village of Slinger Utilities	Addition of two shallow aquifer wells with 0.20 MG reservoir each	1,824	2,134	300.5	330.6
Allenton Sanitary District No. 1	Addition of 0.20 MG elevated tank, one deep aquifer well with 0.30 MG reservoir	1,672	1,956	149.0	163.9
Village of Newburg Area Potential Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.30 MG elevated tank	2,169	2,538	40.7	44.8
Land Acquisition for Wells and Storage Tanks	10 acres	700	819	- -	- -
Countywide	Five rainfall infiltration systems	2,634	3,082	27.0	29.7
Subtotal	Seven Wells, Eight Storage Tanks, One Lake Michigan Supply Connection, Five Rainfall Infiltration Systems	25,879	29,604	4,837.6	5,321.5

Table 194 (continued)

County and Utility	New, Expanded, or Upgraded Programs and Facilities Description[a,b]	Capital Cost for New, Expanded, or Upgraded Facilities ($ X 1,000)		Annual Operation and Maintenance Costs ($ X 1,000)	
		2005 Costs	2010 Costs	2005 Costs	2010 Costs
Waukesha County					
City of Brookfield Municipal Water Utility (east)	Lake Michigan supply connection	19,682	23,028	-359.8	-395.8
City of Brookfield Municipal Water Utility (west)	No additions	- -	- -	1,075.4	1,182.9
City of Delafield Municipal Water Utility	Addition of five shallow aquifer wells, 0.40 MG elevated tank	4,019	4,702	435.4	478.9
City of Muskego Public Water Utility	Lake Michigan supply connection	12,675	14,830	-710.1	-781.1
City of New Berlin Water Utility (east)	Addition of 0.40 MG reservoir	526	615	1,113.7	1,225.1
City of New Berlin Water Utility (central)	Lake Michigan supply connection[m]	6,685	7,821	-305.6	-336.2
City of Oconomowoc Utilities	No additions	- -	- -	939.1	1,033.0
City of Pewaukee Water and Sewer Utility	Addition of three shallow aquifer wells, one with reservoir, one deep well with radium treatment and reservoir, service pumps, one 0.50 MG elevated tank, and one 0.20 MG elevated tank[n]	5,209	6,095	1,397.4	1,537.1
City of Waukesha Water Utility	Lake Michigan supply connection	60,752 to 88,331	71,080 to 103,347	-1,408.3 to -907.8	-1,549.1 to -998.6
Village of Butler Public Water Utility	Addition of 0.25 MG reservoir	351	411	421.4	463.5
Village of Dousman Water Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.40 MG reservoir	1,631	1,908	200.0	220.0
Village of Eagle Municipal Water Utility	Addition of 0.20 MG elevated tank, one shallow aquifer well with 0.40 MG reservoir	1,631	1,908	127.1	139.8
Village of Hartland Municipal Water Utility	Addition of one shallow aquifer well	625	731	607.4	668.1
Village of Menomonee Falls Water Utility (east)	No additions	- -	- -	2,865.1	3,151.6
Village of Menomonee Falls Water Utility (west)	Addition of 0.20 MG elevated tank, two shallow aquifer wells	1,755	2,053	219.2	241.1
Village of Mukwonago Municipal Water Utility	Addition of three shallow aquifer wells	2,195	2,568	642.1	706.3
Village of Pewaukee Water Utility	Radium treatment facility for Well No. 5[o]	671	785	490.1	539.1
Village of Sussex Public Water Utility	Addition of one shallow aquifer well	625	731	663.7	730.1
Town of Brookfield Sanitary District No. 4	Addition of 0.35 MG reservoir	467	546	512.9	564.2
Village of Big Bend Potential Utility	Addition of two shallow aquifer wells with 0.15 MG reservoir each, 0.5 MG elevated tank	2,584	3,023	76.1	83.7
Village of Elm Grove Potential Utility	Lake Michigan supply connection	2,797	3,272	-466.7	-513.4
Village of Lannon Potential Utility	Addition of two shallow aquifer wells, one with 0.15 MG reservoir, 0.75 MG elevated tank	3,098	3,625	118.7	130.6
Village of North Prairie Utility	Addition of 0.50 MG elevated tank	878	1,027	19.5	21.5
Village of Wales Potential Utility	Addition of two shallow aquifer wells, 0.30 MG elevated tank	1,941	2,271	42.5	46.8
Town of Eagle-Eagle Spring Lake Area Potential Utility	Addition of one shallow aquifer well with 0.15 MG reservoir	853	998	5.4	5.9
Town of Oconomowoc-Okauchee Lake Area Potential Utility	Addition of four shallow aquifer wells, one with 0.15 MG reservoir, two 0.30 MG elevated tanks	4,110	4,809	120.2	132.2

Table 194 (continued)

County and Utility	New, Expanded, or Upgraded Programs and Facilities Description[a,b]	Capital Cost for New, Expanded, or Upgraded Facilities ($ X 1,000)		Annual Operation and Maintenance Costs ($ X 1,000)	
		2005 Costs	2010 Costs	2005 Costs	2010 Costs
Waukesha County (continued)					
Town of Ottawa-Pretty Lake Area Potential Utility	Addition of one shallow aquifer well with 0.10 MG reservoir	787	921	3.2	3.5
Town of Summit-Golden Lake Area Potential Utility	Addition of one shallow aquifer well with 0.10 MG reservoir	787	921	2.2	2.4
Land Acquisition for Wells and Storage Tanks	43 acres	3,010	3,522	- -	- -
Countywide	Two rainfall infiltration systems	938	1,097	7.5	8.3
Subtotal	31 Wells, 26 Storage Tanks, Five Lake Michigan Supply Connections, Two Rainfall Infiltration Systems	141,282 to 168,861	165,298 to 197,565	8,854.8 to 9,355.3	9,740.1 to 10,290.6
Total	100 Wells, 100 Storage Tanks, Eight Lake Michigan Supply Connections, Three Treatment Plant Upgrades, One New Treatment Plant, 31 Rainfall Infiltration Systems	333,805 to 361,384	388,791 to 421,057	101,307.6 to 101,808.1	111,438.4 to 111,988.9

[a] *All utilities' programs include water conservation programs as refined in Appendix K. Water distribution system costs are not included.*

[b] *The operation and maintenance costs are for increased incremental costs associated with new, expanded, or upgraded facilities and for water conservation measures. The estimated annual cost for water conservation is included as an operation and maintenance cost for all utilities.*

[c] *The depth and aquifer of new wells to be developed in the Town of Salem will depend upon more-detailed hydrogeologic elevations. The costs included assume shallow aquifer wells. However, site-specific evaluations may indicate that some wells would be finished in the deep aquifer.*

[d] *Based upon plant expansion program for which construction was under way in 2009. Costs are based upon actual bid prices, plus 15 percent for engineering, legal, and contingencies. The City of Oak Creek Water and Sewer Utility plans to conduct a rerating analysis of its water plant once the ongoing plant expansion is completed late in 2010. The rerating analysis will be designed to demonstrate a plant capacity of 35 mgd, an increase of 7 mgd from the current rating of 28 mgd.*

[e] *The We Energies-Water Services water supply system serving portions of the City of Mequon and Villages of Bayside and Thiensville was acquired by the City of Mequon in 2009. The City of Mequon Water Utility contracts with City Water, LLC, to manage and operate the water supply system serving portions of the City of Mequon and Villages of Bayside and Thiensville.*

[f] *The recommended regional water supply plan includes viable options for the provision of Lake Michigan water supply to the Cedarburg Light and Water Commission and the Grafton Water and Wastewater Commission, which are recommended to be evaluated during implementation. These options include connections to the expanded City of Port Washington Water Utility system or to the Milwaukee Water Works.*

[g] *The City of Burlington radium treatment facilities are included in the recommended plan based upon studies by the City conducted in 2009 and 2010. No treatment was envisioned under the alternative and preliminary recommended plans documented in Chapters VIII and IX.*

[h] *Includes the Village of Sturtevant Water Utility which was purchased by the City of Racine Water and Wastewater Utility in 2007 and is now served by the City Utility on a retail basis.*

[i] *Includes the former Caddy Vista Sanitary District and the former Caledonia Utility District No. 1 which were consolidated in 2006 to form the Caledonia West Utility District*

[j] *Includes the former Crestview Sanitary District and the former North Park Sanitary Districts which were consolidated in 2007 to form the Caledonia East Utility District.*

[k] *Includes the former Town of Rochester and Village of Rochester service areas as delineated in Chapter IV of this report. In December 2008, the Village and Town of Rochester were consolidated as the Village of Rochester.*

[l] *One of the new Village of East Troy wells was in place and operational as of 2008.*

[m] *The City of New Berlin central Lake Michigan supply connection was completed in 2009.*

[n] *Based upon a locally developed plan, the City and Village of Pewaukee Water Utility consolidation study, August 2009, prepared by Ruekert & Mielke, Inc. Three of the four wells are assumed to be shallow wells, and one well is assumed to be a deep well. However, the local plan indicates there may be a need to use deep wells and radium treatment. The well depth will have to be determined on a site-specific basis.*

[o] *Based upon a locally developed plan, the City and Village of Pewaukee Water Utility consolidation study, August 2009, prepared by Ruekert & Mielke, Inc. The facilities needed for the Village of Pewaukee were revised to include radium treatment at Well No. 5, rather than replacement of Well No. 5, as set forth in the earlier chapters of this report.*

Source: Ruekert & Mielke, Inc., and SEWRPC.

Table 195

ABILITY OF THE RECOMMENDED REGIONAL WATER SUPPLY PLAN FOR SOUTHEASTERN WISCONSIN TO ACHIEVE THE AGREED UPON WATER SUPPLY OBJECTIVES AND STANDARDS[a]

Objective			
Number	Description	Standard	Degree to Which Standard is Met
1	Support of existing land use patterns and support and direction of planned land use patterns	Public water supply systems should be designed to serve lands planned to be developed in urban uses, in accordance with the adopted regional land use plan	Met
		Areas of high potential for groundwater contamination should be excluded for the siting of potentially contaminating land uses or facilities	Could be met[b]
		Important groundwater recharge and discharge areas should be identified for preservation or application of land development plans and practices which maintain the natural surface and groundwater hydrology, while protecting the groundwater quality	Largely met
		Sources of water supply should be specifically allocated to adequately serve lands planned to be maintained in agricultural uses	Largely met
		Primary environmental corridors should be preserved in essentially natural, open uses and the extension of urban services, including public water supply services, into such corridors should be avoided, except for corridor-dependent uses, such as recreational facilities and water transmission main, sewage conveyance facilities, and other utility crossings	Met
		Secondary environmental corridors and isolated natural resource areas should be preserved in essentially natural¸ open uses to the extent practicable, as determined in county and local plans	Met
		The most productive soils, those designated by the U.S. Natural Resources Conservation Service as comprising agricultural soil capability Classes I and II, should be preserved for agricultural use, to the extent practicable, recognizing that certain Class I and Class II farmland will have to be converted to urban use in order to accommodate the orderly expansion of urban service areas within the Region, The extension of urban services, including public water supply services, into such areas should be avoided, except as these lands are converted to urban uses	Largely met
		Development of water sources in areas to be preserved for agricultural uses should be carried out in a manner which preserves the agricultural uses of the land as envisioned in the adopted regional land use plan	Met
2	Conservation and wise use of the surface water and groundwater supplies	The use of the deep sandstone aquifer should be managed so that the potentiometric surface in that aquifer is sustained or raised under use and recharge conditions within the Southeastern Wisconsin Region. Declines in the potentiometric surface of the aquifer within the Region due to uses in areas beyond the Region should be identified for purposes of promoting interregional planning and action	Met
		The uses of the shallow aquifer should be managed so that the aquifer yields are sustainable	Largely met
		The uses of the deep and shallow aquifers should be managed so as to minimize the ecological impacts on the surface water system of the Region	Largely met
		Lake Michigan as a source of supply should be utilized recognizing the constraints of the current regulatory framework and the status and provisions of the Great Lakes-St. Lawrence River Water Resources Compact	Met

Table 195 (continued)

Objective		Standard	Degree to Which Standard is Met
Number	Description		
2 (continued)	Conservation and wise use of the surface water and groundwater supplies (continued)	The use of groundwater and surface water for water supply purposes should be carried out in a manner which minimizes adverse impacts to the water resources system, including lakes, streams, springs, and wetlands	Largely met
		Residential per capita water usages should be reduced to the extent practicable based upon the conclusions developed in SEWRPC Technical Report No. 43, *State-of-the-Art of Water Supply Practices,* and recognizing that differences in levels of conservation may be appropriate, depending upon the source of supply and related natural resources	Met
		Both indoor and outdoor water uses should be optimized through conservation practices which do not adversely affect the public health	Largely met
		Water uses for commercial, industrial, and institutional land uses should be reduced to the extent practicable through water conservation measures, duly considering the source of supply and related natural resources, as well as the economic viability and economic development needs of the Region	Could be met[c]
		Unaccounted-for water in utility systems should be minimized	Met
		The type and extent of stormwater management and related land management practices should be determined through preparation of local stormwater management plans and land development practices and policies specifically considering the impact of those activities on groundwater recharge and should promote such practices which maintain or enhance the natural groundwater hydrology to the extent practicable, while protecting surface water and groundwater quality and quantity	Could be met[b]
3	Protection of public health, safety, and welfare	Water supply systems should be designed, constructed, and operated to deliver finished water to users which meets the drinking water standards established by the Wisconsin Department of Natural Resources to protect the public health, safety, and welfare[d]	Met
		Water supply systems should be designed, constructed, and operated consistent with technically sound water supply industry standards directed toward the protection of the public health, safety, and welfare	Met
		The selection of sources of supply and the design, contribution, and operation of related treatment facilities should be made cognizant of the potential presence of unregulated emerging pollutants, such as pharmaceuticals, personal care products, and certain viruses	Could be met[e]
		The reuse of wastewater should be evaluated for applications where there is no potential of direct human consumption and limited potential for direct human contact, unless the pre-use treatment level is such as to preclude risks to public health	Met
		Surface water and groundwater supply treatment plants should be provided with state-of-the-art barriers to substances harmful to human health and safety	Met
		Water supply sources and treatment processes should be selected to minimize potential problems with subsequent treatment and disposal of created waste streams	Largely met
		Groundwater and surface water sources of supply should be protected from sources of contamination by appropriate siting, design, and land use regulation	Met

Table 195 (continued)

Objective		Standard	Degree to Which Standard is Met
Number	Description		
3 (continued)	Protection of public health, safety, and welfare (continued)	The level of treatment and design provided at public sewage treatment plants and industrial wastewater discharge locations should be determined directly related to the achievement of adopted water use objectives and supporting surface water and groundwater standards[f]	Met
		The density, design, operation, and level of treatment of onsite sewage disposal systems should be related to the achievement of the groundwater quality standards and the safety and public health requirements of any potentially affected water supplies	Could be met[g]
		The type and extent of stormwater management or associative preventive land management practices to be applied in both urban and rural areas should be determined by State and local regulations, local stormwater management plans, county land and water management plans, and farm management plans directly related to protection of potentially affected water supplies and to the established water quality standards for the receiving surface water and groundwater systems	Could be met[b]
		There should be no known wastewater or stormwater discharges to the surface water or groundwater systems used for water supply of inorganic compounds, synthetic compounds, volatile organics, or other substances in quantities known to be bioaccumulative, acutely or chronically toxic or hazardous to human health, fish or other aquatic life, wildlife, and domestic animals	Largely met
4	Economical and efficient systems	The sum of water supply system operating and capital investment costs should be minimized. Costs for waste disposal byproducts of water treatment, long-term energy and operation and maintenance, and legal costs should be considered	Met
		Maximum feasible use should be made of all existing and committed water supply facilities, which should be supplemented with additional facilities only as necessary to serve the anticipated water supply needs	Largely met
		The use of new or improved technologies and management practices should be allowed and encouraged if such technologies and practices offer economies in construction costs or by their superior performance lead to the achievement of water supply objectives at a lesser cost	Could be met[b]
		Water supply facilities should by designed for staged or incremental construction where feasible and economical so as to limit total investment in such facilities and to permit maximum flexibility to accommodate changes in the rate of population growth and the rate of economic activity growth or changes in the technology for water supply management	Could be met[b]
5	Responsive and adaptive plans	The recommended regional water supply plan components should be adaptable to change in scope, capacity, and effectiveness to the extent practicable	Met
		The recommended water supply plan should be designed to incorporate redundancy, system backup features, and emergency operation requirements to the extent practicable in order to insure a safe delivery of water	Largely met
		The regional water supply plan components should be designed for staged incremental construction to the extent practicable, so as to permit maximum flexibility to accommodate unanticipated changes in future conditions	Largely met

Table 195 (continued)

Objective		Standard	Degree to Which Standard is Met
Number	Description		
5 (continued)	Responsive and adaptive plans (continued)	The regional water supply plan should be adaptable to changes in the regulatory structure, including the 2001 Great Lakes-St. Lawrence River Basin Water Resources Compact and the State of Wisconsin 2003 Act 310	Met

[a]*Planning objectives, principles, and standards are presented and discussed in Chapter V of this report.*

[b]*This standard could only be met through agency or local community action.*

[c]*This standard could only be met through private sector action.*

[d]*Drinking water standards are set forth in Chapter V and Appendix I of this report.*

[e]*Additional research on the issue of emerging pollutants will be required in order to meet this standard.*

[f]*Water use objectives and supporting water quality standards and criteria are set forth in Appendices I and J of this report.*

[g]*Action by agencies or local communities regarding the operation and maintenance of these systems may be required in order to meet this standard.*

Source: SEWRPC.

Most standards would be met, or are largely met under the recommended regional water supply plan, as indicated in Table 195. The remaining standards could be met under the recommended plan, but their achievement would require that actions be taken by State agencies, local communities, or the private sector. The recommended regional water supply plan represents a means of providing a sustainable water supply for the Southeastern Wisconsin Region through the plan design year of 2035. The plan is specifically designed to be consistent with the Great Lakes-St. Lawrence River Basin Water Resources Compact and with the groundwater protection provisions of Chapter 281.34 of the *Wisconsin Statutes.* Although it is recognized that additional planning, engineering, legal, and environmental analyses are needed to meet the requirements of the Compact when a diversion of Lake Michigan water is involved in a plan implementation action, the conduct of the analyses is recommended as an integral part of the second-level planning and preliminary engineering and the associated WDNR environmental analysis procedures.

Chapter XI

PLAN IMPLEMENTATION

INTRODUCTION

The recommended regional water supply plan for southeastern Wisconsin, as described in Chapter X of this report, provides a design for the abatement of existing and probable future water supply problems and for the attainment of sustainable sources of water supply within the seven-county planning area. The recommended regional water supply plan addresses six areas of concern: 1) sources of supply; 2) water conservation; 3) protection of groundwater recharge areas; 4) stormwater management; 5) siting of high-capacity wells; and 6) rainfall infiltration. The recommended regional water supply plan is designed to attain, to the extent practicable, the agreed upon water supply objectives and supporting standards set forth in Chapter V of this report.

The recommended regional water supply plan, however, is not complete until the steps required to implement the plan—that is, to convert the plan into action policies and programs—are specified. This chapter identifies those steps, and is intended as a guide for use in the implementation of the plan. The chapter outlines the actions that need to be taken by the various levels and agencies of government in concert with private sector organizations if the recommended plan is to be fully carried out by the design year. Those units and agencies of government which have applicable plan adoption and endorsement and plan implementation powers are identified; desirable plan adoption and endorsement actions are specified; and specific implementation actions are recommended to each of the units and agencies of government and private sector organizations with responsibility for the actions concerned. In addition, financial and technical assistance programs available to help implement the plan are identified.

While this chapter focuses on the role of the various units and agencies of government concerned, it should be recognized that implementation of the regional water supply plan depends as well upon the cooperation of private-sector interests. These private sector interests range from developers, builders, and engineering and design consultants—who have a major influence on water supply system development in the Region—to private natural resource conservancy groups that play an important role in the protection and management of environmentally significant open spaces, including groundwater recharge areas.

PRINCIPLES OF PLAN IMPLEMENTATION

The plan implementation recommendations contained in this chapter are, to the maximum extent possible, based upon and related to current government programs and private sector initiatives, and are predicated upon existing enabling legislation. Because of the possibility of unforeseen changes in economic conditions, State and Federal legislation, case law decisions, governmental organization, and public-sector tax and fiscal policies, it is not possible to define precisely how a process as complex as implementation of a regional water supply plan should be accomplished. In the continuing regional planning program for southeastern Wisconsin, it will, therefore, be necessary to periodically update not only the water supply plan itself and the data and forecasts on which the plan is based, but the recommendations for plan implementation. In addition to consideration of possibly unforeseen changes in economic conditions, such updates should consider changes in county and municipal land use plans, water utility and sanitary sewer service area plans, changes in hydrologic and hydraulic conditions within the Region, changes in statutory and case law, and in the powers and responsibilities of State, county, and local governmental agencies.

Principal Means of Plan Implementation

There are three principal ways through which implementation of the recommended regional water supply plan may be achieved: 1) the collection, analysis, and dissemination of basic planning and engineering data; 2) second-level local water supply facility planning and preliminary engineering; and 3) Federal, State, county, and local planning and regulatory actions. These require a receptive attitude and active planning and plan implementation programs at the local, county, State, and Federal levels of government and coordination and cooperation between public and private sector organizations with vested interests in successfully implementing the plan recommendations.

A great deal can be achieved in guiding water supply development into a more desirable pattern through the simple task of collecting, analyzing, and disseminating basic planning and engineering data on a continuing, uniform, areawide basis. Experience within the Southeastern Wisconsin Region has shown that, if this important inventory function is properly carried out, the resulting information will be used and acted upon both by local, State, and Federal agencies of government and by private investors. A wealth of definitive information on the planning area, including on the existing and proposed land use patterns; existing and proposed water supply facilities; on the natural resource base; on the hydrology and hydrogeology; and on surface and groundwater quantity and quality conditions was assembled under the regional water supply planning effort. In addition, a regional aquifer simulation model was developed, calibrated, and utilized in the water supply planning effort. This model was developed with a telescoping feature that allows for the finer-scaled simulation of aquifer performance for use in subregional and local planning efforts. The use of this information base in arriving at development decisions on a day-to-day basis by the public and private interests concerned can contribute substantially toward implementation of the recommended regional water supply plan.

With respect to second-level local water supply facility planning and preliminary engineering, it is essential that some of the regional plan proposals be carried into greater depth and detail for sound plan implementation. Some of the regional plan elements must be carried through further facility planning and preliminary engineering to the final design stages. For all municipal water utilities concerned, such further planning and engineering may be required for: the preparation of water supply service area plans consistent with developing Wisconsin Department of Natural Resources (WDNR) regulations; completion of preliminary and final design for the maintenance and expansion of water supply and treatment, storage, and transmission and distribution facilities; the formulation of water conservation programs, consistent with the levels recommended in the regional plan reflecting the type and sustainability of the source of supply and the probable future water supply infrastructure requirements, as well as consistency with developing WDNR regulations; and the evaluation of opportunities for cooperative development of water supply facilities and systems.

For those municipal water utilities for which the plan recommends the continued utilization of groundwater as a source of water supply, such further planning and engineering may be required for: the siting and construction of needed additional wells, utilizing the recommended high-capacity well siting, monitoring, and impact mitigation procedure recommended in the regional plan; the design, siting, and construction of any measures required to mitigate the potential impacts of new high-capacity wells constructed in the shallow aquifer that may be indicated in the findings of the high-capacity well siting, monitoring and impact mitigation procedure; and the design, siting, and construction of enhanced groundwater recharge facilities.

Additional regional plan elements that must be carried through preliminary engineering to the final design stages include the design, siting, and construction of transmission mains and associated pumping stations and storage facilities to support the recommended conversion from a groundwater source of water supply to a Lake Michigan source of water supply; facility planning, preliminary engineering and final design for those existing Lake Michigan water treatment plants recommended for expansion or upgrading; and facility planning, preliminary engineering and final design for the new Lake Michigan water treatment plant recommended to serve the City of Cedarburg and the Village of Grafton, or for use of an existing Lake Michigan plant; delineation, refinement, and detailing of water supply service areas for municipal water utilities, as needed. Additional planning and engineering and related legal and administrative studies will also be required for the creation of recommended new municipal water utilities as dictated by demonstrated local needs and initiatives. Further studies will be required to evaluate the available viable options and the selection of an option for providing the Village of Elm Grove and the eastern portion of the City of Brookfield with a Lake Michigan water supply. Importantly, further studies and in-depth environmental assessments will be needed to identify the most appropriate return flow option attendant to the provision of Lake Michigan water to the City of Waukesha. The studies and assessments should include analysis of the potential effects of the return flow options meeting WDNR environmental impact statement requirements.

The proper conduct of the further, more-detailed, planning and engineering will require the development of close working relationships between the Regional Planning Commission staff; the municipal water utilities and local units of government concerned; and the regulatory agencies concerned, in particular, the WDNR and the Public Service Commission of Wisconsin (PSC).

To achieve a high degree of plan implementation, it will be important for the implementing agencies to utilize the Regional Planning Commission as a center for the coordination of local, areawide, State, and Federal planning and plan implementation activities within the planning area. It will be particularly important for regulatory agencies, such as the WDNR and the Wisconsin Public Service Commission, to utilize the Commission and the adopted regional water supply planning in this way as the WDNR now does with respect to sanitary sewage system development. Regulatory actions, as well as further more-detailed local facility planning and engineering should be conducted in accordance with the adopted regional plan. In this respect, it should be noted that county, city, village, and town comprehensive plans prepared for cities, towns, and villages in accordance with Sections 62.23 and 66.1001 and; for villages, in accordance with Sections 61.35, 62.23, and 66.1001; and for counties in accordance with Sections 59.69 and 66.1001 of the *Wisconsin Statutes* must contain a utilities and community facilities element which should include a water supply component. That component should be consistent with the regional water supply plan adopted under the provision of Section 66.0309 of the *Wisconsin Statutes*.

Public Works Development Process

The planning process used to prepare the regional water supply plan for the Southeastern Wisconsin Region constituted the first, or systems planning, phase of what may be regarded as a three-phase public works development process. Second-level facilities planning and preliminary engineering constitute the second phase in this sequential process; with final design and construction being the third and last phase. Because effective implementation of the water supply plan requires an understanding of this three-phase process, that process is briefly described below. Although emphasis is placed on use of the process in preparing and implementing the regional water supply plan, it is important to note that the three-phase process is applicable to any regional or subregional plan containing recommendations for the development of public works for water supply, flood control, pollution abatement, sanitary sewerage, transportation, park and open space, or other public facilities and services.

Systems Planning

The systems planning phase concentrates on the definition of the problems to be addressed and on the development and evaluation of alternative measures for resolution of these problems on an areawide basis. Systems planning is intended to permit the selection, from among the alternative measures considered, of the most cost-effective measure to resolve the identified problems in accordance with agreed upon objectives and supporting standards. In this first, or systems-level planning phase, each alternative plan element is developed to sufficient detail to permit a sound, consistent comparison of the technical, economic, and environmental characteristics of the alternatives considered.

Properly conducted, systems planning is comprehensive in three ways. First, it is comprehensive in that it takes into consideration the entire system concerned and attendant rational planning area. In this respect, water supply problems should be approached on a regional basis because the sources of supply are shared among the communities of the Region. Human use of the land and of the sources of supply, and changes in such uses in one portion of the Region can markedly influence land use and supply source conditions in other areas of the Region.

Second, properly conducted systems planning is comprehensive in that it considers not only the immediate problems concerned, but the relationship of those problems to broader socioeconomic and environmental considerations. For example, regional water supply planning must recognize that the quantity and quality of groundwater in the aquifers underlying the Region and the demand for water are determined, in part, by existing and planned land use in the Region and that land use is, in turn, determined by socioeconomic conditions within, as well as outside, the Region. The regional water supply plan was based upon the regional land use plan so as to reflect regional socioeconomic and environmental conditions likely to influence the cause of, and solution to, water supply problems within the Region. At the very beginning of the water supply planning effort it was indicated that, should that planning effort identify any water resource constraints on the development patterns envisioned in the adopted regional land use plan, the Commission would initiate a process to amend the land use plan in an appropriate manner. However, it has become clear as the planning effort progressed, that water supply is not a limiting factor on land use development within this Region with respect to the location of urban development either east or west of the subcontinental divide, based upon plan recommendations, including water conservation program practices.

Third, properly conducted systems planning is comprehensive in that a full spectrum of potential solutions to the water supply and water supply-related problems are considered. Because of the many measures, variations on measures, and combinations of measures that are available to address water supply and water supply-related problems, there are an almost unlimited number of solutions to a given problem that, in effect, form a continuum of possible solutions. The key to efficient systems planning is in not examining each of the many possible alternative measures, but rather examining alternatives that define the boundaries of the continuum and that are truly representative of the full range of available measures within the continuum.

Second-Level Facilities Planning and Preliminary Engineering

Although systems planning requires considerable effort, it is not normally carried to the level of detail needed to permit implementation of the recommended measures. In general, it is essential that the analysis of the technical, economic, environmental, and other features of the plan elements be carried into greater detail as the first step toward implementation of the system plan. This second phase of the three-phase public works development process is referred to as second-level facility planning or preliminary engineering. Such second-level planning is most properly carried out subsequent to the adoption of the systems plan, by the implementing units and agencies of government and private-sector organizations concerned. The water supply service area planning for water utilities set forth under 2007 Wisconsin Act 227, and implementing regulations being developed by the WDNR is an example of second-level planning.

The second-level facilities planning and preliminary engineering phase begins where the systems planning phase ends, and the analysis is no longer comprehensive. Under this phase, emphasis is placed on function, and concentration is on the basic solution to the problem at hand as that problem and its solution have been identified in the systems planning phase. This phase of the three-phase public works development process presumes that the optimum solution in terms of technical practicality, economic feasibility, environmental consequences, and other considerations has been identified under the previous systems planning phase.

Depending on the nature of the systems plan recommendation that is under consideration for implementation, the next step in further developing the characteristics of that component could be either second-level facility planning or preliminary engineering. Those two procedures have many similar characteristics and both concentrate on examining variations of the recommended solution in order to determine the best way to implement a specific system plan recommendation. The main distinguishing feature is that second-level facility planning is generally applied to a system that functions at a larger geographic scale, such as a subwatershed, while preliminary engineering focuses on a specific function or facility. Second-level planning is applied to examine how to meet a broader objective recommended under a systems plan. It may involve consideration of more-targeted alternatives developed within the framework of an overall systems plan recommendation. Preliminary engineering concentrates on examining variations of a recommended solution in depth in order to determine the best way to carry out a more-specific solution recommended under a systems plan.

Examples of second-level planning include the preparation of water supply system facilities plans or water supply service area plans for the purpose of expanding or upgrading a utility water supply system and local planning evaluation to consider consolidation or sharing of water supply system facilities.

Final Design and Construction

Upon acceptance of the findings and recommendations of the second-level facilities planning or preliminary engineering phase by the governmental units and agencies concerned, the third or final design phase of the public works development process is initiated. This work should also be carried out by the implementing units and agencies of government concerned. Starting with the solution to the problem at hand as set forth in the final, approved version of the facilities plan or preliminary engineering report, the final design phase should move toward the development of the detailed construction plans and specifications needed to completely implement the recommended solution. In the case of a public works project involving construction, the plans and specifications should provide sufficient detail to permit potential contractors to submit bids for the project and to actually construct the recommended works. Engineers responsible for carrying out the final phase should also have responsibility for securing the necessary permits and other approvals from regulatory and review agencies, for providing supervisory and inspection services during the actual construction process, and for certifying to the governmental units and agencies involved that the construction is carried out in accordance with the design provisions and specifications.

Other Considerations

For many reasons, the three-phase public works development process does not always proceed sequentially in the three-step fashion described above. In some situations, an iterative process is set in motion whereby a reexamination of an earlier step is required. For example during the preliminary engineering phase, a new alternative, based on additional information, may be developed that must be subjected to systems analysis. Similarly, issues emerging out of contract negotiations or modifications may require reexamination of an earlier phase of the public works development process.

Ever-changing Federal and State regulations and guidelines can require modification to the three-phase public works development process. This is particularly true if a significant change in those regulations and guidelines occurs subsequent to the systems planning phase and prior to or during the preliminary engineering phase, thus necessitating an iteration to the systems planning phase to reconsider measures studied during that phase or to analyze additional measures as may be necessitated by regulation and guideline changes. As a result of the passage of time between the systems planning phase and the second-level facilities planning or preliminary engineering phase, significant changes may occur in the explicitly stated or implicitly expressed values and objectives of elected officials and concerned citizens. In an environment of changing values and objectives, a solution to an environmental problem that was originally accepted as optimal, based on systems planning techniques and an agreed upon set of objectives, could later, because of changing public values, be rejected or encounter considerable opposition, necessitating an iteration to the systems planning phase.

The effective functioning of the three-phase public works development process is highly dependent on close cooperation among governmental units and agencies concerned. Most importantly, the systems level planning must be acceptable to local governmental units and agencies concerned in order to make full use of the recommendations resulting from that phase of the public works development process.

In carrying out the three-phase public works development process, there is a tendency to circumvent a critical step, usually the systems planning phase, in response to intense public concern and controversy over a pressing environmental or developmental problem. This approach sometimes achieves short-term gains in that it leads to prompt problem solving activity. Unfortunately, circumvention of key steps in the public works development process often leads to long-term losses as a result of the failure to fully identify and quantify the problem at hand and to determine the most effective solution to that problem in terms of technical practicality, economic feasibility, and environmental impact.

PLAN IMPLEMENTATION ORGANIZATIONS

Although the Regional Planning Commission can promote and encourage water supply plan implementation in various ways, the advisory role of the Commission makes actual implementation of the recommended regional water supply plan dependent upon action by local, areawide, State, and Federal agencies of government and private organizations with an interest in the management and protection of sources of water supply in the Region. Examination of existing enabling legislation reveals an array of departments, commissions, committees, boards, and districts at all levels of government available to assist in implementing the adopted regional water supply plan. These agencies include general-purpose local units of government, such as counties, cities, villages, towns, municipal utilities, and town utility districts. These agencies also include State regulatory bodies, such as the WDNR and the PSC; and Federal agencies that provide financial and technical assistance for plan implementation, such as the U.S. Environmental Protection Agency (USEPA), and the U.S. Department of Agriculture, Rural Utilities Service (USDA-RUS).

Because of the many and varied public agencies in existence, it becomes important to identify those agencies having the legal authority and financial capability to most effectively implement the recommended water supply plan elements. Accordingly, those agencies whose actions will have a significant effect, either directly or indirectly, upon the successful implementation of the recommended plan and whose full cooperation in plan implementation will be essential are listed and their potential role in plan implementation described. The agencies are, for convenience, listed by level of government. It is recognized, however, that interdependence between the various levels, as well as between the various agencies of government exist with respect to potential plan implementation actions. A need, therefore, exists for close intergovernmental cooperation in the implementation of the regional water supply plan recommendations.

Continuing Commission Advisory Committee Structure

Since planning at its best is a continuing function, a public body should remain to coordinate and advise on the execution of the adopted regional water supply plan, and to undertake plan updating and renovation as may be necessitated by changing events. Although the Regional Planning 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 and representatives of appropriate public and private organizations, through an appropriate advisory committee structure.

An advisory committee on regional water supply planning was convened by the Regional Planning Commission in September 2005, pursuant to Section 66.0309(8) of the *Wisconsin Statutes* to facilitate preparation of the regional water supply plan. This Committee guided preparation of the plan, including the companion technical reports on state-of-the-art water supply practices, water law, groundwater budget indicators, groundwater recharge, and shallow groundwater sustainability.[1] The Committee members included representatives from local

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[1]*SEWRPC Technical Report No. 43,* State-of-the-Art of Water Supply Practices, *July 2007; SEWRPC Technical Report No. 44,* Water Supply Law, *April 2007; SEWRPC Technical Report No. 46,* Groundwater Budget Indices and Their Use in Assessing Water Supply Plans for Southeastern Wisconsin, *February 2010; SEWRPC Technical Report No. 47,* Groundwater Recharge in Southeastern Wisconsin Estimated By a GIS-Based Water-Balance Model, *July 2008; SEWRPC Technical Report No. 48,* Shallow Groundwater Quantity Sustainability Analysis Demonstration for the Southeastern Wisconsin Region, *November 2009.*

water utilities; County planning, administrative, and public works staffs; County land conservation staffs; the U.S. Geological Survey (USGS); the Wisconsin Geological and Natural History Survey (WGNHS); the WDNR; environmental organizations; private industry; and academia. It is recommended that this Committee be reconstituted as a continuing advisory committee to provide a focus for the coordination of actions by units and agencies of government at all levels, and of appropriate private organizations, in the implementation of the plan, and to guide any plan revisions that may be needed over time. It is recommended that all government agency and private-sector and organization representatives currently serving on the Committee remain as members of the continuing Committee. It is further recommended that the membership of the Committee remain open so that additional members could be added to the Committee as may be deemed appropriate by the Regional Planning Commission. In this regard, consideration will be given by the Commission to the recommendations in the socioeconomic analysis of the regional water supply plan[2] relating to representation by environmental justice communities.

Local-Level Agencies

Statutory provisions exist for the creation at the County and municipal level of the following agencies having planning and plan implementation powers, including police powers, powers of eminent domain, and powers of taxation and appropriation, important to water supply plan implementation.

Municipal Water Utilities

In the Region, most water systems that provide water to the public are owned and operated by municipalities. Municipalities have the authority to own and operate water systems pursuant to Section 66.0803 of the *Wisconsin Statutes*. This includes authority to plan, design, construct, purchase or acquire, lease, operate, and maintain the plants and equipment necessary to operate such systems. Clearly the municipal water utilities within the Region will have the primary responsibility for implementation of the most important elements of the recommended plan. Water utilities in the Region are typically operated as self-supporting municipal enterprise funds. In 2010, there were 79 municipal water utilities within the Region. These are listed in Table 196.

Municipal Utility and Sanitary Districts with Water Supply Responsibilities

Municipal utility districts may be created by cities, villages, and towns pursuant to Section 66.0827 of the *Wisconsin Statutes*. Town sanitary districts may be created pursuant to Sections 60.71 and 60.72 of the *Wisconsin Statutes*. Such special districts are authorized to plan, design, construct, operate, and maintain various public utility systems, including sanitary sewerage, water supply, and stormwater management systems. In 2010, there were within the Southeastern Wisconsin Region the following active sanitary or utility districts with water supply responsibilities: the Allenton Sanitary District No. 1 in the Town of Addison, Washington County; the Town of Bristol Utility District No. 1 and the Town of Bristol Utility District No. 3, in Kenosha County; the Brookfield Sanitary District No. 4 in the Town of Brookfield, Waukesha County; the Caledonia East Utility District and the Caledonia West Utility District in the Village of Caledonia,[3] the North Cape Sanitary District in the Towns of Norway and Raymond, Town of Yorkville Utility District No. 1, in Racine County; and the Country Estates Sanitary District in the Town of Lyons, the Town of East Troy Sanitary District No. 3, the Lake Como Sanitary District No. 1 in the Town of Geneva, the Pell Lake Sanitary District No. 1 in the Town of Bloomfield, and the Troy Sanitary District No. 1 in the Town of Troy, all in Walworth County.

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[2]*University of Wisconsin-Milwaukee Center for Economic Development,* A Socio-Economic Impact Analysis of the Regional Water Supply Plan for Southeastern Wisconsin, *July 2010.*

[3]*Following incorporation of the Town of Caledonia as the Village of Caledonia, the former Caddy Vista Sanitary District and Caledonia Utility District No. 1 were combined into the Caledonia West Utility District and the former Crestview Sanitary District and the former North Park Sanitary District were combined into the Caledonia East Utility District.*

Table 196

RECOMMENDED LOCAL WATER UTILITY PLAN IMPLEMENTATION ACTIONS RELATING TO SOURCES OF SUPPLY

County and Utility	Upgrade and Maintain Existing Source of Supply as Needed	Increase Reliance upon Shallow Aquifer and Decrease Reliance upon Deep Aquifer over Time	Increase Reliance upon Shallow Aquifer and Treatment of Deep Aquifer Water	Conversion from Groundwater to Lake Michigan Source of Water Supply	Provide Return Flow to Lake Michigan	Maintain, Upgrade, and Expand Distribution System as Needed
Kenosha County						
City of Kenosha Water Utility	X	- -	- -	- -	- -	X
Village of Paddock Lake Municipal Water Utility	X	- -	- -	- -	- -	X
Village of Pleasant Prairie Water Utility	X	- -	- -	- -	- -	X
Town of Bristol Utility District No. 1[a]	- -	X	- -	- -	- -	X
Town of Bristol Utility District No. 3	X	- -	- -	- -	- -	X
Town of Somers Water Utility	X	- -	- -	- -	- -	X
Milwaukee County						
Milwaukee County	- -	- -	- -	- -[b]	- -	- -
Milwaukee Metropolitan Sewerage District	- -	- -	- -	- -[b]	- -	- -
City of Cudahy Water Utility	X	- -	- -	- -	- -	X
City of Franklin Water Utility	X	- -	- -	- -	- -	X
City of Glendale Water Utility	X	- -	- -	- -	- -	X
City of Milwaukee Water Works	X	- -	- -	- -	- -	X
City of Oak Creek Water and Sewer Utility	X	- -	- -	- -	- -	X
City of South Milwaukee Water Utility	X	- -	- -	- -	- -	X
City of Wauwatosa Water Utility	X	- -	- -	- -	- -	X
City of West Allis Water Utility	X	- -	- -	- -	- -	X
Village of Brown Deer Public Water Utility	X	- -	- -	- -	- -	X
Village of Fox Point Water Utility	X	- -	- -	- -	- -	X
Village of Greendale Water Utility	X	- -	- -	- -	- -	X
Village of Shorewood Municipal Water Utility	X	- -	- -	- -	- -	X
Village of Whitefish Bay Water Utility	X	- -	- -	- -	- -	X
We Energies-Water Services	X	- -	- -	- -	- -	X
Municipalities within Which Are Streams with Potential Return Flow Impacts	- -	- -	- -	- -[b]	- -	- -
Ozaukee County						
City of Cedarburg Light and Water Commission/Village of Grafton Water and Wastewater Commission	- -	- -	- -	X	- -[c]	X
City of Port Washington Water Utility	X	- -	- -	- -	- -	X
Village of Belgium Municipal Water Utility	X	- -	- -	- -	- -	X
Village of Fredonia Municipal Water Utility	X	- -	- -	- -	- -	X
Village of Saukville Municipal Water Utility	- -	- -	- -	X	- -[c]	X
We Energies-Water Services	X	- -	- -	- -	- -	X
Racine County						
Racine County	- -	- -	- -	- -[b]	- -	- -
City of Burlington Municipal Waterworks	X	- -	- -	- -	- -	X
City of Racine Water and Wastewater Utility[d]	X	- -	- -	- -	- -	X

Table 196 (continued)

County and Utility	Upgrade and Maintain Existing Source of Supply as Needed	Increase Reliance upon Shallow Aquifer and Decrease Reliance upon Deep Aquifer over Time	Increase Reliance upon Shallow Aquifer and Treatment of Deep Aquifer Water	Conversion from Groundwater to Lake Michigan Source of Water Supply	Provide Return Flow to Lake Michigan	Maintain, Upgrade, and Expand Distribution System as Needed
Racine County (continued)						
Village of Caledonia West Utility District[e] (Oak Creek)	X	- -	- -	- -	- -	X
Village of Caledonia West Utility District[e] (Racine)	X	- -	- -	- -	- -	X
Village of Caledonia East Utility District[f] (Oak Creek)	X	- -	- -	- -	- -	X
Village of Caledonia East Utility District[f] (Racine)	X	- -	- -	- -	- -	X
Village of Union Grove Municipal Water Utility	- -	X	- -	- -	- -	X
Village of Waterford Water and Sewer Utility	X	- -	- -	- -	- -	X
Village of Wind Point Municipal Water Utility	X	- -	- -	- -	- -	X
North Cape Sanitary District	X	- -	- -	- -	- -	X
Town of Yorkville Water Utility District 1	- -	- -	- -	X	- -[g]	X
Municipalities within Which Are Streams with Potential Return Flow Impacts	- -	- -	- -	- -[b]	- -	- -
Walworth County						
City of Delavan Water and Sewerage Commission	- -	X	- -	- -	- -	X
City of Elkhorn Light and Water	- -	X	- -	- -	- -	X
City of Lake Geneva Municipal Water Utility	X	- -	- -	- -	- -	X
City of Whitewater Municipal Water Utility	X	- -	- -	- -	- -	X
Village of Darien Water Works and Sewer System	X	- -	- -	- -	- -	X
Village of East Troy Municipal Water Utility	X	- -	- -	- -	- -	X
Village of Fontana Municipal Water Utility	X	- -	- -	- -	- -	X
Village of Genoa City Municipal Water Utility	X	- -	- -	- -	- -	X
Village of Sharon Waterworks and Sewer System	X	- -	- -	- -	- -	X
Village of Walworth Municipal Water and Sewer Utility	X	- -	- -	- -	- -	X
Village of Williams Bay Municipal Water Utility	X	- -	- -	- -	- -	X
Town of Bloomfield Pell Lake Sanitary District No. 1	X	- -	- -	- -	- -	X
Town of East Troy Sanitary District No. 3	X	- -	- -	- -	- -	X
Town of Geneva Lake Como Sanitary District No. 1	X	- -	- -	- -	- -	X
Town of Troy Sanitary District No. 1	X	- -	- -	- -	- -	X
Country Estates Sanitary District	X	- -	- -	- -	- -	X
Washington County						
City of Hartford Utilities	- -	X[h]	- -	- -	- -	X
City of West Bend Water Utility	X	- -	- -	- -	- -	X
Village of Germantown Water Utility	- -	- -	- -	X	- -[i]	X
Village of Jackson Water Utility	X	- -	- -	- -	- -	X
Village of Kewaskum Municipal Water Utility	X	- -	- -	- -	- -	X
Village of Slinger Utilities	X	- -	- -	- -	- -	X
Allenton Sanitary District No. 1	X	- -	- -	- -	- -	X
Waukesha County						
Waukesha County	- -	- -	- -	- -[b]	- -	- -
City of Brookfield Municipal Water Utility (east)	- -	- -	- -	X	- -[i]	X
City of Brookfield Municipal Water Utility (west)	- -	- -	X	- -	- -	X
City of Delafield Municipal Water Utility	X	- -	- -	- -	- -	X

Table 196 (continued)

County and Utility	Upgrade and Maintain Existing Source of Supply as Needed	Increase Reliance upon Shallow Aquifer and Decrease Reliance upon Deep Aquifer over Time	Increase Reliance upon Shallow Aquifer and Treatment of Deep Aquifer Water	Conversion from Groundwater to Lake Michigan Source of Water Supply	Provide Return Flow to Lake Michigan	Maintain, Upgrade, and Expand Distribution System as Needed
Waukesha County (continued)						
City of Muskego Public Water Utility	- -	- -	- -	X	- -[i]	X
City of New Berlin Water Utility (east)	X	- -	- -	- -	- -	X
City of New Berlin Water Utility (central)	- -	- -	- -	X	- -[i]	X
City of Oconomowoc Utilities	X	- -	- -	- -	- -	X
City of Pewaukee Water and Sewer Utility	- -	- -	X	- -	- -	X
City of Waukesha Water Utility	- -	- -	- -	X[b]	X	X
Village of Butler Public Water Utility	X	- -	- -	- -	- -	X
Village of Dousman Water Utility	X	- -	- -	- -	- -	X
Village of Eagle Municipal Water Utility	X	- -	- -	- -	- -	X
Village of Hartland Municipal Water Utility	X	- -	- -	- -	- -	X
Village of Menomonee Falls Water Utility (east)	X	- -	- -	- -	- -	X
Village of Menomonee Falls Water Utility (west)	X	- -	- -	- -	- -	X
Village of Mukwonago Municipal Water Utility	X	- -	- -	- -	- -	X
Village of Pewaukee Water Utility	- -	- -	X	- -	- -	X
Village of Sussex Public Water Utility	- -	- -	X	- -	- -	X
Town of Brookfield Sanitary District No. 4	X	- -	- -	- -	- -	X
Municipalities within Which Are Streams with Potential Return Flow Impacts	- -	- -	- -	- -[b]	- -	- -

[a] *On December 1, 2009, a portion of the Town of Bristol containing the Town of Bristol Utility District No. 1 incorporated as the Village of Bristol. The District is now the Village of Bristol Utility District No. 1.*

[b] *Plan endorsement and participation on City of Waukesha Water Utility return flow oversight committee if stream within jurisdiction is to be impacted by a return flow option developed and approved under the subsequent plan implementation steps.*

[c] *Return flow to Lake Michigan for the City of Cedarburg and the Villages of Grafton and Saukville is currently in place though public wastewater treatment plants that discharge into the mainstem or tributaries of the Milwaukee River.*

[d] *Includes the Village of Sturtevant Water Utility which was purchased by the City of Racine Water and Wastewater Utility in 2007 and is now served by the City Utility on a retail basis.*

[e] *Includes the former Caddy Vista Sanitary District and the former Caledonia Utility District No. 1 which were consolidated in 2006 to form the Caledonia West Utility District.*

[f] *Includes the former Crestview Sanitary District and the former North Park Sanitary District which were consolidated in 2007 to form the Caledonia East Utility District.*

[g] *Return flow to Lake Michigan for the Town of Yorkville Utility District No. 1 is currently in place through a public wastewater treatment plant that discharges into a tributary of the Root River.*

[h] *As of June 2009, the City of Hartford completed development of a new sand and gravel aquifer well. In addition, the City initiated construction of a new 750,000 gallon elevated storage reservoir. These improvements implement the conversion to the shallow aquifer and the City will no longer rely on the deep aquifer as a source of supply.*

[i] *Return flow to Lake Michigan for the eastern portion of the City of Brookfield, the central portion of the City of New Berlin, the City of Muskego, and the Village of Germantown are currently in place through connection to the Milwaukee Metropolitan Sewerage District for sanitary sewerage treatment.*

Source: SEWRPC.

Municipal Planning Agencies

Municipal planning agencies include city, village, and town plan commissions and town zoning committees created pursuant to Sections 62.23(1), 61.35, and 60.61(4) of the *Wisconsin Statutes*. Such agencies are important to plan implementation at the local level. Of the 147 local units of government within the Region, most have established plan commissions. The comprehensive plans prepared and adopted by these units of government must contain information concerning water supply as part of the utilities and community facilities element that, as has already been noted, should be consistent with the adopted regional water supply plan.

County, City, Village, and Town Units of Government

General-purpose units of local government, such as counties, cities, villages, and towns, have powers under State law which may give them a role in the implementation of the regional water supply plan.

Cities in Wisconsin are granted general zoning powers under Section 62.23 of the *Wisconsin Statutes.* The same powers are granted to villages under Section 61.35 of the *Statutes.* Counties are granted general zoning powers within their unincorporated areas under Section 59.69 of the *Wisconsin Statutes*. However, a county zoning ordinance becomes effective only in those towns that ratify the county ordinance. Towns that have not adopted a county zoning ordinance may adopt village powers, and subsequently utilize the village zoning authority conferred in Section 60.22(3), subject, however, to county board approval where a general-purpose county zoning ordinance exists. Alternatively, a town may adopt a zoning ordinance under Section 60.61 of the *Wisconsin Statutes* where a general-purpose county zoning ordinance has not been adopted, but only after the county board fails to adopt a county ordinance at the petition of the governing body of the town concerned. The zoning authority granted to these units of government under State law give them a role in determining the location and intensity of urban development requiring water supply facilities and services, and in preserving environmental corridors and agricultural lands. The latter function is particularly important to the preservation of the protection of important groundwater recharge areas. In addition, pursuant to their responsibilities related to stormwater management under Chapters NR 151 and NR 216 of the *Wisconsin Administrative Code,* counties, cities, villages, and towns also have a role in the implementation of the stormwater management recommendations contained in the recommended water supply plan.

Local units of government are also authorized to borrow so as to effectuate their powers and discharge their duties. Section 67.04 of the *Wisconsin Statutes* grants municipalities the power to borrow money and issue bonds to finance any project undertaken for a public purpose. In addition, Section 66.0619 of the *Wisconsin Statutes* grants municipalities the power to borrow money and issue public improvement bonds to finance the costs of construction and/or acquisition of any revenue-producing public improvement. Such borrowing powers may provide a mechanism for funding infrastructure construction and improvements necessary for implementation of the regional water supply plan.

As previously noted, water supply system development and operation and maintenance costs for municipalities are typically met by creating utilities which operate as self-supporting municipal enterprise funds for the purpose of providing water supplies on a fee basis.

County Park and Planning Agencies

County governments have considerable latitude in forming agencies to perform the park and outdoor recreation and zoning and planning functions within the county. Counties may organize park commissions or park and planning commissions pursuant to Section 27.02 and 59.69(2), respectively of the *Wisconsin Statutes.* Instead of organizing such commissions, counties may elect to utilize committees of the County Board to perform the park and outdoor recreation and zoning and planning functions. The powers are, however, essentially the same no matter how an individual County chooses to organize these functions. If, however, a County elects to establish a county park or county park and planning commission, these commissions have the obligation to prepare a county park system plan and a county street and highway system plan. There is no similar mandate for plan preparation when a County elects to carry out these functions with committees of the County Board. The planning, zoning, and plat review regulatory functions vary somewhat from county to county within the Region. Three of the seven counties—Kenosha, Racine, and Walworth—fully exercise the planning, zoning, and plat review functions designated by the *Statutes*; one county—Waukesha—fully exercises the planning function, but exercises the zoning functions in a limited number of the towns within the County, and partially exercises the plat review function; two counties—Washington and Ozaukee—fully exercise the planning function, but the zoning function is exercised only in shoreland areas; Washington County fully exercises the plat review function, while Ozaukee County exercises that function only in shoreland areas and as an approving agency elsewhere. One county—Milwaukee County—partially exercises the planning function for parks and highways, partially exercises the plat review function as an approving agency, and does not exercise the zoning function.

County Land and Water Conservation Committees

County land and water conservation committees are responsible for land conservation programs within the county and are also responsible for implementing the State soil and water resource management program. These committees report to the County Board. Sections 92.07 and 92.10 of the *Wisconsin Statutes* authorize the land and water conservation committees to have a broad range of powers and duties. These powers and duties include:

- Development and adoption of standards and specifications for management practices to control erosion, sedimentation, and nonpoint sources of water pollution;
- Distribution and allocation of available Federal and State cost-sharing funds relating to soil and water conservation;
- Conduct of research and educational information programs relating to soil and water conservation;
- Conduct of programs designed to prevent flood damage, drainage, irrigation, groundwater, and surface water problems;
- Provision of financial, technical, and other assistance to landowners;
- Acquisition of land and other interests and property, machinery, equipment, and supplies required to carry out various land conservation programs;
- Construction, improvement, operation, and maintenance of structures needed for land conservation, flood prevention, and nonpoint source pollution control; and
- Preparation of a long-range natural resource conservation plan for the County, including an erosion control plan and program.

As a committee of the County board, all of the activities of a county land and water conservation committee are closely supervised by the County Board and subject to the fiscal resources made available to the committee by the County Board. All seven counties in the Region have created Land Conservation Committees to perform these various functions. These Committees have important responsibilities in the implementation of the regional water supply plan relative to the protection of groundwater recharge areas and stormwater management elements of the plan.

Stormwater Drainage Districts

Wisconsin Act 53, enacted on December 19, 1997, amended and expanded Section 66.0821 of the *Wisconsin Statutes* to specifically grant municipalities the legal authority to assess service charges to users of a stormwater and surface water sewerage system. This legislation granted municipalities the authority to establish stormwater utilities. Such utilities can be used to carry out a variety of stormwater management activities, including the development and operation of stormwater drainage systems and nonpoint source pollution abatement measures with funding provided through the utility fee structure.

Areawide Agencies

Statutory provisions exist for the creation of the following areawide agencies having both general and specific planning and plan implementation powers potentially applicable to the implementation of the regional water supply play.

Metropolitan Sewerage Districts

The Milwaukee Metropolitan Sewerage District (MMSD) is a special-purpose unit of government directed by an appointed Commission. Sections 200.21 through 200.65 set forth the enabling legislation for the establishment of metropolitan sewerage districts which include cities of the first class. The MMSD includes all municipalities in Milwaukee County, except for the City of South Milwaukee and portions of the City of Franklin. By contract with the served communities, the District also provides sewage conveyance, storage, and treatment services for portions of Ozaukee, Racine, Washington, and Waukesha Counties. The District has a number of important responsibilities in the area of water resources management, including the provision of floodland management programs for most of the major streams within the District and the collection, transmission, storage, and treatment of domestic, industrial, and other sanitary sewage generated in the District and its contract service areas. The MMSD has a role in implementation of the recommended water supply plan through its currently existing provision of return flow of spent water to Lake Michigan for several water utilities utilizing Lake Michigan as a source of supply and recommended for conversion to Lake Michigan as a source of water supply. In this respect, the District may have a role in the evaluation of potential impacts associated with some return flow options considered in connection with the provision of Lake Michigan water to the City of Waukesha.

In addition to the MMSD, two other metropolitan sewerage districts have been created in the Region. The Western Racine County Sewerage District serves the Villages of Rochester and Waterford and portions of the Towns of Rochester and Waterford. The Walworth County Sewerage District serves the Cities of Delavan and Elkhorn, the Villages of Darien and Williams Bay, the Delavan Lake Sanitary District, the Geneva National Sanitary District, the Town of Geneva Lake Como Sanitary District No. 1, and the Walworth County institutions. The areawide nature of some of the recommended sanitary sewerage systems in the Region lends itself to the formation of potential additional metropolitan sewerage districts. The service areas of both of these metropolitan sewerage districts are located west of the subcontinental divide in the western portion of the Region, where diversions of water from Lake Michigan are either unlikely to occur, or are prohibited by the Compact.

Regional Planning Commission

The Regional Planning Commission has no statutory plan implementation powers. However, in its role as a coordinating agency for planning and development activities within the Southeastern Wisconsin Region, the Commission can influence plan implementation through the community planning assistance services which it renders to its constituent counties and municipalities, and through review and comment on Federal and State grant-in-aid applications, waste discharge permits, sanitary sewer extensions, and municipal water utility service area extensions. In addition, the Commission provides a basis for the creation and continued functioning of the Regional Water Supply Planning Advisory Committee, which should remain as an important influence on water supply plan implementation.

On September 17, 1974, the seven-county Southeastern Wisconsin Region and the Southeastern Wisconsin Regional Planning Commission were formally designated by the Governor as a Section 208 planning area and planning agency pursuant to the Clean Water Act. In addition, the seven-county Southeastern Wisconsin Region and the Southeastern Wisconsin Regional Planning Commission have also been designated by the Governor as an areawide water quality planning area and planning agency pursuant to Chapter NR 121 of the *Wisconsin Administrative Code.*

Wisconsin Act 227 of 2007 requires that the WDNR establish, by rule, and administer a continuing water supply planning process for the preparation of water supply plans for persons operating public water supply systems. Further, it directs that a regional planning commission may prepare plans for persons operating public water supply systems. The Act also specifies that, for the purposes of these plans, an areawide water quality management agency designated by the Governor under Chapter NR 121 of the *Wisconsin Administrative Code* shall delineate the proposed water supply service areas to be used to prepare water supply service area plans for the public water supply systems within the planning area for which the agency is designated. The Act also requires that the proposed water supply service areas delineated shall be consistent with the adopted areawide water quality management plan. In addition, the Act provides that an areawide water quality management agency may provide regional water needs assessments and other regional water supply planning information. The process for conducting regional activities under this Act should be consistent with the process for regional water supply planning for a groundwater management area designated under Section 281.34(9) of the *Wisconsin Statutes*.

Cooperative Contract Commissions

Section 66.0301(2) of the *Wisconsin Statutes* provides that municipalities[4] may contract with each other to form cooperative service commissions for the joint provision of any services and for the joint exercise of any powers that each municipality may be authorized to exercise separately. Such commissions have been given bonding powers for the purposes of acquiring, developing, and equipping land, buildings, and facilities for areawide projects. Economies can often be achieved through the provision of 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, in some cases, be efficiently and economically provided through the use of a cooperative contract commission. The North Shore Water Commission, for example, is a cooperative contract commission created by an intergovernmental agreement between three different communities—the City of Glendale and the Villages of Fox Point and Whitefish Bay—to provide water supply to their communities.

Intergovernmental cooperation under such cooperative contract commissions may range from the sharing of expensive public works equipment to 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 water supply plan implementation and may be utilized in lieu of any of the aforementioned areawide organizations for such implementation.

State-Level Agencies

Wisconsin Department of Natural Resources

The WDNR has broad authority and responsibility in the areas of natural resources protection, water quality control, and water regulation. The WDNR has the obligation to develop long range, statewide resource conservation plans, presumably including water resource plans. In addition, it has the authority to designate such sites as necessary to protect, develop, and regulate the use of State parks, forests, fish, game, lakes, streams, certain forms of plant and animal life, and other outdoor resources, and to acquire conservation and scenic easements.

Water Supply Planning

Wisconsin Act 227 of 2007 requires that the WDNR establish and administer a water supply planning process for public water supply systems in the State. The Act requires that those systems that serve a population of 10,000 or more and withdraw water from waters of the State, which includes both surface and groundwater, be covered by a plan approved by the WDNR no later than December 31, 2025. Such plans may cover a period of not more than 20 years.

Additional water supply planning requirements are also under consideration by the WDNR pursuant to Wisconsin Act 310, adopted in 2003, which established a State-level Groundwater Advisory Committee charged with making recommendations for needed regulations for groundwater management. The Groundwater Advisory Committee was charged in preparing two reports. The first report, *2006 Report to the Legislature on Groundwater Management Areas*, issued in December 2006, dealt with issues and recommendations related to management of groundwater resources within groundwater management areas. The second report, *2007 Report to the Legislature*, assessed the effectiveness of the Wisconsin Act 310 and the adequacy of specific provisions in the law primarily related to surface water environmental protection. In the 2006 report, the Groundwater Advisory Committee recommended that groundwater management plans be prepared for the designated groundwater management areas in the State, one of which includes most of the Southeastern Wisconsin Region. The requirements for the

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[4]*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.*

groundwater management plans are to be developed by Administrative Rule. In addition, the 2006 report recommends that the WDNR use available funds to provide assistance and support in areas where groundwater quantity problems exist or may be developing. The regional water supply plan for the Southeastern Wisconsin Region has been designed to be consistent with the recommendations of the Wisconsin Groundwater Advisory Committee, and is intended to form the basis for the groundwater management planning recommended by that Committee.

Safe Drinking Water Act (SDWA) Administration
The WDNR is the primacy agency in the State of Wisconsin for enforcement of the Federal Safe Drinking Water Act. Pursuant to this responsibility, the WDNR administers programs related to several aspects of drinking water safety, including wellhead protection, source water protection, local public water system capacity development, and water system operator certification.

The WDNR has established standards for drinking water designed to protect the public health, safety, and welfare. Standards have been established for five groups of substances: inorganic compounds, synthetic compounds, volatile organics, radionuclides, and lead and copper. In many cases, these standards are based upon national primary drinking water standards promulgated by the USEPA, which is the agency responsible for establishing and enforcing such standards. The WDNR has also established sampling and analytical requirements to accompany the drinking water standards. These requirements are documented in Chapter NR 809 of the *Wisconsin Administrative Code*.

The WDNR is the lead State agency for developing the State wellhead protection program pursuant to the 1996 amendments to the SDWA. Chapter NR 811.16(5) of the *Wisconsin Administrative Code* requires that a wellhead protection plan be developed for any municipal well to be constructed after May 1, 1992. The plan must be approved by the WDNR before the municipal well can be placed into service. The WDNR encourages wellhead protection plans for municipal wells constructed prior to May 1, 1992. The Department also provides assistance and guidance to public water systems developing wellhead protection programs.

The 1996 Amendments to the SDWA require states to conduct source water assessments for all public drinking water systems. A source water assessment report provides drinking water supply systems with the information they need to protect the water source concerned–well or intake—from contamination. Source water assessments consist of several components:

- An identification of the source water area. This is the land area that contributes water to the drinking water system;
- An inventory of significant potential sources of contamination within that area;
- A determination of susceptibility to contamination for each system; and
- Recommendations for source water protection.

For groundwater systems, the susceptibility determination is based upon the geology, well construction, monitoring results, and potential contaminant sources conditions within the source water area.

The 1996 amendments to the SDWA require states to prepare a capacity development strategy to assist public water systems to acquire and maintain the technical, managerial, and financial capability to ensure safe drinking water. The WDNR requires capacity evaluations be performed for all new community and nontransient, noncommunity water systems prior to construction. For existing systems, the WDNR evaluates capacity and provides support through the development and provision of a variety of capacity development measures. Priority is given to systems that are out of compliance or that are on the verge of being out of compliance with the SDWA.

Because ensuring the knowledge and skills of public water system operators is widely considered one of the most important, cost-effective means to strengthen drinking water safety, the 1996 amendments to the SDWA require states to carry out a program of public water system operator certification. Pursuant to the rules set forth in Chapter NR 114 of the *Wisconsin Administrative Code*, the WDNR administers a program of water system operator certification and for operators of municipal community, other than municipal community, and non-transient, noncommunity public water system operators.

The 1996 amendments to the SDWA also created a Federal revolving fund to assist communities in installing and upgrading safe drinking water treatment. In Wisconsin, the WDNR is the primary administrator of this fund through its Safe Drinking Water Loan Program (SDWLP). This program provides loans to public water systems to design, build, upgrade, or replace water supply infrastructure to protect public health and address Federal and State safe drinking water requirements. The Wisconsin Department of Administration (WDOA) is the financial manager for this program.

Review of Public Water System Improvements
Chapter 281.41 of the *Wisconsin Statutes* requires that plans for new construction or improvements relating to public water systems submitted for approval by the WDNR. An approval is required:

- For any new community water system intended to serve 15 or more service connections used by year-round residents or that regularly serves at least 25 year-round residents;
- For any improvements, extensions, or alterations which may affect the quality or quantity of water delivered by an existing community water system; and
- For wellhead protection plans for new wells serving municipal water systems.

In addition to approval of the plans and specifications, all new community water systems must receive capacity certification from the Department prior to placing the system into service.

Private wells are, by definition, wells that are not part of a public water supply. Private wells must have fewer than 15 connections and serve fewer than 25 people, and most commonly are wells that serve a single home. Private wells are regulated by the WDNR under Chapters NR 146 and NR 812 of the *Wisconsin Administrative Code*. In the Region, Waukesha County also regulates private wells. Wisconsin has had well and pump regulations in force since 1936 and has been recognized as a national leader in the administration of well construction and pump installation standards. The State regulations are based on the premise that if a well and water system is properly located, constructed, installed, and maintained, the well should provide safe water without the need for treatment.

Designation of State Project Areas
In its role of designating sites to protect the natural resources of the State, the WDNR can play an important role in implementing and funding the components of the recommended regional water supply plan, that call for groundwater recharge area protection and enhanced recharge of the shallow aquifer. Protection of high or very high recharge potential areas may be accomplished in whole, or in part, through creation of a State Project Area within which the WDNR could acquire, develop, and manage land. Section 23.09(2)(d) of the *Wisconsin Statutes* lists purposes for which the State may acquire lands through purchase, lease, or gift. The listed purposes that may be applicable to the recommended protection or recharge areas include: State forests; State natural areas; wildlife habitat areas and fisheries; and any other purpose for which gift lands are suitable, as determined by the WDNR.

Chapter NR 1 of the *Wisconsin Administrative Code*, establishes priorities for WDNR acquisition of lands. The categories that are applicable to the recommended groundwater recharge area protection element of the plan, in descending priority, are: protection of water-based resources; accommodation of natural resources-based outdoor recreation activities; and land within 40 miles of Wisconsin's 12 largest cities.[5]

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[5]*Many of the potential high and very high groundwater recharge areas are within 40 miles of the Cities of Janesville, Kenosha, Milwaukee, Racine, Waukesha, and West Allis all of which are among the 12 largest cities in the State.*

Establishment of Groundwater Protection Areas
As previously noted, Wisconsin's Groundwater Protection Act directs the WDNR to establish groundwater management areas in areas of the State where the water level of the deep sandstone aquifer has been drawn down more than 150 feet from pre-development levels. As of 2010, two such management areas have been established, including one encompassing much of the Southeastern Wisconsin Region. This groundwater management area includes Waukesha, Kenosha, Racine, Milwaukee, and Ozaukee Counties, and portions of Washington and Walworth Counties.

The groundwater management areas are intended to encourage a coordinated management strategy among the State, county and municipal governments, regional planning commissions, and public and private users of groundwater to address problems caused by over-pumping of the deep aquifer, including problems of increased levels of radium, arsenic and salinity in the water.

Administration of Great Lakes-St. Lawrence River Basin Water Resources Compact
The WDNR is the primary State agency responsible for implementing the Great Lakes-St. Lawrence River Basin Water Resources Compact. In Wisconsin, the legal authorization for implementation of the Compact is contained in 2007 Wisconsin Act 227. This Act authorizes the WDNR to interpret policies and establish programs that implement the Compact. Included among the programs established under this Act are provisions related to: registration and reporting of water withdrawals, interbasin transfers, and diversions; regulation of diversions from the Great Lakes basin under the exceptions allowed by the Compact; regulation of water withdrawals in the Great Lakes basin; establishment of water conservation and efficiency programs; formulation of public participation; and assessment and reporting.

The Act requires any person within the State that, on June 1, 2011, has a water supply system with the capacity of withdrawing an average of 100,000 gallons per day or more in any 30-day period; that initiates such a withdrawal after that date; or that increases such a withdrawal after that date, to register the withdrawal with the WDNR and provide specified information about the system and the withdrawal.

The Act also requires that the WDNR administer the prohibition on diversions of water from the Great Lakes basin and regulate the exceptions allowed under the Compact to this prohibition. Under the Compact, all diversions outside the Great Lakes basin are prohibited with three limited exceptions: A diversion is defined in the Compact to occur whenever water is transferred from the Great Lakes basin into another watershed by any means other than incorporation into a product. The three exceptions from the prohibition are for straddling communities, communities within straddling counties, and intra-basin transfers. The Act gives the Department the authority to approve applications for diversions under these exceptions, when specified conditions are met, and to reject such applications when such conditions are not met. In addition to approval by the WDNR, diversions to some communities in straddling counties require unanimous approval of the Great Lakes-St. Lawrence River Basin Water Resources Council, consisting of the governors of the eight Great Lakes states.

The WDNR also administers the procedure established under the Act for the management and regulation of new or increased, withdrawals and consumptive uses of Great Lakes water, including the establishment of a permitting system. This applies to both surface water and groundwater withdrawal in the Great Lakes basin. The Act requires that the Department determine a baseline level for all existing withdrawals in order to determine when an increased withdrawal occurs. It also requires the Department to set a threshold withdrawal and consumptive use level above which new or increased withdrawals and consumptive uses would initiate State review under the Compact.

The Act requires the WDNR to specify water conservation and efficiency goals for all of the waters of the State and to develop a statewide water conservation and efficiency program. This program is to include:

- The promotion of environmentally sound and economically feasible water conservation measures through a voluntary statewide program;

- Mandatory and voluntary conservation and efficiency measures for the waters of the Great Lakes basin that are necessary to implement interbasin transfer approvals and general and individual water use permits and water supply plans; and

- Water conservation and efficiency measures required or authorized by the Wisconsin Department of Commerce in the State plumbing code and other regulations and by the PSC for water utilities.

Finally, the Act directs the WDNR, beginning no later than June 11, 2011 and every five years thereafter, to publish a water use report summarizing water usage in the State, identifying related trends and areas of future water usage concerns, and recommending future actions to promote sustainable water use.

Water Pollution Control Function
The responsibility for water pollution control in Wisconsin is centered in the WDNR. The basic authority and accompanying responsibilities relating to the water pollution control function of the WDNR are set forth in Chapter 283 of the *Wisconsin Statutes*. Under that chapter, the WDNR is given broad authority with respect to:

- Preparing water use objectives and supporting water quality standards;

- Protecting water quality through abatement of nonpoint source pollution from construction site erosion, agricultural runoff, and nonagricultural (urban) runoff;

- Protecting navigable waters, including authorizing municipal shoreland zoning regulations;

- Regulating groundwater withdrawals from high-capacity wells to ensure that operation of such wells does not adversely affect a public water supply or, when located in a groundwater protection area, defined as an area within 1,200 feet of an outstanding or exceptional resource water and Class I, II, or III trout stream;

- Conserving and managing water resources through regulation of withdrawals from the waters of the State;

- Reviewing and approving plans and specifications for components of sanitary sewerage systems;

- Reviewing and approving the creation of cooperative sewerage systems;

- Regulating the servicing of septic tanks, soil absorption fields, holding tanks, grease interceptors, privies, and other components of private sewage systems;

- Regulating the disposal of septage in municipal sewerage systems;

- Performing "activities to clean up or to restore the environment in an area that is in or adjacent to Lake Michigan or Lake Superior or a tributary of Lake Michigan or Lake Superior if the activities are included in a remedial action plan that is approved by the Department."; and

- Administering a financial assistance program for the construction of pollution prevention and abatement facilities.

Each of the above authorities is important to the implementation of the regional water supply plan. The loans and grants available through the financial assistance program are particularly relevant to facilities planning, preliminary engineering, and final engineering and construction of point and nonpoint source water pollution abatement facilities to meet nonpoint source water pollution abatement needs identified in areawide water quality management plans.

Other WDNR Authority
The WDNR also has authority to regulate the construction of ponds, lagoons, waterways, and stream improvements; the construction, maintenance, and abandonment of dams; and the water levels of navigable lakes and streams and of lake and stream improvements, including the removal of certain lakebed materials. The WDNR also makes cost-share monies available for a number of activities including, dam removal, river protection, land and water conservation and stewardship activities, stormwater and runoff management, lake planning and protection, and aquatic invasive species control. With such broad authority for the protection of the natural resources of the State, the WDNR is an extremely important agency with respect to the implementation of the major elements of the recommended regional water supply plan.

Public Service Commission of Wisconsin
The PSC regulates public utility rates and associated services under Chapter 196 of the *Wisconsin Statutes*. The PSC must approve any proposed changes in water rates before they are implemented. The PSC has up to six months from receipt of a rate change request to issue the new rate order.

The PSC also has broad authority to review and approve construction projects by public water utilities pursuant to Section 196.49(2) of the *Wisconsin Statutes*. Projects requiring PSC review include:

- The construction of new wells and other sources of water supply;
- The construction of pumping stations, purification or treatment facilities, water reservoir storage facilities, and utility buildings;
- Additions to or replacement of pumping stations, purification or treatment facilities, water reservoir storage facilities, and utility buildings having a cost in excess of $100,000 or 25 percent of existing investment, whichever is smaller; and
- Projects in which a utility intends to install facilities outside its service area in an area that could also be served by another public utility.

The PSC may refuse to certify a project if it appears that the completion of the project will do any of the following:

- Substantially impair the efficiency of the service of the public utility;
- Provide facilities unreasonably in excess of the probable future requirements; or
- When placed in operation, add to the cost of service without proportionally increasing the value of available quantity of service.

The PSC has authority to regulate various aspects of water utility operations. Examples of operations regulated under this authority include metering requirements, water accounting and loss control requirements, and standards for pressure management. The PSC also conducts outreach and training programs directed at public utilities and related to rate-setting, improving efficiency of operations, and reducing water loss from distribution systems.

Wisconsin Department of Commerce
The Wisconsin Department of Commerce has established plumbing code requirements through the Wisconsin Uniform Plumbing Code. This code sets forth plumbing standards, including standards for maximum flow rates for water conserving fixtures.

The Department of Commerce also administers the Community Development Block Grants-Public Facilities (CDBG-PF) and the Community Development Block Grants-Public Facilities for Economic Development (CDBG-PFED) programs. The CDBG-PF program is a versatile financing tool for general-purpose local units of government in need of funds to undertake needed infrastructure and public improvement projects. Projects that may be eligible for public infrastructure grants under this program include the installation, repair, or replacement of public water systems, including wells, water towers, and distribution systems. The CDBG-PFED program helps to underwrite the cost of municipal infrastructure for business development that retains or creates employment opportunities. Eligible activities include improvements to public facilities, such as municipal water systems, that are owned by a local unit of government and that will principally benefit businesses and, as a result, induce businesses to create jobs and invest in the community.

University of Wisconsin-Extension

A University of Wisconsin-Extension office is located within each County. Although the Extension has no statutory plan implementation powers, the Extension can aid communities in solving environmental problems by providing educational and informational programs to the general public, and by offering advice to local decision-makers and community leaders. The Extension carries out these responsibilities by conducting meetings, tours, and consultations, and by providing newsletters, bulletins, and research information.

The WGNHS, a part of the University of Wisconsin-Extension, is an interdisciplinary organization that conducts natural resources surveys and research to produce information used for decision making, problem solving, planning, management, development, and education. The WGNHS has no specific regulatory or enforcement responsibilities, but has the principal responsibility among State agencies for conducting groundwater surveys and research. Activities under this responsibility are closely coordinated with the WDNR and with the USGS. The WGNHS is the main repository for well records in the State. This agency maintains two major sets of well data: well constructor’s reports and geologic logs. More than 400,000 well constructor’s reports are on file at WGNHS. Geologic logs are prepared from examination of drill cuttings. Approximately 7,000 of these records are available. Finally, the WGNHS conducts a variety of research projects related to the State’s groundwater resources including developing water table maps, building computerized mathematical models of groundwater flow, and developing models of groundwater recharge.

The WGNHS was an important cooperator in the development of the water supply planning program for the Region. In that role, the WGNHS was a partner in developing basic groundwater inventories and a groundwater simulation model for the Region which served as important input for the regional water supply plan. In addition, the WGNHS developed important technical reports relating to groundwater recharge and sustainability for the Region which were used in the plan preparation.

Wisconsin Department of Health Services, Division of Public Health

As a cooperative agreement partner to the U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry, the Wisconsin Department of Health Services, Division of Public Health, conducts health consultations in response to specific requests for information about health risks related to specific sites such as a well, a chemical release, or the presence of hazardous material. Health consultations provide advice on specific public health issues related to real or possible human exposure to toxic material. Because such consultations may be initiated in response to exceedences of drinking water or groundwater quality standards, they may provide valuable information regarding the quality of available sources of water supply and the potential need for establishment of municipal water utilities in unserved urban-density areas.

Federal-Level Agencies

The following Federal agencies administer aid and assistance programs that are applicable to implementation of the recommended regional water supply plan. Funding from such programs may be used for land acquisition and construction of specific facilities.

U.S. Environmental Protection Agency

The Safe Drinking Water Act gives the USEPA the responsibility for setting national drinking water standards for public water systems. The USEPA sets standards that, when combined with protecting groundwater and surface water, are critical to ensuring safe supplies of drinking water. USEPA works through its regional offices with states to protect public health through implementing the Safe Drinking Water Act. Since 1974, USEPA has set national standards for over 88 contaminants that may occur in drinking water. For the State of Wisconsin, the USEPA has designated the WDNR as the primacy agency for enforcement of the Federal SDWA.

As already noted, the Safe Drinking Water Act, as amended in 1996, established the Drinking Water State Revolving Fund to make funds available to drinking water systems to finance infrastructure improvements. The program emphasizes providing funds to small and disadvantaged communities and to programs that encourage pollution prevention as a measure for ensuring safe drinking water. In Wisconsin, the WDNR is the primary administrator of this fund through its Safe Drinking Water Loan Program (SDWLP).

The USEPA also provides guidance related to the implementation of the rules and regulations under the SDWA. The guidance available from USEPA includes:

- Compilations of policy decisions pertaining to implementation issues under SDWA;
- Guidance related to small public drinking water systems developed to help states, technical assistance providers, and small public drinking water systems identify compliance options;
- Water security assistance related to ensuring the continued security of drinking water systems; and
- Guidance related to specific compliance issues faced by public drinking water systems, such as compliance with drinking water standards for contaminants such as arsenic and radionuclides.

In 2006, the USEPA launched WaterSense, a partnership program that seeks to promote efficiency in water supply and enhance the market for water-efficient products, programs, and practices. WaterSense brings together local water utilities and governments, product manufacturers, retailers, consumers, and other stakeholders to:

- Decrease indoor and outdoor nonagricultural water use through the adoption of more efficient products and practices;
- Help consumers make water-efficient choices, including differentiating between products and services in the marketplace and adopting simple daily activities that reduce water use;
- Encourage innovation in manufacturing; and
- Establish and standardize rigorous certification criteria that ensure product efficiency, performance, and quality.

WaterSense helps consumers identify water-efficient products and programs that meet WaterSense® water efficiency and performance criteria. Products carrying the WaterSense label perform well, help save money, and encourage innovation in manufacturing. WaterSense partners with manufacturers, retailers and distributors, and utilities to bring WaterSense labeled products to the marketplace and make it easy to purchase high-performing, water-efficient products. WaterSense also partners with irrigation professionals and irrigation certification programs to promote water-efficient landscape irrigation practices.

U.S. Department of Agriculture, Rural Utilities Service

The Water and Environmental Programs (WEP) of the USDA-RUS provides loans, grants and loan guarantees for drinking water, sanitary sewer, solid waste and storm drainage facilities in rural areas and cities, villages, and towns with a population of 10,000 or less. Public bodies, nonprofit organizations, and recognized Indian tribes may qualify for assistance. WEP also makes grants to nonprofit organizations to provide technical assistance and training to assist rural communities with their water, wastewater, and solid waste problems. In addition, the Household Water Well System Grant Program of the USDA-RUS provides grants to qualified nonprofit organizations to establish lending programs for household water wells. Under these programs homeowners, or other eligible individuals, may borrow money from an approved organization to construct, refurbish, service, or upgrade private well systems.

U.S. Department of Interior, Geological Survey

The USGS conducts continuing programs for water resource appraisal and monitoring. Programs conducted by the USGS include monitoring of groundwater levels, computer modeling of groundwater levels and flow, assessments of water use and water use trends, gaging of streamflow and lake levels, and monitoring of water quality. As a part of these programs, the USGS conducts a cooperative stream gaging program in cooperation with the Southeastern Wisconsin Regional Planning Commission and several local units of government, water utilities, and wastewater utilities. Through these programs the USGS can provide valuable assistance to local agencies involved in implementing the recommended water supply plan.

The USGS was an important cooperator in the development of the regional water supply planning program for the Region. In that role, the USGS developed a groundwater simulation model for the Region which served an important quantitative role in evaluating existing and alternative future conditions during the planning process. The groundwater simulation model which was developed and operated by the USGS included a surface water interface which allows the assessment of surface water baseflows under existing and alternative future conditions.

Private Organizations

Land trusts and conservancies—such as the Caledonia Conservancy, the Cedar Lakes Conservation Foundation, the Geneva Lake Conservancy, the Kenosha/Racine Land Trust, the Kettle Moraine Land Trust, the Land Trust of Walworth County, the Milwaukee Area Land Conservancy, the Muskego Lakes Conservancy, the Ozaukee Washington Land Trust, the River Revitalization Foundation, the Tall Pines Conservancy, and the Waukesha County Land Conservancy—purchase, or obtain conservation easements on, environmentally valuable lands through member contributions, land or easement donations, and grants obtained from other sources. These organizations can play a significant part in plan implementation through coordination of their land acquisition and easement programs on the recommendations in the plan for preservation of important groundwater recharge areas.

Water efficiency and conservation groups and coalitions, such as the Alliance for Water Efficiency and the Waukesha County Water Conservation Coalition, may be able to assist in plan implementation by providing technical information and assistance related to water efficiency and conservation and by providing materials and assistance in the education of water users.

PLAN ADOPTION, ENDORSEMENT, AND INTEGRATION

Upon adoption of the regional water supply plan for the Southeastern Wisconsin Region by resolution of the Southeastern Wisconsin Regional Planning Commission, in accordance with Section 66.0309(10) of the *Wisconsin Statutes*, the Commission will transmit a certified copy of the resolution adopting the plan, together with the plan itself, to all local legislative bodies within the study area and to all of the existing Federal, State, areawide, and local units and agencies of government that have potential plan implementation functions. It is recommended that each of the concerned agencies and units of government endorse the regional water supply plan and integrate the findings and recommendations of the plan into their planning, regulatory, and other activities related to water supply.

Endorsement, or formal acknowledgment of the regional water supply plan by the local legislative bodies and the existing local, areawide, State, and Federal level agencies concerned is highly desirable to assure a common understanding among the several governmental levels and to enable their staffs to program the necessary implementation work. A model resolution for endorsement of the regional water supply plan for the Southeastern Wisconsin Region is provided in Appendix Q. Endorsement of the recommended regional water supply plan by any unit or agency of government pertains only to the statutory duties and functions of an endorsing agency within its geographic area of jurisdiction, and such endorsement 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. Nor does endorsement formally commit the endorsing agency or unit of government to carry out plan implementation. However, endorsement will indicate that the plan will be used as a guide in considering water supply issues.

Upon endorsement of the plan by a unit or agency of government, it is recommended that the policymaking body of the unit or agency direct its staff to review in detail the elements of the water supply plan. Once such review is completed, the staff can propose to the policymaking body for its consideration and approval the steps necessary to fully integrate the water supply plan elements into the plans and programs of the agency or unit of government.

The importance of integrating the regional water supply plan into county and community planning efforts cannot be overly emphasized. The State's comprehensive planning legislation enacted in 1999 effectively requires that cities, villages, towns, and counties prepare and adopt long-range comprehensive plans—including nine prescribed plan elements[6]—and further specifies that, beginning in 2010, zoning, land subdivision regulations, and official mapping regulations must be consistent with such plans. The year 2035 regional land use plan is intended to serve as a regional framework for the required planning and the regional land use plan serves as the basis for the regional water supply plan. The regional water supply plan includes recommendations that relate directly to four of the required local comprehensive plan elements, including the land use element; the agricultural, natural, and cultural resources element; the utilities and community facilities element; and the intergovernmental cooperation element. The State comprehensive planning law does not mandate consistency between local comprehensive plans and the regional land use and water supply plans.[7] It is, nonetheless, strongly recommended that cities, villages, towns, and counties use the regional land use and water supply plans as a framework for the preparation and implementation of their comprehensive plans, integrating the findings and recommendations of the regional plans as appropriate.

Local-Level Agencies

It is recommended that the Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, and Waukesha County Boards of Supervisors formally endorse the regional water supply plan for the Southeastern Wisconsin Region by resolution, pursuant to Section 66.0309(12)(a) of the *Wisconsin Statutes,* after review, a report, and recommendation by the appropriate county committees.

It is recommended that the plan commissions of the cities, villages, and towns within the Region, endorse the regional water supply plan by resolution, pursuant to Section 62.23(3)(b) of the *Wisconsin Statutes,* and certify such adoption to their respective governing bodies, and that upon such certification the governing bodies also act to endorse the recommended plan.

It is recommended that the governing boards and commissions of the municipal water utilities in the Southeastern Wisconsin Region endorse the regional water supply plan by resolution.

It is recommended that the governing boards and commissions of the Allenton Sanitary District No. 1 in the Town of Addison, Washington County; the Town of Bristol Utility District No. 1 and the Town of Bristol Utility District No. 3, in Kenosha County; the Brookfield Sanitary District No. 4 in the Town of Brookfield, Waukesha County; the Caledonia East Utility District and the Caledonia West Utility District in the Village of Caledonia, the North Cape Sanitary District in the Towns of Norway and Raymond, Town of Yorkville Utility District No. 1, in Racine County; and the Country Estates Sanitary District in the Town of Lyons, the Town of East Troy Sanitary District No. 3, the Lake Como Sanitary District No. 1 in the Town of Geneva, the Pell Lake Sanitary District No. 1 in the Town of Bloomfield, and the Troy Sanitary District No. 1 in the Town of Troy, all in Walworth

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[6]*The nine required elements of comprehensive plans as prescribed in the State comprehensive planning law include the following: issues and opportunities; housing; transportation; utilities and community facilities; agricultural, natural, and cultural resources; economic development; intergovernmental cooperation; land use; and implementation.*

[7]*Under the State comprehensive planning law, local comprehensive plans must incorporate regional transportation plans. This is the only consistency requirement between local comprehensive plans and regional plans specified in that law.*

County, and all such districts with water supply responsibilities created within the Region in the future, endorse the regional water supply plan by resolution, pursuant to 66.0309(12)(a) of the *Wisconsin Statutes*.

State-Level Agencies

It is recommended that the Natural Resources Board which oversees the WDNR endorse the regional water supply plan for southeastern Wisconsin as the water supply plan for the Southeastern Wisconsin Region pursuant to 2007 Wisconsin Act 227, and direct the staff of the WDNR to integrate the recommended plan elements into its broad range of agency responsibilities as well as to assist in coordinating plan implementation activities over time. It is further recommended that the WDNR use the regional water supply plan as a guide for decisions and permitting related to water supply in the Southeastern Wisconsin Region, and as a guide in the review and approval of local water supply plans within the Southeastern Wisconsin Region pursuant to 2007 Wisconsin Act 227.

It is recommended that the PSC endorse the regional water supply plan for southeastern Wisconsin and direct PSC staff to give due consideration to the plan in the exercise of the various PSC responsibilities governing regulation of public water utilities.

It is recommended that the Wisconsin Department of Commerce endorse the regional water supply plan for southeastern Wisconsin and direct the Department staff to give due consideration to the plan in the exercise of the various Department responsibilities governing the administration of the State plumbing code and other responsibilities related to water supply.

It is recommended that the University of Wisconsin-Extension, WGNHS, endorse the regional water supply plan for southeastern Wisconsin, continue its groundwater monitoring and analysis activities within the Region, and work with utilities, municipalities, counties, and the Regional Planning Commission to continue to monitor the surface water and groundwater resources of the Region.

Federal-Level Agencies

1. It is recommended that the USEPA formally acknowledge and endorse the regional water supply plan for southeastern Wisconsin and utilize the plan in the performance of its broad range of agency responsibilities relating to water management.

2. It is recommended that the U.S. Department of Agriculture, Rural Utilities Service acknowledge and endorse the regional water supply plan for southeastern Wisconsin and utilize the plan recommendations in the administration of its programs of rural utility development.

3. It is recommended that the U.S. Department of the Interior, Geological Survey, acknowledge and endorse the regional water supply plan for southeastern Wisconsin, continue its groundwater monitoring and cooperative stream gaging programs within the Region, and work with utilities, municipalities, counties, and the Regional Planning Commission to continue to monitor the surface water and groundwater resources of the Region.

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 the regional water supply plan for the Southeastern Wisconsin Region, to be viable and of use to local, State, and Federal units and agencies of government, should be continually adjusted through formal amendments, extensions, additions, and refinements to reflect changing conditions. The Wisconsin Legislature clearly foresaw this when it very specifically 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 66.0309(9) of the *Wisconsin Statutes*.

Amendments, extensions, and additions to the regional water supply plan may be expected to be forthcoming not only from the work of the Commission under various 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, as new programs are created, or as existing programs are expanded or curtailed. Adjustments must also come from local planning programs which are conducted to greater detail than the regional plan and which may result in refinement of that plan. Areawide adjustments may come from subsequent regional or State planning programs, which may include additional comprehensive or special purpose planning efforts.

Some adjustments to the recommended water supply plan may be necessary in order to conform to administrative rules related to existing legislation or to requirements that are likely to be addressed in future legislation. As previously noted Wisconsin Act 227 of 2007 requires that the WDNR establish and administer a water supply planning process for public water supply systems in the State. The Act requires that those systems that serve a population of 10,000 or more, and which withdraw water from waters of the State, be covered by a plan approved by the WDNR no later than December 31, 2025. Such plans may cover a period of not more than 20 years. *Administrative* rules related to this Act are currently being drafted by the WDNR. In addition, Wisconsin Act 310 of 2003 directed the WDNR to establish two separate groundwater management areas in areas of the State where extensive groundwater pumping has resulted in declines in the water level of the deep aquifer since from predevelopment levels that exceed 150 feet. One of these groundwater management areas, the Southeast Groundwater Management Area, encompasses most of the Southeastern Wisconsin Region. This Act also established the Wisconsin Groundwater Advisory Committee (GAC) and directed the Committee to submit a report to the Legislature containing recommendations related to the management of groundwater in groundwater management areas, including recommendations related to potential future legislation and administrative rules development. The GAC submitted this report to the Legislature in December 2006.[8] This report recommended that legislation be enacted requiring the development and approval of a groundwater management plan for each groundwater management area and specifying certain procedures related to development of such plans. The report also recommended development and promulgation of administrative rules that would specify the required content of such plans. While bills containing elements addressing some of the Committee’s recommendations were introduced in both houses during the 2009-2010 sessions, the Wisconsin Legislature has not, as of June 2010, taken action on the elements.

It is recommended that the regional water supply plan serve as a point of initiation and basis for the preparation of future plans related to water supply and groundwater management that may be developed to meet the requirements of Act 227 of 2007, future legislation addressing the recommendations contained in the aforementioned report of the GAC, other future legislation related to water supply and groundwater management, and associated administrative rules.

All of these adjustments and refinements will require cooperation by local, areawide, State, and Federal agencies of government, with the Regional Planning Commission, which is empowered under Section 66.0309(8) of the *Wisconsin Statutes* to act as a coordinating agency for programs and activities of the local units of government within the Region. To achieve this coordination between local, State, and Federal programs most effectively and efficiently and, therefore, to assure the timely adjustments of the water supply plan, it is recommended that all of the State, areawide, and local agencies having various plan and plan implementation powers transmit copies of all subsequent planning studies, plan proposals and amendments, and plan implementation actions to the Commission for consideration as to integration into, and adjustment of, the water supply plan. Of particular importance in this respect will be the continuing role of the Regional Water Supply Planning Advisory Committee in intergovernmental coordination.

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[8]*Wisconsin Groundwater Advisory Committee,* 2006 Report to the Legislature on Groundwater Management Areas, *December 2006.*

IMPLEMENTATION OF THE PLAN RECOMMENDATIONS CONCERNING SOURCES OF WATER SUPPLY

The implementation of the plan elements concerning the sources of water supply is of central importance to the realization of the overall objectives of the plan. These elements require cooperation and coordination among municipal water utilities, local units of government, and the areawide, State, and Federal agencies concerned if the water supply objectives set forth in the regional plan are to be fully achieved. Because of the confined nature of much of the deep aquifer underlying the Region, historical withdrawals have resulted in a major regional cone of depression centered in eastern Waukesha County. Coordination among communities will be required in order to limit withdrawals from this aquifer to levels that will be sufficient either to sustain or raise its potentiometric level. While pumping from the shallow aquifer generally causes little regional drawdown, coordination among communities will be necessary to minimize the potential adverse impacts related to the associated reduction of groundwater discharge to local surface waterbodies.

The major responsibility for implementation of the plan recommendations concerning the sources of water supply rest with the existing and potential future water utilities in the Region. The recommendations related to sources of supply for each existing utility are set forth in Table 196.

With regard to the recommendation for the conversion of the source of supply for the City of Waukesha Water Utility to Lake Michigan and the attendant development of a return flow system, active participation by the counties and municipalities concerned in the implementation process related to the return flow component is recommended. Should the return flow option selected and approved during the subsequent plan implementation steps involve use of either Underwood Creek or the Root River, or both streams, it is recommended that a return flow oversight committee be created by the WDNR to guide the WDNR permitting and regulatory actions. The committee would be responsible for the development and oversight of the planning related to the return flow facilities, including measures for mitigating impacts during high-flow periods. In addition, the committee would be responsible for recommending needed post-implementation monitoring of facility performance. This oversight would be coordinated with, and be advisory to, the WDNR, whose decisions concerning permitting would be final. The committee would be comprised of representatives of the units and agencies of government most directly affected, including the WDNR, Milwaukee County, Racine County, Waukesha County, the Milwaukee Metropolitan Sewerage District, the City of Waukesha Water Utility, SEWRPC, and the local units of government, including the City of Milwaukee, within which the affected streams are located, with the final composition of the committee depending upon the return flow option involved. It is recommended that these units and agencies of government adopt or endorse the regional water supply plan.

Currently, both urban and rural development in a significant portion of the Region are served by private wells. It is recommended that the WDNR and those counties that regulate private wells continue to support the maintenance and use of private wells in these areas.[9] In addition, it is recommended that the local governments, in cooperation with the WDNR and the Wisconsin Department of Health Services, monitor the need for municipal water utilities in areas of urban-density development that are not served by municipal water systems. Table 197 summarizes these responsibilities. Table 197 also makes recommendations of the sources of water supply to be used in existing urban-density areas of development not currently served by municipal water utilities should a municipal utility be formed. It is important to note that the development of any new municipal water utilities is envisioned only if a demonstrated need were to arise based upon groundwater quality or quantity issues and, if a local initiative is then undertaken to implement a municipal system. When such systems are developed, it is recommended that special consideration be given to providing assistance to low- to medium-income residents for funding the initial costs of the water supply system. The section of this chapter on financial and technical assistance provides additional information regarding this recommendation.

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[9]*As of June 2010, Waukesha County is the only county in the Southeastern Wisconsin Region that regulates private wells.*

Where opportunities exist, it is recommended that municipal water utilities in the Southeastern Wisconsin Region give consideration to cooperative facility development, systems integration, and consolidation of activities. Such activities may ensure provision of water in the event of emergencies such as a breakdown in facilities, a major fire, or a terrorist attack. In addition, these activities may allow for the achievement of economies of scale that allow for less costly operation of the utilities and more favorable rates for utility customers. The range of activities contemplated includes interconnections among adjacent utilities; cooperative development of utility infrastructure, such as supply, treatment, and distribution infrastructure; or integration and consolidation of existing systems. The scope and extent of the activities implemented is most appropriately determined by the utilities and affected communities. Table 192 in Chapter X of this report lists the utilities where such activities could potentially be viable and result in system efficiencies.[10]

IMPLEMENTATION OF THE PLAN RECOMMENDATIONS CONCERNING WATER CONSERVATION

The regional water supply plan recommends that all water utilities in the Region formulate and implement water conservation programs, including both supply side efficiency measures and demand side conservation measures. The scope and content of these conservation programs are to be determined on a utility-specific basis, reflecting the type and sustainability of the source of supply and the existing and probable future water supply infrastructure requirements.

Three levels of conservation programs are recommended for application in the Region. These are described in Chapter IX of this report. Details regarding the kinds of measures recommended for these programs are set forth in Chapter IX of this report; while recommended levels of water conservation and estimated annual costs for individual utilities are set forth in Appendix K and graphically displayed on Map 125 of Chapter X. The recommended measures are intended to constitute a guide to be used by local utilities in developing utility-specific programs. Implementation of these programs will require selecting measures and refining program details in further planning efforts conducted by the individual utilities. The water conservation measures described are primarily related to the municipal water utility water service areas; however, the plan envisions that the base-level water conservation measures would also apply to private individual, self-supplied systems.

The water conservation programs developed by the water utilities must be designed to meet the requirements of the WDNR administrative rules that are being developed to meet the requirements of the Great Lakes-St. Lawrence River Basin Water Resources Compact, State groundwater-related protection legislation, and the September 2006 Report to the Governor on Water Conservation. Wisconsin Act 227 requires that the WDNR establish statewide water conservation and efficiency goals and objectives and establish rules specifying the requirements for water conservation and efficiency for applicants for new or increased diversions. The WDNR initiated the water conservation rulemaking process during 2009, with completion expected in late 2010. The Public Service Commission of Wisconsin also considers proposed water conservation measures during its review of water utility budgets and rates.

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[10]*The Town of Cedarburg recently studied the need and feasibility of creating a water utility. This study found that an adequate groundwater supply source is available and the creation of a water utility is a feasible option. The Town has expressed its willingness to work with neighboring communities to study the feasibility of a regional water utility. As of June 2010, no neighboring community has expressed interest. The Town also indicated its willingness to consider purchasing water from a neighboring water utility that utilizes groundwater and/or surface water sources, such as Lake Michigan.*

Table 197

RECOMMENDED PLAN IMPLEMENTATION ACTIONS FOR AREAS NOT CURRENTLY SERVED BY MUNICIPAL WATER UTILITIES

Municipality	Continue Support for Upkeep and Maintenance of Private Wells	Monitor Need for Municipal Water Utilities in Unserved Urban-Density Areas	Recommended Source of Water Supply Should a Municipal Utility be Formed Following a Local Initiative[a]		
			Purchased Lake Michigan Surface Water	Shallow Aquifer Groundwater	Combination of Shallow Aquifer and Deep Aquifer Groundwater
Kenosha County	- -	X	- -	- -	- -
Village of Bristol	- -	X	- -	- -	- -
Village of Silver Lake	- -	X	- -	X	- -
Village of Twin Lakes	- -	X	- -	X	- -
Town of Brighton	- -	X	- -	- -	- -
Town of Bristol	- -	X	- -	- -	- -
Town of Paris	- -	X	- -	- -	- -
Town of Randall[b]	- -	X	- -	X	- -
Town of Salem	- -	X	- -	- -	X[c]
Town of Somers	- -	X	- -	- -	- -
Town of Wheatland[b]	- -	X	- -	X	- -
Milwaukee County	- -	X	- -	- -	- -
Village of River Hills	- -	X	- -	- -	- -
Ozaukee County	- -	X	- -	- -	- -
City of Mequon	- -	X	- -	- -	- -
Town of Belgium	- -	X	- -	- -	- -
Town of Cedarburg	- -	X	- -	- -	- -
Town of Fredonia[d]	- -	X	- -	X	- -
Town of Grafton	- -	X	- -	- -	- -
Town of Port Washington	- -	X	- -	- -	- -
Town of Saukville	- -	X	- -	- -	- -
Racine County	- -	X	- -	- -	- -
Village of Caledonia	- -	X	- -	- -	- -
Village of Rochester[e]	- -	X	- -	X	- -
Town of Burlington[f]	- -	X	- -	X	- -
Town of Dover[g]	- -	X	- -	X	- -
Town of Norway[h]	- -	X	- -	X	- -
Town of Raymond	- -	X	- -	- -	- -
Town of Waterford[i]	- -	X	- -	X	- -
Town of Yorkville	- -	X	- -	- -	- -
Walworth County	- -	X	- -	- -	- -
Town of Bloomfield	- -	X	- -	- -	- -
Town of Darien	- -	X	- -	- -	- -
Town of Delavan[j]	- -	X	- -	X	- -
Town of East Troy[k]	- -	X	- -	X	- -
Town of Geneva	- -	X	- -	- -	- -
Town of Lafayette	- -	X	- -	- -	- -
Town of La Grange	- -	X	- -	- -	- -
Town of Linn	- -	X	- -	- -	- -
Town of Lyons	- -	X	- -	X	- -
Town of Richmond	- -	X	- -	- -	- -
Town of Sharon	- -	X	- -	- -	- -
Town of Spring Prairie	- -	X	- -	- -	- -
Town of Sugar Creek	- -	X	- -	- -	- -
Town of Troy	- -	X	- -	- -	- -
Town of Walworth	- -	X	- -	- -	- -
Town of Whitewater	- -	X	- -	- -	- -
Washington County	- -	X	- -	- -	- -
Village of Newburg	- -	X	- -	X	- -
Village of Richfield	- -	X	- -	- -	- -
Town of Addison	- -	X	- -	- -	- -
Town of Barton	- -	X	- -	- -	- -
Town of Erin	- -	X	- -	- -	- -
Town of Farmington	- -	X	- -	- -	- -
Town of Germantown	- -	X	- -	- -	- -
Town of Hartford	- -	X	- -	- -	- -
Town of Jackson	- -	X	- -	- -	- -
Town of Kewaskum	- -	X	- -	- -	- -

Table 197 (continued)

Municipality	Continue Support for Upkeep and Maintenance of Private Wells	Monitor Need for Municipal Water Utilities in Unserved Urban-Density Areas	Recommended Source of Water Supply Should a Municipal Utility be Formed Following a Local Initiative[a]		
			Purchased Lake Michigan Surface Water	Shallow Aquifer Groundwater	Combination of Shallow Aquifer and Deep Aquifer Groundwater
Washington County	- -	X	- -	- -	- -
Town of Polk	- -	X	- -	- -	- -
Town of Trenton	- -	X	- -	- -	- -
Town of Wayne	- -	X	- -	- -	- -
Town of West Bend	- -	X	- -	- -	- -
Waukesha County	X	X	- -	- -	- -
City of Muskego[h]	- -	X	- -	- -	- -
Village of Big Bend	- -	X	- -	X	- -
Village of Chenequa	- -	X	- -	- -	- -
Village of Elm Grove	- -	X	X	- -	- -
Village of Lannon	- -	X	- -	X	- -
Village of Merton	- -	X	- -	- -	- -
Village of Nashotah	- -	X	- -	- -	- -
Village of North Prairie[d]	- -	X	- -	X	- -
Village of Oconomowoc Lake	- -	X	- -	- -	- -
Village of Wales	- -	X	- -	X	- -
Town of Delafield	- -	X	- -	- -	- -
Town of Eagle[m]	- -	X	- -	X	- -
Town of Genesee	- -	X	- -	- -	- -
Town of Lisbon	- -	X	- -	- -	- -
Town of Merton	- -	X	- -	- -	- -
Town of Mukwonago	- -	X	- -	- -	- -
Town of Oconomowoc[n]	- -	X	- -	X	- -
Town of Ottawa[o]	- -	X	- -	X	- -
Town of Summit[p]	- -	X	- -	X	- -
Town of Vernon	- -	X	- -	- -	- -
Town of Waukesha	- -	X	- -	- -	- -

[a]*Recommended sources of water supply apply to the existing urban density areas identified in Chapter IV of this report. The recommended plan envisions that new municipal water utilities will be formed only upon a local initiative following demonstration of a need. In the absence of a demonstrated need and local initiative, the plan envisions these areas continuing to rely upon private wells.*

[b]*This includes the existing urban density areas in the Benedict Lake-Powers Lake-Tombeau Lake area, as identified in Chapter IV of this report.*

[c]*The well depths and aquifer actually utilized will be dependent upon more-detailed evaluations. Accordingly, it is recognized that there is a potential for some wells to be finished in the deep aquifer, as well as the shallow aquifer in the Town of Salem should there be a future need for municipal wells in portions of the Town.*

[d]*This includes the existing urban density areas in the Waubeka area, as identified in Chapter IV of this report.*

[e]*Includes the former Town of Rochester and Village of Rochester service areas as delineated in Chapter IV of this report.*

[f]*This includes the existing urban density areas in the Bohner Lake area, as identified in Chapter IV of this report.*

[g]*This includes the existing urban density areas in the Eagle Lake area, as identified in Chapter IV of this report.*

[h]*This includes the existing urban density areas in the Wind Lake-Waubeesee Lake-Ke Nong Go Mong Lake-Denoon Lake area, as identified in Chapter IV of this report.*

[i]*This includes the existing urban density areas in the Tichigan Lake area, as identified in Chapter IV of this report.*

[j]*Includes the Delavan Lake Sanitary District portion of the City of Delavan Water and Sewer Commission water supply service area as delineated in Chapter IV of this report.*

[k]*This includes the existing urban density areas in the Potter Lake area, as identified in Chapter IV of this report.*

[l]*The recommended water supply plan recommends that the existing Prairie Village Water Trust which currently serves the Village of North Prairie be converted to a municipal water utility and serve the Village of North Prairie water supply service area.*

[m]*This includes the existing urban density areas in the Eagle Spring Lake area, as identified in Chapter IV of this report.*

[n]*This includes the existing urban density areas in the Okauchee Lake area, as identified in Chapter IV of this report.*

[o]*This includes the existing urban density areas in the Pretty Lake area, as identified in Chapter IV of this report.*

[p]*This includes the existing urban density areas in the Golden Lake area, as identified in Chapter IV of this report.*

Source: SEWRPC.

IMPLEMENTATION OF THE PLAN RECOMMENDATIONS CONCERNING GROUNDWATER RECHARGE AREA PROTECTION

The protection of groundwater recharge areas classified as having a high or very high recharge potential, as recommended in the plan, may be largely achieved through the implementation of the adopted design year 2035 regional land use plan and county and local comprehensive plans consistent with the regional plan. These plans recommend preservation of the environmental corridors, isolated natural resource areas, and prime and other agricultural areas of the Region that facilitate recharge. As shown on Map 128 and in Table 188 in Chapter X of this report, about 75 percent of the highly rated and very highly rated recharge areas may be expected to be preserved by inclusion in the environmental corridors, isolated natural resource areas, and prime and other agricultural areas identified for preservation in the adopted regional land use plan or in other existing dedicated park land. Depending on the zoning and development practices utilized, additional highly rated and very highly rated recharge areas may also be substantially protected through inclusion into suburban-density and low-density residential areas. In these areas, it is recommended that careful site design and the use of selected stormwater management practices be carried out which are designed to maintain natural hydrology and recharge conditions. This will increase the level of protection for the important recharge areas. It is also recommended that the important recharge areas be considered, along with other natural resource values, when lands are considered for conservation purposes by agencies and organizations involved in land conservancy activities.

The recommended regional water supply plan recommends that consideration be given by the Regional Planning Commission to expanding the currently delineated primary and secondary environmental corridors to include some of the recharge areas identified as having high or very high recharge characteristics. The procedures historically utilized for environmental corridor delineation have been well accepted and consider natural resource features, size, and length of the area being considered. The recharge characteristics could be integrated into the current procedures. However, such integration should be done on a comprehensive basis as part of the regional land use planning program when the corridor delineations are updated and with the guidance of the Commission Advisory Committee on Regional Land Use Planning. It is anticipated that the next iteration of corridor delineation will be initiated by the Commission in 2011.

There may also be opportunities to achieve additional protection of important groundwater recharge areas through coordination of recharge area protection with other environmental management efforts. For example, the regional water quality management plan update for the greater Milwaukee watersheds[11] recommends that a total of 10 percent of existing farmland and pasture in these watersheds be converted to either wetland or prairie conditions, focusing that effort on mostly marginally productive land.[12] Including highly rated and very highly rated groundwater recharge areas among the lands selected for prairie restoration under this recommendation may achieve protection of some important recharge areas that would not otherwise be protected. It is recommended that groundwater recharge potential of candidate lands be considered when areas are selected for grassland and prairie restoration under this recommendation of the regional water quality management plan update and under programs such as the WDNR's North Branch Milwaukee River Wildlife and Farming Heritage Area[13] and similar programs.

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[11]*The term "greater Milwaukee watersheds" consists of all five watersheds which lie entirely or partially in the greater Milwaukee area, the Lake Michigan direct drainage area, as well as the Milwaukee Harbor estuary and a portion of nearshore Lake Michigan. The watersheds involved are those of the Kinnickinnic River, Menomonee River, Milwaukee River, Oak Creek, and Root River.*

[12]*SEWRPC Planning Report No. 50,* A Regional Water Quality Management Plan Update for the Greater Milwaukee Watersheds, *December 2007.*

[13]*Wisconsin Department of Natural Resources,* North Branch Milwaukee River Wildlife and Farming Heritage Area Feasibility Study, *March 2003.*

As plan implementation actions are undertaken to protect important recharge areas or to preserve the recharge characteristics of area, it is recommended that the population and land uses in, and adjacent to, the concerned areas be inventoried, Consideration should be given to the potential impacts of any regulations or other actions to preserve the recharge area or characteristics on the population in, or adjacent to, these areas.

IMPLEMENTATION OF THE PLAN RECOMMENDATIONS CONCERNING STORMWATER MANAGEMENT

Implementation of state-of-the-art stormwater management practices as recommended in the regional water supply plan may be expected to be largely achieved through the provisions of Chapter NR 151 of the *Wisconsin Administrative Code* and through county and municipal stormwater management ordinances adopted in accordance with Chapter 216 of the *Wisconsin Administrative Code*, including related State and local programs and regulations.

IMPLEMENTATION OF THE PLAN RECOMMENDATIONS CONCERNING HIGH-CAPACITY WELL SITING

The primary responsibility for conducting the analyses and monitoring related to the implementation of the high-capacity well siting procedure recommended in the plan belong to the utilities or other entities proposing installation of a high-capacity well. The WDNR is the permitting authority for the location and construction of high-capacity wells within the State. It is recommended that the WDNR consider the recommendations set forth herein concerning high-capacity well siting as it reviews and revises it related regulations and policies.

The high-capacity well siting regulation element of the regional water supply plan recommends the additional steps to be taken in the early stages of locating sites for wells in the shallow aquifer. Prior to drilling test wells, desktop analyses intended to develop a conceptual understanding of the hydrogeological system associated with each candidate site and its surrounding area should be undertaken. This should include an understanding of important interactions between the shallow groundwater system of the site and surrounding area and the surface water system. This understanding should include characterization of the subsurface geological setting, the hydraulic characteristics of the primary geological units, the water budget characteristics of the groundwater and surface water basin in which the candidate well sites are located, the hydraulic characteristics of the aquifer targeted for the production well, as well as other relevant factors which might contribute to an understanding of likely impacts of the proposed high-capacity well upon nearby existing wells and surface waterbodies, including springs, when their location is known. Where potential locations of multiple future wells are known, consideration should be given to the cumulative impacts of the multiple wells. In addition to assessing the likelihood of potential impacts, these analyses should identify areas of uncertainty related to the conceptual understanding developed and identify any additional information needed in order to resolve these uncertainties and additional analyses needed to better characterize potential impacts of the proposed wells. The findings of these desktop analyses may lead to a conclusion that alternative sites be considered, or that additional data collection and analysis be performed either prior to or concurrent with the drilling and operation of a test well.

Following completion and interpretation of the desktop analyses and any subsequent analyses, installation of a test well would be appropriate, depending upon the results of the analyses. During the test well phase, monitoring of water levels in nearby wells should be conducted and, where necessary to address additional data needs, special monitoring wells should be installed. The test well should be operated at a pumping rate close to the anticipated discharge of the proposed well and for a length of time sufficient to assess likely impacts of installation and operation of the well.

Monitoring of water levels should continue once any new well constructed in the shallow aquifer goes into operation, particularly in instances where potential negative impacts have been indicated by the analyses. In those instances where negative impacts resulting from installation and operation of the well are likely to occur, the utility owning the well or wells should develop and enter into an agreement with the adjacent communities affected to protect the water supply in the aquifer and to remedy in a timely fashion any problems with private wells resulting from installation and operation of the new well or wells.

In instances where potential negative impacts on surface waterbodies are identified, consideration should be given to alternative well sites, modified pumping schedules, and developing artificial recharge to compensate for surface water baseflow changes as described under the next plan component.

The well siting procedures are envisioned to also incorporate source water protection considerations. These considerations include well separation from potential sources of contamination, the establishment of wellhead protection areas, and the development and implementation of wellhead protection plans. Such measures are normally carried out for municipal utility wells as a matter of sound practice and in order to comply with WDNR site regulations.

IMPLEMENTATION OF THE PLAN RECOMMENDATIONS CONCERNING ENHANCED RAINFALL INFILTRATION

Implementation of the enhanced rainfall infiltration recommendations of the regional water supply plan can be best achieved in conjunction with the results of the analyses performed as part of implementation of the high-capacity well siting element described in the previous section. It is recommended that these infiltration systems be installed as a mitigative measure to provide additional recharge when such analyses indicate that installation of the high-capacity well or wells would result in impacts to surface waterbodies and existing private wells. The primary responsibility for the development and installation of these infiltration systems rests with the utility or other entity installing the high-capacity well that would generate the impact.

The primary responsibility for implementing plan components which provide for increased groundwater recharge through changes in agricultural land tillage practices should also rest with the utility or other entity proposing to install a well. However, in such cases, the agricultural land owner would have to be a partner in the proposed project and the county land and water conservation committee should be asked to lend support. In this regard, it is recommended that the county land and water conservation committees serving Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, and Waukesha Counties consider the groundwater recharge benefits of low- or no-tillage practices along with other factors as they update county land and water conservation plans and other programs and policies, and that they consider partnering with water utilities to pursue cost share funding which may be available for conversion to no-till practices.

In addition to the development of enhanced infiltration systems in conjunction with well siting, it is envisioned that there will be opportunities to enhance infiltration in conjunction with other open space preservation and management opportunities. Open space preservation can often serve multiple purposes, such as recreation, wildlife habitat, stormwater management, and preserving rural heritage. Another such objective can be groundwater recharge. As such, land trusts and conservancies may have a role in development of enhanced recharge systems.

Development of the constructed systems will require additional second-level planning and analysis in order to determine the best approach to the location, design, and configuration of the infiltration system concerned. Locating sites for these systems will require site-specific analyses to ensure that they are located in the recharge areas of the waterbodies and private wells expected to be impacted, and that they are located in suitable areas for shallow groundwater recharge. A variety of designs and methods are possible for these systems and the appropriate design will need to be determined on a case-by-case basis. The systems could be in the form of rain gardens, larger bioretention basins, infiltration ponds, infiltration ditches, and other systems. On a Regional basis, a mix of various measures developed on a site-specific basis will likely be the most effective means of providing groundwater recharge. It is recommended that consideration be given, as appropriate, to developing groundwater monitoring programs in conjunction with the rainfall infiltration systems. Because the rainfall infiltration facilities can potentially be developed to serve multiple purposes over-and-above groundwater recharge, including reducing stormwater runoff rates and volumes, providing aesthetic amenities, and improving wildlife habitat, the sites will have to be specifically designed to serve the desired purposes.

There are multiple benefits attendant to enhancing rainfall infiltration on agricultural lands by changing tillage practices, including reductions in runoff and erosion. In considering the application of groundwater infiltration measures, the estimates of the groundwater recharge effectiveness should be developed on a site by site basis.

FINANCIAL AND TECHNICAL ASSISTANCE[14]

It is important for water utilities and local units of government within the Region to effectively utilize all available sources of financial and technical assistance for the timely implementation of the recommended plan. In addition to utilizing public utility earnings and current tax revenue sources, such as property taxes, fees, fines, and State-shared taxes, the local units of government can also make use of revenue sources such as borrowing, special taxes and assessments, special assessments, areawide assessments, contributions in aid of construction, impact fees, and establishment of stormwater utilities.

Various types of technical and financial assistance useful in plan implementation are also available from county, State, and Federal agencies. The types of assistance available include State and Federal cost-share funding for such projects as the development, installation, and upgrading of water utility infrastructure, groundwater recharge area protection, and stormwater management measures; technical advice on land and water management practices related to stormwater management provided by Federal Natural Resources Conservation Service staff and county land conservation staffs; groundwater monitoring and modeling services provided by WGNHS and USGS staffs; and educational, advisory, and review services provided by the University of Wisconsin-Extension Service and the Regional Planning Commission.

Borrowing

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 their taxable property, with certain exceptions, including school bonds and revenue bonds. The general obligation bonds issued are secured by the full faith and credit of the municipality due to its ability to levy property taxes to support the principal and interest payments of the bonds. In addition, Chapter 66 of the *Wisconsin Statutes* empowers municipalities to borrow money and issue public improvement bonds to finance the costs of construction and acquisition of any revenue-producing public improvement of the municipality. These revenue bonds are issued with a pledge of future rates or charges being available to support the bonds. The principal and interest payments for revenue bonds are payable solely from the revenue generated by the project or utility.

Special Taxes and Assessments

Municipalities have special assessment powers for constructing public works or improvements under Section 66.0701 of the *Wisconsin Statutes.* In addition, 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 and placed into a separate fund and to be paid out only upon order of the county park commission for the purchase of land and other expenses. Town sanitary districts, metropolitan sewerage districts, cities, and villages also have taxing and special assessment powers under Sections 33.32(5), 200.13(1), 66.0827(2), and 62.18(16) of the *Wisconsin Statutes.*

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[14]*The financial assistance programs described in this section and the accompanying appendices were active as of the date of publication of this report. Such programs are subject to modification or elimination based on budget considerations, and additional programs may be enacted over time to address emerging issues. As this plan is implemented, information on grant program changes should be collated as necessary. The Catalog of Federal Domestic Assistance Programs can be accessed at* http://www.cfda.gov. *Additional information on grants can be accessed through the University of Wisconsin-Madison Libraries Grants Information collection at:* http://grants.library.wisc.edu.

Special Assessments
A commonly used method of reducing the overall cost of a capital improvement project is the use of special assessments to recover the cost of public improvements which are of direct benefit to real property. For example, for each accessible property which a water main abuts, a set charge per assessable front foot may be levied against the property. The property owners who receive such an assessment are usually given the option of paying the assessment in full within a short timeframe or utilizing an installment plan which ranges from five to 10 years in length.

Areawide Assessments
Areawide assessments are often used in conjunction with special assessments to recover the costs associated with municipal improvements whereby the benefit received by a property is not as apparent or direct as needed to justify special assessments against specific real properties. Examples of water supply infrastructure improvements which provide an indirect benefit to a property are such items as water towers, wells, and water reservoirs. In levying areawide assessments, the construction costs less the special assessments are charged to all benefiting properties using an equivalent unit, such as acreage or residential equivalent unit. Each property owner who receives such an assessment is usually given the same type of financing option as are made available for special assessment charges-assessments.

Contributions in Aid of Construction
The typical case of contribution in aid of construction would be requiring a private developer to pay for any water supply infrastructure improvements that are necessary to service a new development. Depending upon the type of improvement and the potential it has for serving a greater area, a community may elect to participate in financing any oversizing or extraordinary costs. The contributions are usually collected as part of the land subdivision process and, as such, apply to new water system components. The components can involve oversizing for broader purposes, which typically involves partial community funding. Another case of contribution in aid of construction would involve a private industrial facility paying for water main oversizing required by or benefiting the facility.

Impact Fees
Cities, villages, and towns have the ability to levy impact fees in support of the provision of infrastructure needed to serve new development under Section 66.0617 of the *Wisconsin Statutes.* Impact fees are charges to new development for public improvements that serve the development concerned. Impact fees offset the costs of expanded public infrastructure needed in response to new development. Residential development impact fees are commonly based upon a specified dollar amount per residential unit. Industrial and commercial development impact fees are commonly based upon a per square foot of improved space basis. Impact fees may only recover capital costs entailed in constructing, expanding, or improving public facilities. Capital costs may include the cost of land purchase, legal services, engineering services, and design costs. The improvements must be directly related to, or required for, the new development.

Impact fees are required to bear a “rational relationship” to the need for new, expanded, or improved public facilities, and may not exceed the proportionate share of capital costs required to serve the land development when compared to the existing land uses within the municipality. Impact fees cannot be imposed to prevent or inhibit development, nor may they be used as a revenue source to cover existing deficiencies. Recent legislation has changed some aspects governing the use of impact fees. A seven-year time limit for using impact fees was set by 2005 Wisconsin Act 203. This was generally changed to 10 years by 2007 Wisconsin Act 44, although the way in which the time limit is applied can depend upon when the fees are collected. Local governments are prohibited from imposing fees or charges as a condition of plat approval by 2005 Wisconsin Act 477. The fees are to be collected through the administration of building permits. The 2005 Wisconsin Act 477 also requires that revenues from each impact fee be placed in a separate account to be used to pay the capital costs of the public facility or facilities for which the fee was assessed. Any unexpended fees must be refunded to the current owner of the property concerned within a time period specified in the local impact fee ordinance.

Grant and Loan Programs

The identification of potential funding sources, including sources other than solely local-level sources, is an integral part of the implementation of a successful plan. The following description of funding sources includes those that appear to be applicable as of the year 2010. Funding programs and opportunities are constantly changing. Accordingly, the involved local staffs need to continue to track the availability and status of potential funding sources and programs. It is intended that this list facilitate the implementation of the activities set forth in the recommended plan. Some of the programs described herein may not be available under all envisioned conditions for a variety of reasons, including local eligibility requirements or lack of funds in Federal and/or State budgets at a given time. Nonetheless, the list of sources and programs should provide a starting point for identifying possible funding sources for implementing the watershed plan recommendations.

There are numerous grant and loan programs offered through both public and private sources for many aspects of plan implementation. Appendix Table R-1 summarizes many of the major grant and assistance programs that are available to municipalities and utilities under the areas of water system infrastructure development, wildlife and fish habitat preservation, water quality protection, land acquisition for park and open spaces, and other areas such as education and sustainable development that have the potential to indirectly affect the quantity and quality of the water resources of the Region. Appendix Table R-2 also lists contacts for details about the grant programs. It may also be possible to obtain additional assistance in finding funding sources for specific implementation efforts from the Wisconsin Department of Administration, Division of Intergovernmental Relations.

The grant and funding programs listed in the following subsections are categorized relative to their relationship to specific water supply plan elements and recommendations; however, some programs may have a primary relationship to a given element and a secondary relationship to another element. Thus, some programs may be applied to implement recommendations related to multiple plan elements.

Possible Funding Sources Relating to Development of Sources of Supply

Safe Drinking Water Loan Program

In Wisconsin, the Federal Drinking Water State Revolving Fund provided for under the 1996 amendments to the Safe Drinking Act are implemented through the State's Safe Drinking Water Loan Program. Through this WDNR-administered program, funds are available to plan, design, construct, or modify public water systems, as per Sections 281.59 and 281.61 of the *Wisconsin Statutes*, and Chapter NR 166 of the *Wisconsin Administrative Code*. Low interest loans are provided at 55 percent of the Clean Water Fund Program market interest rate. Under certain circumstances, a municipality may be eligible for a loan at 33 percent of the Clean Water Fund Program market interest rate. A municipality must send the WDNR a notice of its intent to apply for assistance by December 31st of the fiscal year preceding its application. Applications must be submitted on or before April 30th. Applications are approved following a project priority ranking, eligibility determination, and a determination by the Wisconsin Department of Administration that the applicant meets financial conditions. Applications are funded as they appear on a funding list that ranks projects based on their priority ranking. Eligible applicants include counties, cities, villages, towns, town sanitary districts, and inland lake protection and rehabilitation districts.

Community Development Block Grant Programs

The Wisconsin Department of Commerce administers the Community Development Block Grants-Public Facilities (CDBG-PF) and the Community Development Block Grants-Public Facilities for Economic Development (CDBG-PFED) programs. For some communities, funds may be available through these programs for implementing sources of water supply elements of the recommended water supply plan.

The CDBG-PF program is a designed to assist communities with public facilities improvements. Projects that may be eligible for public infrastructure grants under this program include the installation, repair, or replacement of public water systems, including wells, water towers, and distribution systems. Eligible applicants are cities, villages and towns with a population less than 50,000 and any county other than Milwaukee and Waukesha

Counties within the Region. Projects must meet at least one of following three national objectives: the project principally benefits low- and moderate-income persons; the project eliminates slum and blight; or the proposed activity meets an urgent local need.

Grant funds through the CDBG-PF program are made available on a continuing annual basis. While the maximum grant for any single application is $750,000, awards are rarely made for more than $500,000, or 50 percent of the local share of the costs, whichever is less. An applicant can receive only one grant during a 12-month period.

The CDBG-PFED program is designed to assist communities in expanding or upgrading municipal infrastructure necessary to accommodate businesses that have made a firm commitment to create jobs and invest in the community. Eligible activities include improvements to public facilities, such as municipal water systems, that are owned by a local unit of government and that will principally benefit businesses and, as a result, induce businesses to create jobs and invest in the community. Eligible applicants are general purpose units of local government with a population of less than 50,000. Applications must comply with the following criteria:

- The business must create or retain, at a minimum, one full-time-equivalent job for each $10,000 of CDBG-PFED funding;[15]
- At least 51 percent of the jobs must be made available to persons of low- and moderate-income;
- The business investment must at least equal the CDBG-PFED funding;
- The business must demonstrate the feasibility of the project;
- The local unit of government must demonstrate its financial need for the project and that the proposed project is the best alternative; and
- The local unit of government must provide at least 25 percent of project funding.

Grant funds are available through the CDBG-PF program on a continuing annual basis. The total amount of all CDBG-PFED assistance received by an eligible local unit of government may not exceed $750,000 per calendar year. The total amount of CDBG-PFED assistance that can be provided to benefit a single business may not exceed $750,000 for the duration of time that the business is in operation.

State Trust Fund Loan Program

The State Trust Fund Loan Program administered by the Wisconsin Board of Commissioners of Public Lands provides loans to municipalities for any public purpose, including water utility projects. Eligible borrowers include counties, cities, villages, towns, metropolitan sewerage districts, town sanitary districts, public inland lake protection and rehabilitation districts, and drainage districts. Loans are available with terms of up to 20 years. The interest rates and maximum amount that may be borrowed per calendar year are based upon the availability of funds. Applicants must provide a general obligation bond.

U.S. Department of Agriculture, Rural Utilities Service—Water and Environment Programs

The USDA-RUS administers three programs which may provide funding to eligible communities relative to the maintenance or improvement of sources of water supply.

The USDA-RUS Water and Environment Program provides loans and grants to eligible municipalities to construct, improve, or modify municipal drinking water, wastewater, and stormwater systems. Eligible applicants include cities, villages, towns, and sanitary districts in rural areas with populations up to 10,000. Priority is given

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[15]*The actual funding amount per job is based on wages, benefits, and number of jobs. In addition, the impact of the created and retained jobs on the local and area economy is also considered in setting the funding amount.*

to municipalities with a population less than 5,500, projects serving low income communities, and projects necessary to alleviate a health and sanitary problem. The maximum loan available is for 100 percent of project cost. The maximum grant available is based upon the median household income of the municipality and whether health and sanitary problems exist. The anticipated Fiscal Year 2010 allocations for Wisconsin are about $24 million for loans, and $8 million for grants. Applications are accepted throughout the fiscal year.

The USDA-RUS Guaranteed Water and Environment Program provides loan guarantees to eligible municipalities to construct, improve, or modify municipal drinking water, wastewater, and stormwater systems. Projects guaranteed under this program must have adequate capacity to serve existing population and reasonable growth. The applicant must be unable to obtain credit without the loan guarantee and have the legal authority to own, operate, and maintain the facility. The facility must comply with Federal, State, and local laws. Eligible applicants include cities, villages, towns, and sanitary districts in rural areas with population up to 10,000. The maximum loan guarantee available is for 100 percent of project cost. Applications are accepted throughout the fiscal year.

The USDA-RUS Emergency Community Water Assistance Grant Program provides grants to rural communities for disaster mediation. Eligible applicants are public bodies and nonprofit corporations servicing rural areas, including cities, villages, and towns whose population does not exceed 10,000. Applicants must demonstrate that a significant decline in the quantity or quality of water occurred within two years of the date that the application was filed with the Rural Utilities Service. Eligible activities include:

- Extending, repairing, or performing significant maintenance on existing water systems; constructing new water lines, wells, or other sources of water, reservoirs, and treatment plants; replacing equipment; and paying costs associated with connection fees;

- Paying related expenses such as legal and engineering fees, environmental impact analyses, or acquiring rights associated with developing sources of treating, storing, or distributing water; and

- Achieving compliance with the requirements of the Federal Water Pollution Control Act or with the Safe Drinking Water Act when noncompliance is directly related to a recent decline in the quality of potable water.

Grants made to alleviate a significant decline in the quantity or quality of water available from the sources of water supplies in rural areas that occurred within two years of filing the application cannot exceed $500,000. Grants made for repairs, partial replacement, or significant maintenance on an established system to remedy an acute shortage or significant decline in the quantity or quality of potable water cannot exceed $75,000. Subject to these limitations, grants may be made for 100 percent of eligible project costs.

National Rural Water Association Revolving Loan Fund
The National Rural Water Association's Revolving Loan Fund provides loans to public entities with a population up to 10,000. Eligible projects include predevelopment costs associated with proposed water projects, short-term costs incurred for replacement of equipment, and small-scale extensions of services. Loans can be obtained for up to 75 percent of project costs or $100,000, whichever is less. Applications are taken on a continuous basis.

Wisconsin Community Action Program Association Rural Community Assistance Program
The Rural Community Assistance Program of the Wisconsin Community Action Program Association provides training and technical assistance to small, rural, low-income communities and sanitary districts. This assistance is available both to develop and improve water systems and to develop capacity to manage, operate, and maintain water utilities.

Wisconsin Rural Water Association Construction Loan Program
The Wisconsin Rural Water Association's (WRWA) Construction Loan Program provides interim loans to small communities that have been awarded, but have not yet received, funding through either the CDBG-PF program or the Safe Drinking Water Loan Program. Rural communities with a population less than 10,000 are eligible for

such assistance for approved rural utility service, clean water, safe drinking water, and brownfield projects. The WRWA also provides assistance to eligible communities in locating funding for water and drinking water projects. In addition, it provides training and technical assistance to rural utilities and operates an equipment loan program.

Possible Funding Sources for Individuals and Households Relative to Sources of Supply

Assistance may be available to some households for expenses related to implementation of recommendations in the plan related to sources of water supply. Such assistance may include financial assistance to defer the cost of replacing or repairing private wells, properly abandoning private wells, or connecting to municipal water systems. Applicable programs are described below:

U.S. Department of Agriculture, Rural Development Programs

Assistance to low-income rural residents may be available through two grant programs administered under the USDA Rural Development Programs.

The Section 504 Rural Housing Repair and Rehabilitation Loan and Grant Program provides loans and grants to very low-income rural residents who own and occupy a dwelling in need of repairs. Loans of up to $20,000 for up to a period of 20 years at an interest rate of 1 percent and grants of up to $7,500 are available. To be eligible for loans, applicants must live in a rural community with a population of less than 10,000, have an income below 50 percent of the area median income, and be unable to obtain affordable credit elsewhere. Grants are available only to homeowners who are 62 years of age or older and who cannot repay a Section 504 loan. Eligible activities include installing or repairing essential features, including private wells, and removing health and safety hazards.

The Section 502 Rural Housing Direct Loan Program provides loans that are primarily used to help low-income individuals and households purchase homes in rural areas. Funds from this program can be used to provide water facilities. Applicants must have household incomes below 80 percent of the area median income. In 2008, these median incomes ranged from a low of $36,727 in Milwaukee County to a high of $60,298 in Waukesha County.

Wisconsin Department of Natural Resources Well Compensation Program

The WDNR Well Compensation Program provides assistance to the owners of chemical- or bacteria-contaminated private water supplies that exceed the standard health advisory level. In order to be eligible, applicants must either have received a Health Advisory letter or have had qualifying water tests performed by a certified laboratory. The contaminated well must either serve a residence or be used for watering livestock. This program provides a grant of 75 percent of eligible costs up to a maximum of $9,000. Eligible activities include replacement, reconstruction, treatment, and abandonment of contaminated private wells, and connection to municipal water systems. Full grants may be provided for applicants who have an annual family income of $45,000, or less. Reduced grants are available for applicants with an annual family income of between $45,000 and $65,000.

Wisconsin Department of Veterans Affairs Programs

Two loan programs operated by the Wisconsin Department of Veterans Affairs may provide assistance to residents who are military veterans. Under the Home Improvement Loan Program, qualified borrowers may borrow up to 90 percent of the equity that they have in their home for a period of 15 years at a fixed interest rate in order to finance home improvements to their residence, including improvements to private water systems. Under the Personal Loan Programs, qualified borrowers may borrow up to $25,000 at a fixed rate for any purpose. Qualified borrowers include veterans who meet military service and State residency requirements set by the State Legislature, spouses of deceased veterans who have not remarried, and dependent children of qualified veterans.

Foundation for Rural Housing Water Well System Loan Program

The Foundation for Rural Housing's Water Well System Loan Program provides low interest loans to low income rural owner-occupants for the replacement or repair of private wells. Applicants must be low income, permanent owner-occupants of the property who are current in their property tax payments and home insurance. Loans are available at an interest rate of 1 percent on a 20-year term. The maximum loan available is $11,000.

Possible Funding Sources for Protection of Important Groundwater Recharge Areas and Establishment of Enhanced Rainfall Infiltration Facilities

As noted in the foregoing section on implementation of the groundwater recharge area protection element of the recommended water supply plan, about 75 percent of the highly rated and very highly rated recharge areas may be expected to be preserved by inclusion in the environmental corridors, isolated natural resource areas, and prime and other agricultural areas identified for preservation in the adopted regional land use plan or in other existing dedicated park land. Protection of additional important groundwater recharge areas could be achieved through coordination of recharge area protection with other environmental management efforts. Depending upon the specific design used, the rainfall infiltration facilities could also be developed to serve multiple purposes over-and-above groundwater recharge, including reducing stormwater runoff rates and volumes; providing aesthetic amenities; improving wildlife habitat; providing buffer areas along streams and watercourses; preserving flood-prone lands in natural open uses; and potentially expanding environmental corridor lands. While no currently available funding programs specifically target protection or preservation of important groundwater recharge areas or construction of facilities for enhanced groundwater recharge, it may be possible to take advantage of the fact that these lands can serve multiple uses in order to obtain funding for recharge area protection or establishment of enhanced rainfall infiltration facilities based upon the additional uses served by these lands. For example, it may be possible to utilize State Stewardship Fund monies to preserve some otherwise unprotected high quality groundwater recharge areas, based upon their value as natural areas and/or wildlife habitat. Programs that may be able to provide funding based upon additional uses of these lands are described below. In addition, funding or assistance for land acquisition may be available from conservancies and land trusts operating in the Southeastern Wisconsin Region. These organizations are listed in Appendix Table R-3.

State Trust Fund Loan Program

As described above in the subsection on funding sources for utilities and municipalities for implementation of sources of water supply elements, the State Trust Fund Loan Program administered by the Wisconsin Board of Commissioners of Public Lands provides loans to municipalities for any public purpose, including water utility projects.

Wisconsin Department of Natural Resources Knowles-Nelson Stewardship Program

The Knowles-Nelson Stewardship Program was established to preserve the State's most significant land and water resources for future generations and to provide the land base and recreational facilities needed for quality outdoor experiences. The program achieves these goals by funding the acquisition of land and easements for conservation and recreation purposes, developing and improving recreational facilities, and restoring wildlife habitat. The administrative rules for the program are set forth in Chapters NR 50 and NR 51 of the *Wisconsin Administrative Code*. The program provides 50 percent matching grants to local units of government and qualified nonprofit conservation organizations for the acquisition of land and easements.

Wisconsin Department of Natural Resources Lake Protection Grant and River Protection Grant Programs

The Lake Protection Grant program as set forth in Chapter NR 191 of the *Wisconsin Administrative Code* was designed to assist local governments, lake districts and associations, and other nonprofit organizations in improving and protecting water quality in lakes. The funding that is available is a 75 percent State cost-share with a 25 percent local match. Projects that are eligible for cost-share assistance include land acquisition for easement establishment, wetland restoration, and various lake improvement projects such as those involving pollution prevention and control, diagnostic feasibility studies, and lake restoration.

The River Protection Grant program as set forth in Chapter NR 195 of the *Wisconsin Administrative Code* was designed to assist local governments, lake districts and associations, and other nonprofit organizations in improving and protecting water quality in rivers. A 75 percent State cost-share is available, with a 25 percent local match. Cost-share funding cannot exceed $50,000 for a management project. The types of projects that are eligible for cost-share assistance include management activities such as land acquisition, easement establishment, ordinance development, installation of nonpoint source pollution abatement projects, river restoration projects, and river plan implementation projects.

Wisconsin Department of Natural Resources Municipal Flood Control Grant Program
Under Chapter NR 199, "Municipal Flood Control Grants," of the *Wisconsin Administrative Code* municipalities, including cities, towns, and villages, as well as metropolitan sewerage districts are eligible for cost-sharing grants from the State for projects related to municipal flood control management. It may be possible to couple protection of some groundwater recharge areas with eligible projects such as riparian restoration projects; acquisition of vacant land, or purchase of easements, to provide additional flood storage or to facilitate natural or more efficient flood flows; or construction of facilities for the collection, detention, retention, storage, and transmission of stormwater and groundwater for flood control and riparian restoration projects. Municipalities and metropolitan sewerage districts are eligible for up to 70 percent State cost-share funding for eligible projects, and would have to provide at least a 30 percent local match. Applications are due on March 15 of each calendar year.

U.S. Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS) Programs
For groundwater recharge area protection projects that also serve to protect wetlands or grasslands, it is possible that funding may be available through two USDA-NRCS programs.

The Wetlands Reserve Program (WRP) is a voluntary program offering landowners the opportunity to protect, restore, and enhance wetlands on their property. It provides landowners with technical assistance and financial incentives and assistance to restore and enhance wetlands in exchange for retiring marginal agricultural land. The program offers landowners three options: permanent conservation easements, 30-year conservation easements, and restoration cost-share agreements of a minimum 10-year duration. For permanent easements, the WRP provides an easement payment of up to the fair market value of the land concerned, and pays 100 percent of the costs of restoration. For 30-year easements, the WRP pays an easement payment of 75 percent of what would be paid for a permanent easement. In addition, the program pays 75 percent of restoration costs. For restoration cost-share agreements the WRP pays 75 percent of restoration costs.

The Grassland Reserve Program (GRP) is a voluntary program for landowners and operators to protect grazing uses and related conservation values by conserving grassland, including rangeland, pastureland, shrubland, and certain other lands. Participants voluntarily limit future development and cropping uses of the land while retaining the right to conduct common grazing practices and operations related to the production of forage and seed. The program offers eligible landowners and operators two options: permanent easements and rental contracts of 10-year, 15-year, or 20-year duration. For permanent easements, the GRP offers compensation up to the fair market value of the land concerned less the grazing value of the land. For rental contracts, the GRP provides annual payments of 75 percent of the grazing value established by the Federal Farm Service Agency, up to $50,000 to a single person or legal entity. Certain grassland easements or rental contracts may also be eligible for cost-share assistance of up to 50 percent of the cost to reestablish grassland functions and values where land has been degraded or converted to other uses. Payments of this cost-share assistance may not exceed $50,000 per year to a single person or legal entity.

U.S. Fish and Wildlife Service Programs
For groundwater recharge area protection projects that also serve to preserve or enhance habitat for wildlife, it is possible that funding may be available through two U.S. Fish and Wildlife Service programs.

The Pittman-Robertson Wildlife Restoration Program provides grants to State fish and wildlife agencies for projects to restore, conserve, manage, and enhance wildlife and wildlife habitat. This program provides 75 percent Federal cost-share assistance for eligible projects and requires a 25 percent match from nonFederal sources. Eligible projects include identification, restoration, and improvement of areas of land or water adaptable as feeding, resting, or breeding places for wildlife.

The State Wildlife Grants Program provides grants to State fish and wildlife agencies for the development and implementation of projects for the benefit of fish and wildlife and their habitats, including species that are not hunted or fished. Priority is placed on projects that protect species of greatest conservation concern. Two types of grants are made under this program: planning grants and implementation grants. Planning grants provide up to

75 percent Federal cost-share assistance for eligible projects and require a 25 percent match from nonFederal sources. Implementation grants under this program provide up to 50 percent Federal cost-share assistance for eligible projects and require a 50 percent match from nonFederal sources.

National Fish and Wildlife Foundation—Acres for America

The National Fish and Wildlife Foundation administers the Wal-Mart Stores, Inc. Acres for America Program. This program seeks to offset the footprint of the company's domestic facilities on at least an acre by acre basis through the permanent conservation of important wildlife habitat. Eligible applicants include states, local units of government, and nonprofit conservation organizations. Eligible projects include land acquisition and the acquisition of permanent conservation easements. All grant awards require a minimum 50 percent match of funds or contributed goods and services. Higher ratios of matching funds will aid in making applications more competitive. Approximately $2.5 million are expected to be available through this program nationally through the year 2014. Preproposals are due April 1st and September 1st. Applicants are urged to discuss project ideas with the National Fish and Wildlife Foundation before submitting preproposals. Full proposals are due June 1st and November 1st.

Possible Funding Sources for Stormwater Management Practices

State Trust Fund Loan Program

As described above in the subsection on funding sources for utilities and municipalities, the State Trust Fund Loan Program administered by the Wisconsin Board of Commissioners of Public Lands provides loans to municipalities for any public purpose, including water utility projects.

Wisconsin Department of Natural Resources Clean Water Fund Program

The State Clean Water Fund Program (CWFP) provides financial assistance to municipalities for the planning, design, and construction of projects to control and treat urban stormwater runoff. Eligible applicants include cities, towns, villages, counties, town sanitary districts, public inland lake protection and rehabilitation districts, and metropolitan sewerage districts. Projects must be required by either a Wisconsin Pollutant Discharge Elimination System permit, a performance standard, or a plan approved by the WDNR. The primary purpose of an eligible urban runoff project must be to improve water quality. The program provides loans at an interest rate of 65 percent of the current CWFP market rate. Notice of intent to apply and priority evaluation and ranking forms are due on December 31.

The Clean Water Fund Program also has a Small Loan Program that provides interest rate subsidies to municipalities that have a loan from the State Trust Fund Loan Program for the planning, design, and construction of urban runoff projects with total estimated costs of $1 million or less.

Wisconsin Department of Natural Resources River Protection Grant Program

As described above, the River Protection Grant program as set forth in Chapter NR 195 of the *Wisconsin Administrative Code* was designed to assist local governments, lake districts and associations, and other nonprofit organizations in improving and protecting water quality in rivers. A 75 percent State cost-share is available, with a 25 percent local match. Cost-share funding cannot exceed $50,000 for a management project. The types of projects that are eligible for cost-share assistance include management activities such as land acquisition, easement establishment, ordinance development, installation of nonpoint source pollution abatement projects, river restoration projects, and river plan implementation projects.

Wisconsin Department of Natural Resources Municipal Flood Control Grant Program

As described above, municipalities, including cities, towns, and villages, as well as metropolitan sewerage districts are eligible for cost-sharing grants from the State for projects related to municipal flood control management through the Municipal Flood Control Grant Program. Eligible projects include the construction of facilities for the collection, detention, retention, storage, and transmission of stormwater and groundwater for flood control. Municipalities and metropolitan sewerage districts are eligible for up to 70 percent State cost-share funding for eligible projects, and would have to provide at least a 30 percent local match. Applications are due on March 15 of each calendar year.

Wisconsin Department of Natural Resources Targeted Runoff Management Grant Program
The Targeted Runoff Management Grant Program provides cost-share funds to control nonpoint source pollution from both urban and agricultural areas. Projects funded by this program are site-specific and serve areas smaller than a subwatershed. Eligible applicants include cities, villages, towns, counties, regional planning commissions, and special purpose districts such as lake districts, sewerage districts, and sanitary districts. The maximum cost-share rate available to grant recipients is 70 percent of eligible costs, with the total of State funding not to exceed $150,000. Examples of eligible projects include detention basins, wet basins, infiltration basins and trenches, and wetland basins. These and other eligible practices are listed in Chapter NR 153 and Section NR 154.04 of the *Wisconsin Administrative Code.* Highest priority in selecting projects under this program is given to projects that implement performance standards and prohibitions contained in Chapter NR 151 of the *Wisconsin Administrative Code* or that address waterbodies listed on the Federal Section 303(d) list of impaired waters.

Wisconsin Department of Natural Resources Urban Nonpoint Source and Storm Water Management Grants
The Urban Nonpoint Source and Storm Water Management Grant Program provides cost-share funds for planning and construction activities for controlling nonpoint source pollution from urban project areas. Projects funded by this program are site-specific, serve areas smaller than a subwatershed, and are targeted to address high-priority problems. Eligible applicants include cities, villages, towns, counties, regional planning commissions, and special purpose districts such as lake districts, sewerage districts, and sanitary districts. In addition, an urban project area must meet at least one of the following criteria:

- The area has a residential population density of at least 1,000 persons per square mile;
- The area has commercial or industrial land use;
- The area is a portion of a privately owned industrial site not covered under a WPDES permit issued under Chapter NR 216 of the *Wisconsin Administrative Code*; or
- The area is a municipally owned industrial site.

The maximum cost-share rate available for planning grants is 70 percent of eligible costs. The maximum cost-share rate available for construction grants is 50 percent of eligible costs, with a total State share for a construction project of $150,000 and a potential grant of an additional $50,000 for land acquisition, where needed. Planning grants can be used to pay for a variety of eligible activities, including stormwater management planning for existing and new development, related information and education activities, ordinance and utility district development, and enforcement. Construction grants can be used to pay for the construction of best management practices to control stormwater pollution from existing urban areas. Projects may be eligible for funding whether or not they are designed to meet the performance standards identified in Section NR 151.13 of the *Wisconsin Administrative Code*, but the highest priority in selecting projects under this program is given to projects that implement performance standards and prohibitions contained in Chapter NR 151 of the *Wisconsin Administrative Code* or that address waterbodies listed on the Federal Section 303(d) list of impaired waters.

CONTINUING REGIONAL WATER SUPPLY PLANNING PROGRAM

As previously noted, it is essential that a planning body remain in place to coordinate and advise on the execution of the recommended regional water supply plan and to undertake plan updating and extension efforts as may be necessitated by changing events. As the designated areawide water quality management planning agency, under Section 208 of the Federal Water Pollution Control Act, the Regional Planning Commission is charged with the responsibility of conducting this continuing areawide water quality management planning program, and has been conducting that program in collaboration with the WDNR, metropolitan sewerage districts, utility and sanitary districts, counties, cities, villages, and towns since the initial regional water quality management plan was adopted in 1979.

Wisconsin Act 227 of 2007 specifies that, the areawide water quality management agency designated by the Governor under Chapter NR 121 of the *Wisconsin Administrative Code*, and pursuant to Section 208 of the

Federal Clean Water Act, shall delineate the proposed water supply service areas for all of the public water supply systems within the planning area for which the agency is designated. The Act also requires that the proposed water supply service areas delineated shall be consistent with the areawide water quality management plan. In addition, the Act provides that an areawide water quality plan may provide regional water needs assessments and other regional water supply planning information.

Scope and Content of Continuing Regional Water Supply Planning Effort

The continuing regional water supply planning effort is based on the conduct of six major planning functions. These six functions are: plan surveillance; plan reappraisal; plan expansion; service and plan implementation; procedural development; and documentation. These functions provide the basis for the continuing regional water supply planning program.

Plan Surveillance

Under the plan surveillance function, regional development is to be monitored in relation to the assumptions underlying the recommended regional water supply plan. The extensive data base created by the inventories conducted as part of this planning effort are to be maintained current. In addition, data pertaining to the amounts and spatial locations of changes in population, economic activity, and land use development are to be monitored. The annual work program of the Commission will specify the precise scope of the plan surveillance function in any given year.

Consideration of regional water supply planning information on local water supply facility planning is foreshadowed in 2007 Wisconsin Act 227. Because of the importance to provide consistency in local and regional plans, it is recommended that the WDNR submit copies of local water supply facility plans and water supply service area plans developed for the Region to the Regional Planning Commission for consideration and comment. Comments and recommendations made by the Regional Planning Commission would be considered advisory to the WDNR.

Plan Reappraisal

Under the plan reappraisal function, the regional water supply plan elements and the forecasts and assumptions underlying these plan elements are to be continually reappraised in light of changes in actual regional development as those changes are revealed by the surveillance function. Plan amendments may be issued to adjust plan recommendations based on the findings of the plan surveillance function. Major plan updates and revisions are proposed to be undertaken periodically, subject to the availability of funding. Those reappraisals would examine the continued validity of the regional water supply plan in light of possible identified changes in the water supply objectives and standards, as well as in any basic assumptions and forecasts upon which the plan is based. For major plan updates, consideration will be given to the recommendations directed to the Regional Planning Commission in the socioeconomic analysis[16] to prepare a formal public participation plan for the planning effort.

Plan Expansion

In a program like the regional water supply planning program, it is necessary to limit the initial plan development to consideration of the most urgent and highest priority needs. Under the plan expansion function of a continuing program, the scope of the initial planning effort may be expected to be expanded to address additional emerging problems. It is envisioned, for example, that additional detailed groundwater flow studies could be undertaken using finer-scaled insets to the regional aquifer simulation model. These studies would both simplify the analyses called for under the high-capacity well siting procedure recommended under the plan and would help make these analyses more uniform across the Region. In addition, the program could include delineation of water supply service areas for the public water supply systems in the planning area. Such service area delineations are required

[16] *University of Wisconsin-Milwaukee Center for Economic Development,* Socio-Economic Impact Analysis of the Regional Water Supply Plan for Southeastern Wisconsin, *July 31, 2010.*

under Chapter 281 of the *Wisconsin Statutes* and are required to be consistent with the approved areawide water quality management plan. Whether or not the plan is expanded into additional areas will be largely dependent upon the availability of local, State, and Federal funding.

Service and Plan Implementation

Under the service and plan implementation function, the data and forecasts upon which the water supply plan is based are to be made available to the designated management agencies as a basis for making day-to-day water supply decisions, thereby promoting integration of Federal, State, and local planning and plan implementation efforts. The service and plan implementation function is important because, to be of use in decision making, the adopted plan requires almost constant interpretation. In addition, the inventory data, analyses, and forecasts on which the plan is based must be made available on request for review and utilization in subsequent planning and plan implementation efforts. In addition, detailed facilities planning, necessary to refine the regional water supply plan, should be fully coordinated with the regional plan.

Procedural Development

Under the procedural development function, the techniques and procedures used for water supply planning are to be evaluated, improved upon, and, where necessary, replaced through the development of new techniques and procedures. This function includes maintaining a current state-of-the-art of water supply planning capability at the regional level.

Documentation

The documentation function is used to meet the continuing need to provide an important historical record of the water supply planning process for the Southeastern Wisconsin Region. The documentation effort under the continuing planning program may consist of the following: plan amendment documents; major planning reports documenting the plan reappraisal and expansion efforts; community assistance planning reports documenting the more detailed local planning efforts of communities in the Region; technical reports and technical records documenting any procedural development activities; and annual reports setting forth a record of the salient water supply planning and plan implementation activities in the Region. Such annual reports will be included in the Commission's statutorily required *Annual Report*.

Financial Support for Continuing Planning Effort

The Commission intends to provide modest support in order to provide a base level for plan monitoring; however, it is recognized that other continuing planning activities may require funding from other sources.

Chapter XII

SUMMARY

INTRODUCTION

This report documents the regional water supply plan for southeastern Wisconsin, as prepared by the Southeastern Wisconsin Regional Planning Commission (SEWRPC), as well as the process used to arrive at that plan. The plan constitutes a major element of the evolving comprehensive plan for the seven-county Southeastern Wisconsin Region.

The regional water supply plan consists of seven elements addressing 1) service areas, sources of water supply, and major facilities; 2) water conservation; 3) groundwater recharge area protection; 4) stormwater management practices; 5) high-capacity well siting practices; 6) enhanced rainfall infiltration systems; and 7) auxiliary measures. The recommendations contained in these elements, taken together, are intended to serve as a basis for the provision of a sustainable water supply for the Southeastern Wisconsin Region through 2035, the design year of the plan.

STUDY AREA

The 2,690 square mile Southeastern Wisconsin Region, as shown on Map 1 in Chapter I of this report includes all of Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, and Waukesha Counties. In 2000, there were 147 municipal governmental units within the Region. In addition, there were 18 special-purpose units of government, such as town utility and sanitary districts, which provide water supply services. In 2000, the resident population of the Region was about 1.93 million. About 1.56 million, or about 81 percent, of the residents of the Region were served by public water supply systems. About 37,000, or about 2 percent, of the residents were served by privately, or cooperatively owned, water supply systems; and about 333,000, or about 17 percent, of the residents were served by private domestic wells.

A subcontinental divide which separates the Great Lakes-St. Lawrence River basin from the Mississippi River basin traverses the Region. This divide is an important consideration in water supply and related sanitary sewerage and stormwater management systems planning due not only to the physical constraints it places on the design of water supply and sewerage systems, but also due to the regulations and policies governing the use of surface and groundwater in, and adjacent to, the Great Lakes-St. Lawrence River basin.

The Region relies upon two major sources of water supply: surface water provided by Lake Michigan, and groundwater. Lake Michigan is a major source of water for domestic, municipal, and industrial users in areas of the Region lying east of the subcontinental divide. Groundwater occurs within three major aquifers that underlie the Region. From the land surface downward, these consist of: 1) the sand and gravel deposits of the glacial drift;

2) the shallow dolomite strata of the underlying bedrock; and 3) the deeper sandstone, dolomite, siltstone, and shale strata. Because of their proximity to the land surface and hydraulic interconnection, the first two aquifers are commonly referred to collectively as the "shallow aquifer," while the latter is commonly referred to as the "deep aquifer." Within most of the Region, the shallow and deep aquifers are separated by a layer of Maquoketa shale, which forms a relatively impermeable barrier between the two aquifers.

AUTHORITY FOR PLAN PREPARATION

The Southeastern Wisconsin Regional Planning Commission is, pursuant to State legislation, the official areawide planning agency for the seven-county Southeastern Wisconsin Region. The Commission is charged by law with the duty of preparing and adopting a comprehensive plan for the physical development of the Region. The permissible scope and content of that plan, as outlined in the enabling legislation, extends to all phases of regional development, implicitly emphasizing, however, the preparation of plans for the use of land and for the supporting transportation, utility, and other public infrastructure facilities. The Commission is also the State-designated and Federally-recognized areawide water quality management planning agency for southeastern Wisconsin. The work of the Commission is intended to assist the responsible Federal, State, county, and local municipal units and agencies of government in the making of decisions concerning the development of the planning Region.

Pursuant to requests received from several constituent counties and municipalities within the Region, the Commission following its long-established practices, with the assistance of an advisory committee on water supply planning created for this purpose, prepared a prospectus for the preparation of a regional water supply system plan.[1] The prospectus set forth the need for, and the scope and content of, a regional water supply planning program; an estimated cost of the needed program; and a recommended means for funding the program. The membership of the advisory committee that guided the preparation of the prospectus included knowledgeable and concerned representatives of the constituent counties and municipalities; of concerned State and Federal agencies; of the academic community; and of concerned businesses and industries.

STUDY PURPOSE, SCOPE, AND ORGANIZATION

The primary purpose of the regional water supply planning program was to develop a sound and workable plan to guide the provision of adequate water supply service to existing and planned future development within the Region, and to do so in a manner consistent with the protection and wise use of the natural resource base, particularly, of the ground and surface water resources of the Region. The plan is intended to identify measures to resolve existing water supply problems and to avoid the future creation of such problems. The plan is intended to be in sufficient depth and detail to provide a framework within which sound local water supply planning and engineering can be conducted. To this end the plan contains recommendations concerning the location and extent of areas to be served by public water supply, and identifies attendant sources of supply. The plan is also intended to address associated legal and environmental issues, including such issues involving the transfer of water across the subcontinental divide traversing the Region. Given the entirely advisory nature of the Commission and its work, it is important to recognize that plan implementation will be dependent upon the actions of the Federal, State, county, and municipal units and agencies of government concerned, including, but not limited to: the refinement and detailing of water supply service areas; the development of detailed local water supply facility plans consistent with the regional system plan and with applicable regulations regarding sources of water supply and the diversion of water across the subcontinental divide; and the integration of the plan recommendations into comprehensive county and municipal plans and planning programs.

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[1]*See* Regional Water Supply Planning Program Prospectus, *Southeastern Wisconsin Regional Planning Commission, September 2002.*

Summary of Previous Water Supply Planning Efforts

The preparation of the regional water supply plan represents the third, and final, element of a Commission water supply planning program. The first element consisted of basic groundwater resource inventory. The second consisted of the development of a mathematical model which could accurately simulate the performance of the aquifers underlying the Region under varying conditions of use, including simulation of the attendant impacts on surface water conditions within the Region. The findings of the groundwater resource inventory are present in SEWRPC Technical Report No. 37, *Groundwater Resources of Southeastern Wisconsin,* June 2002. The regional groundwater simulation model is described in SEWRPC Technical Report No. 41, *A Regional Aquifer Simulation Model for Southeastern Wisconsin*, June 2005. The completion of these two elements involved cooperative efforts with the U.S. Geological Survey (USGS), the Wisconsin Geological and Natural History Survey (WGNHS), the University of Wisconsin-Milwaukee (UWM), the Wisconsin Department of Natural Resources (WDNR), and a number of the water supply utilities serving the Region.

Approach to Developing the Regional Water Supply Plan

The regional water supply planning program was comprised of the following major work efforts:

- Formulation of a set of regional water supply development and management objectives and supporting standards;
- Conduct of the inventories required of the service areas and capacities of the existing water supply facilities within the planning area;
- Conduct of the inventories required of the surface water and groundwater resources, and of the demographic and economic, land and water use, natural resource base conditions within the planning area, and an inventory of applicable water law;
- Determination of the state-of-the-art of water supply;
- Technical analyses of the inventory data, preparation of forecasts of probable future water supply needs, and identification of existing and probable future water supply problems;
- Preparation, test, and evaluation of alternative water supply plans;
- Selection of a recommended plan, including identification of recommended sources of supply, development of the infrastructure needed to deliver the supply, and of conservation measures needed to reduce water demand; and
- Identification of plan implementation measures.

Relationship to Other Planning Programs

The regional land use plan for 2035, which was completed in 2005 and is documented in SEWRPC Planning Report No. 48, *A Regional Land Use Plan for Southeastern Wisconsin: 2035,* June 2006, provides the basis for the land use development pattern envisioned in the regional water supply plan. In addition to the regional land use plan, the regional water supply plan is directly, or indirectly, related to a number of other completed regional, county, and municipal plans and planning programs. These include, among others, the regional transportation system plan, the regional water quality management plan and updates to that plan; county land and water resource management plans; the comprehensive or “smart growth” plans being prepared at the county and municipal levels of government within the Region; and the basin planning being carried out by the WDNR. The regional water supply plan is also related to the ongoing activities of the State Groundwater Advisory Committee created to make recommendations to the State Legislature regarding future groundwater management needs.[2] In addition to these plans and programs, there are other local planning programs which are relevant to the regional water supply planning effort and which were considered, as appropriate, in the regional water supply planning process. These include, among others, local water supply system facility plans, local stormwater management plans, and local land use plans.

Organizational Structure for the Planning Effort

Technical staffing for the regional water supply plan preparation was carried out under a cooperative arrangement involving the Commission staff; a consulting engineering firm; a consulting law firm; and the hydrogeology staffs of the Wisconsin Geological and Natural History Survey, the U.S. Geological Survey, and the University of Wisconsin-Milwaukee. The Commission served as the lead agency in the planning effort.

The work leading to the preparation of the regional water supply plan was carried out under the guidance of the Regional Water Supply Planning Advisory Committee. Members of the Advisory Committee included knowledgeable and concerned representatives of the constituent counties and municipalities; of concerned State and Federal agencies; of the academic, agricultural, and environmental communities; and of concerned businesses and industries. A list of the membership of the Advisory Committee is provided on the inside front cover of this report. The Advisory Committee guided the planning process, and carefully reviewed and approved this report.

Public Outreach for the Plan

During the course of the study, the Commission staff worked with a number of interests through individual and group meetings, providing information about, and obtaining input on, the plan and the planning process. These meetings included over 150 presentations to elected officials and interested business, civic, and environmental groups and organizations from within the Region. Also during the course of the study, newsletters were issued on a work progress basis to a wide audience including elected officials, appointed public planning and engineering officials, interested citizen groups, business and industry groups, print and broadcast media, and citizens who had in the past, or during the conduct of the planning effort, indicated an interest in the issues concerned. A series of nine public informational meetings were held to present the preliminary recommended water supply plan for public review and comment. In addition to these nine public informational meetings, two sessions of the "Water-Wise Conference" held in the City of Waukesha on March 7, 2009 were devoted to obtaining public reaction to the proposed plan. This conference was sponsored by the Waukesha County Environmental Action League, a citizen organization based in Waukesha County. One session included a presentation on the proposed plan and one session was devoted to obtaining public comments on the plan.

The Commission also maintains an Internet website which included materials prepared under the water supply planning effort, including drafts of the planning documents and newsletters, and which provided opportunity to offer comments on the planning effort.

Scheme of Presentation

Following Chapter I, the introductory chapter of this report, Chapter II presents base year 2000 information regarding demographic and economic base, land use, natural resource base, and other pertinent conditions within the Southeastern Wisconsin Region. Chapter III presents an inventory of the existing water supply sources and systems in the Region. Chapter IV sets forth forecasts of anticipated changes in population, households, and employment within the Region through the plan design year of 2035, and forecast water supply demands under

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[2]*The Groundwater Advisory Committee was charged with preparing two reports. The first report,* 2006 Report to the Legislature on Groundwater Management Areas*, issued in December 2006, dealt with issues and recommendations related to management of groundwater resources within groundwater management areas. The second report,* 2007 Report to the Legislature*, assesses the effectiveness of the Wisconsin Act 310 and the adequacy of specific provisions in the law primarily related to surface water environmental protection.*

planned land use conditions. Chapter V presents the water supply system development and management objectives and supporting standards adopted for use in the water supply planning program. Chapter VI summarizes the legal structure affecting water supply planning. Chapter VII identifies the water supply problems and issues which need to be addressed in the planning program as revealed by the forecasts and analyses of the existing water supply systems. Chapter VIII presents a description and evaluation of alternative regional water supply plans designed to address the identified existing and probable future water supply problems and issues. Chapter IX presents a comparative evaluation of the alternative plans considered, and sets forth a preliminary recommended regional water supply plan to be presented for public review. Chapter X presents a recommended water supply system plan designed to serve anticipated design year 2035 conditions within the Region. Chapter XI describes the actions which should be taken by the units and agencies of government concerned and others to implement the recommended plan. Finally this chapter, Chapter XII, summarizes the major findings and recommendations of the planning program.

This planning report is supplemented by five technical reports. These reports document findings of an inventory of the state-of-the-art of water supply practices,[3] an inventory of water supply law;[4] the development and application of groundwater impact indices to be used in alternative plan evaluation;[5] an inventory and analysis of aquifer recharge in the Region;[6] and an analysis of the impacts of varying densities of residential development on groundwater sustainability.[7] In addition, as part of the planning effort, an aquifer simulation model was developed and calibrated for the Region.[8]

ANTICIPATED GROWTH AND CHANGE AFFECTING WATER SUPPLY IN THE REGION

As previously noted, the forecasts of the levels and spatial distribution of future population and economic activity used to determine future demands for water use in the preparation of this water supply plan were based upon the adopted design year 2035 regional land use plan. This use of forecasts prepared for comprehensive, areawide planning purposes helps to assure consistency between the regional water supply plan and other long-range, areawide plan elements. For water supply planning purposes, the population forecasts were expressed in terms of resident individuals and households, while the economic activity forecasts were expressed in terms of employment. The spatial distributions concerned were expressed in terms of land use patterns.

As described in Chapter IV, the Commission employment forecasts envision a total employment level of 1.37 million jobs within the Region in 2035, an increase of 145,000 jobs, or about 12 percent, over the 2000 level of 1.22 million jobs. The population of the Region is forecast to increase from the year 2000 level of 1.93 million persons to about 2.28 million persons by the plan design year 2035, an increase of about 345,000 persons, or about 18 percent, over the 35-year period. Accompanying the changes in the size of the resident population of the

[3]*SEWRPC Technical Report No. 43,* State-of-the-Art of Water Supply Practices*, July 2007.*

[4]*SEWRPC Technical Report No. 44,* Water Supply Law*, April 2007.*

[5]*SEWRPC Technical Report No. 46,* Groundwater Budget Indices and Their Use in Assessing Water Supply Plans for Southeastern Wisconsin*, February 2010.*

[6]*SEWRPC Technical Report No. 47,* Groundwater Recharge in Southeastern Wisconsin Estimated by a GIS-Based Water-Balance Model*, July 2008.*

[7]*SEWRPC Technical Report No. 48,* Shallow Groundwater Quantity Sustainability Analysis Demonstration for the Southeastern Wisconsin Region*, November 2009.*

[8]*SEWRPC Technical Report No. 41,* A Regional Aquifer Simulation Model for Southeastern Wisconsin*, June 2005.*

Region are changes in the number and size of households. The number of households in the Region is forecast to increase from about 749,000 in 2000 to about 925,700 in 2035, an increase of about 176,700, or about 24 percent, over the 35-year period. Also, the average household size in the Region is forecast to decrease from the 2000 level of 2.52 persons per household to 2.39 persons per household by the plan design year 2035, a decline of 0.13 persons per household, or about 5.2 percent, over the 35-year period.

Under the regional land use plan, the combined area in the urban land use categories would increase from about 732 square miles in 2000 to about 825 square miles in 2035, an increase of about 93 square miles, or about 13 percent. Also under the 2035 regional land use plan, the area in urban use would account for about 31 percent of the total area of the Region, compared to about 27 percent in 2000. Under the adopted year 2035 regional land use plan, urban development is envisioned to occur within delineated urban service areas—areas that can be readily provided with basic urban services and facilities, including public sanitary sewer, water supply, and mass transit service. To the extent practicable, new urban land uses would be accommodated within existing urban service areas as infill development and through redevelopment as appropriate, thus maintaining and enhancing the viability of existing urban areas; maximizing the use of existing public infrastructure and services; and moderating the amount of open land converted to urban use. Additional urban development required to meet projected needs of the growing Region would be accommodated on lands proximate to existing urban service areas where basic urban services and facilities can be readily provided, resulting in the orderly expansion of existing urban service areas.

Based upon the changes in employment and population levels and in land use development, forecasts of future water use demand and pumpage were prepared for each utility expected to be in operation within the Region in the design year of the plan. The total water use demand on an average daily basis for the municipal water utilities so operating within the Region is forecast to increase from about 201 mgd in 2000, to about 258 mgd in 2035, an increase of about 28 percent. Of this total, the use of Lake Michigan water is expected to increase from a total of about 163 mgd to about 208 mgd, while the use of groundwater is expected to increase from about 38 mgd to about 50 mgd. The average per capita total water use was forecast to decrease moderately from about 128 gallons per capita per day in 2000, to about 123 gallons per capita per day in 2035.

PLANNING OBJECTIVES

Water supply system development and management objectives must be logically sound, related in a demonstrable and measurable way to alternative physical development proposals, and must be consistent with, and grow out of, regionwide development objectives. This is essential if the regional water supply plan is to comprise an integral element of a comprehensive plan for the physical development of the Region, and if sound coordination of the various interrelated aspects of regional development is to be achieved.

The Regional Planning Commission, in its planning efforts to date, has, after careful review and recommendation by various advisory and coordinating committees, adopted a number of regional development objectives relating to land use, transportation, sanitary sewerage, water quality management, air quality management, stormwater management and flood control, and park and open space preservation. These objectives, together with their supporting principles and standards, are set forth in Commission planning reports. Some of these objectives and standards are directly applicable to the water supply planning effort and are presented in this report. Some of these objectives have been refined based upon review of the planning objectives by the Advisory Committee on Regional Water Supply Planning. That review also resulted in the creation of some new objectives and supporting principles and standards. The plan objectives are listed below. More detailed descriptions of the objectives, along with the associated principles and standards, are presented in Chapter V of this report.

Objective No. 1—Support of Existing Land Use Patterns and Support and Direction of Planned Land Use Patterns

A regional water supply system which, through its capacity and efficiency, will effectively serve the existing regional land use pattern, promote the implementation of the regional land use plan, and identify any constraints to development in subareas of the Region which may require refinement of the regional land use plan.

Objective No. 2—Conservation and Wise Use of the Surface Water and Groundwater Supplies
A regional water supply plan which conserves and wisely utilizes the surface water and groundwater supplies of the Region so as to sustain those supplies for future, as well as existing needs.

Objective No. 3—Protection of Public Health, Safety, and Welfare
A regional water supply system which protects the public health, safety, and welfare.

Objective No. 4—Economical and Efficient Systems
The development of water supply facilities, operational improvements, and policies, that are both economical and efficient, best meeting all other objectives at the lowest practical cost, considering both long-term capital and operation and maintenance costs.

Objective No. 5—Responsive and Adaptive Plans
The development of water supply systems, operations, and policies which are flexible and adaptive in response to changing conditions.

ALTERNATIVE PLANS

As part of the planning process, a number of problems and issues related to water supply within the Region were identified and characterized. The water supply problems which have been identified within the Region are related to the adequacies of the capacities of the existing water supply infrastructure to meet forecast water supply demands; to the quantity and quality of the groundwater supplies; and to the sustained ability of those supplies to meet probable future needs. The water supply issues which have been identified within the Region are primarily related to: the availability of Lake Michigan supply and the diversion of such water across the subcontinental divide; the underutilization of existing Lake Michigan water supply capital facilities; groundwater-surface water interdependence; the relationship of water supply systems to other comprehensive plan elements; water conservation effectiveness; the relationship of recharge and use attributable to areas located adjacent to the Region; impacts of land use development within the Region on groundwater recharge; surface water quality; and climate change. These issues and problems are described in Chapter VII of this report.

Four alternative regional water supply plans were developed and considered to address these problems and issues and to meet the water supply development and management objectives and supporting standards described in Chapter V of this report. These alternative plans are described and evaluations of their performance, attendant costs, and environmental impacts are presented in Chapter VIII of this report. Selected characteristics of these alternative plans are presented in Table 198.

Alternative Plan 1—Continuation of Existing Sources of Water Supply
This alternative plan, as shown on Map 73 in Chapter VIII of this report, would maintain the existing sources of water supply utilized by the water utilities operating within the Region; groundwater for those now using groundwater and Lake Michigan water for those now using Lake Michigan water. For those groundwater-based utilities largely dependent upon the deep aquifer that were found to be experiencing water quality problems, appropriate treatment of the deep aquifer groundwater was assumed. In the Kenosha area, Lake Michigan water would continue to be provided west of the subcontinental divide by the City of Kenosha Water Utility to portions of the Village of Pleasant Prairie, the Town of Somers, and the Town of Bristol, as well as to portions of the City itself, recognizing longstanding inter-municipal agreements, investment in Lake Michigan water supply infrastructure, and provision for return flow already in place.

Alternative Plan 2—Limited Expansion of Lake Michigan and Shallow Groundwater Aquifer Supplies
This alternative plan, as shown on Map 83 in Chapter VIII of this report, would shift the source of supply of a limited number of communities from groundwater to Lake Michigan water in order to reduce drawdowns in the deep aquifer and address water quality issues associated with continued use of that aquifer. Under this alternative plan, four communities located east of the subcontinental divide—the Villages of Elm Grove and Germantown,

Table 198

SELECTED CHARACTERISTICS OF ALTERNATIVE REGIONAL WATER SUPPLY PLANS

Alternative Plan	New Components	2035 Groundwater Pumpage Amounts	2035 Lake Michigan Municipal Supply Amount
Alternative Plan 1: Design Year 2035 Forecast Conditions Under Existing Trends and Committed Actions	108 wells (8 deep, 100 shallow) 105 storage tanks 17 radium treatment systems 2 water plant expansions	106 mgd, an increase from 77 mgd in 2005 67 mgd from shallow aquifer 39 mgd from deep aquifer	214 mgd, an increase from 209 mgd in 2005
Alternative Plan 2: Design Year 2035 Forecast Conditions With Limited Expansions of Lake Michigan and Shallow Groundwater Aquifer Supplies	135 wells (all shallow) 97 storage tanks 2 water treatment plant expansions 6 Lake Michigan supply connections	93 mgd, of which 72 mgd is from the shallow aquifer and 21 mgd is from the deep aquifer	227 mgd
Alternative Plan 3: Design Year 2035 Forecast Conditions with Groundwater Recharge Enhancement	135 wells (all shallow) 97 storage tanks 2 water treatment plant expansions 6 Lake Michigan supply connections 83 rainfall infiltration sites 4 wastewater treatment infiltration systems 9 deep aquifer injection wells	93 mgd, of which 72 mgd is from the shallow aquifer and 21 mgd is from the deep aquifer	227 mgd, plus 9 mgd used for deep aquifer recharge
Alternative Plan 4: Further Expansion of Lake Michigan Supply	99 wells (all shallow) 90 storage tanks 2 to 4 water treatment plant expansions or new water treatment plant development, depending upon the subalternative selected 17 Lake Michigan supply connections Lake Michigan return flow component	65 mgd, of which 50 mgd is from the shallow aquifer and 15 mgd is from the deep aquifer	255 mgd

Source: Ruekert & Mielke, Inc., and SEWRPC.

the eastern portion of the City of Brookfield, and a portion of the Town of Yorkville—and two communities which straddle the subcontinental divide—the central portion of the City of New Berlin and the City of Muskego—would be converted from groundwater to Lake Michigan water as the source of supply. These communities already have return flow to Lake Michigan in place. In addition, for those groundwater-based utilities with deep aquifer water quality problems, shallow aquifer groundwater sources would replace or supplement deep aquifer groundwater.

Alternative Plan 3—Limited Expansion of Lake Michigan and Shallow Groundwater Aquifer Supplies with Groundwater Recharge Enhancement

This alternative plan would be the same as Alternative Plan 2, but would include groundwater aquifer recharge measures for both the shallow and deep aquifers. Locations of the systems that would provide these measures are shown on Maps 89 and 90 in Chapter VIII of this report. Shallow groundwater aquifer recharge measures would include identification and protection of the remaining most significant groundwater recharge areas within the Region either through preservation or development in a manner which would preserve the natural hydrology and rainfall infiltration; enhanced rainfall infiltration through measures distributed over about four square miles of open space at sites selected to minimize the impacts of groundwater use on lakes, streams, and wetlands; and the development of systems for further treatment and discharge of wastewater treatment plant effluent into the shallow groundwater at selected locations. Given that the intent of these aquifer recharge measures would be to supplement the groundwater aquifers, they may violate current State regulations and policies regarding groundwater management, and would require changes to, or variances from, those regulations and policies. Deep aquifer groundwater recharge measures would involve replenishment of the deep aquifer through a series of groundwater injection wells utilizing treated Lake Michigan water from existing Lake Michigan water treatment facilities. These injection wells would be located east of the subcontinental divide. Such injection wells would also require changes to, or variances from, State regulations and policies.

Alternative Plan 4—Further Expansion of Lake Michigan Supply

This alternative plan, as shown on Map 102 in Chapter VIII of this report, would further expand the use of Lake Michigan as a source of water supply—replacing groundwater as the source of supply—beyond the measures proposed in Alternative Plan 2, including expansion to communities located east of the subcontinental divide, communities straddling the subcontinental divide, and nonstraddling communities in counties straddling the subcontinental divide. The additional communities using Lake Michigan water located east of the subcontinental divide would include: the City of Cedarburg and the Villages of Fredonia, Grafton, and Saukville, all in Ozaukee County. The additional communities using Lake Michigan water straddling the subcontinental divide would include: the western portion of the City of Brookfield, the western portion of the Village of Menomonee Falls, the Town of Brookfield, all in Waukesha County, and the Village of Union Grove in Racine County. The nonstraddling communities using Lake Michigan water in counties straddling the subcontinental divide would include: the Cities of Pewaukee and Waukesha, and the Villages of Lannon, Pewaukee, and Sussex, all in Waukesha County. For all communities converting from groundwater to Lake Michigan water, return flow of treated wastewater would be provided. Three options for return flow were considered pending more detailed second level environmental assessments. These options were discharge to Underwood Creek, a tributary of the Menomonee River which flows to Lake Michigan; discharge to the Root River, a tributary to Lake Michigan; discharge to both Underwood Creek and the Root River; and discharge directly to Lake Michigan.

Comparative Evaluation of Alternative Plans

Table 199 summarizes the projected impacts of the alternative water supply plans on the groundwater and surface water systems of the Region. Under Alternative Plan 1 conditions, drawdown of the deep aquifer is expected to continue over most of the Region, although the rate of drawdown is expected to abate significantly. By contrast, Alternative Plans 2, 3, and 4 are expected to result in drawups over most of the Region. Figure 37 indicates that the amount of drawup and the geographical extent of the drawups differ among these alternative plans. The differences in the results show that higher and more widespread drawups in the deep aquifer could be achieved by either providing enhanced recharge to the deep aquifer or by shifting more water utilities from using the deep aquifer to using Lake Michigan or the shallow aquifer as their source of water supply.

Table 199 summarizes the impacts of the four alternative water supply plans on the shallow aquifers and surface water systems. Localized impacts in water levels in the shallow aquifer may be expected to occur around community wells under any of these alternative plans. The average drawdowns on a countywide basis which may be expected to result under the alternative plans would be one foot or less, with localized maximums of less than 80 feet. Some reduction in groundwater-derived baseflow to surface waterbodies would occur under each of the four alternative plans. While the average reduction would be small, some localized impacts would be significant. The analyses indicate that higher reductions in groundwater-derived baseflow would accompany greater reliance upon the shallow aquifer as a source of water supply. The analyses also indicate that lower reductions in groundwater-derived baseflow could be achieved by either providing enhanced recharge to the shallow aquifer or by shifting more water utilities from use of the shallow aquifer to use of Lake Michigan and their source of water supply.

Table 200 summarizes the estimated costs of the four alternative water supply plans. The costs presented represent those associated with new, expanded, or upgraded facilities. Capital costs of the alternative plans range from about $172 million for Alternative Plan 1 to about $475 million for Alternative Plan 4. The higher capital costs within this range are attendant to those alternative plans requiring the construction of major facilities to support shifting the source of water supply for some communities from the deep aquifer to the shallow aquifer or to Lake Michigan; for providing return flow to Lake Michigan, and for providing enhanced groundwater recharge. The operation and maintenance costs given in Table 200 represent the net amount arrived at by combining the operation and maintenance costs of the proposed new facilities and the reductions in costs resulting from the

Table 199

GROUNDWATER AND SURFACE WATER IMPACTS OF ALTERNATIVE REGIONAL WATER SUPPLY PLANS

Alternative Plan	Groundwater Level Impacts		Surface Water Baseflow Impacts
	Deep Aquifer	Shallow Aquifer	
Alternative Plan 1: Design Year 2035 Forecast Conditions Under Existing Trends and Committed Actions	**Significant slowdown in the drawdown of the deep aquifer** Average drawdown by county of 10 to 22 feet Maximum drawdown of 64 feet No drawup	**Localized impacts around community wells** Average drawdown by county of one foot or less Maximum drawdown of 76 feet	**Average 4.5 percent reduction in groundwater-derived baseflow** Average baseflow change by county of 0.0 to 7.4 percent reduction 19 of 100 sensitive sites have reduction of 10 percent or more
Alternative Plan 2: Design Year 2035 Forecast Conditions With Limited Expansions of Lake Michigan and Shallow Groundwater Aquifer Supplies	**Drawup in the deep aquifer** Average drawup by county of eight to 92 feet Maximum drawup of 237 feet No significant drawdown	**Localized impacts around community wells** Average drawdown by county of one foot or less Maximum drawdown of 76 feet	**Average 5.3 percent reduction in groundwater-derived baseflow** Average baseflow change by county of 2.0 percent augmentation to 10.4 percent reduction 23 of 100 sensitive sites have reduction of 10 percent or more
Alternative Plan 3: Design Year 2035 Forecast Conditions with Groundwater Recharge Enhancement	**Drawup in the deep aquifer** Average drawup by county of 14 to 212 feet Maximum drawup of 368 feet No significant drawdown	**Localized impacts around community wells** Average drawdown by county of one foot or less Maximum drawdown of 76 feet	**Average 1.7 percent reduction in groundwater-derived baseflow** Average baseflow change by county of 3.1 percent augmentation to 3.9 percent reduction 16 of 100 sensitive sites have reduction of 10 percent or more
Alternative Plan 4: Further Expansion of Lake Michigan Supply	**Drawup in the deep aquifer** Average drawup by county of 35 to 136 feet Maximum drawup of 270 feet No significant drawdown	**Localized impacts around community wells** Average drawdown by county of one foot or less Maximum drawdown of 51 feet	**Average 0.7 percent reduction in groundwater-derived baseflow** Average baseflow change by county of 14.9 percent augmentation to 4.5 percent reduction 13 of 100 sensitive sites have reduction of 10 percent or more

Source: U.S. Geological Survey and SEWRPC.

proposed replacement of existing facilities, and the elimination of individual residential water softener or other water treatment devices. Equivalent annual costs, including both capital and operation, range from about $11.1 million for Alternative Plan 2 to about $17.8 million for Alternative Plan 3.

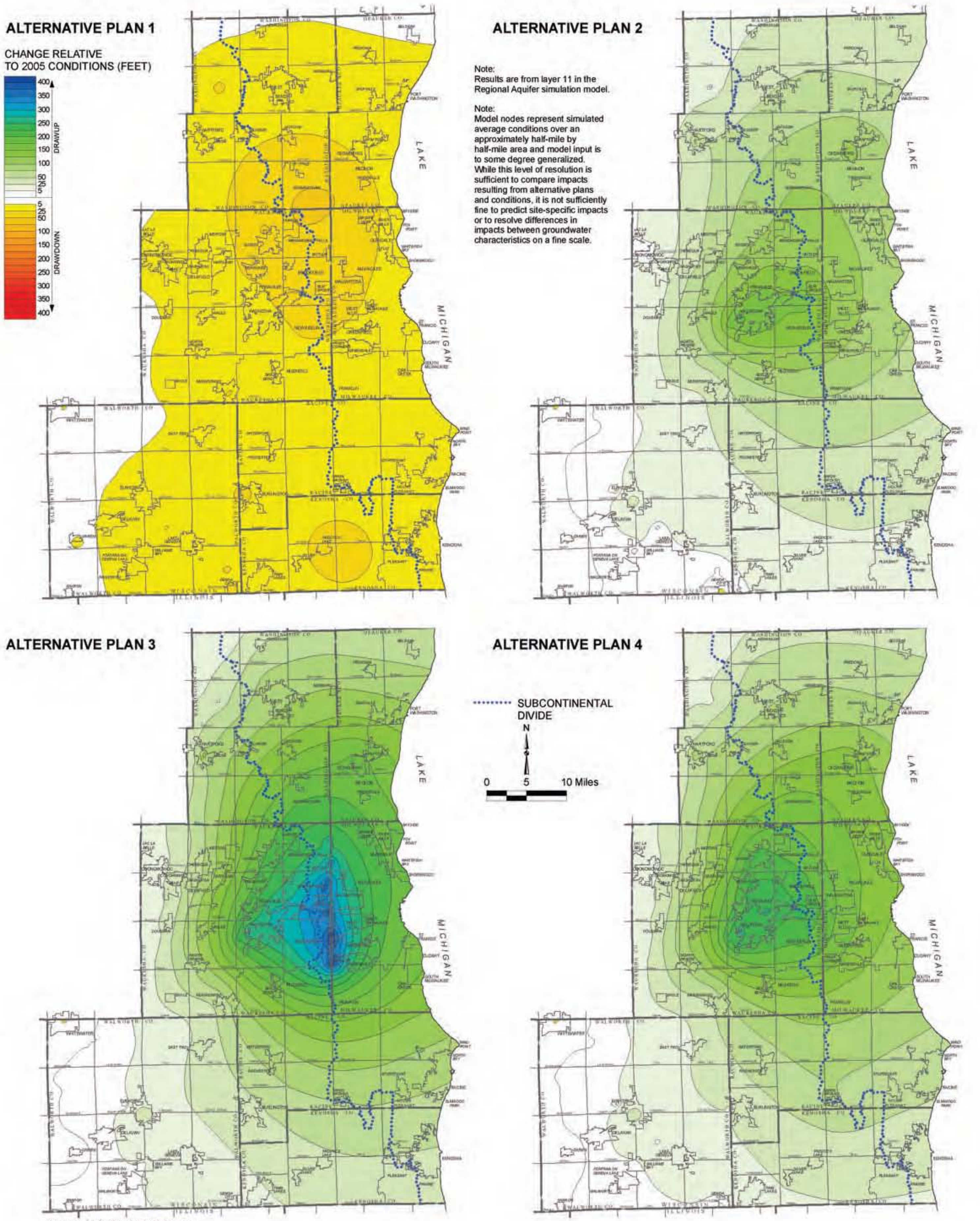
A comparative evaluation of the alternative plans was conducted by comparing the performance of each plan with respect to attainment of the water supply planning objectives and attendant supporting standards. The findings of this comparative evaluation are presented in Chapter IX of this report. Based upon the comparative evaluation of the four alternatives considered, the following conclusions were drawn:

- Some recovery of the deep groundwater aquifer could be achieved through an intermediate level shifting of utilities from use of the deep groundwater aquifer to Lake Michigan as a source of supply, and by placing greater reliance on the shallow groundwater aquifer as a source of water supply. This would provide for the long-term sustainable use of the deep aquifer,

- Although artificial recharge of the deep groundwater aquifer through injection wells would result in a greater rebound in water levels, such recharge is not needed in order to achieve long-term sustainability. Moreover, the additional cost, potential impacts on groundwater quality, and regulatory issues associated with this alternative make it an undesirable, as well as unnecessary, means to achieve sustainable use of the deep groundwater aquifer,

Figure 37

CONDITIONS IN THE DEEP AQUIFER ASSOCIATED WITH ALTERNATIVE WATER SUPPLY PLANS



Source: U.S. Geological Survey.

Table 200

COSTS OF ALTERNATIVE REGIONAL WATER SUPPLY PLANS

Alternative Plan	Capital (dollars)	Annual O&M (dollars)[a]	Equivalent Annual (dollars)
Alternative Plan 1	172 million	5.4 million gross 5.4 million net	11.6 million
Alternative Plan 2	254 million	5.8 million gross -0.7 million net[b]	11.1 million
Alternative Plan 3	403 million	11.8 million gross 5.3 million net[b]	17.8 million
Alternative Plan 4	472 million	7.3 million gross -14.4 million net[c]	14.5 million

[a]*Gross operation and maintenance cost represents the operation and maintenance costs of new, upgraded and expanded facilities. Net operations and maintenance costs includes a credit for reduced household water softening costs.*

[b]*Includes a credit of $6.5 million for reduced household water softening costs.*

[c]*Includes a credit of $21.7 million for reduced household water softening costs.*

Source: Ruekert & Mielke, Inc., and SEWRPC.

- Shifting the source of water supply from the deep groundwater aquifer to the shallow groundwater aquifer would result in reductions in groundwater-derived baseflow to some surface waters in the Region. Some of these streams that would experience reductions receive supplements to baseflow from the discharge of wastewater treatment plant effluent. Other streams, lakes, and wetlands would receive augmentations to baseflow, owing to the shift in supply. The reductions in baseflow would be significant in some areas, particularly in localized situations,

- Infiltration of treated wastewater treatment plant effluent into the shallow groundwater aquifer could supplement localized recharge of the shallow groundwater system. However, the level of treatment required in order to permit such infiltration would make this an expensive option. In addition, significant groundwater quality concerns and regulatory issues would be associated with this option,

- Rainfall infiltration systems could also supplement localized recharge of the shallow groundwater system. In some circumstances, such systems may potentially mitigate the effects of pumping from the shallow groundwater aquifer,

- Shifting the source of water supply from groundwater to Lake Michigan would permit the abandonment of point-of-use water softening systems and result in a reduction in chloride discharges to the environment, and

- Delineation of groundwater recharge areas indicate that a high degree of protection of the best groundwater recharge areas in the Region would be achieved through implementation of the adopted 2035 regional land use plan. Specifically, about 75 percent of the highly rated groundwater recharge areas, and about 78 percent of the very highly rated groundwater recharge areas may be expected to be maintained by inclusion in the environmental corridors, isolated natural resource areas, and prime and other agricultural areas identified for preservation in the adopted land use plan and in rural residential areas also identified in the plan. Careful design of new residential development, including use of cluster and conservation subdivision design, and the use of selected stormwater management practices would be expected to increase this amount.

The results of the comparative evaluation of the alternative plans indicated that each alternative plan considered contained some components that merited consideration for inclusion in a recommended plan. It was therefore concluded that a carefully constructed composite plan incorporating the best components of the alternative plans would be capable of meeting the planning objectives more fully than any of the four alternative plans considered.

Development of Composite Preliminary Recommended Plan

Based upon the comparative evaluation of the four alternative plans considered, a preliminary recommended plan, consisting of a composite plan combining the best elements of the alternative plans, was developed. This plan is described in Chapter IX of this report. The preliminary recommended plan includes the following elements:

- For the vast majority of water utilities required to serve existing and planned water supply service areas, the existing sources of supply—generally Lake Michigan, the shallow aquifer, or a combination of the shallow and deep aquifers underlying the Region—were determined to be adequate. These utilities are listed in Table 147 in Chapter IX of this report.

- The plan proposes that over time four utilities—The City of Delavan Water and Sewage Utility, the City of Elkhorn Water Utility, the Village of Union Grove, and the Town of Bristol Utility District No. 1—place greater reliance on the use of the shallow groundwater aquifer as a source of water supply either by replacing existing deep aquifer wells with shallow aquifer wells or by supplementing pumpage from existing deep wells with pumpage from shallow wells as new wells are constructed. In addition, the preliminary recommended plan recognizes that the City of Hartford Water Utility, in 2009, had a new shallow aquifer well and associated elevated storage tank under development. The well and storage tank were expected to be in service in 2010, at which time the Utility planned to abandon its remaining deep aquifer well.

- The plan proposes the conversion from groundwater to Lake Michigan as a source of water supply of those existing utility service areas, or portions of utility service areas, which currently have return flow to Lake Michigan in place. Seven of these—1) the eastern portion of the City of Brookfield Municipal Water Utility service area, 2) the City of Cedarburg Light and Water Commission, 3) the Village of Elm Grove, 4) the Village of Germantown Water Utility, 5) the Village of Grafton Water and Wastewater Commission, 6) the Village of Saukville Municipal Water Utility, and 7) The Town of Yorkville Utility District No. 1—are located east of the subcontinental divide. Two of these utilities—the central portion of the City of New Berlin Water Utility Service area and the City of Muskego Public Water Utility—serve communities that straddle the divide. These last two are within the Milwaukee Metropolitan Sewerage District sanitary sewer service area and, therefore, have existing return flow.

- The plan proposes that certain areas of existing urban development that are currently served by private, onsite wells be provided with municipal water supply either through the extension of service by existing utilities, or in some cases by the creation of new utilities. Such conversion is proposed only when a need is demonstrated and at the option of the affected utilities. Absent a demonstrated need and local initiative, residents and businesses of the areas would remain on individual wells indefinitely. These areas are listed in Table 148 in Chapter IX of this report.

- The plan envisions that the existing, self-supplied water systems serving residential communities, and most of the systems serving commercial, institutional, and recreational land uses, located within the planned municipal water supply service areas would be connected to the municipal systems by the plan design year 2035. Under the plan, a number of private, self-supplied water supply systems generally located beyond planned municipal water supply service areas would remain. These include self-supplied residential, industrial, commercial, institutional, recreational, agricultural, irrigation, and electric-power generation uses.

- The plan recommends the implementation of comprehensive water conservation programs, including both supply side water supply efficiency measures and demand side water conservation measures. The scope and content of these conservation programs are recommended on a utility-specific basis to reflect the source of supply and existing infrastructure. Expected reductions in demand vary from 4 to 10 percent on an average daily demand basin, and from 6 to 18 percent on a maximum daily demand basis.

- The plan includes a groundwater recharge area protection component directed at preserving existing groundwater recharge areas having a high or very high recharge potential. This component may be expected to be largely achieved through the implementation of the adopted design year 2035 regional land use plan, since that plan recommends preservation of the environmental corridors, isolated natural resource areas, and prime and other agricultural areas of the Region that facilitate recharge. The areas concerned are shown on Map 127 in Chapter X of this report. About 75 percent of the highly rated, and about 78 percent of the very highly rated, recharge areas may be expected to be preserved by inclusion in the environmental corridors, isolated natural resource areas, and prime and other agricultural areas identified for preservation in the adopted land use plan. Careful design of new residential development and the use of selected stormwater management practices would be expected to increase this amount.

- The plan includes a stormwater management component which recommends the implementation of available stormwater management practices, including treatment and infiltration systems, which—to the extent practicable—would maintain the natural recharge characteristics of proposed residential and selected nonresidential land use developments.

- The plan includes recommendations related to the siting of all new high-capacity wells and for the analysis and monitoring of impacts of such wells on the shallow aquifer. These provisions specify the measures that should be taken in the early stages of locating sites for high-capacity wells in the shallow aquifer to develop the necessary understanding of the hydrogeological conditions associated with each candidate site and its surrounding area and to assess the likelihood of impacts of proposed wells upon nearby existing wells and surface waterbodies. These recommendations also provide for monitoring of water levels in the vicinity of new high-capacity wells in the shallow aquifer, both during the test well phase of placement and during operation of the well.

  While it is recognized that siting wells in the shallow aquifer is dependent upon locating productive areas, some additional factors should be considered when siting wells constructed in this aquifer. Preference should be given to site locations that are less likely to produce adverse impacts upon surface waterbodies and existing wells. In addition, preference should be given to sites located adjacent to major rivers receiving treated effluent from municipal wastewater treatment plants downstream from the treatment plants. This application of riverbank filtration has the potential to increase available water supplies without degrading the environment.

- The plan recommends the installation of enhanced rainfall infiltration systems in areas where evaluations conducted in conjunction with siting of high-capacity wells in the shallow aquifer indicate that installation and operation of these wells would probably cause reductions in baseflow in nearby surface waterbodies or in water levels of lakes and wetlands. Locations of these sites are shown Map 108 in Chapter IX of this report.

These last four components of the preliminary recommended plan are intended to form the basis of a process to minimize the negative impacts on surface water systems associated with high-capacity well development.

Subalternatives to the Preliminary Recommended Plan

As part of the development of the preliminary recommended plan, two subalternatives were considered. Table 201 summarizes the principal characteristics of these subalternatives. The two subalternatives differ only with respect to the source of water supply for the City of Waukesha. Under Subalternative 1, the City of Waukesha would continue to utilize groundwater as a source of supply, with the supply being obtained by about equal use of the shallow and deep aquifers. This subalternative is summarized on Map 109 in Chapter IX of this report. Under Subalternative 2, it is envisioned that the City of Waukesha would be connected to a Lake Michigan supply and would provide return flow to Lake Michigan. This subalternative is summarized on Map 116 in Chapter IX of this report. Return flow could be provided by returning treated wastewater either to Lake Michigan or to streams tributary to Lake Michigan. Examples of return flow options are shown on Map 115 in Chapter IX of this report. More detailed planning and engineering developed at the local level as part of the plan implementation process would be required to determine the best means of providing this return flow.

Table 201

SELECTED CHARACTERISTICS OF SUBALTERNATIVES TO THE PRELIMINARY RECOMMENDED PLAN

Alternative Plan	New Components	2035 Groundwater Pumpage Amounts	2035 Lake Michigan Municipal Supply Amount
Subalternative 1: Design Year 2035 Forecast Conditions Intermediate Expansion of Lake Michigan Supply and City of Waukesha on Groundwater Supply	109 wells (2 deep, 107 shallow) 97 storage tanks 1 new water treatment plant 2 water treatment plant expansions 7 Lake Michigan supply connections 37 rainfall infiltration systems	88 mgd, an increase from 77 mgd in 2005 61 mgd from shallow aquifer 27 mgd from deep aquifer	232 mgd, an increase from 209 mgd in 2005
Subalternative 2: Design Year 2035 Forecast Conditions Intermediate Expansion of Lake Michigan Supply and City of Waukesha on Lake Michigan Supply	101 wells (2 deep, 99 shallow) 97 storage tanks 1 new water treatment plant 2 water treatment plant expansions 8 Lake Michigan supply connections 31 rainfall infiltration systems	78 mgd, nearly the same as in 2005 56 mgd from shallow aquifer 22 mgd from deep aquifer	242 mgd, an increase from 209 mgd in 2005

Source: Ruekert & Mielke, Inc., and SEWRPC.

Table 202

GROUNDWATER AND SURFACE WATER IMPACTS OF SUBALTERNATIVES TO THE PRELIMINARY RECOMMENDED PLAN

Alternative Plan	Groundwater Level Impacts		Surface Water Baseflow Impacts
	Deep Aquifer	Shallow Aquifer	
Subalternative 1: Design Year 2035 Forecast Conditions Intermediate Expansion of Lake Michigan Supply and City of Waukesha on Groundwater Supply	**Drawup in the deep aquifer** Average drawup by county of 3 to 39 feet Maximum drawup of 225 feet Some drawdown in Walworth County and portions of Kenosha and Racine Counties	**Localized impacts around community wells** Average drawdown by county of 2 feet or less Maximum drawdown of 71 feet	**Average 3.4 percent reduction in groundwater-derived baseflow** Average baseflow change by county of 14.3 percent augmentation to 4.6 percent reduction 26 of 100 sensitive sites have reduction of 10 percent or more
Subalternative 2: Design Year 2035 Forecast Conditions Intermediate Expansion of Lake Michigan Supply and City of Waukesha on Lake Michigan Supply	**Drawup in the deep aquifer** Average drawup by county of 8 to 85 feet Maximum drawup of 248 feet No significant drawdown	**Localized impacts around community wells** Average drawdown by county of 2 feet or less Maximum drawdown of 71 feet	**Average 2.0 percent reduction in groundwater-derived baseflow** Average baseflow change by county of 14.9 percent augmentation to 4.5 percent reduction 14 of 100 sensitive sites have reduction of 10 percent or more

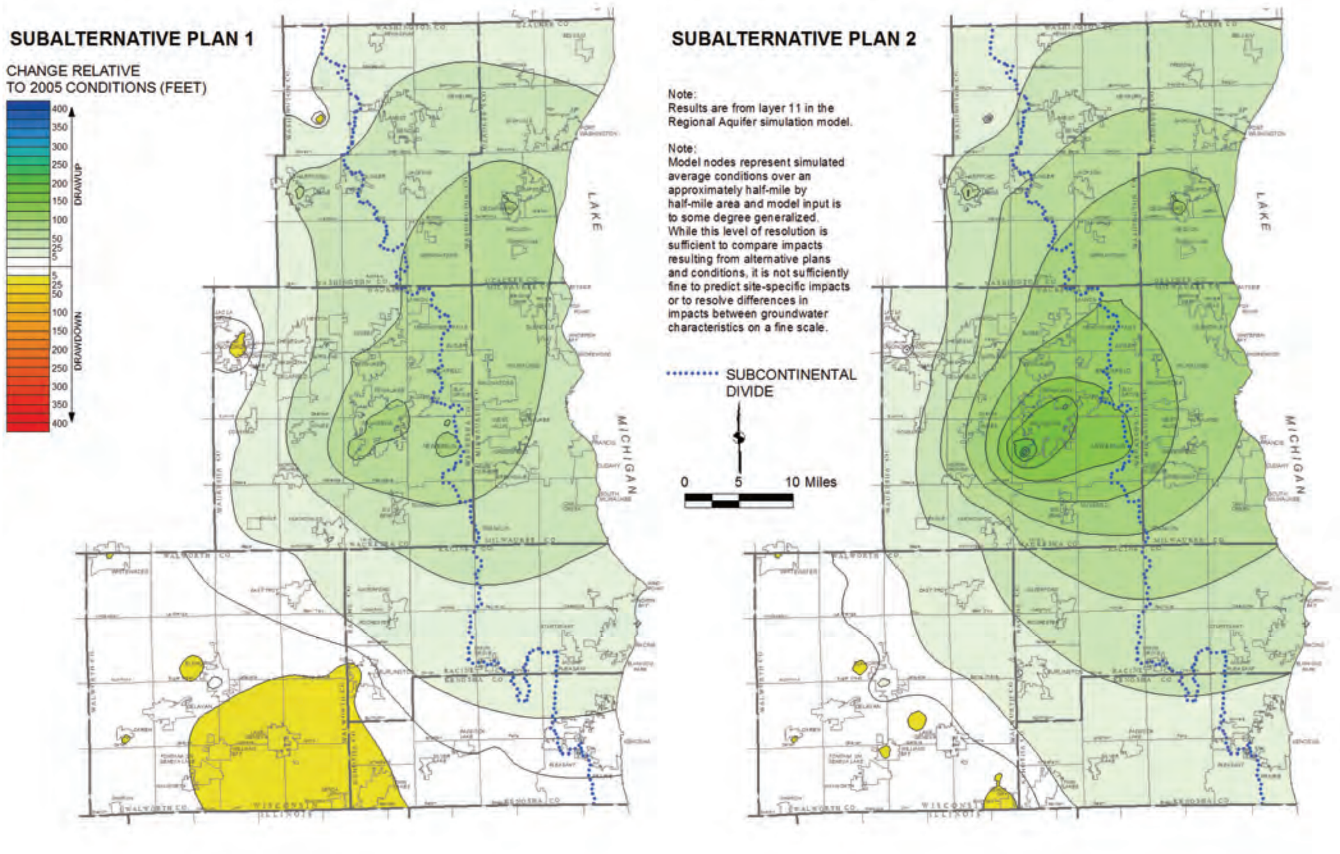
Source: U.S. Geological Survey and SEWRPC.

Evaluation of Subalternatives to the Preliminary Recommended Plan

Table 202 summarizes the projected impacts of the subalternatives to the preliminary recommended water supply plans on the groundwater and surface water systems of the Region. Both subalternatives to the preliminary recommended plan are expected to result in drawups—or rises—in the deep aquifer over a portion of the Region. Figure 38 shows that the amount of the drawups, and the geographical extent of the drawups, differ between the two subalternatives. The analyses indicate that substantially higher and more widespread drawups in the deep aquifer could be achieved by utilizing Lake Michigan water as a source of supply for the City of Waukesha than could be achieved by utilizing a combination of shallow and deep groundwater as a source of supply. These analyses also indicate that the deep aquifer in a large area comprised of much of Walworth County and more

Figure 38

CONDITIONS IN THE DEEP AQUIFER ASSOCIATED WITH THE SUBALTERNATIVES TO THE PRELIMINARY RECOMMENDED PLAN



Source: U.S. Geological Survey.

limited portions of Kenosha and Racine Counties may be expected to experience drawdowns in excess of five feet under Subalternative 1 conditions with lesser drawdown amounts and less extensive drawdown areas under Subalternative 2 conditions. These drawdowns would likely result from the combined effects of pumping from the deep aquifer in the affected area, and groundwater flow related to pumping in more distant areas including Waukesha and northern Illinois.

Table 202 also summarizes the projected impacts of the two subalternatives on the shallow aquifer and surface water systems. Localized impacts in water levels in the shallow aquifer would be expected to occur around municipal water utility wells under either of these subalternatives. The average drawdowns on a countywide basis expected to result under the subalternatives would be two feet or less, with localized maximums of less than about 71 feet. Some reduction in groundwater-derived baseflow to surface waterbodies would occur under both of the subalternatives. While the average reduction would be small, there would be significant localized impacts. These analyses indicated that higher reductions in groundwater-derived baseflow would accompany greater reliance by the City of Waukesha upon the shallow aquifer as a source of water supply.

Table 203 summarizes the estimated costs of the two subalternatives to the preliminary recommended water supply plan. The costs represent those associated with all new, expanded, or upgraded facilities. Capital costs of the preliminary recommended plan range from about $297 million for Subalternative 1, to between $329 million and $356 million for Subalternative 2, depending upon which option for return flow would be found best. The

Table 203

COSTS OF SUBALTERNATIVES TO THE PRELIMINARY RECOMMENDED REGIONAL WATER SUPPLY PLAN

Alternative Plan	Capital (dollars)	Annual Operations and Maintenance[a] (dollars)	Equivalent Annual (dollars)
Subalternative 1	297 million	8.0 million gross -1.4 million net[b]	13.1 million
Subalternative 2	329 to 356 million[c]	8.0 to 8.5 million gross[c] -8.7 to -8.2 million net[c,d]	8.5 to 10.8 million[c]

[a]*Gross operations and maintenance cost represents the operations and maintenance costs of new, upgraded, and expanded facilities. Net operations and maintenance cost includes a credit for reduced household water softening costs.*

[b]*Includes a credit of $9.4 million of reduced household water softening costs.*

[c]*Range of costs is based upon the costs of the options for return flow components.*

[d]*Includes a credit of $16.7 million for reduced household water softening costs.*

Source: Ruekert & Mielke, Inc., and SEWRPC.

gross annual operation and maintenance costs of new facilities under the two subalternatives range between $8.0 million for Subalternative 1 to from about $8.0 million to $8.5 million for Subalternative 2, depending upon which option for return flow would be found best.

It is anticipated that under the plan there would be a reduced use of water softening measures in those areas proposed for conversion to a Lake Michigan water supply. It is expected that this would result in a reduction of costs to the public related to use and operation of water softener and other point-of-use water treatment devices ranging from $9.4 million under Subalternative 1, to $16.7 million under Subalternative 2. When the expected reductions in cost due to the potential elimination of individual residential water softener or other point-of-use water treatment devices are included, Subalternative 1 would result in a net annual savings to the public of about $1.4 million, while Subalternative 2 would result in a net annual savings to the public of between about $8.2 million and $8.7 million. Equivalent annual costs, including both capital and operation, are estimated to be about $13.1 million for Subalternative 1 and to range between $8.5 million and $10.8 million for Subalternative 2, depending upon which option for return flow would be found best.

Based upon this comparative evaluation, Subalternative 2 was selected for inclusion in the preliminary recommended plan. Subalternative 2 was considered to be the more cost-effective alternative when considering the potential savings relating to the discontinuance of water softener and other point-of-use water treatment devices. Subalternative 2 offers an opportunity to utilize excess Lake Michigan water production capacity and provide potential cost advantages to both the supplier and purchasing utilities. Subalternative 2 would provide greater drawups in the deep groundwater aquifer. This factor is important in addressing the objectives of 2003 Wisconsin Act 310 and the recommendations of the State Groundwater Advisory Committee created by that law. This is a particularly important factor because the aquifer performance modeling simulation conducted under the planning effort indicated that it is possible that unsaturated conditions may exist in the Sinnipee Group of the upper portions of the deep aquifer below east-central Waukesha County. This condition could be exacerbated by further pumping of the aquifer. If unsaturated conditions develop in depth and spread with continued pumping, it could limit the sustainability of well yields and affect well water quality due to the increased potential for oxidation and related pollution of the water.

Subalternative 2 also results in lower losses of baseflow to surface waters, and greater reductions in chloride discharges to surface water than Subalternative 1. Subalternative 2 meets the water supply planning objectives more fully than Subalternative 1, and was therefore presented to the public as the preliminary recommended water supply plan for the Southeastern Wisconsin Region.

A comparative evaluation of the subalternatives to the preliminary recommended plan was conducted by comparing the performance of each subalternative with respect to the attainment of the water supply planning objectives and attendant standards. This evaluation is described and its results are presented in Chapter IX of this report.

PUBLIC REACTION TO THE PRELIMINARY RECOMMENDED PLAN

The Commission staff used several means to seek public reaction to the regional water supply plan. As already noted, over the course of the planning effort, the Commission staff worked with a number of interests, holding both individual meetings with elected and appointed officials and representatives of the business, industrial and environmental communities, and group meetings involving interested and concerned citizens to provide information about, and obtain comment on, the plans and the planning process. Also over the course of the study, newsletters were issued on a work progress basis to a wide audience. A series of nine public informational meetings and hearings were held to present the preliminary recommended water supply plan for public review and comment. In addition to these nine public informational meetings, two sessions of the "Water-Wise Conference" held in the City of Waukesha on March 7, 2009, were devoted to obtaining public reaction to the proposed plan. The Commission also maintained an Internet website which provided materials prepared under the water supply planning effort, including summary and background information, drafts of the planning documents, newsletters, and which provided opportunity to offer comments on the plans and planning effort.

Attendance at the nine public information meetings and at the informational sessions held at the Water-Wise Conference totaled 181 persons. Comments on the plan were received from 160 persons, agencies, municipalities, utilities, and organizations; including written comments received at the meetings, comments dictated to the court reporter at the meetings, and comments received via United States mail, fax, e-mail, and the comments page of the Commission website. The comments received are summarized in Chapter X of this report, and are fully documented in the *Record of Public Comments: A Regional Water Supply Plan for Southeastern Wisconsin*, October 2009.

Four of the 160 comments received indicated general support for the preliminary recommended regional water supply plan. Among the written comments generally supporting the plan were letters from the City of Waukesha Water Utility and the Public Service Commission of Wisconsin. Seventeen of the comments received were not relevant to the regional water supply plan, but rather related to such matters as other planned infrastructure improvement proposals, such as highway and sewerage system improvements, and were judged as not requiring response. The remaining 139 comments were related to suggested changes or additions to the plan, support for specific aspects of the plan, or specific concerns or issues regarding the plan and were considered to require careful consideration and response.

At the request of the SEWRPC Environmental Justice Task Force, a socioeconomic analysis of the preliminary recommended plan was conducted. The analysis was conducted by the University of Wisconsin Milwaukee Center for Economic Development, and the findings of the analysis are documented in the report entitled *Socio-Economic Impact Analysis of the Regional Water Supply Plan for Southeastern Wisconsin*, July 2010, prepared by the University Center. The findings of the socioeconomic analysis are summarized in Chapter X, and are further detailed in Appendix P. Recommendations set forth in the socioeconomic impact analysis were incorporated into the recommended plan and plan implementation actions.

RECOMMENDED PLAN

Land Use Basis for Regional Water Supply Plan

As already noted, the adopted design year 2035 regional land use plan served as the basis for the preparation of the regional water supply plan. The regional land use plan was designed to accommodate the regional employment, population, and household forecasts described in Chapter IV of this report. The plan seeks to encourage infill development and redevelopment in existing urban centers, and the location of new urban development adjacent to, and outward from, existing urban centers in areas which can be readily served by sanitary sewerage and water supply systems and by mass transit facilities. The plan seeks to preserve the environmental corridors and isolated natural resource areas within the Region in essentially natural open uses, and to preserve the best remaining agricultural areas of the Region in agricultural uses.

Six of the seven counties comprising the Region, as of 2010, in response to State legislation, adopted “smart growth” plans. The land use elements of those plans are generally in conformance with the adopted regional land use plan, the exceptions being largely associated with the lack of preservation by a few rural communities of some prime agricultural lands as recommended in the regional plan, proposing very low-density urban development instead, and with some urban communities envisioning more substantial growth by the plan year 2035 than does the regional plan. By State law, adoption of the smart growth plans must be by ordinance, and the exercise of certain plan implementation powers, such as zoning and land subdivision control, must be in conformance with the adopted plans. The “smart growth” plan adoptions at the county level indicate strong support by the County Boards for the regional land use plan. Only Milwaukee County has not prepared a county-level smart growth plan, there being little perceived need to do so since the entire County is included within incorporated municipalities which, under the *Wisconsin Statutes*, must prepare their own smart growth plans.

The recommended regional water supply plan set forth herein was judged to be the best of the alternative means identified in meeting the water supply planning objectives set forth in Chapter V, including consideration of costs and environmental impacts. The recommended water supply plan also takes into consideration the substantial comments received during the extensive public informational meetings and hearings conducted as a part of the planning program.

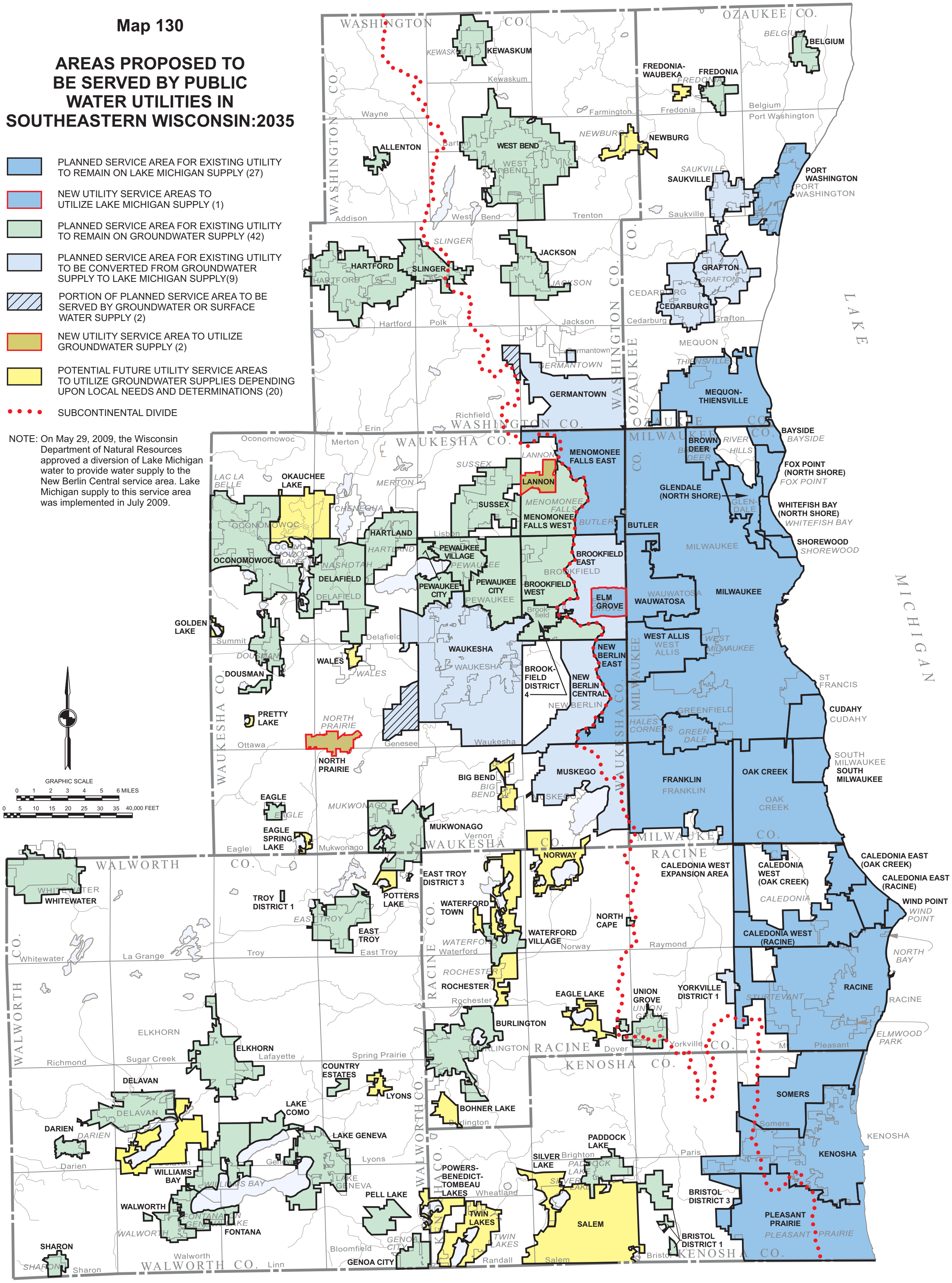
Under the recommended regional water supply plan, the design year 2035 total average annual groundwater pumpage is estimated to approximate 78 million gallons per day (mgd), with about 56 mgd, or about 72 percent, from the shallow aquifer, and about 22 mgd, or about 27 percent, from the deep aquifer. This compares to the year 2005 total pumpage of about 77 mgd; with about 47 mgd, or about 55 percent, from the shallow aquifer; and about 35 mgd, or about 45 percent from the deep aquifer. The design year 2035 municipal water utility average annual groundwater pumpage is estimated to approximate 61 mgd. This compares to a year 2005 pumpage of about 49 mgd. In addition, the design year 2035 municipal water supply pumpage of Lake Michigan water is estimated to approximate 242 mgd. This compares to the year 2005 pumpage of about 209 mgd. While the design year 2035 surface water is expected to increase compared to 2005 water use, the design year amount of surface water expected to be used is lower than the historic 1985 surface water use.

Plan Elements

Based upon careful consideration of the comments received at the public hearings held on the preliminary recommended regional water supply plan, that plan was refined to form the recommended regional water supply plan. The sources of water supply envisioned under the recommended plan for the various existing and proposed service areas are shown on Map 130. The number of utilities proposed to utilize the various sources of supply, together with the estimated design year 2035 population served and average daily pumpage are set forth in Table 185 in Chapter X of this report. Map 131 illustrates the primary facilities envisioned to be used to provide the sources of supply. The elements of the recommended water supply plan may be summarized as follows:

Map 130

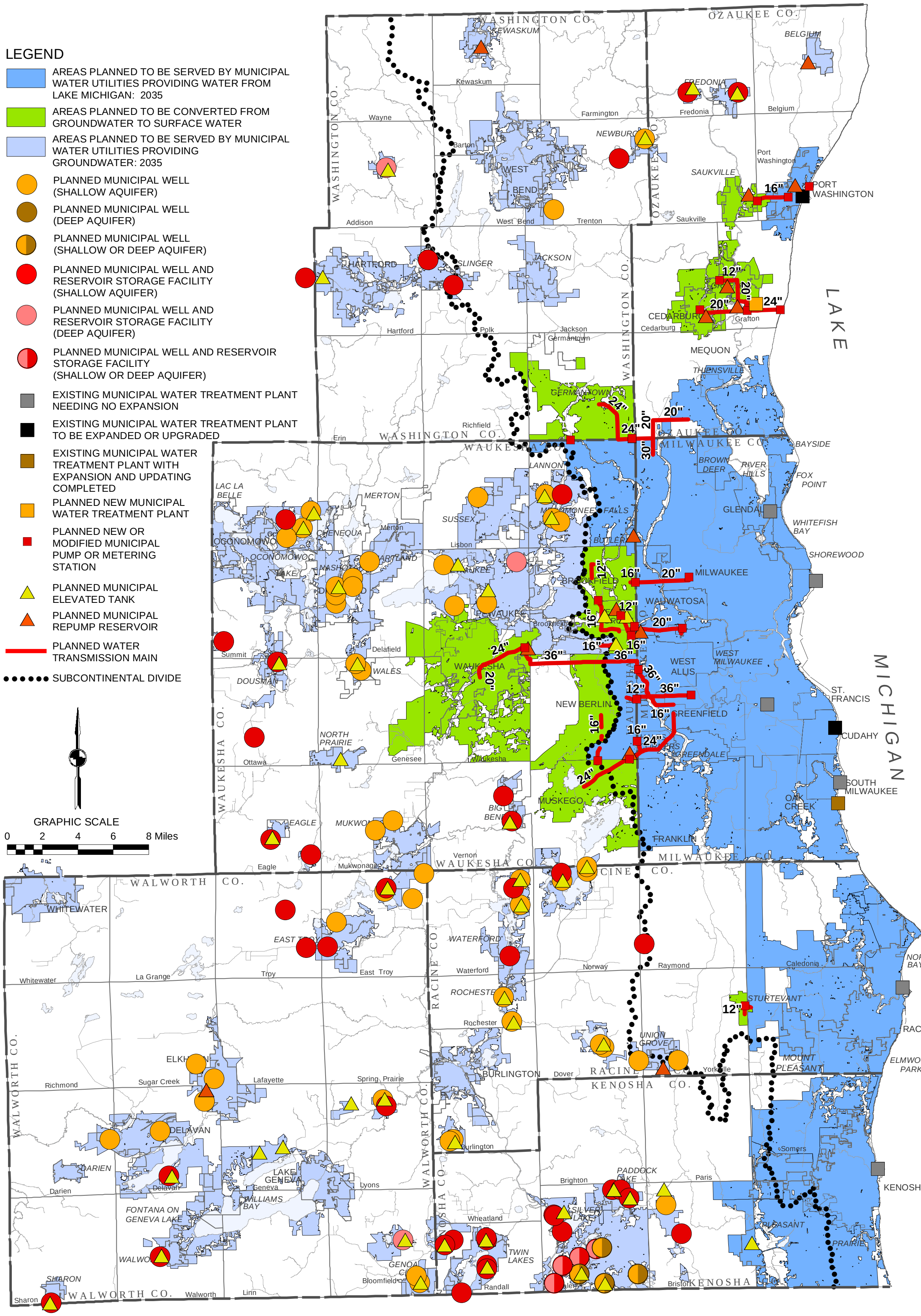
AREAS PROPOSED TO BE SERVED BY PUBLIC WATER UTILITIES IN SOUTHEASTERN WISCONSIN:2035



Source: SEWRPC.

Map 131

RECOMMENDED REGIONAL WATER SUPPLY PLAN FACILITIES: 2035



NOTES: The City of Oak Creek Sewer and Water Utility completed expansion and upgrading of its water treatment plant in 2010.
The City of Hartford completed the recommended new well and storage tank in 2010.
This map does not indicate the return flow options of the recommended plan. See Map 132 for these return flow options.

Source: Ruekert & Mielke, Inc. and SEWRPC.

- There are 60 water utilities or portions of utilities which were determined to have adequate existing sources of supply, and these utilities are recommended to continue to use their existing sources of supply. Of these utilities, 27 rely on Lake Michigan supply; while 33 rely on groundwater supplies. While these 60 utilities may be expected to require infrastructure expansion in most cases to serve the forecast demand in their existing and expanded service areas, the existing sources of supply are adequate to meet existing and probable future demand to the plan design year. These utilities are listed in Table 204 and represent the majority of the existing water utilities within the Region. Table 187 in Chapter X of this report sets forth the number of utilities with existing sources of supply that are considered adequate, and provides the associated plan design year population and average daily pumpage. In this report, it should be noted that the City of Oak Creek Water and Sewer Utility completed construction of a major plant expansion program in 2010. The Utility also plans to conduct a rerating analysis of the plant which is expected to demonstrate a plant capacity of 35 million gallons per day, adequate to meet the expected 2035 demand for the Utility and its customer communities.

- The recommended plan envisions an increased reliance on the shallow aquifer and decreased reliance on the deep aquifer as sources of supply for four utilities—the City of Delavan Water and Sewage Utility, the City of Elkhorn Water Utility, the Village of Union Grove Utility, and the Town of Bristol Utility District No. 1. In addition, the plan recognizes that the City of Hartford Water Utility, in 2009, had a new shallow aquifer well and associated elevated storage tank under development. These facilities are expected to be in service in 2010. With the completion of the new well, the utility plans to abandon its one existing deep aquifer well, so that its water supply will be provided entirely by the existing compliant shallow aquifer wells and the new shallow aquifer well, as recommended in the preliminary and final recommended regional water supply plan.

- There are four utilities for which an increased reliance on the shallow aquifer source and the treatment of the existing deep aquifer sources is recommended following an evaluation under the regional planning effort of the potential for connection to a Lake Michigan supply as well as continued use of the groundwater supplies. These utilities include the western portion of the City of Brookfield Water Utility, the City of Pewaukee Water Utility, the Village of Pewaukee Water Utility, and the Village of Sussex Water Utility.

- The plan recommends the development of a new water utility to serve the Village of Elm Grove. In the plan design both groundwater and Lake Michigan supply options were considered for this utility. Upon evaluation, the Lake Michigan supply option is recommended as the best long-term option.

- For the service areas, or portions of service areas, of eight utilities which currently have provision for return flow to Lake Michigan, the plan recommends conversion to Lake Michigan as the source of water supply. Six of the service areas concerned—the eastern portion of the City of Brookfield Municipal Water Utility service area; the City of Cedarburg Light & Water Commission; the Village of Germantown Water Utility; the Village of Grafton Water and Wastewater Commission; the Village of Saukville Municipal Water Utility; and the Town of Yorkville Utility District No. 1—are located east of the subcontinental divide. Two of the areas—the central portion of the City of New Berlin Water Utility service area, and the City of Muskego Public Water Utility—are located within communities that straddle the subcontinental divide, but are located within the MMSD sanitary sewer service area and, therefore, have provisions in place for return flow.

  With regard to the conversion of the Village of Germantown Water Utility to a Lake Michigan supply, the plan recognizes that the Utility completed construction of a new deep aquifer well in 2009 and that conversion to a Lake Michigan supply is currently not envisioned by the Utility. However, the plan continues to recommend the eventual conversion of the source of supply to Lake Michigan, albeit later in the planning period. This recommendation is made because of the environmental benefits associated with the conversion to a Lake Michigan supply, including a stabilization and recovery

Table 204

UTILITIES CONSIDERED TO HAVE ADEQUATE SOURCES OF WATER SUPPLY UNDER THE PRELIMINARY RECOMMENDED REGIONAL WATER SUPPLY PLAN

County and Utility	Source of Supply
Kenosha County	
City of Kenosha Water Utility	Lake Michigan self-supplied
Village of Paddock Lake Municipal Water Utility	Groundwater shallow aquifer
Village of Pleasant Prairie Water Utility	Lake Michigan purchased supply
Town of Bristol Utility District No. 3	Lake Michigan purchased supply
Town of Somers Water Utility	Lake Michigan purchased supply
Milwaukee County	
City of Cudahy Water Utility	Lake Michigan self-supplied
City of Franklin Water Utility	Lake Michigan purchased supply
City of Glendale Water Utility[a]	Lake Michigan purchased supply
City of Milwaukee Water Utility	Lake Michigan self-supplied
City of Oak Creek Water and Sewer Utility	Lake Michigan self-supplied
City of South Milwaukee Water Utility	Lake Michigan self-supplied
City of Wauwatosa Water Utility	Lake Michigan purchased supply
City of West Allis Water Utility	Lake Michigan purchased supply
Village of Brown Deer Public Water Utility	Lake Michigan purchased supply
Village of Fox Point Water Utility[a]	Lake Michigan purchased supply
Village of Greendale Water Utility	Lake Michigan purchased supply
Village of Shorewood Municipal Water Utility	Lake Michigan purchased supply
Village of Whitefish Bay Water Utility[a]	Lake Michigan purchased supply
We Energies-Water Services[a]	Lake Michigan purchased supply
Ozaukee County	
City of Port Washington	Lake Michigan self-supplied
Village of Belgium Municipal Water Utility	Groundwater shallow aquifer
Village of Fredonia Municipal Water Utility	Groundwater shallow aquifer
We Energies-Water Services	Lake Michigan purchased supply
Racine County	
City of Burlington Municipal Waterworks	Groundwater Deep Aquifer
City of Racine Water and Wastewater Utility[b]	Lake Michigan self-supplied
Village of Caledonia West Utility District[c] Oak Creek	Lake Michigan purchased supply
Village of Caledonia West Utility District[c] Racine	Lake Michigan purchased supply
Expanded Western Portion of Additional Village of Caledonia West Utility District	Lake Michigan purchased supply source to be determined through local planning
Village of Caledonia East Utility District[d] Oak Creek	Lake Michigan purchased supply
Village of Caledonia East Utility District[d] Racine	Lake Michigan purchased supply
Village of Waterford Water and Sewer Utility	Groundwater Deep and shallow aquifers
Village of Wind Point Municipal Water Utility	Lake Michigan purchased supply
North Cape Sanitary District	Groundwater shallow aquifer
Walworth County	
City of Lake Geneva Municipal Water Utility	Groundwater shallow aquifer
City of Whitewater Municipal Water Utility	Groundwater deep aquifer
Village of Darien Water Works and Sewer System	Groundwater deep and shallow aquifers
Village of East Troy Municipal Water Utility	Groundwater deep and shallow aquifers
Village of Fontana Municipal Water Utility	Groundwater deep and shallow aquifers
Village of Genoa City Municipal Water Utility	Groundwater deep and shallow aquifers
Village of Sharon Waterworks and Sewer System	Groundwater deep and shallow aquifers
Village of Walworth Municipal Water and Sewer Utility	Groundwater shallow aquifer
Village of Williams Bay Municipal Water Utility	Groundwater deep and shallow aquifers
Country Estates Sanitary District	Groundwater deep aquifer
Town of Bloomfield Pell Lake Sanitary District No. 1	Groundwater deep aquifer
Town of East Troy Sanitary District No. 3	Groundwater deep and shallow aquifers
Town of Geneva Lake Como Sanitary District No. 1	Groundwater deep aquifer
Town of Troy Sanitary District No. 1	Groundwater shallow aquifer
Washington County	
City of West Bend Water Utility	Groundwater shallow aquifer
Village of Jackson Water Utility	Groundwater shallow aquifer
Village of Kewaskum Municipal Water Utility	Groundwater shallow aquifer
Village of Slinger Utilities	Groundwater shallow aquifer
Allenton Sanitary District No. 1	Groundwater deep aquifer
Waukesha County	
City of Delafield Municipal Water Utility	Groundwater deep and shallow aquifers
City of New Berlin Water Utility (east)	Lake Michigan purchased supply
City of Oconomowoc Utilities	Groundwater deep and shallow aquifers
Village of Butler Public Water Utility	Lake Michigan purchased supply
Village of Dousman Water Utility	Groundwater deep and shallow aquifers
Village Eagle Municipal Water Utility	Groundwater shallow aquifer
Village of Hartland Municipal Water Utility	Groundwater shallow aquifer
Village of Menomonee Falls Water Utility (east)	Lake Michigan purchased supply
Village of Menomonee Falls Water Utility (west)	Groundwater shallow aquifer
Village of Mukwonago Municipal Water Utility	Groundwater deep and shallow aquifers
Town of Brookfield Sanitary District No. 4	Groundwater shallow aquifer

[a] *The North Shore Water Commission provides water to the City of Glendale Water Utility, the Village of Fox Point Water Utility, the Village of Whitefish Bay Water Utility, and a portion of the Village of Bayside served by We Energies-Water Services.*

[b] *Includes the Village of Sturtevant Water Utility which was purchased by the City of Racine Water and Wastewater Utility in 2007 and is now served by the City Utility on a retail basis.*

[c] *Includes the former Caddy Vista Sanitary District and the former Caledonia Sanitary District No. 1 which were consolidated in 2007 to form the Caledonia West Utility District.*

[d] *Includes the former Crestview Sanitary District and the former North Park Sanitary Districts which were consolidated in 2007 to form the Caledonia East Utility District.*

Source: SEWRPC.

of the drawdown in the deep aquifer, the reduction in chloride discharges attendant to the expected reduced water softening, and the expected improvement in groundwater-derived surface water base flows. Conversion from groundwater supplies to a Lake Michigan supply is envisioned only if the local utility undertakes the initiative to implement the change. Absent such an initiative, the Village of Germantown Water Utility would continue to utilize groundwater as a source of water supply.

A portion of the Village of Germantown Water Utility service area extends into the east-central portion of the Village of Richfield. During 2008, the former Town of Richfield was incorporated as a village. Given this new municipal status, this portion of the planned water supply service area is expected to be served by a newly created water utility serving the Village of Richfield. That utility could be served by a separate groundwater-supplied water system, or through a connection to the Village of Germantown Water Utility system. The municipal water supply service area in the Village of Richfield lies east of the subcontinental divide. Thus, no diversion would be involved if a connection to the Village of Germantown system were implemented, and that system was converted to Lake Michigan as a source.

With regard to the conversion of the City of Cedarburg Light & Water Commission and the Village of Grafton Water and Wastewater Utility to a Lake Michigan supply, the cost data included in the recommended plan are based upon the development of a new intake facility and water treatment plant and associated transmission and storage facilities to serve these two utilities. It should be noted that the analyses conducted with respect to Alternative Plan 4, and to the comments received on the preliminary recommended plan, indicated that there were two other viable options available for providing a Lake Michigan supply to these two utilities—one by connection to the City of Port Washington Utility water supply system upon expansion of the water treatment plant concerned; and the other by connection to the City of Milwaukee Water Works system. All three options were estimated to have similar costs. Accordingly, the plan recommends that the three options be considered in greater detail under plan implementation related studies.

With regard to the conversion of the eastern portion of the City of Brookfield Water Utility service area and the Village of Elm Grove proposed utility service area to a Lake Michigan source of supply, the cost data included for the recommended plan are based upon direct connections to the Milwaukee Water Works. Two other viable options would, however, be available for providing a Lake Michigan supply to those two service areas: one by connections through the City of Wauwatosa and City of West Allis water supply systems, and the other by connection to a new transmission system for the City of Waukesha connection to the Milwaukee Water Works, the City of Oak Creek Water and Sewer Utility, or the City of Racine Water and Wastewater Utility water supply systems. Accordingly, the plan recommends that the three options be considered in greater detail under plan implementation related studies.

With regard to the conversion of the eastern portion of the City of Brookfield Water Utility service area, the City of Muskego Water Utility, and the proposed new Village of Elm Grove water supply service area to a Lake Michigan source of supply, the cost data included for the recommended plan are based upon the premise that the supply would be provided through the Milwaukee Water Works. However, other options for providing such supply were also evaluated and are considered viable. These include the provision of the Lake Michigan supply by either the City of Oak Creek Water Utility, or the City of Racine Water and Wastewater Utility. Accordingly, the plan recommends that the three options be considered in greater detail under plan implementation related studies.

With regard to the City of Muskego Water Utility Lake Michigan supply recommendation, the regional plan recognizes that more-detailed engineering, legal, and environmental supporting information will be required to support any application for a Lake Michigan water supply and to meet the requirement of the Great Lakes-St. Lawrence River Basin Water Resources Compact and 2007 Wisconsin Act 227.

- For the City of Waukesha Water Utility, the plan recommends the conversion of the source of supply to Lake Michigan with the provision of return flow to Lake Michigan. Return flow could be provided by returning treated wastewater either directly by pipeline to Lake Michigan, or to streams tributary to Lake Michigan. Examples of return flow options are shown on Map 132 and the return flow options are described in more detail in Chapter IX.

  The regional plan recognizes that more-detailed engineering, legal, and environmental information will be required to support any application for a Lake Michigan water supply and to meet the requirements of the Great Lakes-St. Lawrence River Basin Water Resources Compact and 2007 Wisconsin Act 227. Such information should be assembled under the necessary preliminary engineering and planning studies required for plan implementation. The more-detailed environmental analyses related to the return flow option should include assessment of the potential impacts on floodlands, water quality, stream channel erosion, and stream habitat. Because of the need for further assessment, no final recommendations relating to specific return flow component is included in the recommended regional plan. Rather, the selection of the best return flow option is left open until completion of the required more-detailed assessments. For purposes of developing the cost of the recommended regional water supply plan, a range of costs was used to represent the probable potential costs of the return flow options. It is recognized that the environmental analysis process as set forth in Chapter NR 150 of the *Wisconsin Administrative Code* will also have to be followed as deemed appropriate by the WDNR. This process is designed to insure proper environmental analysis of specific projects, and, as deemed appropriate by the WDNR, may include the preparation of a full environmental impact statement.

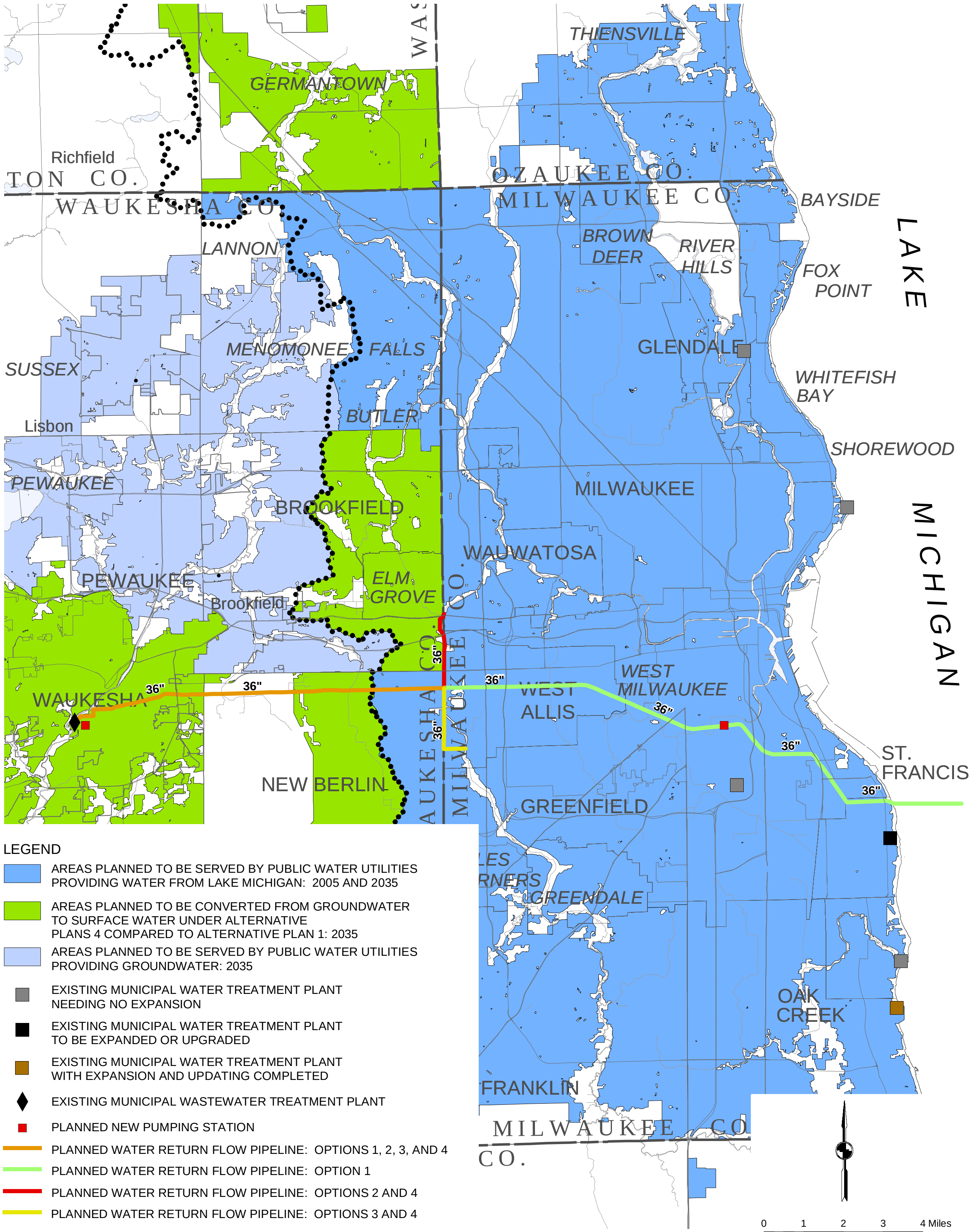
  The potential impacts of a City of Waukesha Water Utility return flow component was an issue raised and commented upon in the public review of the preliminary recommended plan and of the alternatives thereto. The comments focused concern on the potential impacts on Underwood Creek and the Menomonee River and on the Root River should the return flow be discharged to those streams and conveyed to Lake Michigan. Potential impacts on those streams, both positive and negative, based upon the system level analysis conducted under the regional water supply planning program are described in Chapter IX. The WDNR has concluded that an environmental impact statement would have to be prepared to evaluate the return flow options, should the City decide to proceed. The preparation of an environmental impact statement is intended to insure that the environmental impacts of the return flow options are identified and considered during the project development and review phases.

  In addition to the required preparation of an environmental impact statement, other steps in the plan implementation process will ensure the environmental soundness of any return flow option selected. These steps include: the WDNR permitting process and the related review of the return flow proposal for conformance with the regional water quality management plan by the Southeastern Wisconsin Regional Planning Commission (SEWRPC) and the WDNR; County and other local government permitting for construction of facilities in public rights-of-way; and intergovernmental agreements between a Lake Michigan water supplier and the purchaser of that water. Such collegial involvement in the review process would assure careful consideration of County and municipal interests and concerns. Accordingly, it may be concluded that adequate means are available to ensure a thorough review of any return flow proposals and to ensure that a sound decision is reached regarding proposals.

  In order to ensure an orderly and timely evaluation of any return flow project that might be put forth, it is recommended that the City of Waukesha Water Utility and the WDNR directly involve and work cooperatively with SEWRPC, MMSD, and the Counties and the other local units of government directly impacted in conducting the required analyses of any return flow proposals should the Lake Michigan supply be pursued by the City of Waukesha. In this regard, it is recommended that an oversight committee be formed of these agencies and units of government concerned as described in

Map 132

**RETURN FLOW OPTIONS FOR THE RECOMMENDED WATER SUPPLY PLAN:
RETURN FLOW PIPELINES TO LAKE MICHIGAN, THE ROOT RIVER, AND UNDERWOOD CREEK**



NOTE: The City of Oak Creek Sewer and Water Utility completed expansion and upgrading of its water treatment plant in 2010.

Source: Ruekert & Mielke, Inc. and SEWRPC.

Chapter XI. It is also recommended that the concurrence of the Counties and other local units of government directly affected be obtained for the return flow system deemed to be the best option.

The source of the Lake Michigan supply for the City of Waukesha Water Utility could be potentially provided by the City of Milwaukee Water Works, the City of Oak Creek Water and Sewer Utility, or the City of Racine Water and Wastewater Utility, as described in Chapter VIII. For purposes of developing the cost of the recommended regional water supply plan, the source of the supply was assumed to be the City of Milwaukee Water Works. Other options for the provision of a Lake Michigan supply to the City of Waukesha Water Utility and other adjacent utilities were developed and evaluated under the alternative plan design process documented in Chapters VIII and IX. The alternatives so developed and evaluated are also considered viable options which could be further considered during plan implementation.

- There are 20 areas of existing development meeting urban-density standards that are currently served by private, onsite wells. These areas are considered as potential areas for service by municipal groundwater supplies, either through the creation of new utilities which would be served by extension of service from existing utilities or, in some cases, by the creation of new utilities, with new separate sources of supply. The development of municipal water supply systems in the areas concerned is envisioned only if a local demonstrated need were to arise based upon groundwater quality or quantity issues and, if a local initiative was then undertaken to implement a municipal system. In the absence of such a need and initiative, the residents and businesses in these areas would be expected to continue to rely on private wells.

  If conversion to a public supply takes place in accordance with local actions, it is recommended that, to the extent practicable, the areas be served by the extension of service by existing utilities. The Public Service Commission of Wisconsin has found that such extensions offer economies of scale and are often more favorable to rate payers.

  In addition to the aforereferenced 20 areas, the utility proposed to serve the Village of Lannon is recommended to use groundwater as a source of supply. This recommendation is based upon evaluation of alternatives providing for use of a Lake Michigan supply. In addition, it is recommended that the existing Prairie Village Water Trust serving the Village of North Prairie be converted to a municipal water supply utility to serve the Village of North Prairie water supply service area.

  The potential municipal water supply service areas are shown on Map 130 and are listed in Table 188 in Chapter X of this report.

- The plan recommends connection to municipal systems by the plan design year of the existing, self-supplied water systems serving residential communities, and most of the self-supplied systems serving commercial, institutional, and recreational land uses, located within the planned municipal water supply service areas of municipal systems. Under the plan, a number of private, self-supplied water supply systems generally located beyond planned municipal water supply service areas would remain, as would selected systems located within the municipal services area, but serving specialized uses, such as golf course irrigation or certain industrial uses. The number of such systems is enumerated by the type of land used involved in Chapter IX.

- The plan recommends continued use of private domestic wells in areas beyond the planned water supply service areas. About 1,843 square miles of the Region are located outside the planned 2035 municipal water service areas. In addition, there are about 63 square miles of such service areas located in the 20 areas where potential new water utilities are envisioned. Private domestic wells are envisioned to be used by from 175,900 to 254,400 persons—or by about 8 to 11 percent of the regional population—by the design year 2035, depending upon the number of new municipal facilities found to be needed to serve existing development based upon local needs and determinations.

- The plan recommends implementation of comprehensive water conservation programs, including both supply side efficiency measures and demand side conservation measures. The scope and content of these conservation programs are to be determined on a utility-specific basis to reflect the type and sustainability of the source of supply and the probable future water supply infrastructure requirements.

  Three levels of conservation programs are recommended for application in the Region: a base-level program which would provide a reduction of about 4 percent in average daily demand, and a reduction of about 6 to 10 percent in maximum daily demand; an intermediate-level program which would provide a reduction of about 6 to 8 percent in average daily demand, and a reduction of about 12 to 16 percent in maximum daily demand; and an advanced-level program which would provide a reduction of about 10 percent in average daily demand, and a reduction of about 18 percent in maximum daily demand. In addition, an optional higher level water conservation program could be considered by local utilities or individual water users. Such a program would provide a reduction of about 25 to 35 percent in average daily demand, and a reduction of about 30 to 50 percent in maximum daily demand. The measures included in each level of program are summarized in Table 189 in Chapter X of this report and described in Chapter IX of this report.

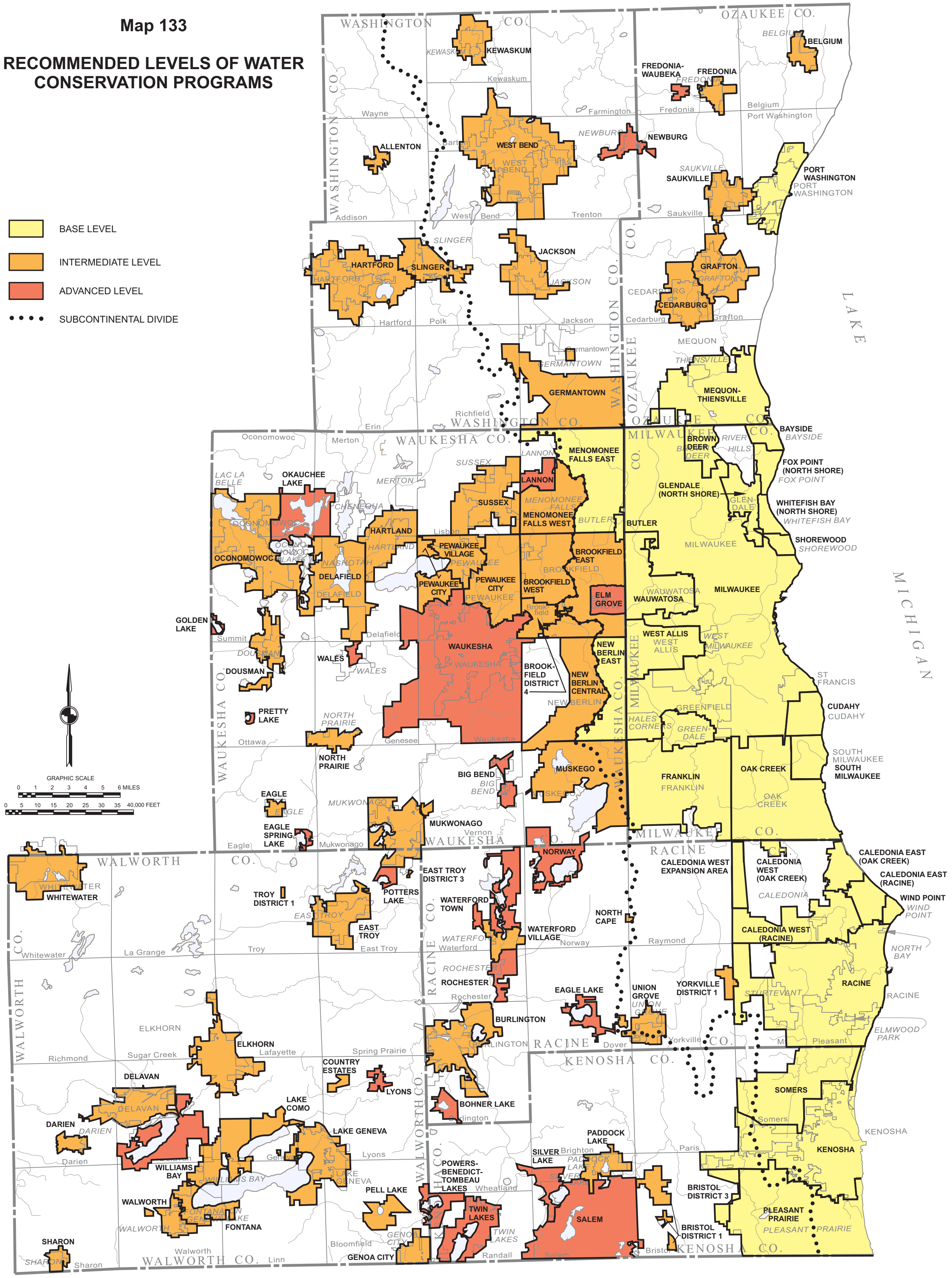
  Recommended program levels of water conservation for individual utilities are summarized on Map 133. The recommended water conservation measures are primarily intended to apply to municipal water utilities; however, the plan envisions that the base-level water conservation measures would also apply to private individual, self-supplied systems. Areas of existing development served by private individual wells are recommended to utilize a base level of water conservation. An advanced level of water conservation is envisioned to be used in those areas when converted to municipal service based upon local needs and initiatives. This recommendation is made in recognition of the potential value of conservation measures in reducing infrastructure costs associated with the development of new water supply systems. The recommended water conservation measures together are expected to reduce the plan design year 2035 water demand in the Region by about 6.0 million gallons per day on an average daily demand basis and by about 15 million gallons per day on a maximum day basis. The WDNR has drafted Chapter NR 852 of the *Wisconsin Administrative Code* which sets forth rules and guidelines related to water conservation pursuant to the requirements of the Great Lakes-St. Lawrence River Basin Water Resources Compact and Wisconsin Acts 227 and 310. As of September 1, 2010, this proposed rule had been approved by the Wisconsin Natural Resources Board, and was submitted to the State Legislature for review.

- The plan recommends the protection and preservation of groundwater recharge areas classified as having a high or very high recharge potential. These recharge areas are shown on Map 127 in Chapter X of this report. Such protection may be largely achieved through the implementation of the adopted design year 2035 regional land use plan and supporting county comprehensive plans, since these plans recommend preservation of the environmental corridors, isolated natural resource areas, and prime and other agricultural areas of the Region that facilitate recharge. As shown on Map 128 in Chapter X of this report and as quantified in Table 190 in Chapter X of this report, about 76 percent of the highly rated and very highly rated recharge areas may be expected to be preserved by inclusion in the environmental corridors, isolated natural resource areas, and prime and other agricultural areas identified for preservation in the adopted regional land use plan.

  The plan recommends that consideration be given to expanding the currently delineated primary and secondary environmental corridors as delineated on the regional land use plan to include selected recharge areas presently located outside of the delineated environmental corridors and classified as having high or very high recharge characteristics. The procedures historically utilized for environmental corridor delineation have been well accepted and consider the location of natural resource

Map 133

RECOMMENDED LEVELS OF WATER CONSERVATION PROGRAMS



Source: SEWRPC.

features and the extent of the areas occupied by such features. Recharge characteristics could be considered for integration into the current procedure. Such integration should be done on a comprehensive basis as part of the regional land use planning program the next time the corridor delineations are updated, and should be accomplished under the guidance of the Commission Advisory Committee on Regional Land Use Planning.

Depending on the zoning and development practices utilized, additional highly and very highly rated recharge areas may also be substantially protected through inclusion into suburban-density and low-density residential development proposals. In these areas, it is recommended that careful site design and the use of stormwater management practices designed to maintain the natural hydrology and recharge potential of the sites be applied. This would increase the level of protection for important recharge areas. It is also recommended that the recharge areas be considered for protection and preservation by agencies and organizations involved in land conservancy activities.

As part of the groundwater recharge area protection element, it is envisioned that selected areas with high or very high recharge characteristics could be added to environmental corridors or otherwise kept in open space uses. Land development practices could be revised to preserve the natural hydrology to the degree practicable. As such plan implementation actions are undertaken, it is recommended that the population and land uses in, and adjacent to, the concerned areas be inventoried, and any regulations or other actions to preserve the recharge area or characteristics consider the potential impacts on the population in, or adjacent to, these areas.

- The plan recommends implementation of state-of-the-art stormwater management practices, including application of treatment and infiltration systems, which, to the extent practicable, will maintain the natural recharge characteristics of areas committed to urban land use development. This component is intended to apply to residential and some nonresidential developments served by both municipal and private water supply systems in order to contribute to a sustainable groundwater supply, as well as for related stormwater management purposes. Such practices are considered important, even in areas served by individual wells and onsite sewage disposal systems where the majority of the water used is returned to the aquifer. Such areas do experience some losses in water used, and good stormwater management practices can enhance aquifer recharge. This recommendation may be expected to be largely implemented through the provisions of Chapter NR 151 of the *Wisconsin Administrative Code*, and through county and municipal stormwater management ordinances adopted in accordance with Chapter 216 of the *Wisconsin Administrative Code*. In particular, the application of practices in accordance with WDNR stormwater management technical standards is recommended. Conservation subdivision design can also enhance infiltration, and its application is recommended particularly in areas where groundwater analyses associated with well siting identify potential negative impacts on surface waters as a result of well siting.

  The plan recommends that studies related to the siting of all new high-capacity wells include analyses of potential impacts. The plan also recommends subsequent monitoring of the actual impacts of such wells on the aquifer concerned, on existing wells, and on surface waters. The siting studies should be designed to develop the necessary understanding of the hydrogeological system associated with each candidate site and to assess the likelihood of impacts of proposed wells upon nearby existing wells and surface waterbodies. The studies should include identification of significant potential negative impacts, needed mitigative actions, and needed site location revisions. Water levels in the vicinity of new high-capacity wells in the shallow aquifer should be monitored before and after wells are constructed and placed into operation to establish baseline conditions, levels expected to be maintained in nearby private wells, and to develop performance and impact data during the test well phase of well development process, and during the subsequent operation of the well over time. While it is recognized that siting wells in the shallow aquifer is dependent upon locating productive areas, some additional factors should be considered when siting wells to be constructed in this aquifer. Preference should be given to site locations that are less likely to produce adverse impacts upon surface waterbodies and existing wells. In addition, preference should be given to sites adjacent to major rivers receiving treated effluent from municipal wastewater treatment plants downstream from their treatment plants. This application of riverbank filtration has the potential to increase available water supplies without degrading the environment.

- The plan recommends enhanced rainfall infiltration particularly in areas where evaluations conducted in conjunction with the siting of high-capacity wells in the shallow aquifer indicate probable reductions in baseflow on nearby streams and in water levels in lakes and wetlands due to installation and operations of these wells. Two means of providing for the enhanced recharge are recommended. One means of providing this infiltration is through the installation of constructed rainfall systems in areas where it is deemed to be especially important where adverse impacts are anticipated in surface water features considered to be highly dependent on groundwater contributions. Locating these systems will require site-specific analyses to ensure that the systems are located in the recharge areas of the waterbodies expected to be impacted, and in areas well suited for shallow groundwater recharge. The specific measures comprising the systems must be selected and designed on a case-by-case, site-specific basis. The systems may include measures such as rain gardens, larger bioretention basins, infiltration ponds, infiltration ditches, and subsurface storage and infiltration galleries. It is recommended that consideration be given to developing a groundwater monitoring program in association with each rainfall infiltration system. It is envisioned that a total of 32 of these rainfall infiltration systems would be installed under the recommended plan. The general locations of the rainfall infiltrations systems that are envisioned are shown on Map 129 in Chapter X of this report.

  The second means of providing for additional groundwater recharge is through applications of farming practices that reduce or eliminate tillage of fields. This means has potential to be applied on an areawide basis, as well as in areas potentially affected by high capacity wells. These practices also have other benefits such as reduced erosion which are often the primary purpose for application of the practice. When applying low- or no-till practices for enhancing groundwater recharge, it will be important to consider additional factors including the potential impact of nutrient management and agricultural chemical management practices on groundwater quality.

  The use of farming practices with reduced or no tillage is recommended to be promoted for the potential enhanced rainfall infiltration as well as its more commonly accepted purposes. For groundwater infiltration purposes the practice would be most applicable in the vicinity of the locations where there are potential negative impacts to surface waters due to reduced baseflows as described previously. In those areas, the practices may offer an attractive alternative to, or supplement of, the constructed systems described previously. In addition, it is recommended that the practice be promoted on a broader basis due to the potential for multiple benefits including substantial groundwater recharge. In this regard it is recognized that agricultural land operators must make decisions on tillage practices based upon a number of variables which are often more directly tied to crop production. However, it is possible that utilities or other high capacity well developers could provide incentives for changes in cropping practices if it is deemed important to well siting situations.

Special Consideration in Areas with Increased Reliance on Shallow Aquifer Supplies

The recommended stormwater management, high-capacity well siting, and rainfall infiltration practices are intended to form the basis of a system intended to abate the negative impacts on ground and surface water resources associated with high-capacity well development. The procedure would provide for initial analyses of potential alternative well sites in order to select sites which minimize adverse impacts on the groundwater and surface water systems. These initial siting analyses would guide the selection of well sites and would be followed by more-detailed analyses of the potential impacts associated with each of the selected sites. Initial monitoring of water levels in nearby private wells to establish baseline conditions is recommended. Where significant potential negative impacts to surface water systems or to existing wells are identified, a mitigation plan should be developed to enhance recharge, including stormwater management and infiltration measures. In addition, other mitigation measures, such as pumping protocols and impacted well compensation measures, could be considered. Measures to mitigate impacts on surface waterbodies could include provision of artificial recharge designed to offset the losses in baseflow to the extent practical.

For areas where an increased reliance on shallow aquifer wells is expected, it is recommended that special consideration be given to application of the recommended water conservation and groundwater recharge protection and enhancement measures; and to implementation of the high-capacity well development siting, monitoring, and impact mitigation measures. Mitigative actions may include limiting municipal service area expansion to areas with identified needs, careful well siting, well operating protocols, groundwater recharge protection and enhancements, artificial groundwater recharge, infiltration-based stormwater management practices, and groundwater monitoring.

Auxiliary Water Supply Plan Recommendations

Auxiliary water supply plan recommendations were included in the plan to address specific water supply problems or issues and to address several opportunities available to water utilities of the Region.

Chloride Reduction Programs

Surface water quality monitoring data documented in various Commission and other agency reports indicate that chloride concentrations in streams and lakes of the Southeastern Wisconsin Region have been steadily increasing over time.[9] While adequate data are not available to assess trends in chloride concentrations in groundwater, the trends in surface waters and the high solubility of chloride in water suggest that chloride concentrations in groundwater may also be increasing. Overall, the increasing chloride concentrations in surface waters and the potential for increasing concentrations in groundwater should be a cause for concern.

It is recommended that the municipalities and counties in the Region continue to reevaluate their practices regarding the application of chlorides for street and highway ice and snow control and strive to achieve minimum application rates consistent with safe operating conditions. It is also recommended that municipalities continue to consider alternatives to current ice and snow control practices, such as the program adopted by the City of Brookfield, which calls for applying a sand-salt mix to land access and collector streets with enhanced street sweeping in the spring of the year to remove accumulated sand; or the program initiated by the City of Franklin which involves application of a salt brine, sometimes along with a liquid derived from sugar beet juice, depending on weather conditions. These programs can serve as models for other municipalities. For those municipalities continuing to use groundwater as a source of water supply, it is recommended that education programs be implemented to provide information about alternative water softening facilities and the use of more-efficient softeners which regenerate on the basis of the amount of water used and the quality of the water, rather than on time schedule.

Stormwater Management Measures Affecting Groundwater Quality

Chlorides that are applied to streets and highways for ice and snow control are conservative substances that are often dissolved in stormwater runoff. Stormwater infiltration practices do not treat and remove chlorides dissolved in runoff. Thus, special safeguards must be applied to avoid adverse effects of chlorides on groundwater quality. It is, therefore, recommended that the design of stormwater management facilities that directly or indirectly involve infiltration of stormwater consider the potential impacts on groundwater quality. Those effects should be

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[9] *See, for example, SEWRPC Technical Report No. 39,* Water Quality Conditions and Sources of Pollution in the Greater Milwaukee Watersheds, *November 2007; SEWRPC Community Assistance Planning Report No. 273,* A Lake Management Plan for Pike Lake, Washington County, Wisconsin, *December 2005; SEWRPC Community Assistance Planning Report No. 283,* A Lake Management Plan for the Waterford Impoundment, Racine County, Wisconsin, *Volume One*, Inventory Findings, *October 2007; SEWRPC Community Assistance Planning Report No. 300,* A Lake Management Plan for George Lake, Kenosha County, Wisconsin, *August 2007.*

a consideration in the design of infiltration facilities such as infiltration trenches, infiltration basins, bioretention facilities, rain gardens, grassed swales, and subsurface storage and infiltration galleries; and in the design of stormwater detention basins. The WDNR has developed post-construction stormwater management technical standards for site-specific evaluation of stormwater infiltration, infiltration basins, bioretention facilities, and wet detention basins.[10] Those standards include provisions intended to protect groundwater quality, and it is recommended that the standards continue to be refined and applied in the design of stormwater management facilities.

Disposal of Emerging and Unregulated Contaminants

Water quality contaminants of emerging concern include pharmaceuticals, personal care products, and endocrine disrupting compounds. Recent research indicates that these contaminants are entering surface and groundwater and may be producing adverse effects on fish and other aquatic organisms. The extent of the threat posed to human health and to the integrity of surface waters and groundwaters by the presence of these compounds is not currently known. Several factors account for this lack of knowledge. These categories represent a large number of chemical compounds. The concentrations of most of these compounds in surface waters and groundwaters have not been determined. The biological and toxicological effects of many of these compounds on human health have not been characterized, especially at environmentally relevant concentrations and under long-term conditions. Few data are available on the fate of these compounds in the environment. Studies examining the presence of these compounds in the environment and the toxicological properties of these compounds have generally not examined their metabolites and transformation products, which may be biologically active.

In view of the potential risks posed by releases of pharmaceuticals and personal care products into the environment, it would be prudent and protective of human health and the integrity of surface waters and groundwater to reduce inputs of these materials into the environment. Therefore, it is recommended that public informational and educational programs be carried out, and that periodic collections of expired and unused medications be conducted. The WDNR has issued guidance on regulatory aspects of collecting unwanted household pharmaceuticals.[11] For those portions of the Region served by the MMSD, the 2020 facilities plan recommends that MMSD continue to support the periodical collection of pharmaceuticals as part of its Household Hazardous Waste Collection program. Because some of these compounds are considered controlled substances and are strictly regulated by the U.S. Drug Enforcement Administration, such collections require the participation of local law enforcement agencies. In addition, Wisconsin allows some unused cancer and chronic disease drugs and supplies to be donated to participating pharmacies or medical facilities for use by other patients. Rules governing these donations are set forth in Chapter HFS 148 of the *Wisconsin Administrative Code.* Consideration could also be given to establishing collection centers for pharmaceuticals at law enforcement offices. It is important to note that under current Wisconsin hazardous waste rules, unless the pharmaceuticals are screened to exclude those that are also considered hazardous waste under the Federal Resource Conservation and Recovery Act, law enforcement agencies participating in this sort of collection would be regulated as permanent household hazardous waste collection facilities. The inability, or reluctance, of law enforcement agencies to comply with hazardous waste requirements may discourage participation in this type of collection option.[12]

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[10]*The technical standards are set forth in a series of documents that can be found on the Wisconsin Department of Natural Resources website at* http://dnr.state.wi.us/runoff/stormwater/techstds.htm*.*

[11]*Wisconsin Department of Natural Resources,* Collecting Unwanted Household Pharmaceuticals: Regulatory Guidance for Organizers of Household Pharmaceutical Collection Events, *Pub. WA-1025-2006, August 9, 2006.*

[12]*Effective June 27, 2006, the WDNR developed an enforcement discretion memorandum, effective for one year, that conditionally exempted from the State's hazardous waste and solid waste rules household pharmaceutical waste collected by law enforcement officials or collected at household pharmaceutical waste collection facilities or events. This enforcement discretion memorandum was extended for an additional two-year period to June 27, 2009, during which time the WDNR was to evaluate both the impacts of the policy and the possibility of revising the Department solid and hazardous waste rules. In June 2009, this enforcement discretion memorandum was extended for an additional two-year period to June 18, 2011.*

Water Supply Quality Monitoring and Enforcement

The regional water supply plan recommendation for source water quality monitoring and enforcement envisions continuation, and expansion as needed, of existing regulations and programs. The USEPA and the WDNR, in conjunction with water utilities and utility organization, are continually working to improve water supply monitoring and treatment protocols designed to protect the public health and welfare. Ongoing programs related to drinking water supply administered by the WDNR include wellhead protection, source water protection, local public water system capacity development, and water system operator certification. The USEPA has the responsibility for setting national drinking water standards for public water systems. The USEPA and the WDNR have established standards for drinking water designed to protect the public health, safety, and welfare. Standards are also established for surface and groundwater quality. Also, plans for new construction or improvements relating to public water supply systems are reviewed and approved by the WDNR. The WDNR has established sampling and analytical requirements to accompany the drinking water standards. The WDNR and some counties regulate private well construction and pump installation. Well drillers and pump installers must be licensed. Municipal utilities, however, have the primary responsibility for providing safe drinking water since such utilities serve the great majority of the population.

Options for Providing Water Supply to Potential New Municipal Utilities and Other Unincorporated Areas Adjacent to Incorporated Areas Served by Water Supply Utilities

As already noted, the plan identifies certain areas of existing urban development that are currently served by private, onsite wells be provided with a municipal water supply either through the extension of service by existing utilities, or in some cases by the creation of new utilities, when a need is demonstrated and at the option of the affected communities. In some cases, these areas include a mix of existing and planned urban development. Should such utilities be formed, alternative arrangements are available for providing water supply to the new utilities within the context of the sources indicated in the recommended plan. The alternatives include formation of a separate utility which would develop its own sources of supply, supplying a separate utility through a cooperative arrangement with an adjacent utility, or extending service from an existing utility into the area concerned. Specific options for potential utilities are set forth in Table 191 in Chapter X of this report. Additional options may exist for other areas adjacent to incorporated areas served by water utilities. These options should be weighed by the communities and utilities involved in considering the needed additional service areas. However, the Public Service Commission of Wisconsin has found that expansion of existing facilities offers economies of scale and are often more favorable to rate payers. Accordingly, it is recommended that expansion of existing utilities be considered carefully in the evaluation of options.

Monitoring of Water Supply Activities in Areas Beyond the Region

Chapter VII identified the interrelationship of groundwater recharge and use in areas located adjacent to the boundaries of the seven-county Southeastern Wisconsin Region. It was concluded that groundwater pumping from centers located outside the Region may have negative impacts on water levels in the deep sandstone aquifer underlying the Region. It was also determined that recharge of this aquifer from outside the Region will continue to be a modest factor in the level of sustainability of the deep aquifer. Groundwater withdrawal and recharge from outside the Region were found not to be significant factors in the sustainability of the shallow aquifer inside the Region. Based upon the analyses conducted, the inclusion of specific plan recommendations for areas located beyond the Southeastern Wisconsin Region was considered to be warranted. The plan, however, recommends continued monitoring of the conditions related to water use and recharge in areas located immediately to the west and south of the Region, with a focus on the areas within counties adjacent to the Region. It is recommended that the assumptions concerning groundwater use and recharge in these areas which were used in developing the regional water supply plan be compared to monitored actual conditions on about a five-year cycle beginning in 2015. Should significant variation be found between the assumptions used in the plan preparation and actual conditions, analyses should be conducted to determine if such variation would be expected to result in negative impacts which would then need to be addressed.

Cooperative Development and Systems Integration of Water Utilities
Where opportunities exist, it is recommended that municipal water utilities in the Southeastern Wisconsin Region give consideration to cooperative facility development, systems integration, and consolidation of activities. Such activities may ensure provision of water in the event of emergency such as a breakdown in facilities, a fire emergency, or a terrorist attack. In addition, these activities may allow for the achievement of economies of scale that allow for less costly operation of the utilities and more favorable rates for utility customers. The range of activities contemplated includes interconnections among adjacent utilities; cooperative development of utility infrastructure, such as supply, treatment, and distribution infrastructure; and integration and consolidation of existing systems. The scope and extent of the activities implemented is most appropriately determined by the utilities and affected communities. Table 192 in Chapter X of this report identifies specific utilities where such activities could potentially be viable and result in system efficiencies.

Ability of Recommended Plan to Meet Objectives and Standards
The water supply development objectives and supporting principles and standards were formulated early in the regional water supply planning effort, and provided an important basis for the design and evaluation of alternative plans and for the selection of a recommended plan. An evaluation of the recommended plan was made on the basis of its ability to achieve the water supply development objectives and supporting standards. The results of this evaluation are presented in summary form in Table 195 in Chapter X of this report.

Most standards would be met, or largely met, by the recommended regional water supply plan, as indicated in Table 195. The remaining standards could be met under the recommended plan, but their achievement would require that certain actions to be taken by State agencies, local communities, or the private sector. The recommended regional water supply plan represents a means of providing a sustainable water supply for the Southeastern Wisconsin Region through the plan design year of 2035. The plan is specifically designed to be consistent with the Great Lakes-St. Lawrence River Basin Water Resources Compact and with the groundwater protection provisions of Chapter 281.34 of the *Wisconsin Statutes* and the recommendations of the Groundwater Advisory Committee created by 2003 Wisconsin Act 310. It is recognized that additional planning, engineering, and legal studies and environmental analyses will be needed to meet the requirements of the Compact when a diversion of Lake Michigan water is involved in a plan implementation action. Such analyses should be conducted as an integral part of the required second-level planning and preliminary engineering and the associated WDNR environmental analysis procedures.

COST ANALYSIS

The principal features of the recommended plan, including the new sources of supply and attendant facilities for each water utility in the Region, and the estimated costs of those facilities are listed in Table 193 in Chapter X of this report. The recommended plan has an estimated capital cost which ranges from about $336.7 million to about $364.3 million, depending upon the return flow alternative included. The annual operation and maintenance costs associated with the proposed new water utility water supply facilities and programs is estimated to range from about $11.0 million to about $11.5 million, also depending upon the return flow alternative included. The annual savings in costs associated with the elimination of individual point-of-entry treatment devices is estimated to be $16.8 million. The annual operation and maintenance costs for existing water supply facilities envisioned to be maintained is estimated to be about $107.1 million. Thus, the total annual operation and maintenance cost of the regional water supply plan water supply existing and new facilities is estimated to range from about $101.3 million to about $101.8 million, depending upon the return flow alternative included.

The costs estimated for the recommended plan are based upon 2005 conditions. These costs were updated to 2010 costs, using the change between 2005 and 2010 in the *Engineering News Record* construction cost value for capital costs and the U.S. Bureau of Labor Statistics consumer price index for operations and maintenance costs. The updated 2010 costs are set forth in Table 194 in Chapter X of this report. The updated capital cost ranges from about $388.8 million to $421.1 million depending upon the return flow alternative included. The updated annual operation and maintenance cost is estimated to range from about $111.4 million to about $112.0 million depending upon the return flow alternative included.

The costs set forth herein are those estimated to be needed to develop or expand the water supply facilities for the municipal water utilities within the Region. Those facilities include: new or upgraded wells; water treatment facilities for both surface and groundwater supplies; selected storage facilities; transmission and pumping facilities associated with connection between utilities for source water purposes; and return flow facilities where needed. The costs do not include provisions for the maintenance, improvement, replacement, development, or expansion of existing water transmission and distribution systems.

PLAN IMPLEMENTATION

While the recommended regional water supply plan is designed to attain, to the extent practicable, the agreed upon water supply objectives, the plan is not complete in a practical sense until the steps required to implement the plan—that is, to convert the plan into action policies and programs—are specified. Chapter XI provides such information and is intended as a guide for use in the implementation of the plan. The chapter outlines the actions which must be taken by the various levels and agencies of government in concert with private sector organizations if the recommended water supply plan is to be fully carried out by the design year. The units and agencies of government which have plan adoption and plan implementation powers applicable to the plan are identified; necessary or desirable formal plan adoption or endorsement actions are specified; and specific implementation actions are recommended for each of the units and agencies of government with respect to the elements of the plan. Also, the coordinated roles of the public and private sectors are described, and financial and technical assistance programs available to implement the water supply plan are identified.

The major implementation responsibilities for the sources of water supply elements of the recommended water supply plan rest with the existing and potential future water utilities in the Region. The major sources of water supply recommendations relate to recommended sources of supply for each existing and potential utility. For currently existing utilities, the recommended sources of supply are summarized in Table 196 in Chapter XI of this report. For potential new utilities which may be formed based upon a local identified need and initiative, funding programs are identified to assist low- to moderate-income residents of such utilities. With regard to the return flow component associated with the City of Waukesha Water Utility conversion to a Lake Michigan supply, it is recommended that an oversight committee be formed by the WDNR to provide guidance on the planning, operation, and monitoring of the return flow. The committee would be comprised of representatives of the agencies and units of government potentially impacted by the return flow as described in Chapter XI.

The major responsibilities for the design and implementation of comprehensive water conservation programs also rest with the existing and potential future water utilities in the Region. The plan recommends that the scope and content of these conservation programs be determined on a utility-specific basis reflecting the type and sustainability of the source of supply and the existing and probable future water supply infrastructure requirements.

For those portions of the Region served by private wells, it is recommended that the Counties and local governments, in cooperation with the WDNR and the Wisconsin Department of Health Services, monitor the need for municipal water utilities in areas of urban-density development that are not served by municipal water systems. Table 197 in Chapter XI summarizes these monitoring recommendations.

The protection of groundwater recharge areas classified as having a high or very high recharge potential is expected to be largely achieved through the implementation of the adopted design year 2035 regional land use plan and county comprehensive plans consistent with the regional plan, since these plans recommend preservation of the environmental corridors, isolated natural areas, prime and other agricultural areas of the Region that facilitate recharge. There may also be additional opportunities for utilities, local units of government, and nongovernmental conservation groups to achieve additional protection of important groundwater recharge areas through coordination of recharge area protection with other environmental management efforts.

Implementation of state-of-the-art stormwater management practices elements of the recommended water supply plan may be expected to be largely implemented through the provisions of Chapter NR 151 of the *Wisconsin Administrative Code* and through county and municipal stormwater management ordinances adopted in accordance with Chapter 216 of the *Wisconsin Administrative Code*, including related State and local programs and regulations. In particular, the application of practices in accordance with the WDNR Stormwater Management Technical Standards is recommended.

It is recommended that the primary responsibility for conducting the analyses and monitoring related to the implementation of the recommended high-capacity well siting procedure belong to the utility or other entity proposing installation of the high-capacity wells concerned and to the WDNR under its well review and permitting program.

The implementation of the enhanced rainfall infiltration systems element of the recommended regional water supply plan can be best achieved in conjunction with the results of the analyses performed as part of implementation of the high-capacity well siting element described in the previous section. It is recommended that these infiltration systems be installed as a mitigative measure to provide artificial recharge when analyses indicate that installation of the high-capacity well or wells would result in impacts to surface waterbodies and existing private wells. The primary responsibility for the development and installation of these infiltration systems belongs to the utility or other entity installing the high-capacity well that would generate the impact.

The plan implementation recommendations include the conduct of a continuing regional water supply planning program providing for ongoing assistance by the Regional Planning Commission in collaboration with the WDNR, water utilities, and the local units of government. This program would provide for plan surveillance, plan reappraisal, plan expansion, preparation of water supply service areas, and review and comment on local water supply facility plans and water supply service area plans.

In this regard, it is recommended that the Regional Water Supply Planning Advisory Committee be reconstituted as a continuing advisory committee to provide focus for coordination of actions in the implementation of the plan and to guide revisions to the plan. The aforenoted socioeconomic analysis of the plan, resulted in a recommendation to the Regional Planning Commission that a representative of the Commission Environmental Justice Task Force be appointed to serve on the Advisory Committee for any future plan updates. It was also recommended that a formal public participation plan be adopted for future plan updates.

Chapter XI provides detailed information on grant and loan funding programs that may be possible sources of funding for the implementation of specific plan recommendations.