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 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 water supply system plans for the existing water supply systems of the Region. The inventory is preceded by a section on the historical perspective of facilities in the Region. Also included in this chapter are data on water uses and descriptions of the sources of both groundwater and surface water supply. In addition, areas of existing urban development not currently served by public water supply facilities are identified. The inventory data presented in this chapter are presented on a county-by-county basis and are summarized on a regional basis. This presentation was thought to be convenient for use of the data.

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 is 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.[1]

[1] *American Water Works Association http://www.awwa.org/Advocacy/learn/info/HistoryofDrinkingWater.cfm accessed April 20th, 2006.*

The mid-19th Century brought the Industrial Revolution, causing rapid growth and change to many cities throughout the United States and Europe. Major urban areas grew rapidly, and in some cases created 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 were 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 urbanized 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 or neighborhood 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 up to this point, 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 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 for the East Coast 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 railroad connecting the Cities of Chicago and Milwaukee. Milwaukee became the most important manufacturing center in the Region, primarily due 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 manufacturers had their foundations in the raw materials supplied by the farms and forests within the study area and the State, and its neighbors.

During the 35-year period from 1910 to the end of World War II in 1945, the trend toward more intensive land use continued, marked particularly by the increasing mechanization of farming and the introduction of a modern, all-weather, high-speed highway system. Since 1950, an affluent and mobile population has been converting land from rural to urban use for residential, commercial, institutional, and transportation purposes 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 in the more rural portions of the Region.

Water Supply Development in Southeastern Wisconsin

Many of the current existing public water supply systems were initially constructed in the latter part of the 19th Century 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 26.

The City of Milwaukee developed the first municipal water supply system in the Region. Prior to this development, Milwaukee citizens acquired water primarily through springs, shallow wells, and horse-drawn water wagons (private vendors) that collected water directly from Lake Michigan. Due to rapid population growth, the methods for distributing the water supply could not keep up with the demand, and fear spread that a major fire would not be containable. Also, as the population grew, so did pollution; historic records indicate that by the 1860s, the rivers were contaminated with raw sanitary sewage, and industrial wastes, and waterborne diseases were endemic within the area. Plans to develop a public 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 the system, the operation of which began in 1874 with the development of the North Point pumping station.[2] Other Lake Michigan cities soon followed, with the Cities of Racine, South Milwaukee, and Kenosha water supply systems beginning operations in 1886, 1893, 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 still a public concern locally, as increasing amounts of sewage were discharged to Lake Michigan. When the City of South Milwaukee constructed its water supply system in 1893, it also constructed 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 were endemic in the area into the early 1930s. The Linnwood Avenue water treatment plant was placed into operation in 1934, ensuring, for the first time, a safe water supply of uniform quality.

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 plant with national markets, and the proposed sale of Waukesha mineral water at the 1893 Chicago World's Fair. It was not until after 1900 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 include those for the City of Burlington in Racine County (1890), the City of Hartford in Washington County (1895), the City of Elkhorn in Walworth County (1898), the City of Oconomowoc in Waukesha County (1900), 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, switched 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 Milwaukee Water Works in 1955 to purchase Lake Michigan water. Similarly, the Village of Greendale Water Utility which began operation in 1936, and the Village of Butler Public Water Utility which began operation in 1965, also switched in 1965 and 1973, respectively, again purchasing water from Milwaukee Water Works. The Villages of Fox Point and Whitefish Bay originally purchased water from Milwaukee Water Works, but then, in cooperation with the City

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

Table 26

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		
Kenosha Water Utility	1894	1998
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	1969	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	1926	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		
Delavan Water and Sewerage Commission	1893	2001
Elkhorn Light and Water	1898	2005
Lake Geneva Municipal Water Utility	1890	2005
Whitewater Municipal Water Utility	1912	1997
Darien Water Works and Sewer System	1968	2005
Village of East Troy Municipal Water Utility	1908	2004
Fontana Municipal Water Utility	1949	2005
Village of Genoa City Municipal Water Utility	1922	1998
Sharon Waterworks and Sewer System	1915	2004
Walworth Municipal Water and Sewer Utility	1911	2006
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	1991	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
Slinger Utilities	1911	2003
Allenton Sanitary District	1960	2000

Table 26 (continued)

Water Utility Facility Name	Initial Year of Operation	Year of Most Recent Upgrade
Waukesha County		
City of Brookfield Municipal Water Utility	1960	2004
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
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
Sussex Village Hall and 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 source 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.

of Glendale, developed their own surface water supply system in 1963, overseen by the North Shore Water Commission.[3]

Although municipal water supply systems continued to emerge and expand throughout the 20th Century, numerous industries and individuals continued to rely on private wells and the use of private wells expanded greatly. Prior to the 1880s, several public and private shallow wells were scattered throughout 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, increasing 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.[4]

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 in the Region under conditions before large-scale pumping began, and through time as pumping increased.[5] This model accounts for changes in pumping both the Region and adjacent counties, and in surrounding areas such as northeastern Illinois.

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

[4]*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.*

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

Prior to 1870, no significant groundwater extraction was done within the Region. Such extraction in southeastern Wisconsin began around 1864. Predevelopment piezometric pressures were estimated to represent average conditions up to 1864. The simulated water table configuration in Figure 13 shows 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 water levels 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, deep pumping centered on Milwaukee, with appreciable shallow pumping along the Rock River in central Rock County (Figure 14). By 2000, the deep pumping center had moved to central and eastern Waukesha County, with appreciable shallow pumping in Rock County, Washington and Ozaukee Counties (Figure 14). The total high-capacity pumping in the Region, plus 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.

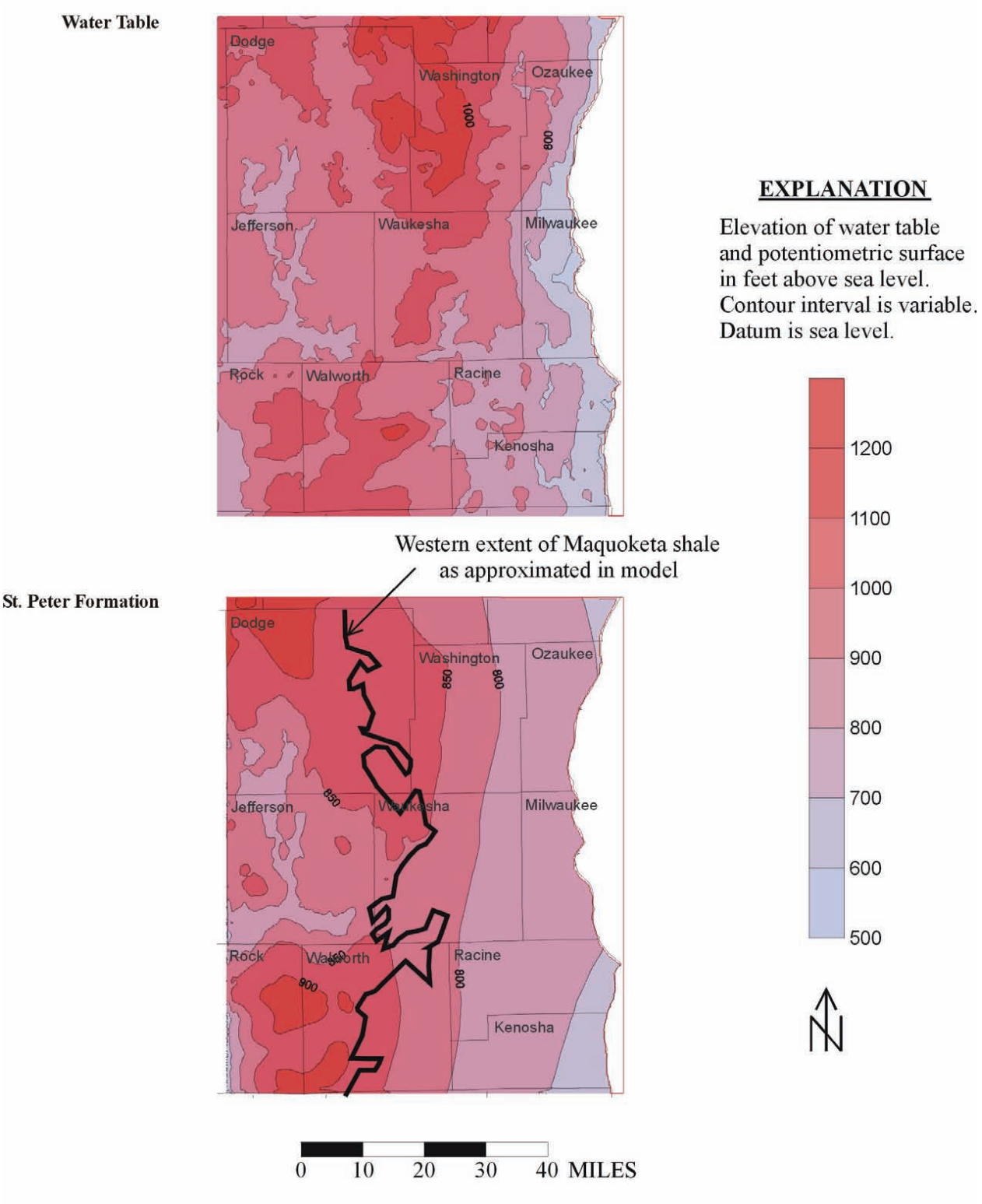
The decline in water levels caused by pumping is different for the shallow and deep aquifers underlying the Region. Pumping from the shallow aquifer generally causes little regional drawdown because local surface water features—streams, lakes, and wetlands—help to offset the withdrawal. Often the major effect of pumping from these shallow wells is to reduce the amount of groundwater discharge to local surface water features. Estimated drawdown in the Silurian dolomite portions of the shallow aquifer occurs mainly in Ozaukee County and parts of eastern Washington, northeastern Waukesha, and northern Milwaukee Counties (Figure 15). Simulated drawdown in the Silurian dolomite between 1864 and 2000, approaches 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 ground through septic systems, and, therefore, have caused a net loss of water to the Silurian dolomite aquifer. Since 1999, We Energies Water Services Division has provided 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 mitigate or potentially reverse 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 driven into the deep aquifer in the Waukesha area were artesian—that is, flowing under their own internal pressure. In 1950, pumping centered in Milwaukee produced a regional cone of depression centered below Milwaukee with maximum drawdown in the deep sandstone aquifer potentiometric surface exceeding 300 feet (Figure 16). By 2000, increased pumping, especially in Waukesha County, and decreased pumping in Milwaukee County, moved the center of the regional cone of depression about nine miles west with maximum drawdown approaching 500 feet. The cone of depression extends not only to the west below Dodge, Jefferson, and Rock Counties, but also under Lake Michigan to the east. The effect of pumping in northeastern Illinois is especially evident in the drawdown contours shown for Racine and Kenosha Counties.

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. Watertown and Oconomowoc are located far from pumping centers and beyond the most westward extent of the Maquoketa shale. At these locations, the sandstone aquifer potentiometric 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, and then 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 13

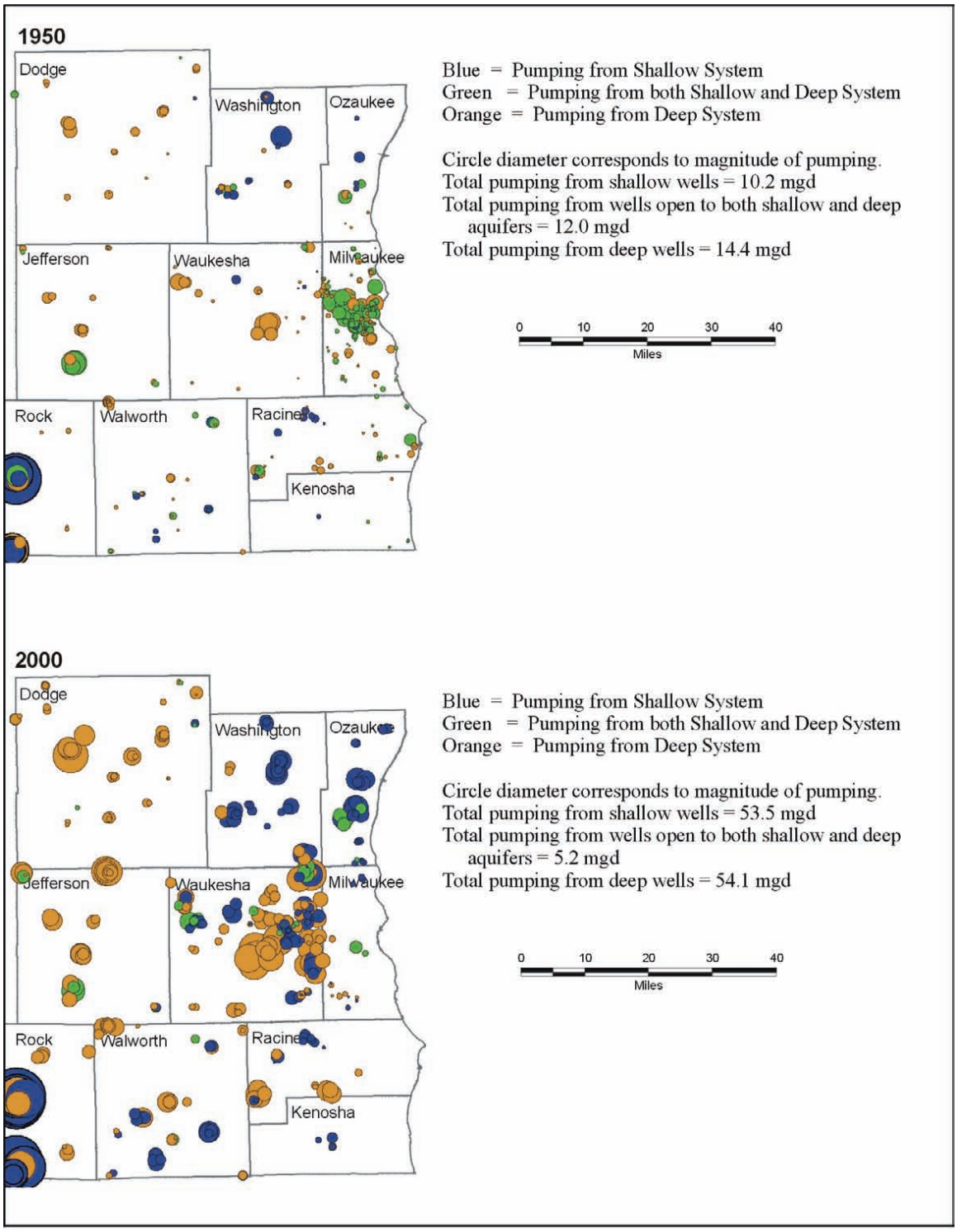
SIMULATED PREDEVELOPMENT WATER LEVELS



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

Figure 14

DISTRIBUTION OF SHALLOW AND DEEP PUMPING

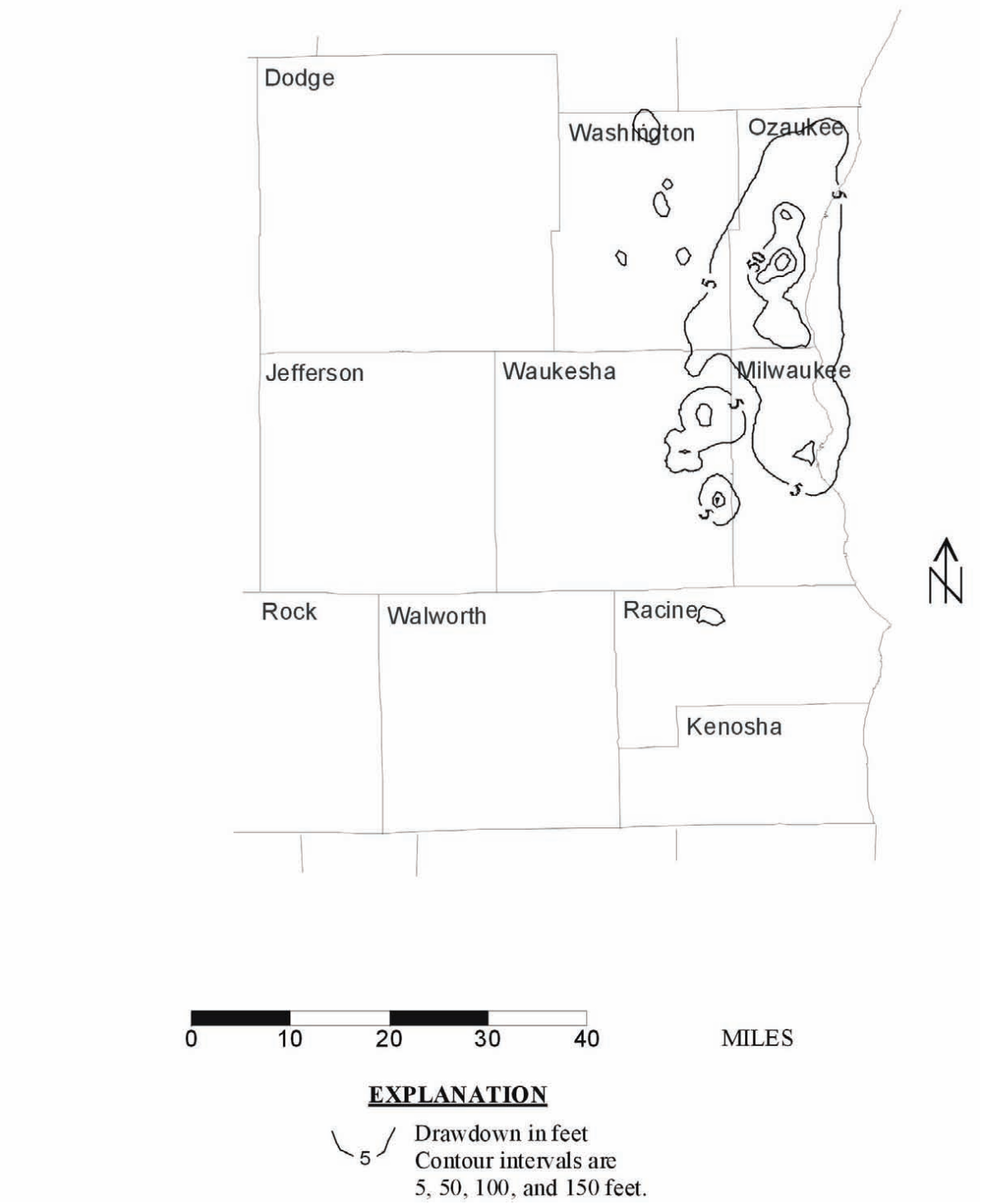


NOTE: The map for 2000 does not include private wells in southeastern Ozaukee County (City of Mequon) that are present in the model after 1960. They are estimated to discharge 3.0 mgd from the shallow part of the flow system in 2000. The map also does not include the deep sanitary tunnel in Milwaukee 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 SILURIAN DOLOMITE AQUIFER FROM PREDEVELOPMENT CONDITIONS TO THE YEAR 2000

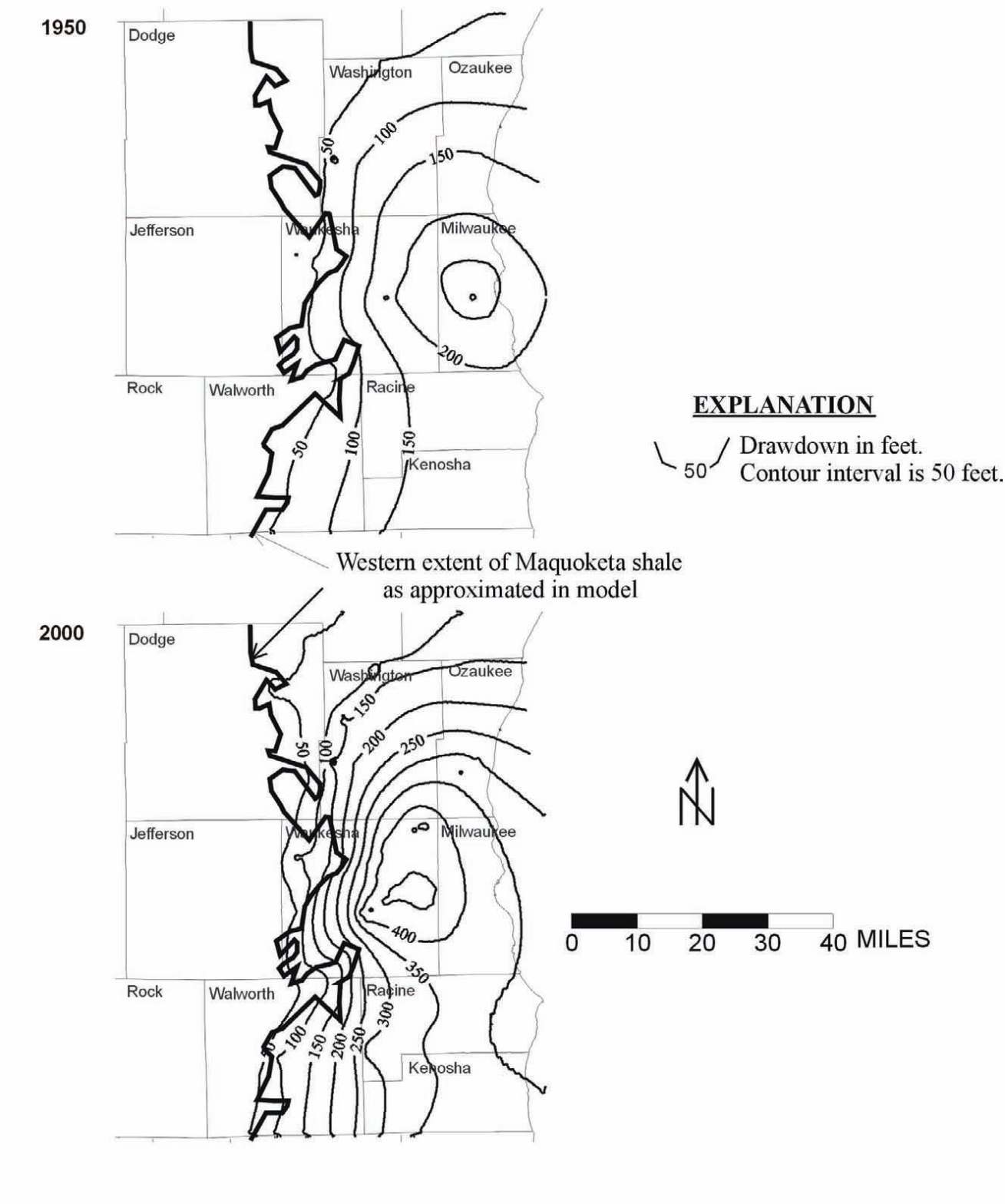


NOTE: The modeling analyses used to develop the drawdown estimates illustrated on this figure did not specifically account for most of private individual—private, onsite—well pumping occurring in the study area. Most of the water pumped by such systems is returned to the aquifer via onsite sewage disposal systems. The modeling did, 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.

Figure 16

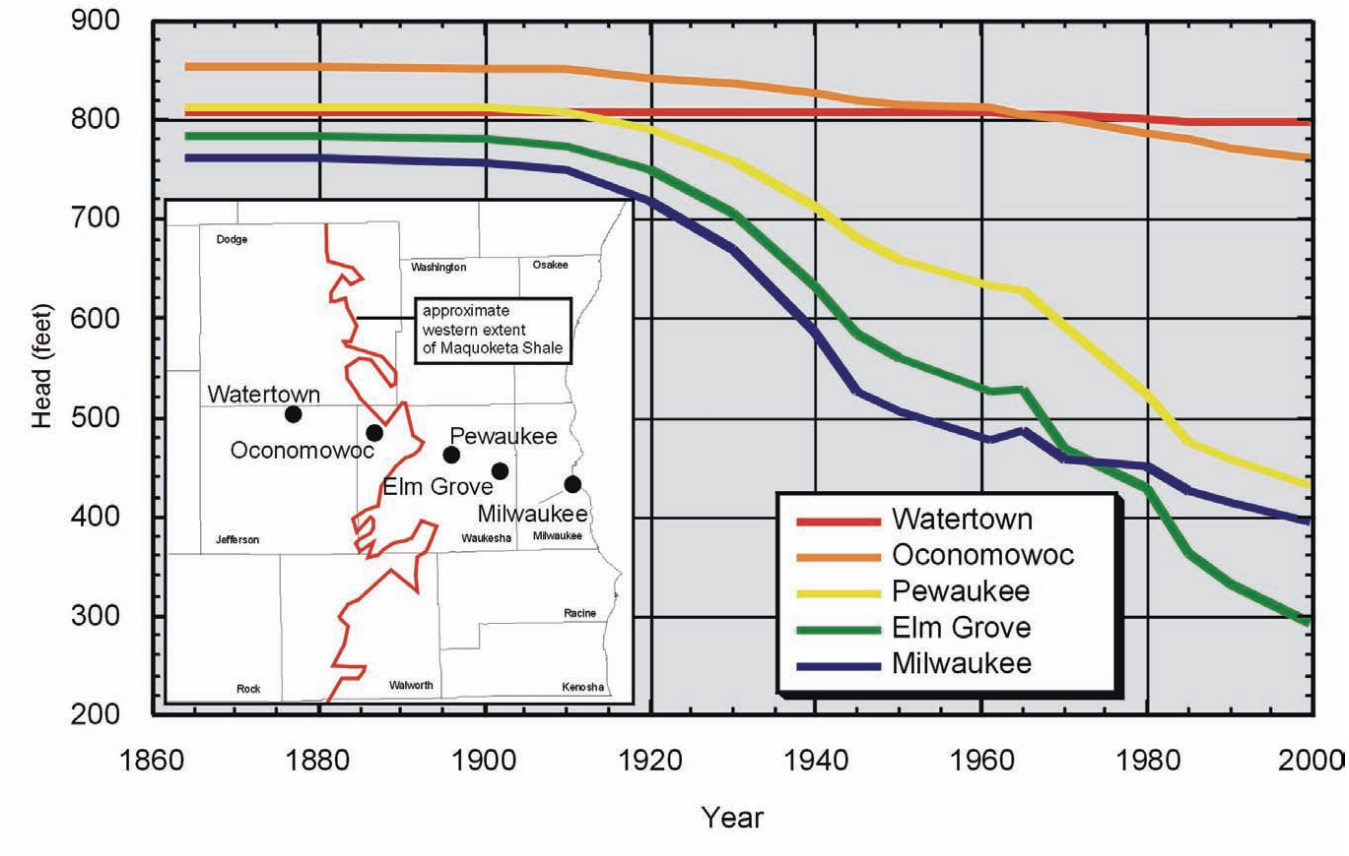
SIMULATED DEEP DRAWDOWN RELATIVE TO PREDEVELOPMENT CONDITIONS: ST. PETER FORMATION



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

Figure 17

WATER LEVELS IN THE DEEP SANDSTONE AQUIFER AT SELECTED LOCATIONS



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 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 Wisconsin Department of Natural Resources (WDNR) and the Public Service Commission of Wisconsin (PSC) data bases. Those data were checked and then entered into a data base established for the water supply planning program.

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 for review and revision, as appropriate. Data on quality data 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 base year 2004. 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 U.S. Geological Survey (USGS).

DEFINITION OF TERMINOLOGY

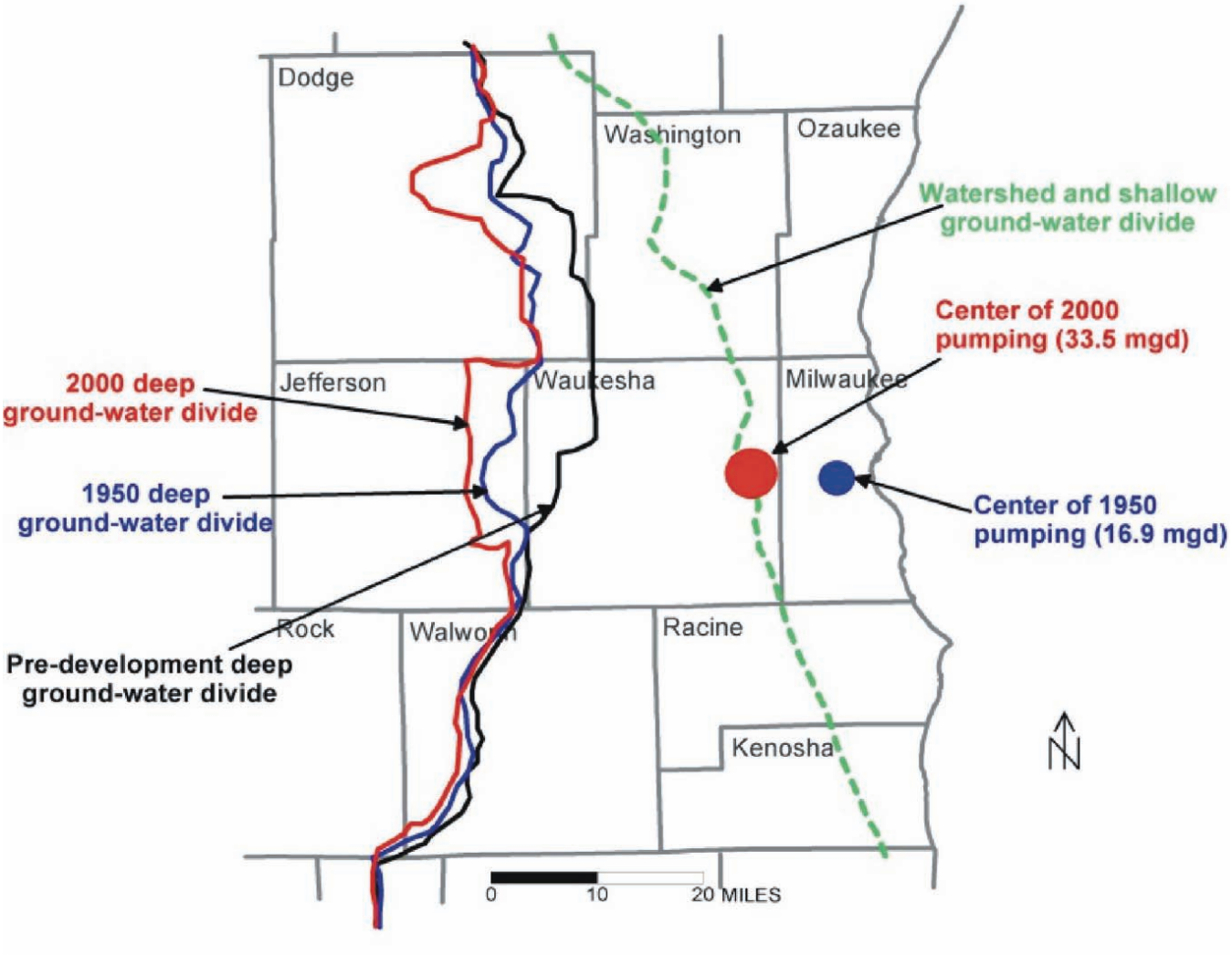
In presenting the findings of the inventory of the existing water supply systems in the Region, a definition of the terminology used is essential in order to provide a common frame of reference. Accordingly, a glossary of water supply-related terms, adopted for use in presenting the inventory findings, evaluations, and analyses, alternative plans, and recommended plan set forth in this report, is provided in Appendix C 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 1,207,000 persons, or about 63 percent of the total resident population of the Region, were served by public water supply utilities using Lake Michigan surface water as the source of supply. About 373,000 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 360,000 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.

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.

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 surface waters; or both gain and lose water from 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 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 for the Southeastern Wisconsin Region in Southeastern Wisconsin Regional Planning Commission (SEWRPC) Technical Report No. 37, *Groundwater Resources of Southeastern Wisconsin*, June 2002. The USGS data indicate that, in 2000, water users in the Region withdrew about 324 mgd of water from surface and groundwater sources, not including water used for thermoelectric-power production (see Table 27). Of that amount, about 96 mgd, or about 30 percent, was comprised of groundwater, and about 228 mgd, or 70 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 27 and Figure 19). Between 1985 and 2000, total water use in the Region remained virtually unchanged. This compares to an increase in population within the Region of about 8 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 1985 to 2000, the use of groundwater increased by about 33 percent, from about 72 to 96 mgd, while the use of surface water decreased about 11 percent, from 256 to 227 mgd (see Table 26 and Figure 19).

The total use of water on a per capita basis within the Region has also fluctuated over time (see Figure 20). Total per capita water use within the Region was stable from 1979 and 2000, and declined by about 9 percent from 1985 to 2000. 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

Individual hydrogeologic units within the Region differ widely in their ability to yield water to wells (see Table 28). 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 1,500 feet in the eastern parts of the Region. For purposes of this report, rock formations within the Region have been grouped into five aquifers, two confining beds, 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 (see Table 28). 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

Table 27

TRENDS IN TOTAL WATER USE IN THE SOUTHEASTERN WISCONSIN REGION BY COUNTY: 1979-2000 (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			
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			
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			
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			
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			
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			
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			
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			

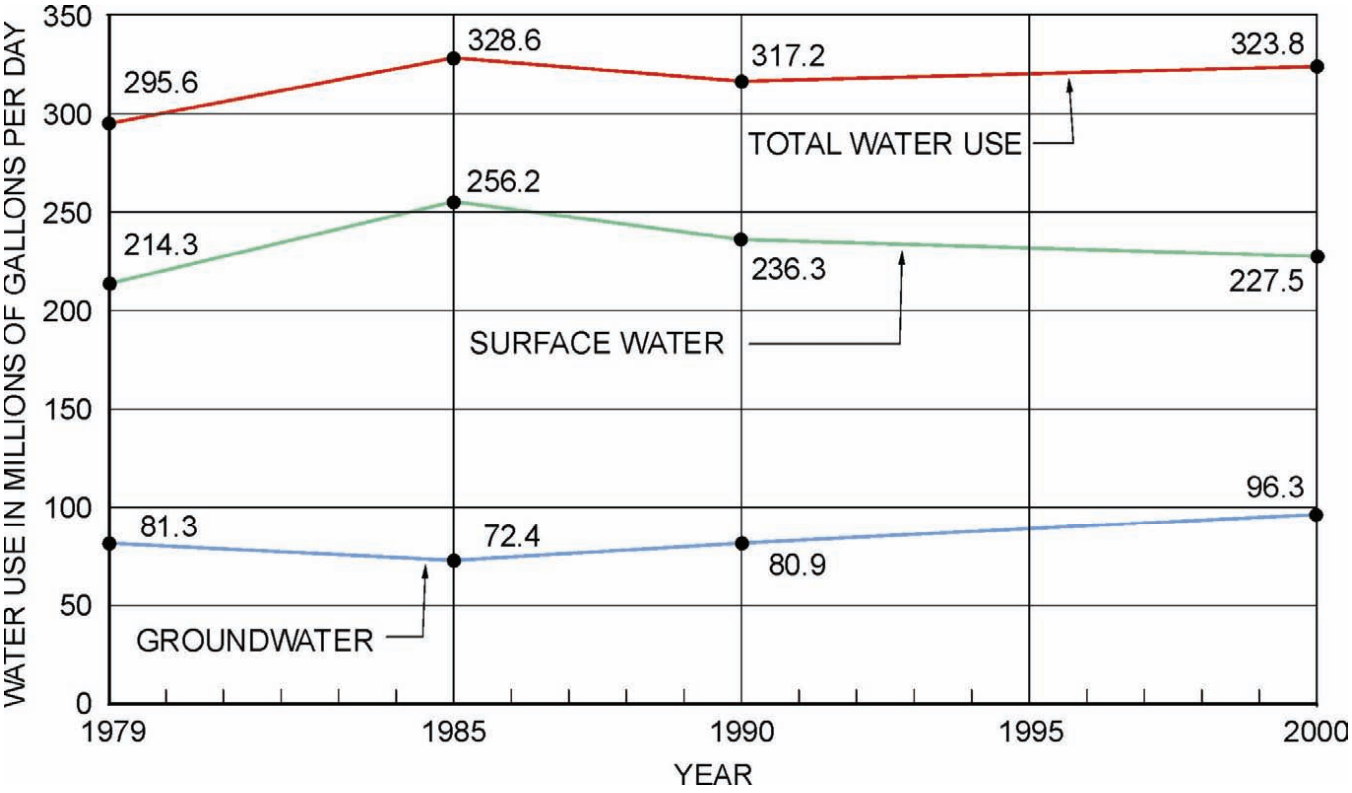
NOTE: Data for 2005 will be added when available.

[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: 1979-2000 (IN MILLION GALLONS PER DAY)[a]



NOTE: Graphic will be expanded to 2005 when data is available.

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

Source: U.S. Geological Survey and SEWRPC.

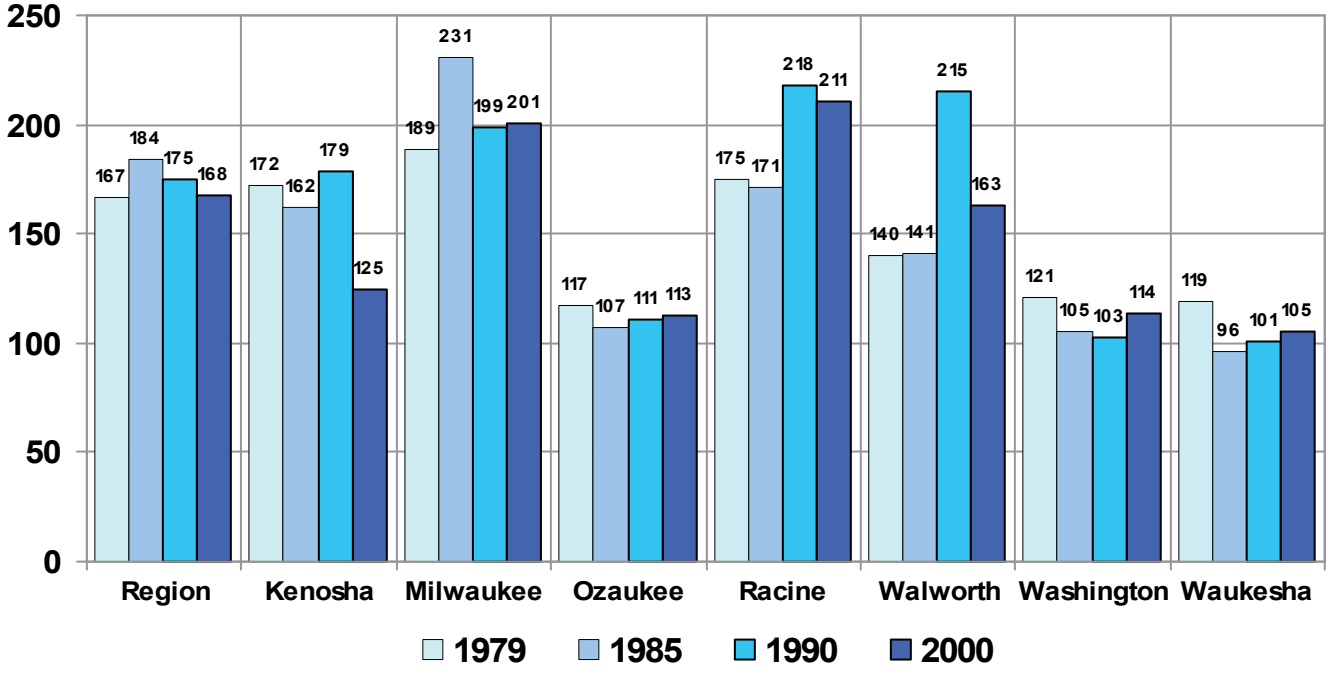
uppermost semi-confining bed; and silty dolomite and fine-grained dolomitic sandstone of the St. Lawrence Formation-Tunnel City Group, the lower semi-confining bed in parts of the Region.

The aquifer systems in southeastern Wisconsin can be divided into two types: unconfined water table aquifers and semi-confined or confined deep bedrock 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 Maquoketa Formation (see Map 26 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 aquifers.

In the deep sandstone aquifer beneath the Maquoketa Formation, the water can be under artesian pressure. Deep high-capacity wells in the eastern 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 northern parts of Washington and Ozaukee Counties and the western part of Waukesha and Walworth Counties. 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

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 uses are relatively consistent between counties, ranging from 65 to 71 gallon per capita per day in 2005. 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.

the Region in the late 1880s, ceased flowing at the beginning of the 1900s, and the potentiometric 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 the record in the late 1940s.

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 26). 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 western limits of the Region where the sandstone aquifer is not overlain by the Maquoketa Formation and is unconfined.

Table 28

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 tens 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 bed	Yields little or no water

NOTE: Fm. = Formation; gpm = gallons per minute; for description, see Chapter V; [1] only in eastern Milwaukee and Ozaukee Counties; [2] not always present in the entire Region; [3] thin or locally absent.

Source: A. Zaporozec, 1997.

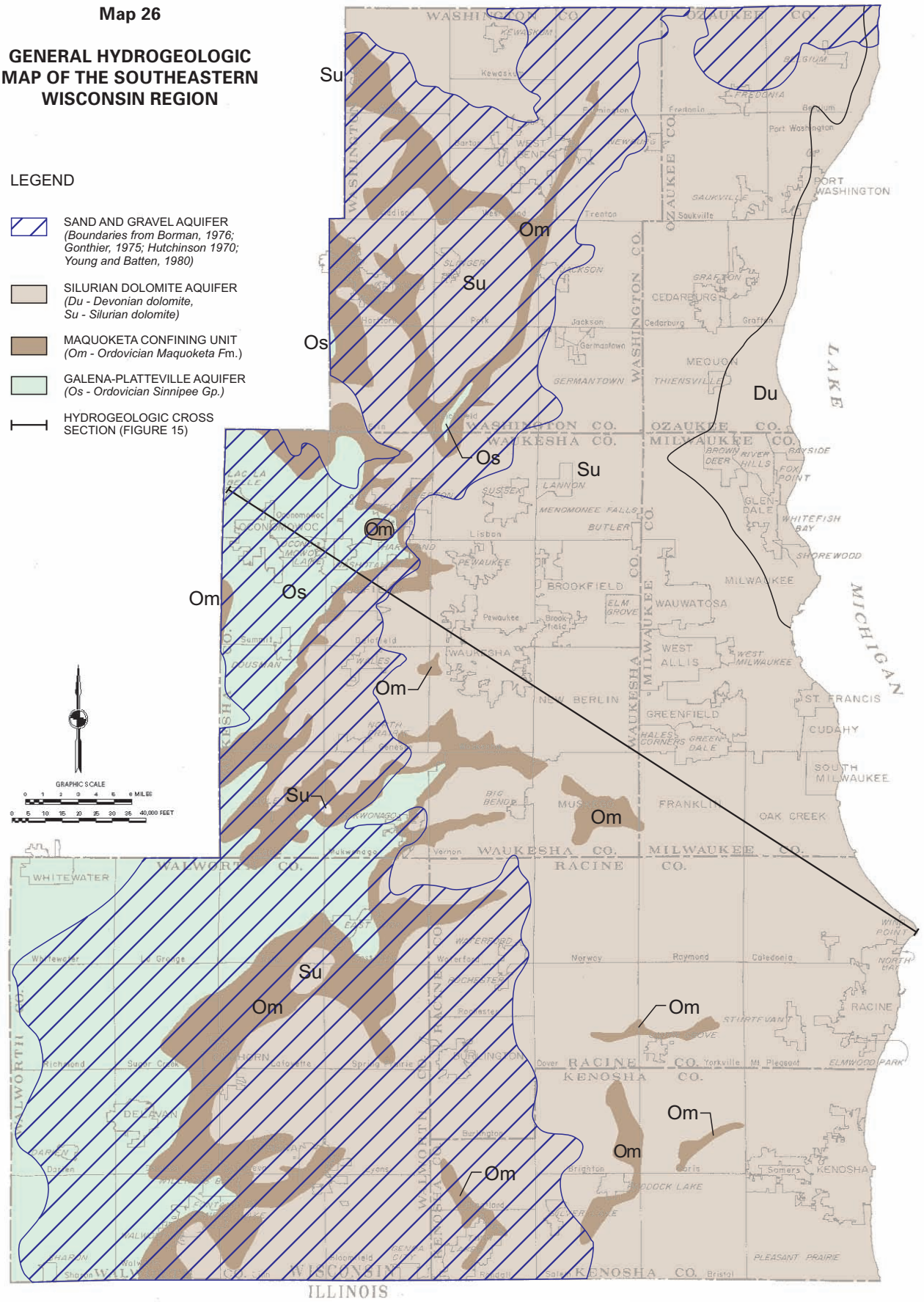
More-detailed description of the areal extent and lithology of aquifers and confining units noted above and including water table depth and elevation mapping can be found in SEWRPC Technical Report No. 37, *Groundwater Resources of Southeastern Wisconsin,* June 2002.

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.

Map 26

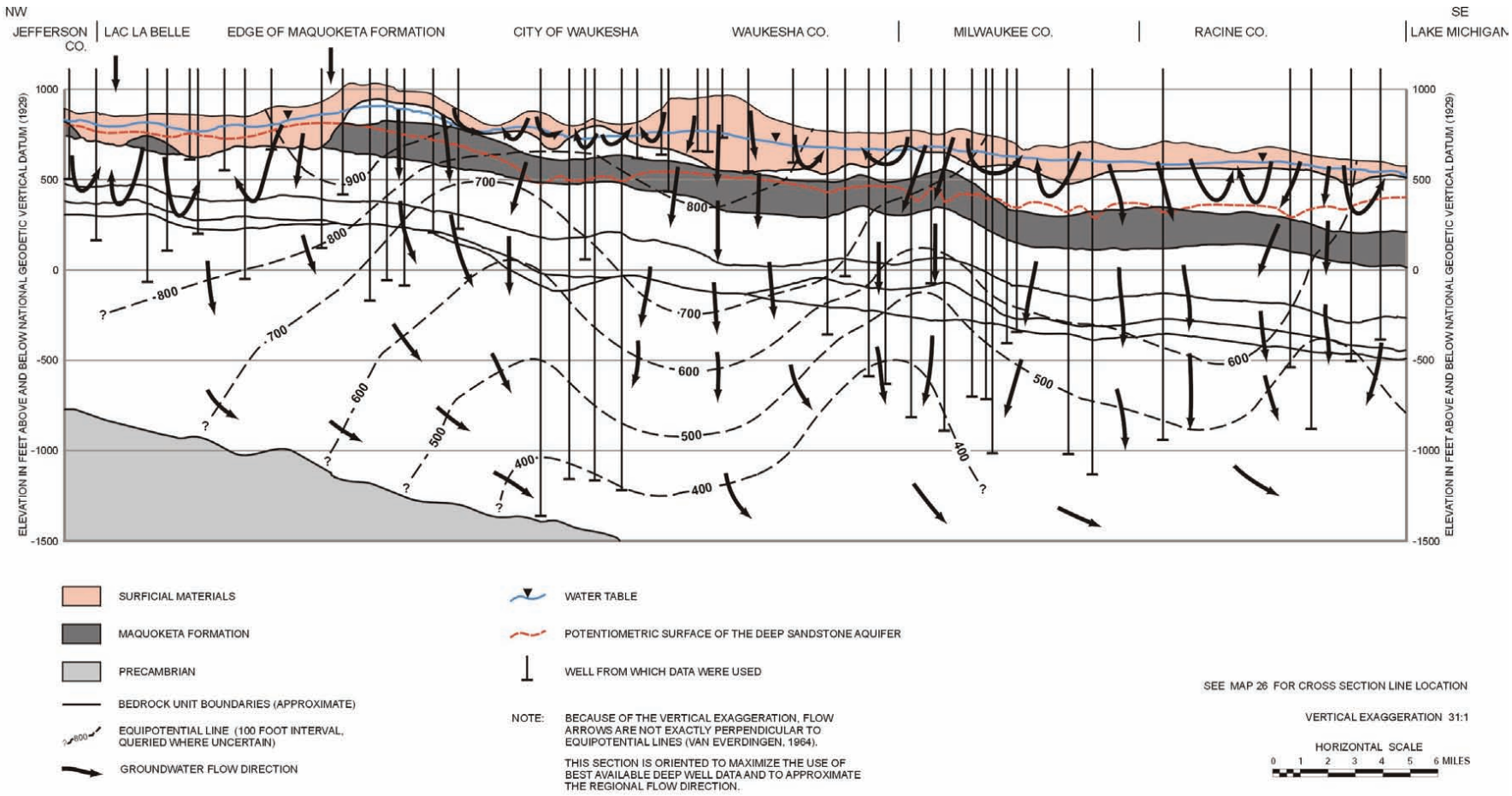
GENERAL HYDROGEOLOGIC MAP OF THE SOUTHEASTERN WISCONSIN REGION



Source: Wisconsin Geological and Natural History Survey.

Figure 21

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



Source: Wisconsin Geological and Natural History Survey.

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. 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 exception to this is the concentration of radium exceeding drinking water standards which occurs in portions of the deep sandstone aquifer underlying the Region.

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.[6]

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 27 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.

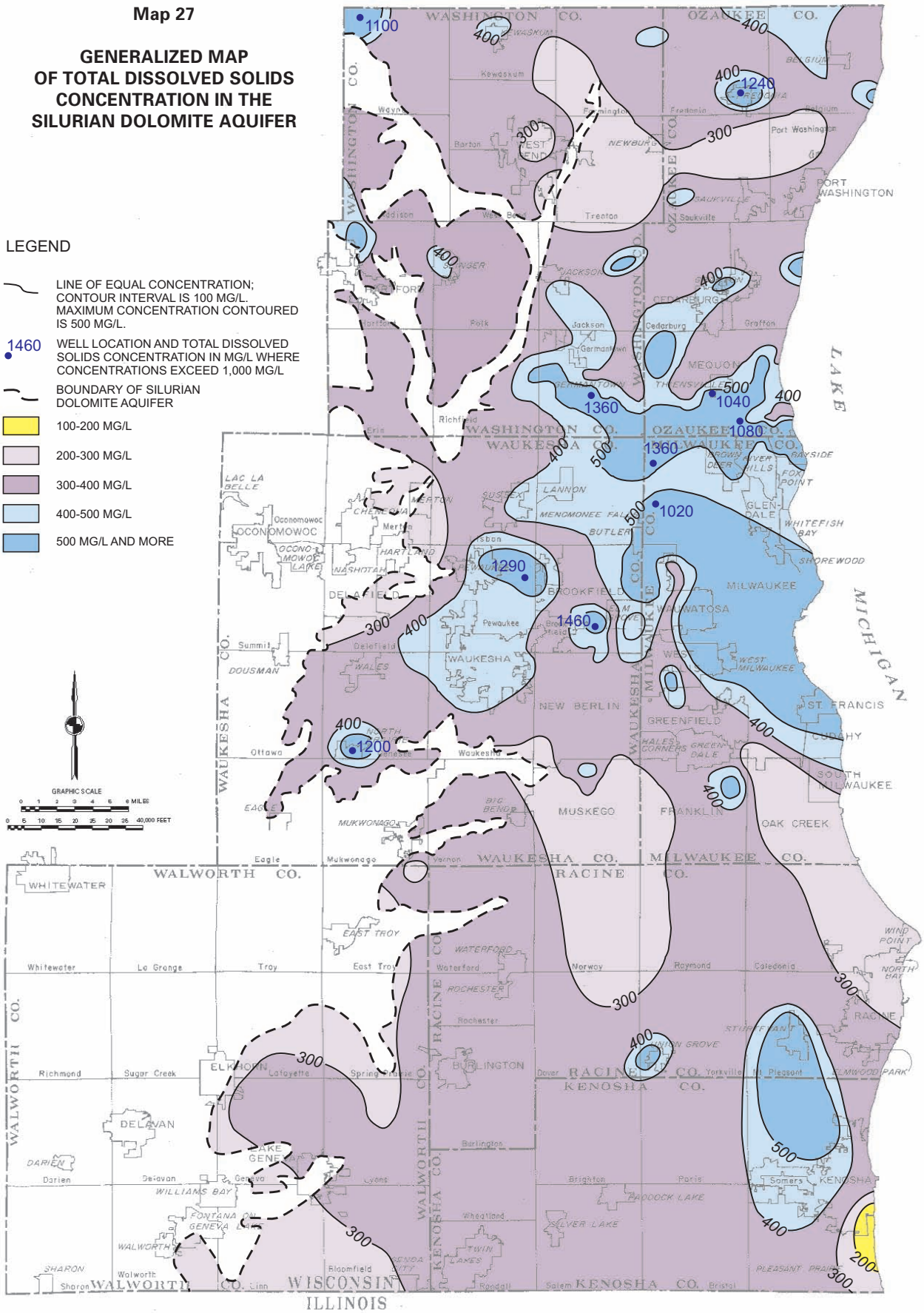
Hardness

Hardness in the groundwater underlying the Region is generally high due to the dominance of calcium-magnesium cations in the groundwater (Map 28). Hardness is reported in terms of equivalent concentration of calcium carbonate (CaCO3), in milligrams per liter. No Federal or State standards for hardness have been

[6] *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 27

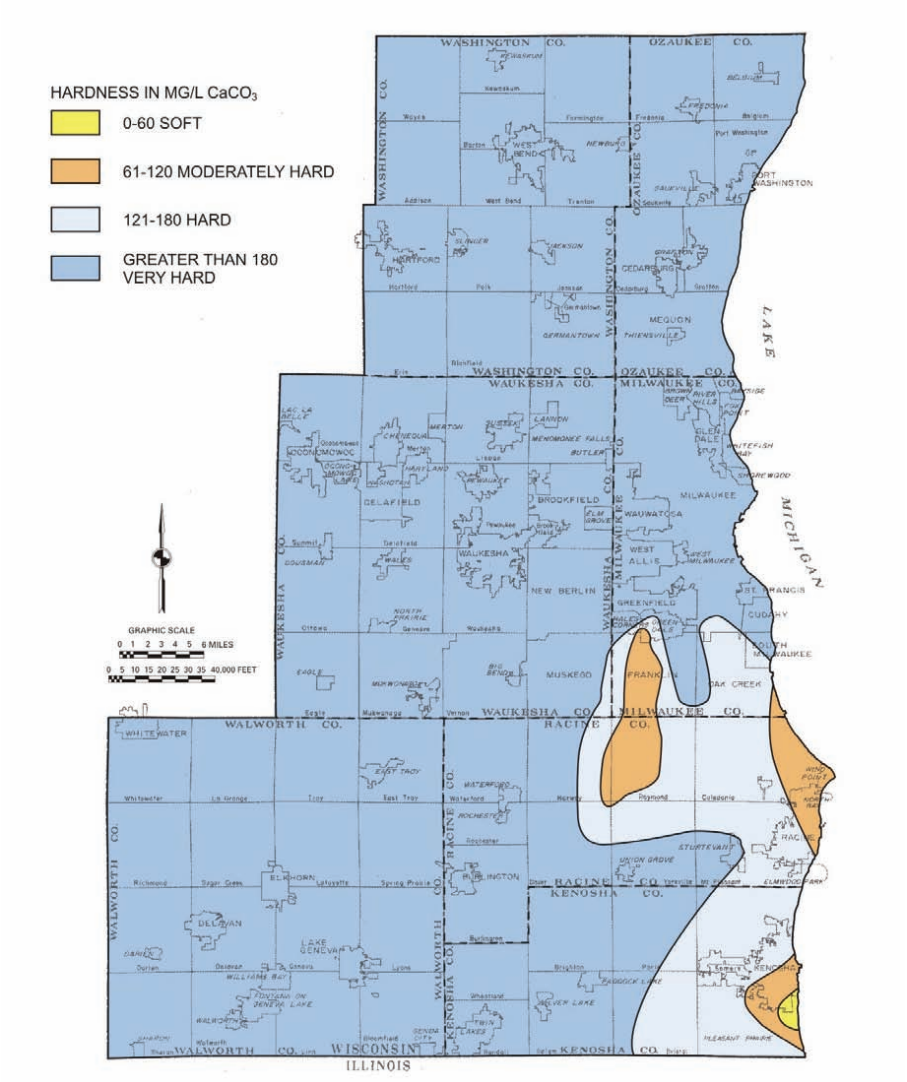
GENERALIZED MAP OF TOTAL DISSOLVED SOLIDS CONCENTRATION IN THE SILURIAN DOLOMITE AQUIFER



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

Map 28

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 CaCO3 is generally considered as suitable for domestic uses. Water having more than 180 mg/l CaCO3 is considered very hard, and softening is required for most purposes. Hardness does vary somewhat between aquifers:[7]

- 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.

[7] *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 CaCO3.

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 CaCO3 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, hardness is objectionably high in the groundwater underlying most of the Region (see Map 28), 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[8] in southeastern Ozaukee County and northeastern Milwaukee County. Several areas in southwestern Ozaukee, northeastern Waukesha, and northern Milwaukee Counties have been reported,[9] 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 27.

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 problem in the shallow aquifer of 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

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[8] *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.*

[9] *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.*

level (MCL) standard for radium (combined Radium-226 and Radium-228). ~~According to the WDNR records, there where 113 samples taken over the six-year period from January 1, 2000 through December 31, 2005, by municipal and "other than municipal, community" water supply systems located within the Southeastern Wisconsin Region which had radionuclide levels exceeding the MCLs. One or more of these 113 samples were reported by 13 of the 50 municipal water utilities and by nine of the approximately 200 "other than municipal, community" water supply systems in the Region using groundwater as a source of supply.~~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, ten 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 a concern because selected municipal and private water supplies exceed a new Federal and State MCL standard of 10 micrograms per liter. ~~According to the WDNR records, there where 265 of the 936 samples taken for arsenic testing over the six-year period from January 1, 2000 through December 31, 2005, by the 2,031 public water supply systems located within the Southeastern Wisconsin Region which had arsenic concentrations of 50 percent or more of the MCLs. One or more of these 265 samples were reported by 15 of the 50 municipal water utilities in the Region using groundwater as a source of supply. The arsenic exceedances can be traced to all of the aquifers in the Region. The primary zone of arsenic mineralization is considered to be below the bottom of the Galena-Platteville Dolomite formation (see Table 28).~~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 sampled 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 and the State preventive action limit of 1 microgram per liter 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 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.[10] 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.[11] 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.

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[10] *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.*

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

Contaminants resulting from human activities, causing groundwater quality problems in the Region, include bacteria, nitrate, pesticides, and volatile organic compounds (VOCs). The first three can affect water quality of water in private wells, but generally do not cause major problems in the Region.

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, up to 73 percent of well have been tested "unsafe." Protected aquifer wells average less that 6 percent unsafe.[12] Overall, coliform detection rates are three times higher in late summer months than midwinter.[13] *E. coli*, the coliform most strongly associated with fecal contamination, is found in fewer than 2.6 percent of private wells.[14] 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. For comparison, 3.7 percent of public water systems in the Region experienced confirmed total coliform contamination in 2005.[15]

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.[16] Viruses can persist and remain infective for several months in soils and soils and groundwater when temperatures are low and soil is moist.[17] 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,[18] 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

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[12] *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.*

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

[14] *Centers for Disease Control,* A Survey of the Quality of Water Drawn for domestic Well in Nine Midwestern States*, 1994.*

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

[16] *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.*

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

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

of wells tested positive for the presence of at least one enteric virus.[19] 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's results 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 sepatge 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 do 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.[20]

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.[21] They can persist in soils for at least three years[22] and are highly resistant to physical and chemical agents, such as heat, ultraviolet light, ionizing radiation, chemical disinfectants, and organic solvents.[23] 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.[24] 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.

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

[20] *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.*

[21] *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.*

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

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

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

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. ~~One analysis[25] indicates that nitrate contamination is a relatively minor problem in the Region. Nitrate-nitrogen was found to exceed the standard in 3.7 percent of 1,245 samples collected, and the exceedence rate was found to range from zero in Milwaukee County to 7.5 percent in Walworth County. The highest exceedence rate was found in the Darien Township, Walworth County, where more than 18 percent of samples exceeded 10 mg/l of nitrate-nitrogen.~~Data from the WDNR GRN databases suggest that nitrate contamination is a relatively 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 2 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. Triazine was detected in 63 of the 263 samples collected by DATCP in all of the counties within southeastern Wisconsin, except Milwaukee.[26] 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. ~~Available data from drinking water sampling conducted in 1985[27] indicated that VOCs were detected in two systems in Ozaukee County, with one over the health advisory limit; one system in Washington County; four systems in Waukesha County, with one over the health advisory limit; and three systems in Walworth County, with one over the health advisory limit. Forty-seven private and noncommunity wells were tested in Washington, Waukesha, and Walworth Counties and VOCs were detected in six of them, with one over the health advisory.~~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

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

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

[27] *M.A. Koth,* The Safety of Wisconsin's Drinking Water*, Wisconsin Department of Natural Resources Publication No. PUBL-WS-006 85, 1985.*

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 extend 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 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 water softening contributions 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. Wisconsin's 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.[28] 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.

The WDNR has recently tested all municipal water systems in the State and a large number of noncommunity and private wells for VOCs. During the contamination source inventory, collated by the Commission, 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 2002 are listed in Table 29 and the locations of the special well casing requirement areas are shown on Map 29. The most often found contaminants were VOCs and bacteria. Other contaminants included petroleum products, nitrates, and landfill leachate.

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

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, for cooling of buildings 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. 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 30. 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. 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 31.

The level of Lake Michigan fluctuates, but is generally at the same elevation as its connection to Lake Huron through the Straits of Mackinac. The level of Lake Michigan has fluctuated from a recorded all time low of 575.5 NGVD 1929 in January 1926 to 584.3 NGVD 1929 in March 1987 (see Table 31 and Figure 22). The primary outlet of Lake Michigan through Lake Huron—that of the entire Great Lakes system—is the St. Lawrence River. A significant diversion of Lake Michigan water occurs at Chicago, both for water supply purposes and for flow modification of the Chicago River and of the Illinois River and its canal system. The current rate of diversion is about 1,000 mgd for water supply purposes, in part, to reduce the pumpage in the deep sandstone aquifer and a similar amount for river and canal flow modifications. 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 rainfall, less evaporation and inflow 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,[29] 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.[30] The water budget of Lake Michigan is reported to be as follows:

[29]*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.*

[30]*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.*

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 or ozonation in order as 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 D of this report.

In 2000, a total of about 2,000 million gallons per day of surface water was withdrawn from Lake Michigan or it estuaries for thermoelectric power generation purposes within southeastern Wisconsin.[31] This is about six 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 planning study area which draw water from Lake Michigan or its estuaries. Three of power plants typically use open-cycle cooling systems which withdraw water from Lake Michigan, pump it through steam condensing equipment, and then return the water to the Lake or estuary system. These facilities are reported to typically return 99.9 percent of the cooling water used to the source.[32] 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 evaporates about 75 percent of the water withdrawn from the Lake. That amounts to 10 to 15 million gallons per day which is evaporated, and not returned directly to the Lake. The amounts of water withdrawn from Lake Michigan and then largely returned may be compared to the total average daily lake inflow of about 35,000 mgd.

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

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

Table 29

SELECTED CHARACTERISTICS OF THE SPECIAL WELL CASING REQUIREMENT AREAS IN SOUTHEASTERN WISCONSIN: 2001

Identification Number[a]	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	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	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	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	Silt loam	- -	220 feet
9	Town of Richfield Sections 12 and 13	Gasoline	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	Town of Germantown Sections 9 and 10	Gasoline	Silt loam	Gravelly, clayey, sandy silt	100 feet
12	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 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, 25, 26, 34, 35, and 36	Bacteria, gasoline	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 29 (continued)

Identification Number[a]	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	VOCs	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, and 21	Leachate	Loam, silt loam	- -	To top of bedrock

NOTE: VOC = Volatile Organic Compound.

[a] *See Map 25.*

Source: Wisconsin Department of Natural Resources.

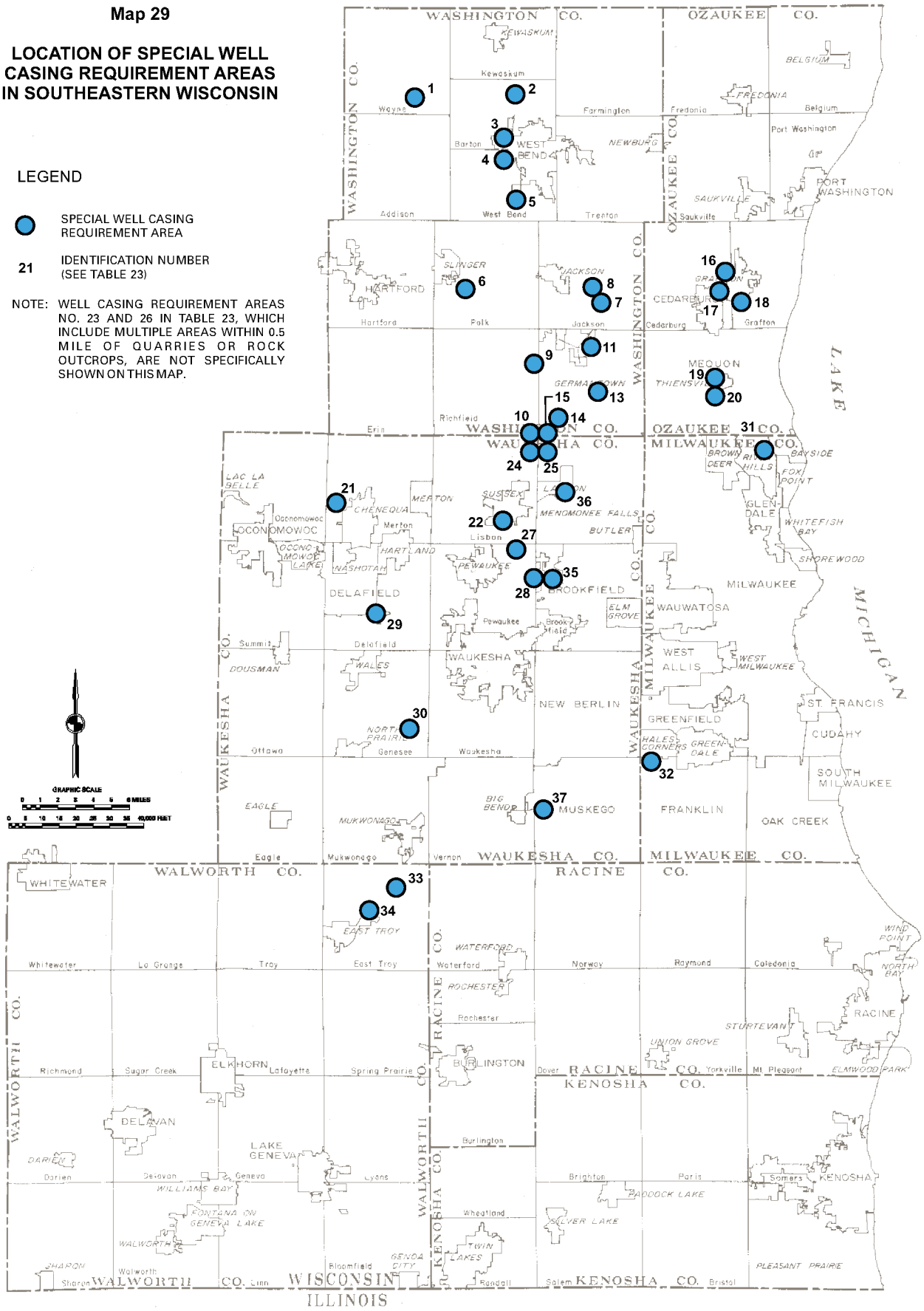
Map 29

LOCATION OF SPECIAL WELL CASING REQUIREMENT AREAS IN SOUTHEASTERN WISCONSIN

LEGEND

- SPECIAL WELL CASING REQUIREMENT AREA
- 21 IDENTIFICATION NUMBER (SEE TABLE 23)

NOTE: WELL CASING REQUIREMENT AREAS NO. 23 AND 26 IN TABLE 23, WHICH INCLUDE MULTIPLE AREAS WITHIN 0.5 MILE OF QUARRIES OR ROCK OUTCROPS, ARE NOT SPECIFICALLY SHOWN ON THIS MAP.



Source: Wisconsin Department of Natural Resources.

Table 30

INLAND SURFACE WATER WHERE 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

Table 31

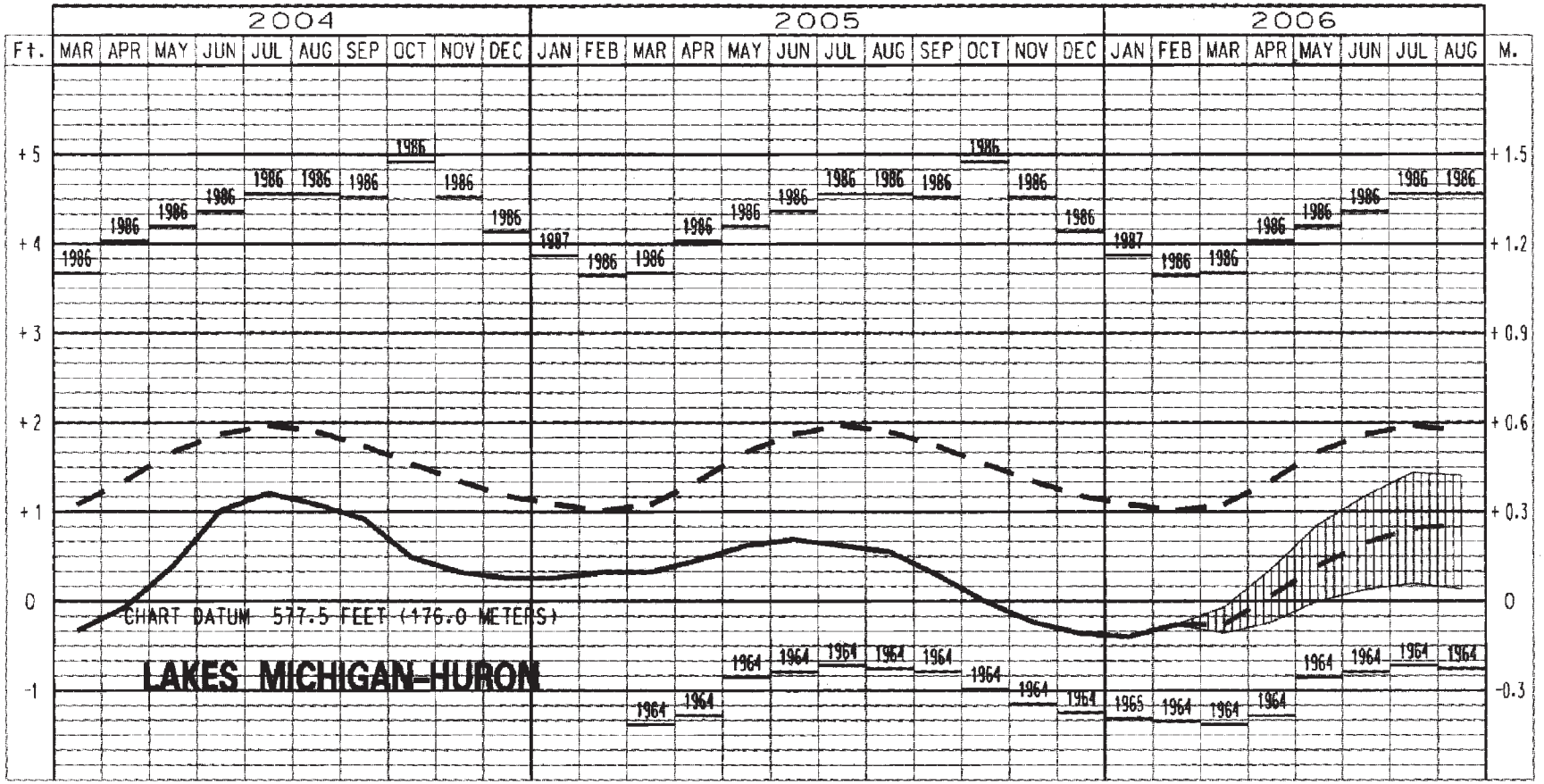
HYDROLOGIC AND MORPHOMETRY OF LAKE MICHIGAN

Parameter	Measurement
Surface Area	22,300 square miles
Length	307 miles
Width	110 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)	
Annual Mean Low Water Level (1964)	577.1
Monthly Low Water Level (1964)	576.8
Annual Mean High Water Level (1986)	582.5
Monthly High Water Level (1986)	583.2

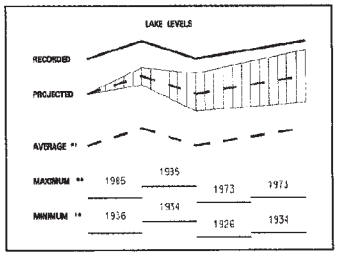
Source: SEWRPC.

Figure 22

LAKE LEVEL ELEVATION CHART: MARCH 2006



LEGEND



The levels on the hydrographs are shown in both feet and meters above (+) or below (–) Chart Datum. Chart Datum, also known as Low Water Datum, is a reference plane on each lake to which water depth and Federal navigation improvement depths on navigation charts are referred.

All elevations and plots shown in this bulletin 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.

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 116,900 persons, or about 73 percent of the residential 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 and one emergency intakes. 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 30 and selected characteristics of each system are presented in Table 32.

In 2005, the total storage capacity for the six municipal water systems operating in Kenosha County was approximately 29 million gallons, divided among the 17 elevated tanks and standpipes and one small reservoir, as listed in Table 32. As the largest water provider, the Kenosha Water Utility maintained eight elevated tanks and standpipes, with a total storage capacity of about 16.7 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 (see Table 32). As shown on Table 33, 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 53 percent of total municipal water used, was for single- and two-family housing units residential purposes; 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 14 percent, was for industrial uses. The remaining 0.8 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 six 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 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. 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 six municipal systems in 2005 was about 11 percent more than used in 2000 and 2004. This increase was due largely to an increase in residential use of from 12 to 14 percent, compared to 2004 and 2000, respectively.

Municipal Water Supply System Interconnection and Intermunicipal Service Provisions

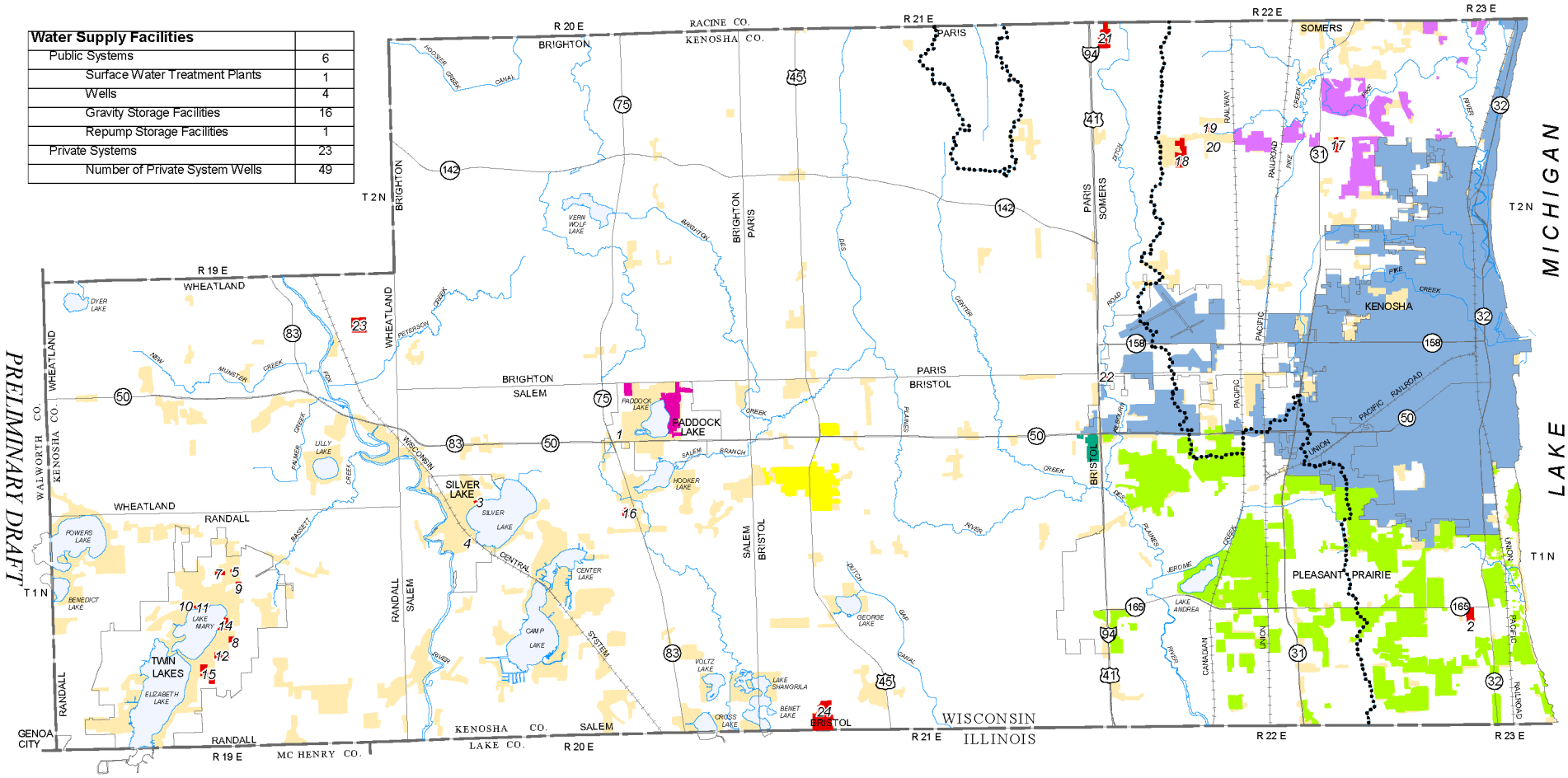
The City of Kenosha Water Utility water treatment plant is the only municipal source of water supply for the greater Kenosha area. The Kenosha Water Utility provides water on both a retail and wholesale basis for use in different portions of the Village of Pleasant Prairie and the Town of Somers and 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 are no other known water supply system interconnections or intermunicipal service provisions in Kenosha County outside of the greater Kenosha area.

Map 30

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

Water Supply Facilities	
Public Systems	6
Surface Water Treatment Plants	1
Wells	4
Gravity Storage Facilities	16
Repump Storage Facilities	1
Private Systems	23
Number of Private System Wells	49



SURFACE WATER SUPPLIED SYSTEMS

- KENOSHA WATER UTILITY SERVICE AREA
- PLEASANT PRAIRIE WATER UTILITY SERVICE AREA
- TOWN OF SOMERS WATER UTILITY SERVICE AREA
- TOWN OF BRISTOL UTILITY DISTRICT 3
- SUBCONTINENTAL DIVIDE

GROUNDWATER SUPPLIED SYSTEMS

- PADDOCK LAKE MUNICIPAL WATER UTILITY SERVICE AREA
- TOWN OF BRISTOL UTILITY DISTRICT 1
- 23 — AREA SERVED BY OTHER THAN MUNICIPAL, COMMUNITY WATER SYSTEMS USING GROUNDWATER. IDENTIFICATION NUMBER CORRESPONDS WITH APPENDIX E
- 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

N

GRAPHIC SCALE

0 2 4 Miles

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

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

Table 32

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 Pumping (mgd)	2005 Maximum Daily Pumping (mgd)	10-Year Maximum Daily Pumping (mgd)	Spent Water Receiving System
Town of Bristol Utility District No. 1	D	0.7	1,400	G	2	1.30	SG, S	- -	H, F	- -	1	100	0.24	0.40	0.75	Bristol Creek
Town of Bristol Utility District No. 3	D	0.1	- -	SP	- -	- -	- -	- -	- -	- -	- -	250	- -[f]	- -[f]	- -[f]	Lake Michigan
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
Paddock Lake Municipal Water Utility	D	0.2	1,000	G	2	0.79	SG	- -	- -	- -	1	10	0.07	0.18	0.58	Brighton Creek
Pleasant Prairie Water Utility	AB	8.7	9,200	SP	- -	- -	- -	- -	- -	- -	6	12,200	1.91	- -[f]	- -[f]	Lake Michigan[g]
Town of Somers Water Utility	C	1.4	2,100	SP	- -	- -	- -	- -	- -	- -	- -	- -	0.08	- -[f]	- -[f]	Lake Michigan
Total	- -	34.2	116,900	- -	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] *Make up code for treatment types, such as:*

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 33

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	99	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	12,200	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 which 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 five 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.

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 existed 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 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 which 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/Town of Somers*, prepared and adopted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the local units of government concerned, 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 84-square-mile urban service area, as shown on Map 31. 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:

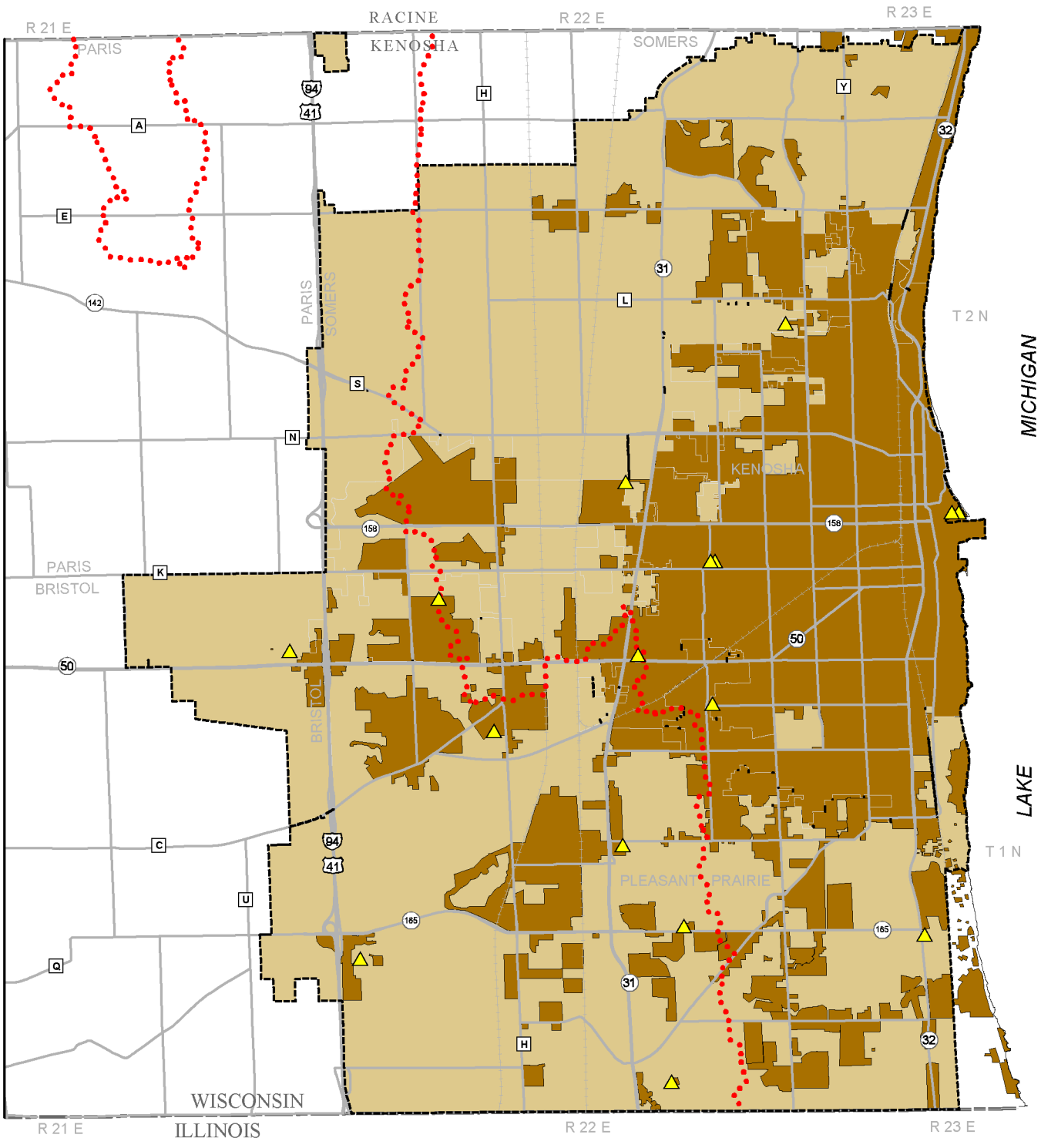
1. A report entitled *Engineering Report for West Side Water System, Village of Paddock Lake, Kenosha County, Wisconsin*, prepared by Baxter & Woodman, Inc., dated October 2004.

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 last June 2005.

Map 31

GREATER KENOSHA AREA PLANNED URBAN SERVICES AREA: 2004



Source: SEWRPC.

A review of the aforelisted local plans indicates that the Village of Paddock Lake 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 water 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 last December 2005.

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 STH 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 23 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 an area of about 0.4 square miles and served a residential population of about 2,000 persons, or about 1.5 percent of the 2005 Kenosha County resident population. Of the 23 systems, six are classified as high-capacity well systems, and 17 are classified as low-capacity wells systems that combined, rely on 45 low-capacity wells, three high-capacity wells, and one well of unknown capacity as a source of supply. The existing service area of these systems is shown on Map 30. Selected characteristics of each system are presented in Table E-1 in Appendix E.

Existing Industrial Water Supply Systems

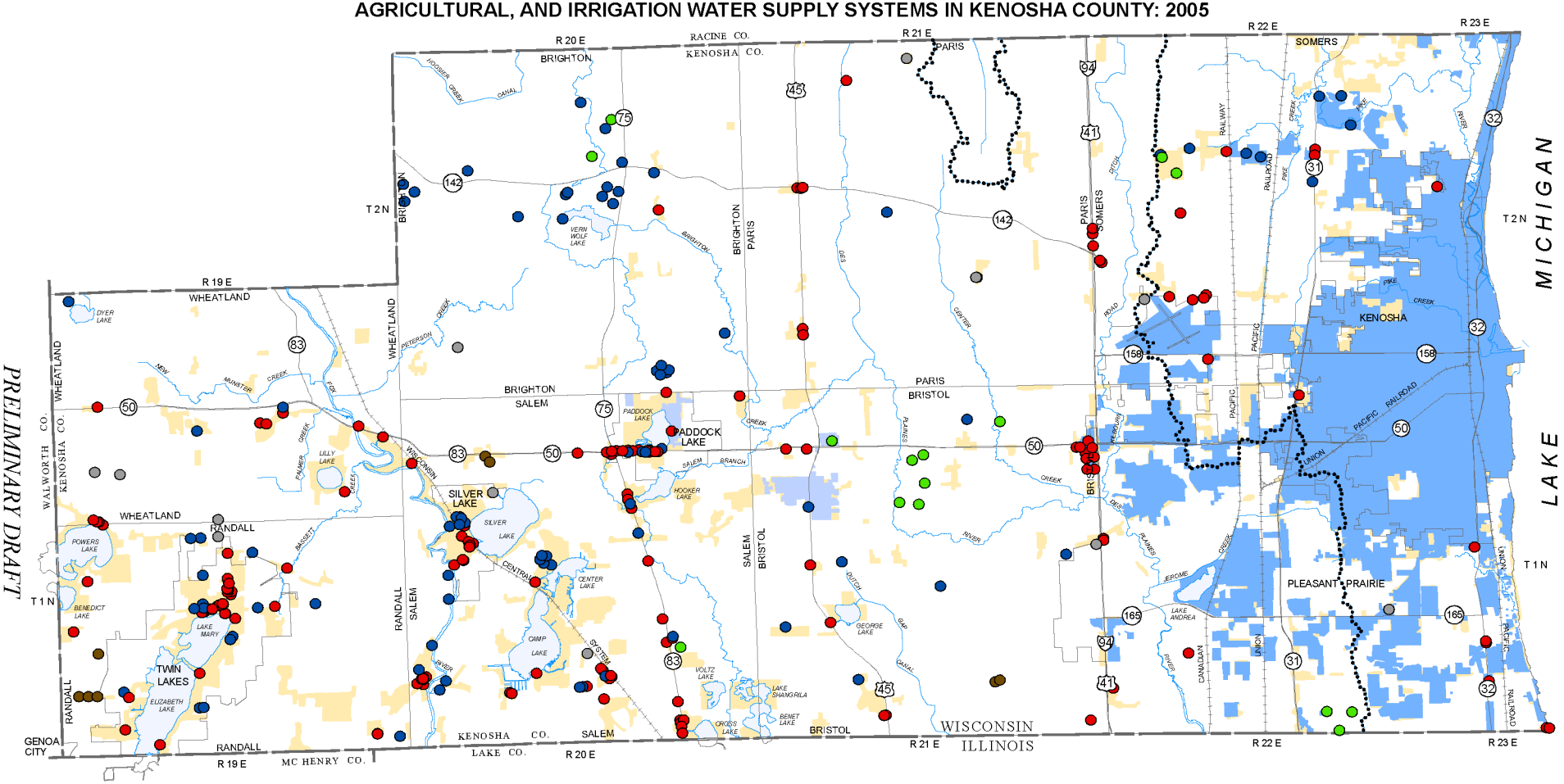
In 2005, there were 10 existing privately owned, self-supplied, water systems operating in Kenosha County which provide water for industrial land uses. Of these, five are classified as high-capacity and five are classified as low-capacity wells systems. These systems all utilize groundwater as a source of supply through seven low-capacity and six high-capacity wells. The locations of these systems are shown on Map 32. Selected characteristics of each system are presented in Table E-2 in Appendix E.

Existing Commercial Water Supply Systems

In 2005, there were 152 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 144 are classified as low-capacity wells 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 32. Selected characteristics of each system are presented in Table E-3 in Appendix E.

Map 32

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



PRELIMINARY DRAFT

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

N

GRAPHIC SCALE
0 2 4 Miles
0 5,000 10,000 15,000 20,000 Feet

NOTE: THE SELF-SUPPLIED WATER SYSTEMS INDICATED ON THE MAP INCLUDE ALL ACTIVE WELLS DEFINED AS NON-COMMUNITY TRANSIENT AND NON-TRANSIENT, AND ALL NON-COMMUNITY HIGH CAPACITY WELLS.

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

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 wells 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 31. Selected characteristics of each system are presented in Table E-4 in Appendix E.

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 32. Selected characteristics of each system are presented in Table E 5 in Appendix E.

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 32. Selected characteristics of each system are presented in Table E-6 in Appendix E.

Existing Thermoelectric-Power Generation Water Supply Systems
In 2005, there were two existing privately owned, self-supplied, water systems 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 Combustion Turbine, a combustion turbine generating facility in the Town of Paris. The Pleasant Prairie Power Plant utilized about 11 million gallons of water per day obtained from Lake Michigan. The majority of the water was used as make-up water for evaporation losses on the plant cooling system. The Paris Combustion Turbine facility utilized 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.

Existing Self-Supplied Residential Water Systems
As of the year 2005, there were about 42,000 persons, or about 27 percent of the total resident year 2005 population of Kenosha County, served by private domestic wells. As shown on Map 30, 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 well within the County would withdraw about 2.7 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 1.6 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. The majority (approximately 90 percent) of the remaining 40 percent of the water withdrawn by private wells, or about 1.0 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 196 square miles of service area, or about 81 percent of the area of Milwaukee County. These systems served a population of about 921,000 persons, or about 97 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 retail and wholesale water to several 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 two utilities in the Village of Caledonia, Racine County. The Northshore 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 Northshore 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 33 and selected characteristics of each system are presented in Table 34.

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 34. Based on Wisconsin Public Service Commission annual reports for the year 2005, approximately 161 million gallons per day of water were pumped for use in the 14 municipal systems concerned (see Table 34). As shown on Table 35, the water use totaled about 113.8 mgd for residential, commercial, industrial, institutional, or other urban uses, with the remaining 47 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 housing units residential purposes; about 31.1 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.

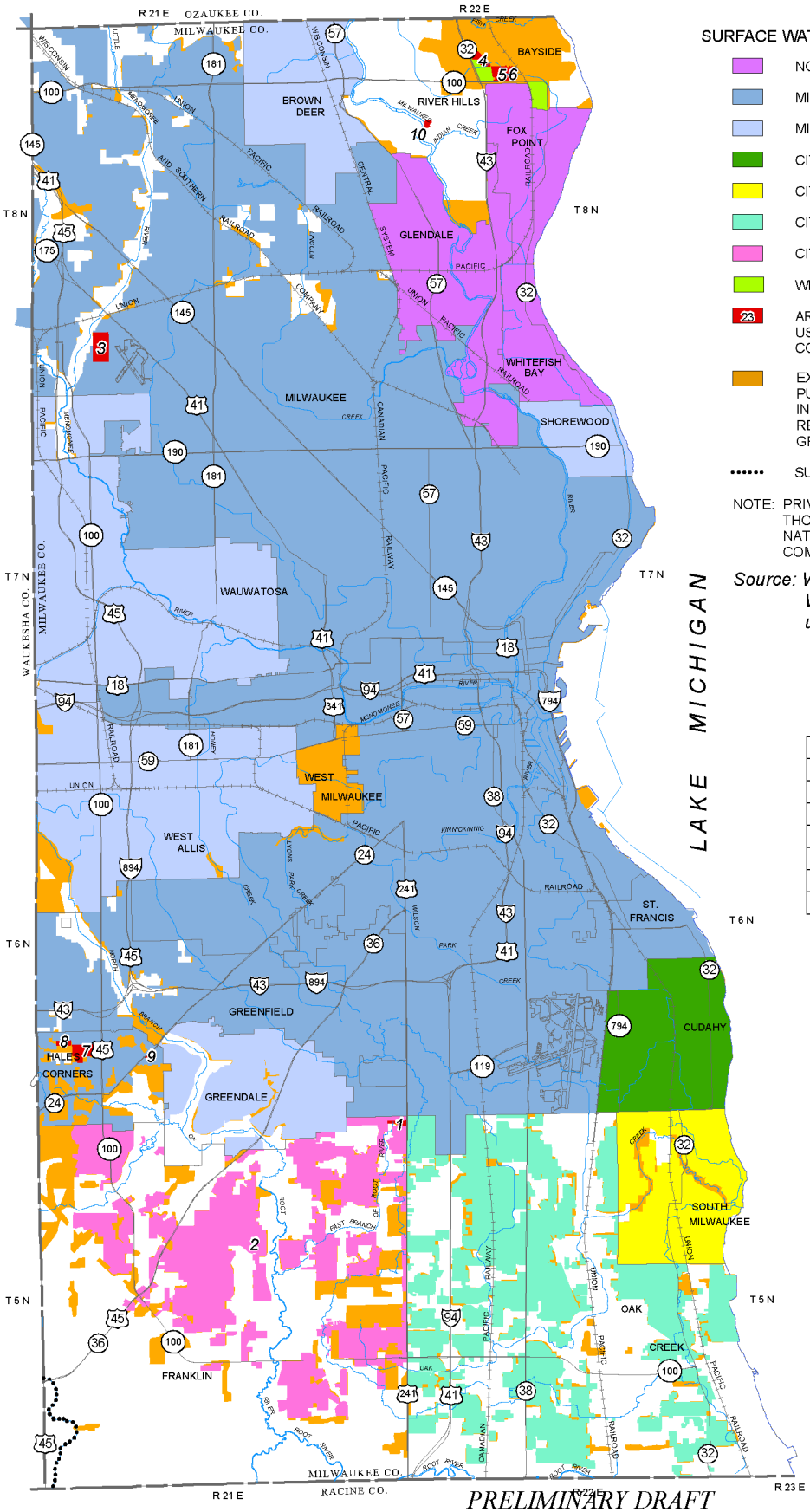
The water used in the 14 municipal systems in 2005 was about 2 percent higher than in 2004, but about 9 percent lower than in 2000. This increase from 2004 to 2005 was due largely to an increase in residential water use of about 3 percent. The reduction from 2000 was due largely to reductions in industrial 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 wholesale and retail water to numerous supply systems within Milwaukee County and in 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 Greendale and Shorewood. Municipal retail customers of the City of Milwaukee Water Works include the Cities of Greenfield, Milwaukee, St. Francis, and a portion of the City of Franklin; and the Villages of Hales Corners and Brown Deer. The Village of West Milwaukee has a unique arrangement with the City of Milwaukee Water Works, as it receives billing services form the City of Milwaukee Water Works and 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.

Map 33

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



SURFACE WATER SUPPLIED SYSTEMS

- NORTH SHORE WATER COMMISSION SERVICE AREA
- MILWAUKEE WATER WORKS RETAIL SERVICE AREA
- MILWAUKEE WATERWORKS WHOLESALE SERVICE AREA
- CITY OF CUDAHY WATER UTILITY
- CITY OF SOUTH MILWAUKEE WATER UTILITY
- CITY OF OAK CREEK WATER AND SEWER UTILITY
- CITY OF FRANKLIN WATER UTILITY
- WE ENERGIES BAYSIDE WATER UTILITY
- AREA SERVED BY PRIVATE WATER SYSTEMS USING GROUNDWATER. IDENTIFICATION NUMBER CORRESPONDS WITH APPENDIX E
- 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

NOTE: PRIVATE COMMUNITY WATER SUPPLY SYSTEMS ARE THOSE IDENTIFIED BY THE WISCONSIN DEPARTMENT OF NATURAL RESOURCES AS 'OTHER THAN MUNICIPAL; COMMUNITY'.

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

Water Supply Facilities	
Public Systems	15
Surface Water Treatment Plants	5
Wells	0
Gravity Storage Facilities	21
Repump Storage Facilities	6
Private Systems	10
Number of Private System Wells	19

N

GRAPHIC SCALE

0 0.75 1.5 2.25 3 Miles

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

PRELIMINARY DRAFT

Table 34

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 Pumping (mgd)	2005 Maximum Daily Pumping (mgd)	10-Year Maximum Daily Pumping (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	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	S	- -	- -	- -	- -	CH, C, D, S, F	18[f]	4	4,856	1.80	4.29	- -	Lake Michigan
City of Milwaukee Water Works[g]	AB	120.9	647,200[h]	S	- -	- -	- -	2	CH, C, D, S, F, FL, O, CC	275 Linwood; 105 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	4	7,088	8.26	8.26[i]	15.66[i]	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	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	S	- -	- -	- -	- -	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	S	- -	- -	- -	1	CH, C, D, S, F		3	5,990	1.47	3.01	- -	Lake Michigan
Total	- -	195.9	920,800					8		432	45	167,092	160.80	248.40	252.73	- -

[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

Table 34 (continued)

[e]*Make up code for treatment types, such as:*

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 Northshore 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]*The City of Milwaukee Water Works provides retail water service to the Cities of Greenfield, Milwaukee, and St. Francis; the Villages of Hales Corners and Brown Deer, and the far northeast 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 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.*

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

Table 35

SUMMARY OF MUNICIPAL WATER USE IN MILWAUKEE 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	51,938	72	1,280	30,453	5,324	35,423	1,515	6,872	124,686	136	8
2004[h]	50,006	69	1,222	22,561	3,901	30,938	1,312	7,705	111,211	121	12
2005[i]	51,645	71	1,260	22,891	3,948	31,160	1,321	8,128	113,825	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]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 which 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 five 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 decreasing the 2000 population by 0.1 percent. Land use did not change.

[I]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.

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 interconnection exist with one connection each between the Milwaukee Water Works and the Northshore 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 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 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 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 by SEWRPC and the MMSD and the Wisconsin Department of Natural Resources as part of the continuing regional water quality management planning program. In addition, the MMSD has conducted facilities planning designed to carry out its sewage management responsibilities, which are collectively referred to as the Milwaukee water pollution abatement program. Currently, the MMSD is carrying out facilities planning to extend it sewerage 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 planning 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, excepting the City of South Milwaukee and includes portions of the surrounding counties. Sewer service area planning conducted for areas in Milwaukee County include the following:

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 aforenoted plans and the reports indicates that, as of 2005, the water utilities and communities involved have plans in place to provide water supply and sanitary sewer service to all of the Milwaukee County urban service area. The entire service area 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 Puetz Road storage facility. In addition, in the longer term, an additional storage facility is expected to be needed in the City's west 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 uses.

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

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, 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.

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.

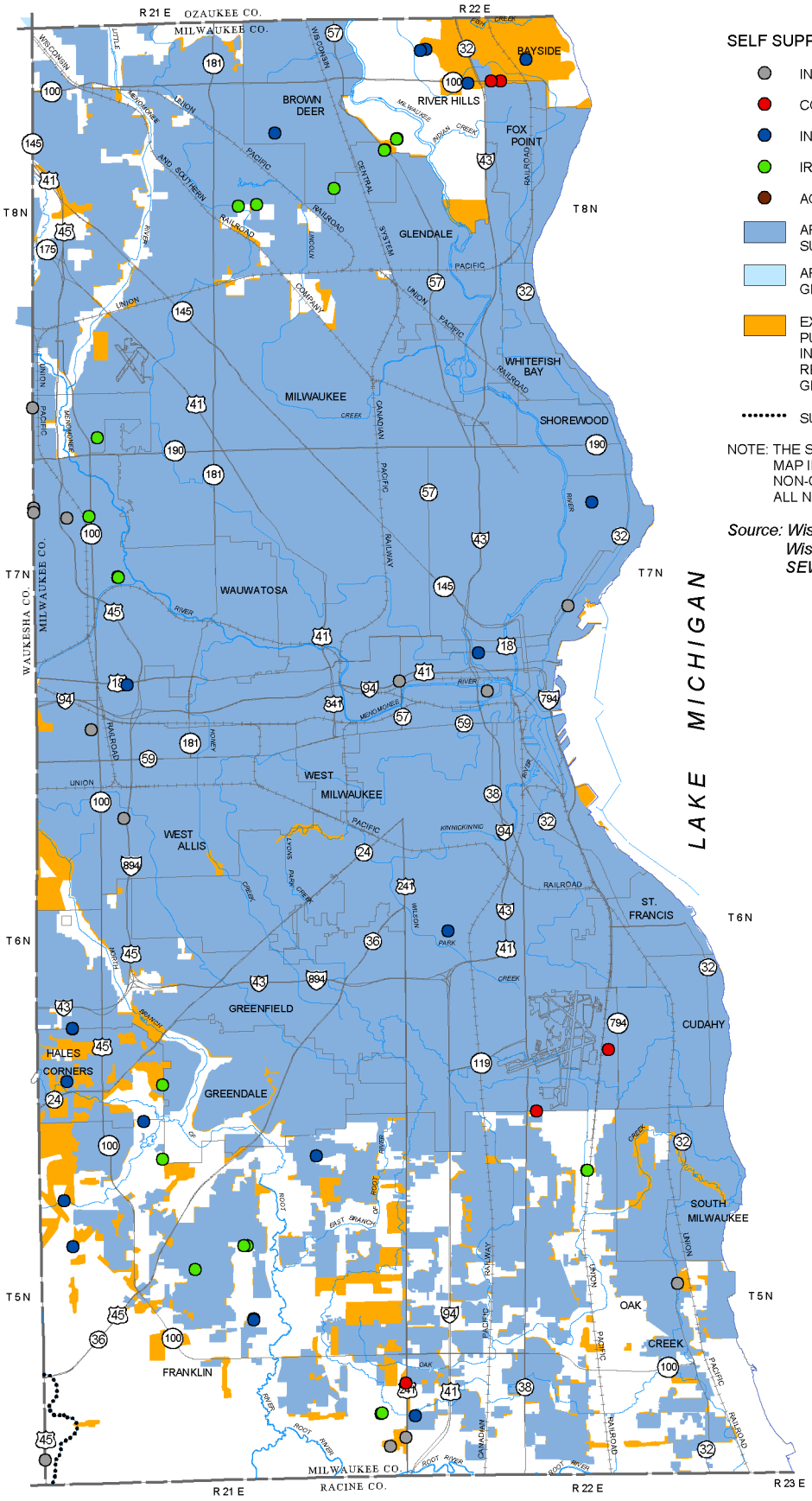
City of South Milwaukee Water Utility
The City of South Milwaukee Water Utility owns and operates a Lake Michigan surface water treatment plant. Inventory information provided by the City indicates that there are no current plans for capacity expansion. However, the water utility has plans to upgrade facilities to address and report that the filtration plant is proposed to be upgraded to membrane filtration in the year 2008.

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 an area of about 0.4 square mile and served a year 2005 resident population of about 3,000 persons, or less than 0.5 percent of the Milwaukee County year 2005 resident population. Of the 10 systems, seven are classified as high-capacity well systems, and three are classified as low-capacity wells systems that combined, utilized groundwater as a source of supply through eight low-capacity and 11 high-capacity wells. The existing service areas of these systems are shown on Map 33. Selected characteristics of each system are presented in Table E-1 in Appendix E.

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 are classified as high-capacity systems and four are classified as low-capacity well 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 34. Selected characteristics of each system are presented in Table E-2 in Appendix E.

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 34. Selected characteristics of each system are presented in Table E-3 in Appendix E.

Map 34
SELF-SUPPLIED INDUSTRIAL, COMMERCIAL, INSTITUTIONAL AND RECREATIONAL, AGRICULTURAL, AND IRRIGATION WATER SUPPLY SYSTEMS IN MILWAUKEE COUNTY: 2005



SELF SUPPLIED WATER SYSTEMS

- 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

NOTE: THE SELF-SUPPLIED WATER SYSTEMS INDICATED ON THE MAP INCLUDES ALL ACTIVE WELLS DEFINED AS NON-COMMUNITY TRANSIENT AND NON-TRANSIENT, AND ALL NON-COMMUNITY HIGH CAPACITY WELLS.

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

N

GRAPHIC SCALE

0 0.75 1.5 2.25 3 Miles

0 4,900 9,800 14,700 19,600 Feet

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 well 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 34. Selected characteristics of each system are presented in Table E-4 in Appendix E.

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.

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 34. Selected characteristics of each system are presented in Table E-6 in Appendix E.

Existing Thermoelectric-Power Generation Water Supply Systems
In 2005, there were three existing privately owned, self-supplied, water systems operating in Milwaukee County which utilize water for coal-based thermoelectric-power-generation; the Menomonee Valley Power Plant located in the City of Milwaukee, the Milwaukee County Power Plant located in 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 obtains 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 and open cycle cooling system which passes the water over a 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 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 13,000 persons, or about 1.4 percent of the total resident year 2005 population of Milwaukee County, served by private domestic wells. As shown on Map 33, 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. Assuming an average use of 65 gallons per capita per day, these private domestic wells would withdraw about 0.8 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 0.7 million gallons per day, was discharged to Lake Michigan as treated sanitary sewage. 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 58 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 wholesale or resale purchase and resale. 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 35 and selected characteristics of each system are presented in Table 36.

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 36. 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 (see Table 36). As shown on Table 37, the 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 116 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.

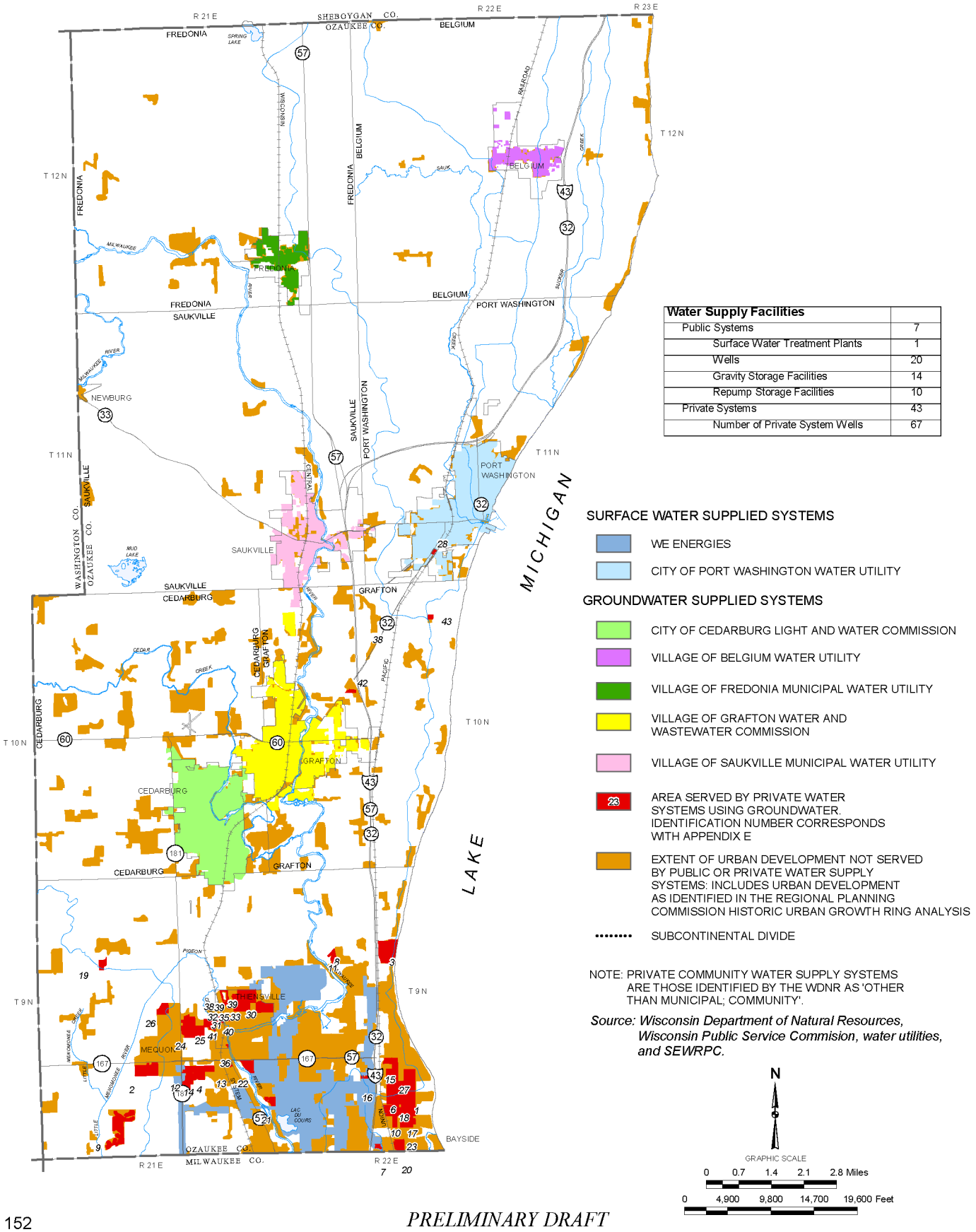
The total water use in the seven municipal systems in 2005 was nearly the same as in 2004 and about 3 percent higher than in 2000. That increase over the year 2000 is consistent with the population growth in the area served.

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. Thus, 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.

Map 35

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



Water Supply Facilities	
Public Systems	7
Surface Water Treatment Plants	1
Wells	20
Gravity Storage Facilities	14
Repump Storage Facilities	10
Private Systems	43
Number of Private System Wells	67

SURFACE WATER SUPPLIED SYSTEMS

- WE ENERGIES
- CITY OF PORT WASHINGTON WATER UTILITY

GROUNDWATER SUPPLIED SYSTEMS

- 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 PRIVATE WATER SYSTEMS USING GROUNDWATER. IDENTIFICATION NUMBER CORRESPONDS WITH APPENDIX E
- 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

NOTE: PRIVATE COMMUNITY WATER SUPPLY SYSTEMS ARE THOSE IDENTIFIED BY THE WDNR AS 'OTHER THAN MUNICIPAL; COMMUNITY'.

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

N

GRAPHIC SCALE

0 0.7 1.4 2.1 2.8 Miles

0 4,900 9,800 14,700 19,600 Feet

PRELIMINARY DRAFT

Table 36

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 Pumping (mgd)	2005 Maximum Daily Pumping (mgd)	10-Year Maximum Daily Pumping (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] *Make up code for treatment types, such as:*

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 37

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	5,576	123	12
2004[h]	2,784	67	553	1,834	3,660	955	523	172	5,744	119	12
2005[i]	2,882	68	572	1,659	3,219	977	469	215	5,733	116	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 which 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 five 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.

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 restrictions 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.

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 existed for a number of the water utilities in the County. It should be noted that all of the Ozaukee County is located well east of the subcontinental divide. Thus, water supply and sanitary sewerage system planning is generally accounted for with regard to the use of Lake Michigan as a source of supply. Those plans are summarized in the subsequent paragraphs.

It should be noted that the 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 addresses 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 and 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 which has occurred, the proposed systems description has been reported on for both 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 and Water Commission is taking measures to ensure that system capacity will be able to meet possible future demand, by performing a well siting study for new Well No. 7. In addition, preliminary planning is being considered for a potential water 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 on the east side of the Village.

The preliminary study noted in Item 2 above, of the option of providing Lake Michigan as a source of supply considered three alternative plans:

- Connection of the Village to an existing surface water supplier—either the City of Port Washington system of 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 to serve the Village of Grafton.

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

Based upon an evaluation and review of the three alternative plans, the following summary statements were made in the December 2002 report noted above:

- With the eventual addition of one well, the current groundwater supply in the Grafton area appears to be adequate through the year 2020 planning period. The current rate of water level decline would not remove a 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 4, although its unstable water levels make its useful life difficult to predict.

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

- At this time, the most cost effective future option for obtaining lake water to supply the Grafton area appears to be the construction of a new water treatment plant by the Village, preferably with some level of regional cooperation.

- If the preferred lake water option were implemented today, the cost of service impact to an average Grafton customer would be approximately 14 percent, or $6.97 per quarter, more expensive than continuing with solely groundwater supply. The year 2010 projected quarterly costs to an average water customer under the three main alternatives discussed are summarized as follows:

SUMMARY OF ALTERNATIVE COST OF SERVICE IMPACTS FOR THE VILLAGE OF GRAFTON

Alternative	Year 2010 Projected Average Quarterly Cost
1. Purchase all Water from Port Washington	$74.30
2. Construct a Surface Water Treatment Plant	55.37
3. Continue the Current Groundwater Supply	48.40

City of Port Washington Water Utility
The City of Port Washington Water Utility system was, in 2005, in the process of preparing a master plan for the water utility. In addition, the following report is applicable.

1. 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.

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., 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 plan indicates that the Village of Saukville is undertaking efforts increase capacity and improve system efficiency. This includes the acquisition of a new well site and the construction of a new test well for proposed Well No 6. In addition, the water utility master plan recommends water distribution improvements.

Village of Fredonia Municipal Water Utility
Plans for the Fredonia Municipal Water Utility include 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 the information provided by the Village of Fredonia Municipal Water Utility indicates that it is intended to develop a new well. The initial sites being considered for the well are 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 44 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 an area of about 2.3 square miles and 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 well systems, and 30 are classified as low-capacity wells systems that combined, rely on 29 low-capacity wells and 38 high-capacity wells as a source of supply. The existing service areas of these systems are shown on Map 35. Selected characteristics of each system are presented in Table E-1 in Appendix E.

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 well 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 36. Selected characteristics of each system are presented in Table E-2 in Appendix E.

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 well systems. These systems all utilized groundwater as a source of supply through 137 low-capacity wells and five high-capacity wells. The locations of these systems are shown on Map 36. Selected characteristics of each system are presented in Table E-3 in Appendix E.

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 well 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 36. Selected characteristics of each system are presented in Table E-4 in Appendix E.

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 purposes for agricultural land uses. 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 36. Selected characteristics of each system are presented in Table E-5 in Appendix E.

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 36. Selected characteristics of each system are presented in Table E-6 in Appendix E.

Existing Thermoelectric-Power Generation Water Supply Systems

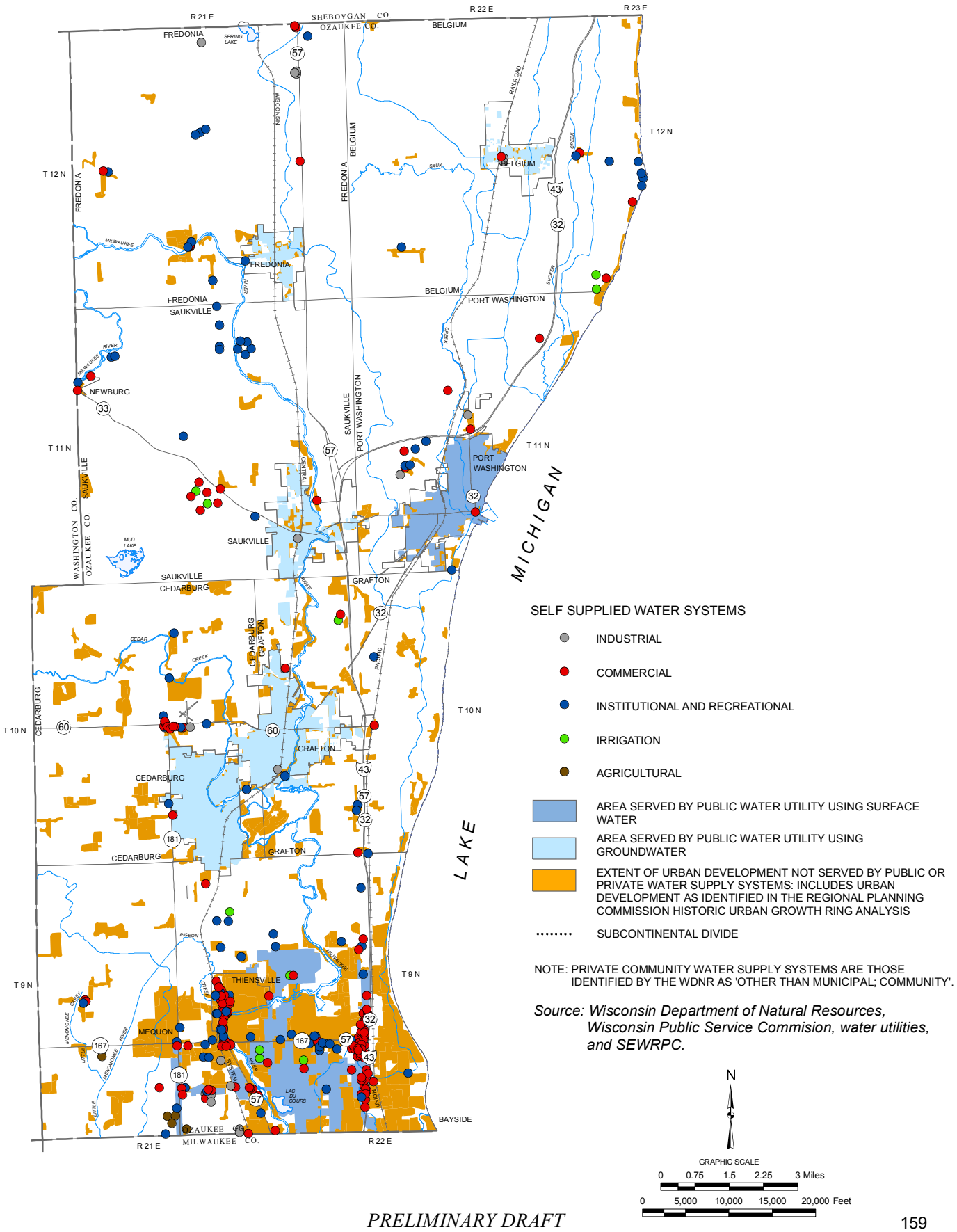
In 2005, the Port Washington Power Plant, located in the City of Port Washington, began conversion from a coal-fired thermoelectric-power-generation to an intermittent load natural gas-fired facility. This facility draws water from Lake Michigan and uses an open cycle cooling system which passes the water over heat exchangers and then returns the water to its source. Based upon a 2001 Wisconsin Department of Natural Resources environmental impact statement, the maximum total water withdrawal rate from the Lake for cooling the proposed facility is estimated to be 560,000 gpm. Of this total, approximately 535,000 gpm would be passed through the condensers and other heat exchange equipment. Another 25,000 gpm would be used to improve the combustion turbine operating efficiency during warmer weather by cooling the intake air by passing it over coils containing once-through circulating lake water.

The Port Washington power plant's existing water intake structure was designed with a capacity of 565,000 gpm, 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.

Map 36

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



NOTE: PRIVATE COMMUNITY WATER SUPPLY SYSTEMS ARE THOSE IDENTIFIED BY THE WDNR AS 'OTHER THAN MUNICIPAL; COMMUNITY'.

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

Existing Self-Supplied Residential Water Systems

As of the year 2005, there were about 36,200 persons, or about 42.2 percent of the total resident year 2005 population of Ozaukee County, served by private domestic wells. As shown on Map 35, areas totaling about 17.8 square miles exist outside of the municipal water utility service areas within Ozaukee County were classified as having urban-density development, and 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 2.3 million gallons per day from the shallow groundwater aquifer. It is estimated that 52 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 52 percent of the private domestic wells, or about 1.2 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 1.0 million gallons per day, was returned to the groundwater aquifer via onsite sewage disposal systems.

INVENTORY FINDINGS–RACINE COUNTY

Existing Municipal Water Supply Systems

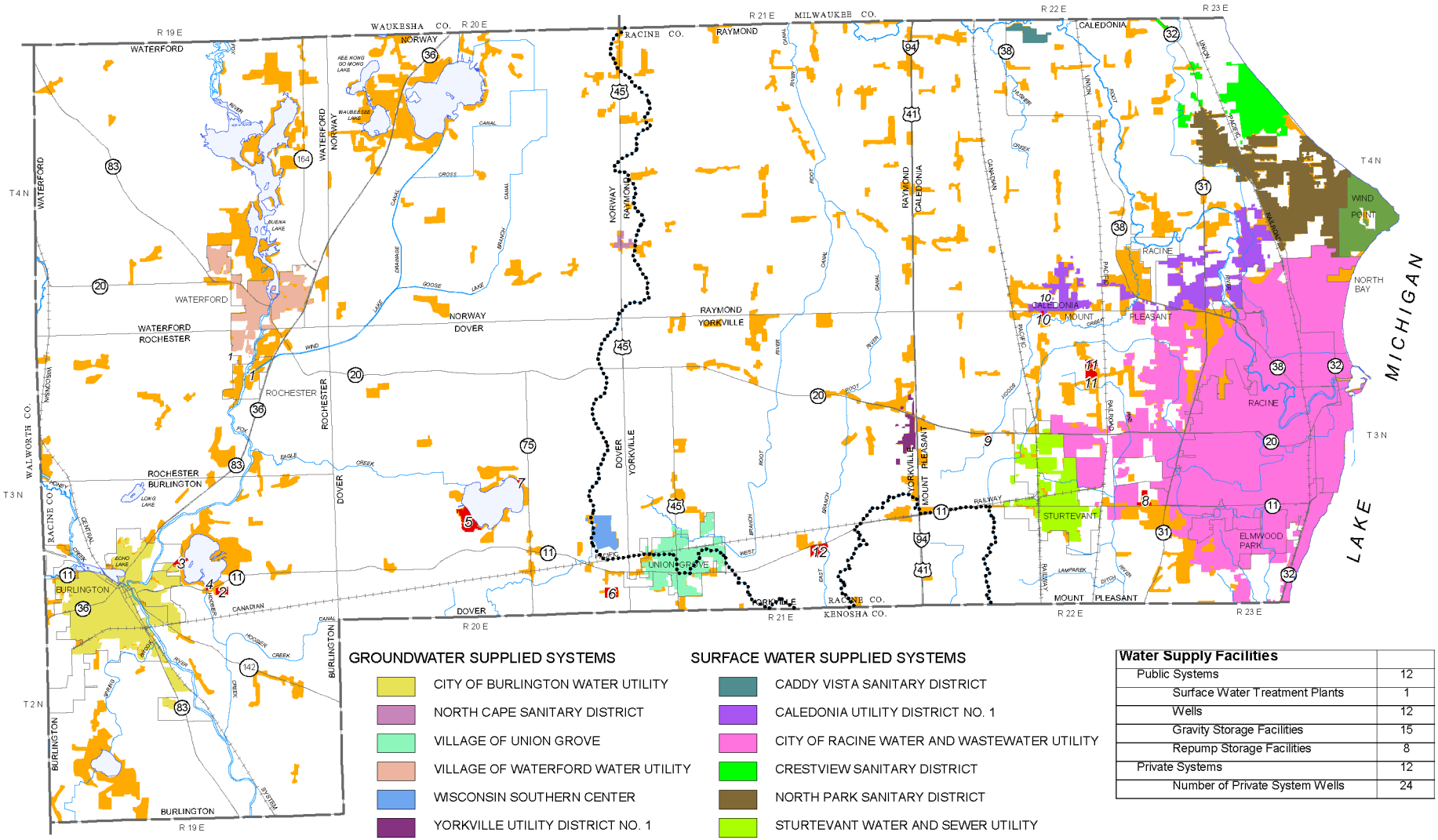
In 2005, 12 municipal water supply utility systems provided water to about 38 square miles of service area, or about 11 percent of the area of Racine County. These systems served a population of about 147,000 persons, or about 76 percent of the residential population in Racine County. Eight of the water supply systems in Racine County rely on Lake Michigan as the source of supply, either directly or indirectly through wholesale or resale 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. Additionally, 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 37 and selected characteristics of each system are presented in Table 38.

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 "municipal, community" 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 38.

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 38. Based on Wisconsin Public Service Commission annual reports for the year 2005, approximately 29.7 million gallons per day of water were pumped for use in the 12 municipal systems concerned (see Table 38). As shown on Table 39, 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

Map 37

MUNICIPAL AND OTHER THAN MUNICIPAL, COMMUNITY WATER SUPPLY SYSTEMS IN RACINE COUNTY: 2005



GROUNDWATER SUPPLIED SYSTEMS

- CITY OF BURLINGTON WATER UTILITY
- NORTH CAPE SANITARY DISTRICT
- VILLAGE OF UNION GROVE
- VILLAGE OF WATERFORD WATER UTILITY
- WISCONSIN SOUTHERN CENTER
- YORKVILLE UTILITY DISTRICT NO. 1
- SUBCONTINENTAL DIVIDE

SURFACE WATER SUPPLIED SYSTEMS

- CADDY VISTA SANITARY DISTRICT
- CALEDONIA UTILITY DISTRICT NO. 1
- CITY OF RACINE WATER AND WASTEWATER UTILITY
- CRESTVIEW SANITARY DISTRICT
- NORTH PARK SANITARY DISTRICT
- STURTEVANT WATER AND SEWER UTILITY
- VILLAGE OF WIND POINT MUNICIPAL WATER UTILITY

Water Supply Facilities	
Public Systems	12
Surface Water Treatment Plants	1
Wells	12
Gravity Storage Facilities	15
Repump Storage Facilities	8
Private Systems	12
Number of Private System Wells	24

23 — AREA SERVED BY PRIVATE WATER SYSTEMS USING GROUNDWATER. IDENTIFICATION NUMBER CORRESPONDS WITH APPENDIX E

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

N

GRAPHIC SCALE
0 0.75 1.5 2.25 3 Miles
0 5,000 10,000 15,000 20,000 Feet

NOTE: PRIVATE COMMUNITY WATER SUPPLY SYSTEMS ARE THOSE IDENTIFIED BY THE WDNR AS 'OTHER THAN MUNICIPAL; COMMUNITY'.

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

Table 38

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 Pumping (mgd)	2005 Maximum Daily Pumping (mgd)	10-Year Maximum Daily Pumping (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 and including Village of Mt. Pleasant Water Users	AB	21.9	102,100	S	- -	- -	- -	3	CH, S, C, MC, F, D, H	40	8	12,846	22.78	37.31	- -	Lake Michigan
Village of Sturtevant Water and Sewer Utility[f]	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	- -[g]	- -[g]	Lake Michigan
Caddy Vista Sanitary District	D	0.2	800	SP	- -	- -	- -	- -	- -	- -	- -	- -	0.04	- -[h]	- -[h]	Lake Michigan
Village of Caledonia Water Utility District No. 1	C	2.0	3,700	SP	- -	- -	- -	- -	- -	- -	1	750	0.60	- -[f]	- -[f]	Lake Michigan
Crestview Sanitary District	D	1.3	3,900	SP	- -	- -	- -	- -	- -	- -	1	100	0.47	- -[h]	- -[h]	Lake Michigan
North Park Sanitary District No. 1	C	3.4	9,200	SP	- -	- -	- -	- -	- -	- -	- -	- -	1.18	- -[f,i]	- -[f,i]	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	<50	G	1	1.60	SD	- -	D, H, CC	- -	1	750	0.23	1.24	1.10	Hoods Creek
Total	- -	38.3	147,000	- -	12	14.18	- -	3	- -	40	23	20,554	29.68	48.51	7.52	- -

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] *Make up code for treatment types, such as:*
- *CH = Pre-Sedimentation Chemical Addition*
- *S = Sedimentation*
- *C = Coagulation*
- *F = Filtration*
- *MC = Micro-Filtration*
- *FL = Fluoridation*
- *Z = Zeolite Softening*
- *SA = Spray Aeration*
- *D = Disinfection*
- *CC = Corrosion Control*
- *i = Ion Exchange*
- *P = Phosphate Addition (sequestering)*
- *SH = Sodium Hypochlorite Chemical Addition*
- *H = Hypochlorination*
- *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] *Included in pumpage values for Crestview Sanitary District.*

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

Table 39

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]			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)	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)	
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	21,372	146	14
2005[i]	8,420	67	879	8,295	5,925	3,885	851	1,191	21,790	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 which 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 five 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.

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.

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 Sturtevant, Village of Wind Point, and for portions of the Village of Caledonia and on a retail basis to the Village of Mt. Pleasant,. 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 five 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, there were locally proposed water supply system modification and expansion plans existed for the City of Racine and City of Burlington systems; the Village of Sturtevant, the Village of Union Grove, the Village of Wind Point, and the 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's. Those plans are summarized in the subsequent paragraphs.

It should be noted that the 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, 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.

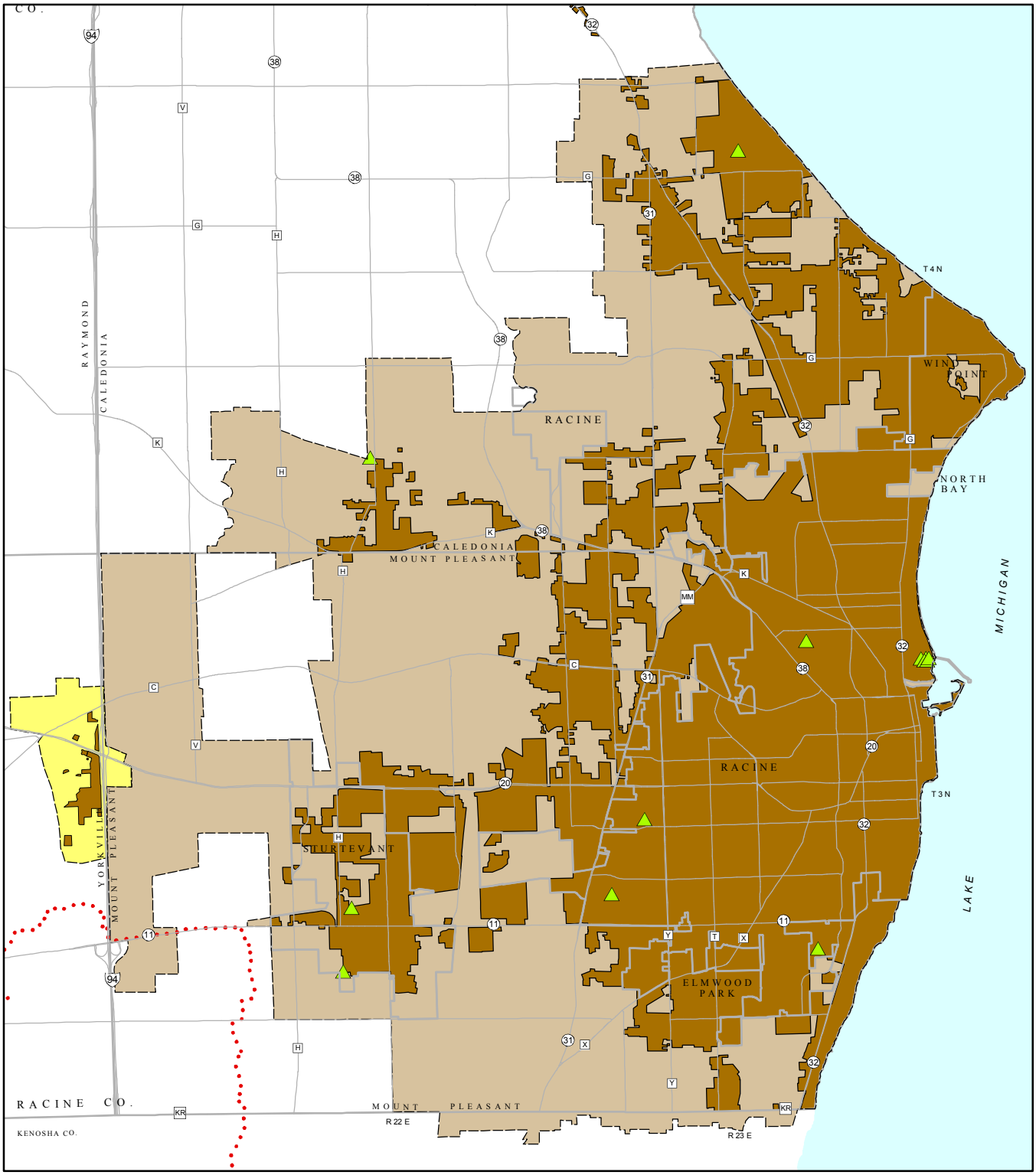
A review of the aforelisted plans indicates that, as of 2005, the water utilities and communities involved have plans in place to provide water supply and sanitary sewer service to an about 70-square-mile urban service area, as shown on Map 38. The entire service area is proposed to be served by water supply provided by the Racine Water and Wastewater Utility water treatment plant which uses 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 is currently in place. 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 to be served.

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 facilities with a capital cost of $43.9 million are estimated at $43.9 million to construct future water distribution system extensions and transmission

Map 38

GREATER RACINE AREA PLANNED URBAN SERVICES AREA: 2005



PLANNED URBAN SERVICES AREA BOUNDARY

EXISTING WATER SUPPLY SERVICE AREA

GREATER RACINE PLANNED URBAN SERVICE AREAS

TOWN OF YORKVILLE PLANNED URBAN SERVICE AREAS

SUBCONTINENTAL DIVIDE

EXISTING STORAGE FACILITIES

N

GRAPHIC SCALE

0 0.5 1 2 Miles

0 3,000 6,000 12,000 Feet

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

mains, including valves and hydrants; and $11.2 million to construct future water supply pumping and storage facilities.

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 study report in 1998, and has continued to monitor and evaluate the water system, and is currently taking steps to address identified issues. Specifically, the utility is currently undergoing the process of constructing a new well with a capacity of about 1,000 gallons per minute and a new 500,000-gallon underground storage tank to the system. These facilities were constructed in 2006.

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 Union Grove Water Utility has recently undergone a system evaluation and the Village of is taking steps to ensure its ability to meet future demand and improve quality. 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 was 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 analysis identifies 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.

A review of the inventory information provided by the Village of Waterford Water Utility indicates that one high-capacity well, Well No. 2, will be abandoned by December 2006, while two new wells, Well Nos. 4 and 5, will be brought on line for use in 2006. The changes are being made to provide adequate capacity and to meet the radium standards in the Village system.

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 an area of about 0.5 square miles and served 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 17 low-capacity and seven high-capacity wells. The existing service areas of these systems are shown on Map 37. Selected characteristics of each system are presented in Table E-1 in Appendix E.

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 well 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 39. Selected characteristics of each system are presented in Table E-2 in Appendix E.

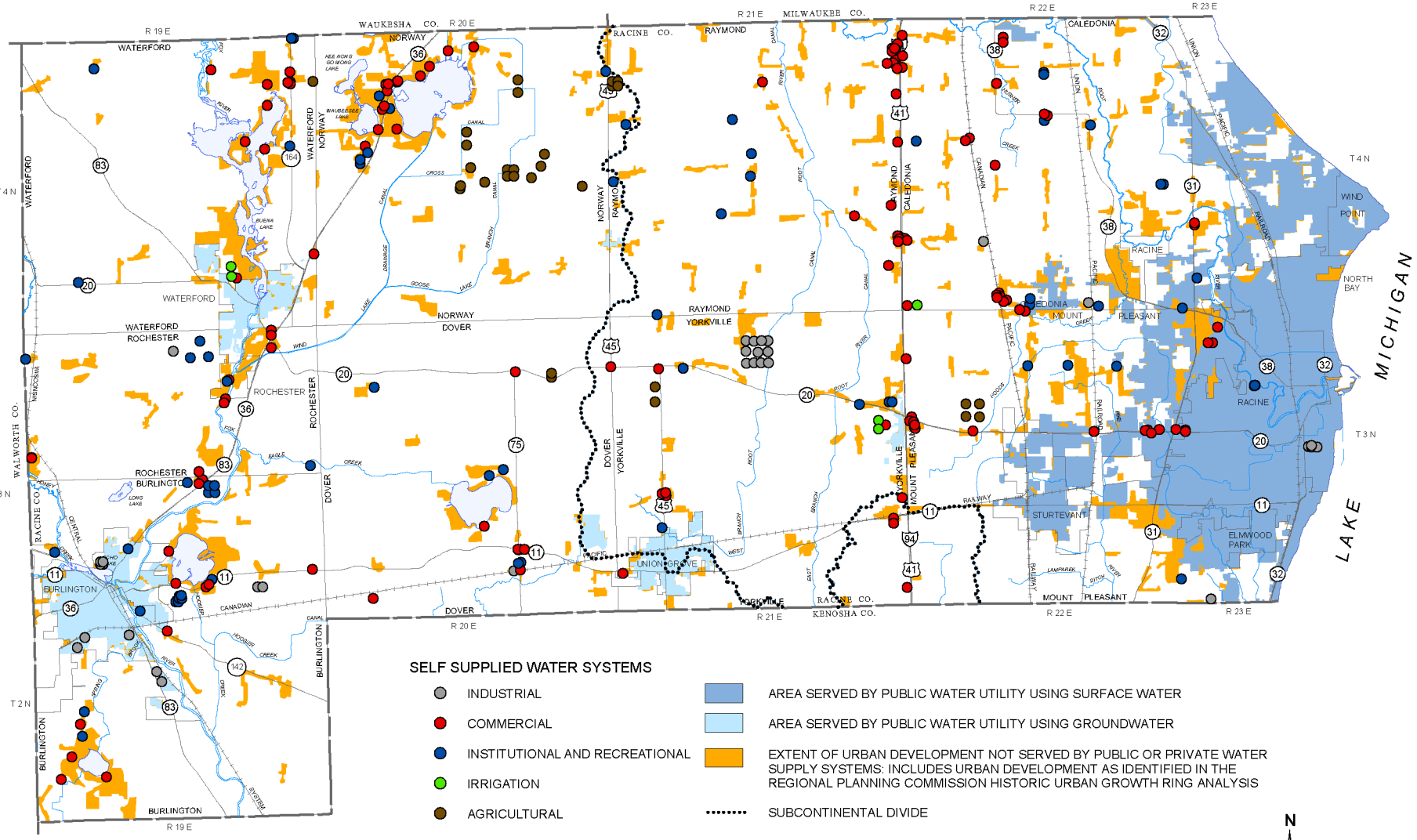
Existing Commercial Water Supply Systems
In 2005, there were 113 existing privately owned, self-supplied, water systems operating in Racine County which provide water for commercial land uses. Of these, four are high-capacity systems and 109 are low-capacity well systems. These systems all utilized groundwater as a source of supply through 132 low-capacity wells and one high-capacity wells. The locations of these systems are shown on Map 39. Selected characteristics of each system are presented in Table E-3 in Appendix E.

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 well 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 39. Selected characteristics of each system are presented in Table E-4 in Appendix E.

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 39. Selected characteristics of each system are presented in Table E-5 in Appendix E.

Map 39

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



NOTE: THE SELF-SUPPLIED WATER SYSTEMS INDICATED ON THE MAP INCLUDE ALL ACTIVE WELLS DEFINED AS NON-COMMUNITY TRANSIENT AND NON-TRANSIENT, AND ALL NON-COMMUNITY HIGH CAPACITY WELLS.

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

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 well 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 39. Selected characteristics of each system are presented in Table E-6 in Appendix E.

Existing Self-Supplied Residential Water Systems
As of the year 2005, there were about 46,300 persons, or about 24 percent of the total resident year 2005 population of Racine County, served by private domestic wells. As shown on Map 38, numerous areas outside of the municipal water utility service boundaries within Racine County were classified as having urban-density development, and were served by private wells. This includes areas that total about 7.1 square miles east of the subcontinental divide, and 9.3 square miles west of the subcontinental divide. Assuming an average use of 65 gallons per capita per day, these private domestic wells would withdraw about 3.0 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 1.7 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.

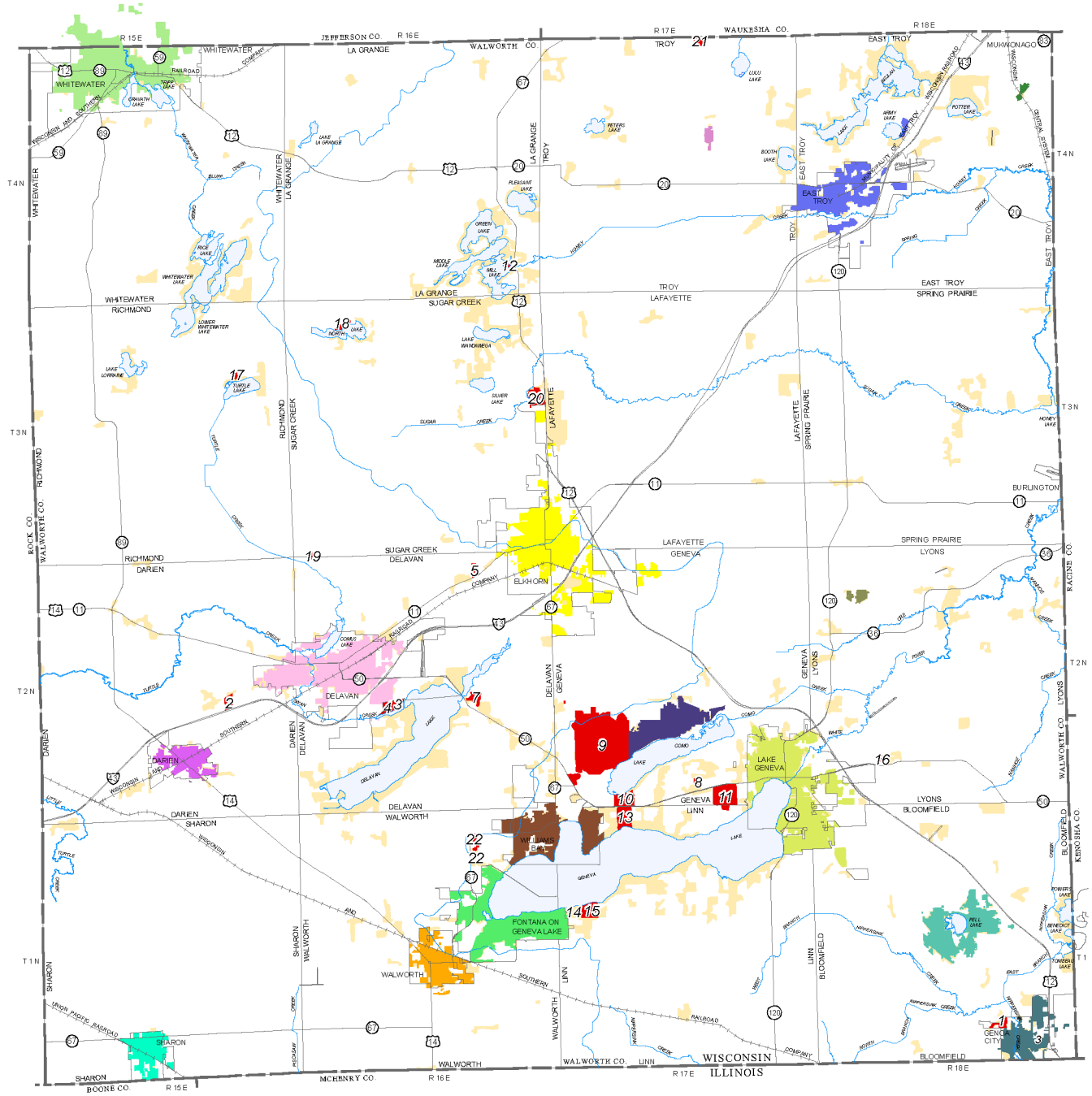
INVENTORY FINDINGS–WALWORTH COUNTY

Existing Municipal Water Supply Systems
In 2005, 16 municipal water supply utility systems provided water to about 22 square miles of service area, or about 4 percent of the area of Walworth County. These systems served a population of about 59,100 persons in 2005, or about 61 percent of the residential population in Walworth County. All of the water supply systems in 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 13,900 total residents, including 2,700 residents residing in Jefferson County, outside of the Region. In 2005, Whitewater pumped approximately 2.4 million gallons per day. In contrast, the Town of East Troy Sanitary District No. 3 is the smallest water utility, serving roughly 40 residents and pumping about 3,700 gallons per day. The existing service areas of these systems are shown on Map 40 and selected characteristics of each system are presented in Table 40.

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 28 elevated tanks and standpipes and 10 reservoirs, as listed in Table 40. As the largest water provider, the Whitewater Municipal Water Utility maintained two elevated tanks and standpipes and two reservoirs, 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 (see Table 40). As shown on Table 41, the 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 65 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. 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

Map 40

MUNICIPAL AND OTHER THAN MUNICIPAL, COMMUNITY WATER SUPPLY SYSTEMS IN WALWORTH COUNTY: 2005



GROUNDWATER SUPPLIED SYSTEMS

- 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
- 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
- SUBCONTINENTAL DIVIDE
- 28 AREA SERVED BY PRIVATE WATER SYSTEMS USING GROUNDWATER. IDENTIFICATION NUMBER CORRESPONDS WITH APPENDIX E
- 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
Wells	44
Gravity Storage Facilities	28
Repump Storage Facilities	10
Private Systems	22
Number of Private System Wells	29

N

GRAPHIC SCALE
0 1 2 3 4 Miles
0 5,000 10,000 15,000 20,000 Feet

Source: Wisconsin Public Service Commision, water utilities, and SEWRPC.

PRELIMINARY DRAFT

Table 40

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 Pumping (mgd)	2005 Maximum Daily Pumping (mgd)	10-Year Maximum Daily Pumping (mgd)	Spent Water Receiving System
Delavan Water and Sewerage Commission	AB	2.8	8,200	G	4	4.20	SG, S	- -	G, F, FL, P, PA	- -	5	2,300	1.130	2.55	2.47	Turtle Creek
Elkhorn Light and Water	AB	2.6	8,600	G	4	- -	S	- -	F, H, SA, I, FL, TA	- -	3	1,000	1.120	1.93	- -	Turtle Creek
Lake Geneva Municipal Water Utility	AB	2.8	8,000	G	4	7.29	SG	- -	F, G, H, P, FL, TA	- -	5	2,260	1.450	2.86	3.00	Groundwater system
Whitewater Municipal Water Utility	AB	3.2	11,200	G	5	7.63	GP	- -	F, H, FL	- -	4	2,400	1.990	3.79	3.79	Whitewater Creek
Darien Water Works and Sewer System	C	0.7	1,600	G	2	- -	S	- -	G, F, SQ, TA	- -	1	100	0.120	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	0.650	1.04	1.26	Honey Creek
Fontana Municipal Water Utility	C	2.0	1,800	G	4	3.04	SG, SD	- -	F, H	- -	3	2,120	0.400	1.10	1.13	Piscasaw Creek
Village of Genoa City Municipal Water Utility	C	0.8	2,400	G	3	- -	SG, S	- -	G, F, P, FL, TA	- -	3	660	0.220	0.53	- -	Nippersink Creek
Sharon Waterworks and Sewer System	C	0.7	1,500	G	2	1.44	S	- -	G, SQ, FL	- -	1	250	0.120	0.17	0.32	Little Turtle Creek
Walworth Municipal Water and Sewer Utility	C	1.0	2,600	G	2	1.25	SG	- -	H	- -	1	500	0.490	0.78	9.90	Piscasaw Creek
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	0.320	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	0.230	0.40	0.40	N. Branch Nippersink Creek
Town of East Troy Sanitary District No. 3	D	0.04	40	G	1	0.60	S	- -	None	- -	1	3	0.004	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	0.140	0.27	0.69	Turtle Creek
Country Estates Sanitary District	D	0.1	500	G	2	1.15	SD	- -	H, Z	- -	1	50	0.020	0.51	0.14	White River
Troy Sanitary District No. 1	D	0.1	100	G	1	- -	GP	- -	None	- -	1	4	0.003	- -	- -	Groundwater system
Total	- -	22.2	59,100	- -	44	35.20	- -	- -	- -	- -	38	13,500	8.410	17.14	- -	- -

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] *Make up code for treatment types, such as:*

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

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

Table 41

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	6,250	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	6,638	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 which 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 five 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.

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.

Municipal Water Supply System Interconnection

As of 2006, only one water system interconnection is 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 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 on 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.

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 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.

Delavan Water and Sewerage Commission
Plans for the 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 is underway in anticipation of the addition of a new, high-capacity well which is 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 for a booster pumping station. It is proposed to create a new, higher pressure zone in the are 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. Also, 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 the City of Delavan and portions of the Town of Darien.

The Utility's Well No. 4 is currently being treated to remove trichloroethylene contaminants caused by an industrial site.

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 recommendation 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, 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 is taking steps 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 near the northern limits of the City south of STH 12.

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, 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 are 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, 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 a water tower. The new well is finished in the deep sandstone aquifer and its treatment system is designed for 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 report:

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 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 to SEWRPC by the Village of East Troy indicates that, as of 2006, the Village is undergoing a well siting project for the addition of a well with a capacity of about 1,000 gallons per minute near the Village boundary 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 late 2006, the legal action was concluded, with the Village proceeding with well construction. 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 is taking steps to protect water resources within its service area, although no system changes are 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. The utility's recent water supply facility management has 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 reports:

1. A document entitled *Village of Sharon Water and Wastewater Emergency Response Plan.*

A review of the available information for the Village of Sharon Waterworks water system indicates that the Utility has developed an emergency response plan for the water utility which clarifies measures to be taken in the event of a disaster, and that the system will continue to be updated as needed. However, no system expansion or modification 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. Also, 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 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 reports:

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 plan. As of 2006, no system changes are anticipated.

Country Estates Sanitary District
Plans for the Country Estates Sanitary District system were documented in the following reports:

1. A report entitled *Sanitary Sewer Service Area for the Town of Lyons Sanitary District No's*, 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 are 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 an area of about 3.0 square miles and served a year 2005 resident population of about 3,860 persons, or less than 4 percent of the Walworth County year 2005 resident population. Of the 22 systems, 10 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 existing service areas of these systems are shown on Map 40. Selected characteristics of each system are presented in Table E-1 in Appendix E.

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 well 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 41. Selected characteristics of each system are presented in Table E-2 in Appendix E.

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 well 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 41. Selected characteristics of each system are presented in Table E-3 in Appendix E.

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 well systems. These systems all utilized groundwater as a source of supply through 135 low-capacity wells and six high-capacity wells. The locations of these systems are shown on Map 41. Selected characteristics of each system are presented in Table E-4 in Appendix E.

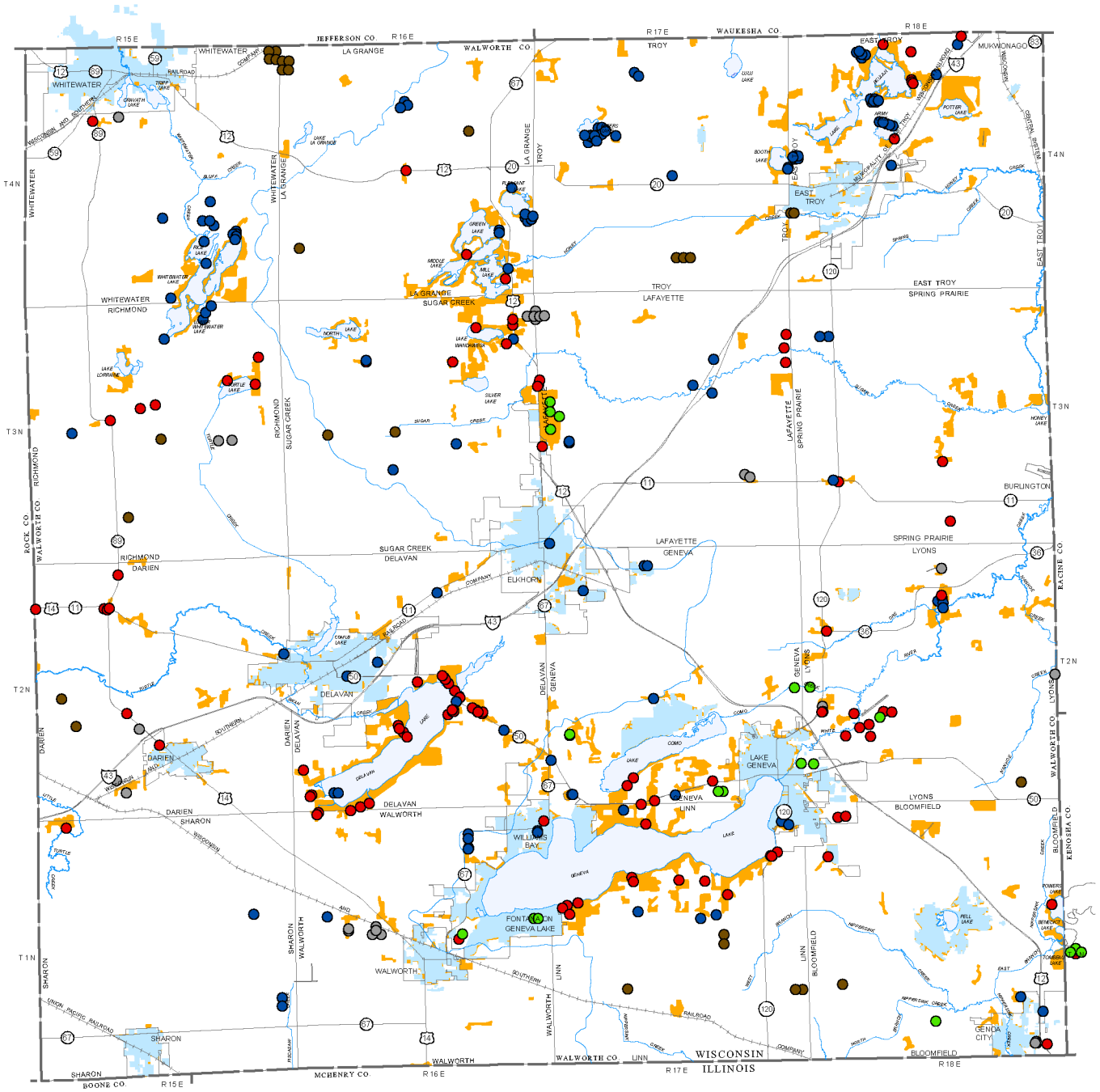
Existing Agricultural Water Supply Systems
In 2005, there were 16 existing privately owned, self-supplied, water systems operating in Walworth County which provided water for irrigation and other purposes for agricultural land uses. All 16 systems are high-capacity systems and all utilized groundwater as a source of supply through 28 high-capacity wells. The locations of these systems are shown on Map 41. Selected characteristics of each system are presented in Table E-5 in Appendix E.

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 41. Selected characteristics of each system are presented in Table E-6 in Appendix E.

Existing Self-Supplied Residential Water Systems
As of the year 2005, there were about 38,000 persons, or about 39 percent of the total resident year 2005 population of Walworth County, served by private domestic wells. As shown on Map 40, about 22 square miles

Map 41

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



SELF SUPPLIED WATER SYSTEMS

- 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
- SUBCONTINENTAL DIVIDE

N

GRAPHIC SCALE

0 0.75 1.5 2.25 3 Miles

0 4,900 9,800 14,700 19,600 Feet

NOTE: THE SELF-SUPPLIED WATER SYSTEMS INDICATED ON THE MAP INCLUDE ALL ACTIVE WELLS DEFINED AS NON-COMMUNITY TRANSIENT AND NON-TRANSIENT, AND ALL NON-COMMUNITY HIGH CAPACITY WELLS.

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

outside of the municipal water utility service 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 2.5 million gallons per day from the shallow groundwater aquifer. It is estimated that 16 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 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 1.9 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 seven municipal water utilities operate and maintain a total of seven treatment facilities in Washington County. 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 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 42 and selected characteristics of each system are presented in Table 42.

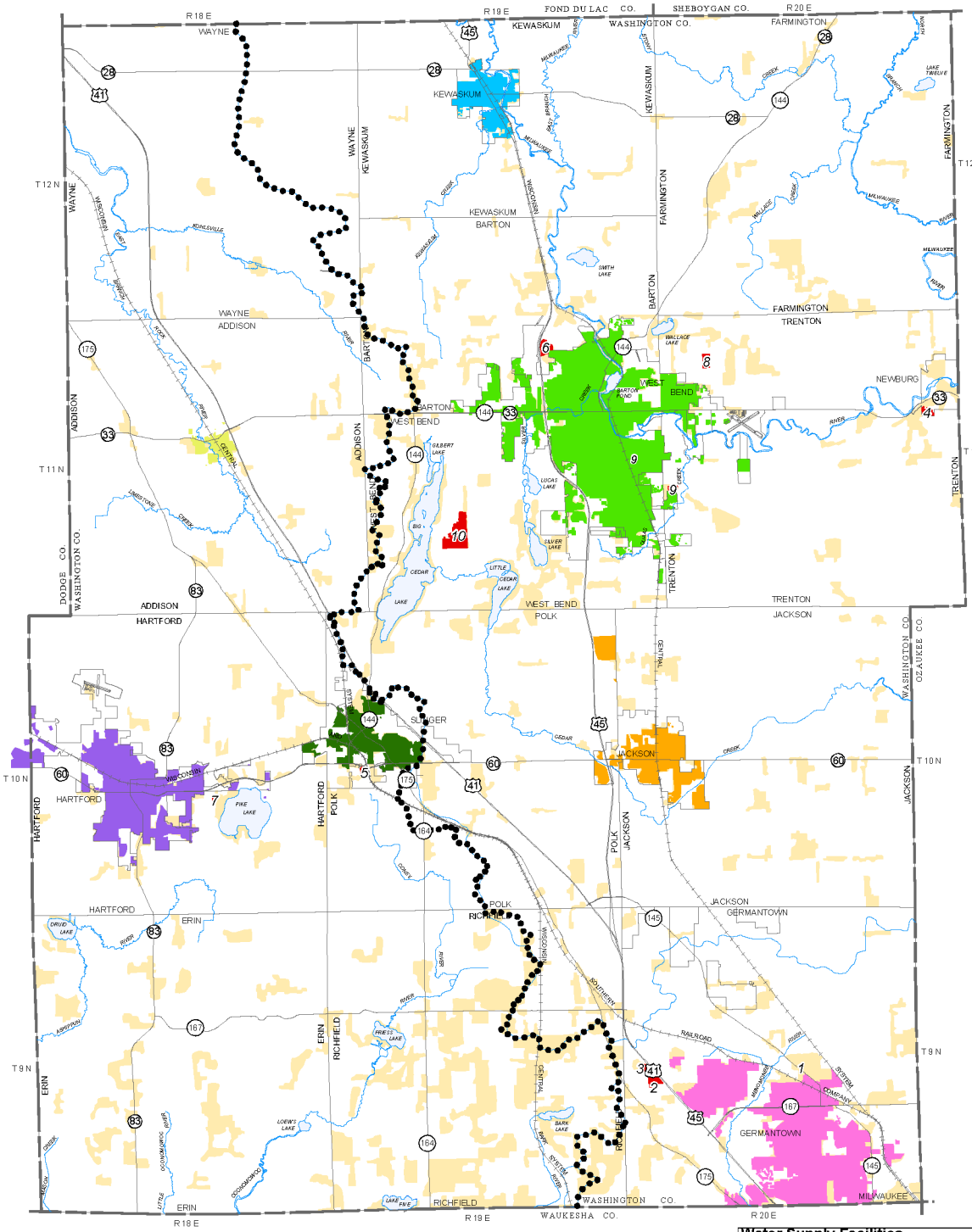
In 2005, the total storage capacity for the seven municipal water systems operating in Washington County was approximately 10 million gallons, divided among the 17 elevated tanks and standpipes and nine reservoirs, as listed in Table 42. As the largest water provider, the City of West Bend Water Utility maintained five 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 (see Table 42). As shown on Table 43, 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 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.

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.

Map 42

MUNICIPAL AND OTHER THAN MUNICIPAL, COMMUNITY WATER SUPPLY SYSTEMS IN WASHINGTON COUNTY: 2005



GROUNDWATER SUPPLIED SYSTEMS

- 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
- AREA SERVED BY PRIVATE WATER SYSTEMS USING GROUNDWATER. IDENTIFICATION NUMBER CORRESPONDS WITH APPENDIX E
- 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
Wells	33
Gravity Storage Facilities	17
Repump Storage Facilities	9
Private Systems	10
Number of Private System Wells	29

N

GRAPHIC SCALE
0 1 2 3 4 Miles
0 5,000 10,000 15,000 20,000 Feet

NOTE: PRIVATE COMMUNITY WATER SUPPLY SYSTEMS ARE THOSE IDENTIFIED BY THE WDNR AS 'OTHER THAN MUNICIPAL; COMMUNITY'.

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

PRELIMINARY DRAFT

Table 42

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 Pumping (mgd)	2005 Maximum Daily Pumping (mgd)	10-Year Maximum Daily Pumping (mgd)	Spent Water Receiving System
City of Hartford Water Utilities	AB	3.4	12,800	G	6	- -	SG, S	- -	G, FL, SQ	- -	5	1,250	1.60	2.99	- -	Rubicon River
City of West Bend Water Utility	AB	8.4	30,000	G	9	1.08	SAG'S	- -	H, P, FL, PA	- -	8	4,615	3.02	4.83	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	- -	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
Slinger Utilities	C	1.4	4,100	G	3	- -	SG, SD	- -	H, P, TA	- -	1	250	0.37	0.43	- -	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	9.78	- -	- -	- -	- -	26	10,040	8.20	14.14	- -	- -

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] *Make up code for treatment types, such as:*

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

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

Table 43

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	95	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	6,742	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 which 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 five 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.

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, there were 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.

It should be noted that the 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 plans to construct a new well (No. 16) and pumping facility. The new facility is proposed to be constructed in the western part of the City in the vicinity of STH 60 in Dodge County. A new storage facility is also planned for the same site. The City of Hartford Well No. 4, located in the downtown area, produces water which exceeds the radium maximum contaminant level. That well is now placed on standby and will only be used if emergency conditions, such as a major fire, warrant. In the longer term, the City is expecting to need one or two additional wells and storage facilities to meet future growth water demands.

City of West Bend Water Utility

Plans for the City of West Bend Water Utility system were documented in the following reports:

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 is 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 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 developed 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 a three new wells. Two of the wells will 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 will 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. The well 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.

Slinger Utilities
Plans for the 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.

No specific plans for expansion and modification are known to be proposed for Slinger Utilities.

Allenton Sanitary District
Plans for the Allenton Sanitary District system were documented in the following reports:

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 to SEWRPC by the Allenton Sanitary District indicates that the utility is taking steps 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 an area of about 0.5 square mile and served a resident population of about 1,400 persons, or less than 1.5 percent of the Washington County residential population. Of the 11 systems, seven were high-capacity and four were low-capacity systems. All of these 11 systems utilized groundwater as a source of supply through 27 low-capacity and three high-capacity wells. The existing service areas of these systems are shown on Map 42. Selected characteristics of each system are presented in Table E-1 in Appendix E.

Existing Industrial Water Supply Systems
In 2005, there were 18 existing privately owned, self-supplied, water systems operating in Washington County which provide water for industrial land uses. Of the 18 systems, 10 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 11 high-capacity wells. The locations of these systems are shown on Map 43. Selected characteristics of each system are presented in Table E-2 in Appendix E.

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 42. Selected characteristics of each system are presented in Table E-3 in Appendix E.

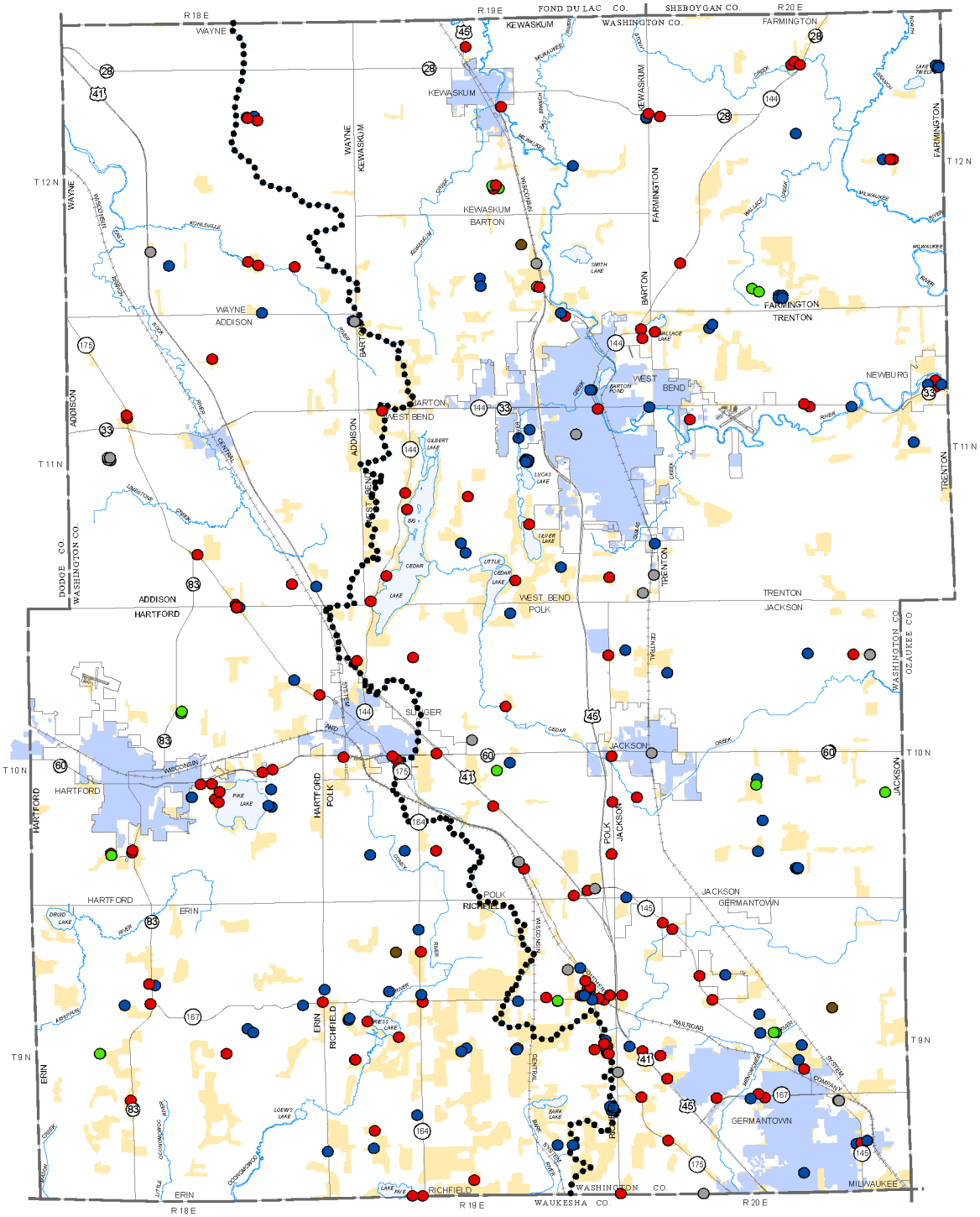
Existing Institutional and Recreational Water Supply Systems
In 2005, there were 79 existing privately owned, self-supplied, water systems operating in Washington County which provided water for institutional and recreational land uses. Of the 79 systems, 24 were high-capacity and 55 were low-capacity systems. These systems all utilized groundwater as a source of supply through 99 low-capacity wells and six high-capacity wells. The locations of these systems are shown on Map 43. Selected characteristics of each system are presented in Table E-4 in Appendix E.

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 43. Selected characteristics of each system are presented in Table E-5 in Appendix E.

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 43. Selected characteristics of each system are presented in Table E-6 in Appendix E.

Map 43

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



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

N

GRAPHIC SCALE

0 1 2 3 4 Miles

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

NOTE: PRIVATE COMMUNITY WATER SUPPLY SYSTEMS ARE THOSE IDENTIFIED BY THE WDNR AS 'OTHER THAN MUNICIPAL; COMMUNITY'.

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

Existing Thermoelectric-Power Generation Water Supply Systems
In 2005, there was one existing privately owned, self-supplied, water system operating in Washington County which provided cooling water for a thermoelectric-power-generation facility. This facility was 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 was 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.

Existing Self-Supplied Residential Water Systems
As of the year 2005, there were about 53,300 persons, or about 42 percent of the total resident year 2005 population of Washington County, served by private domestic wells. As shown on Map 42. about 31.7 square miles 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 of the County, including large portions of the Town of Richfield, and most of the urbanized areas, 18.2 square miles, lie east of the subcontinental divide. Assuming an average use of 65 gallons per capita per day, these private domestic wells would withdraw about 3.5 million gallons per day from the shallow groundwater aquifer. It is estimated that 10 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 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 2.9 million gallons per day, was returned to the groundwater aquifer via onsite sewage disposal systems.

INVENTORY FINDINGS–WAUKESHA COUNTY

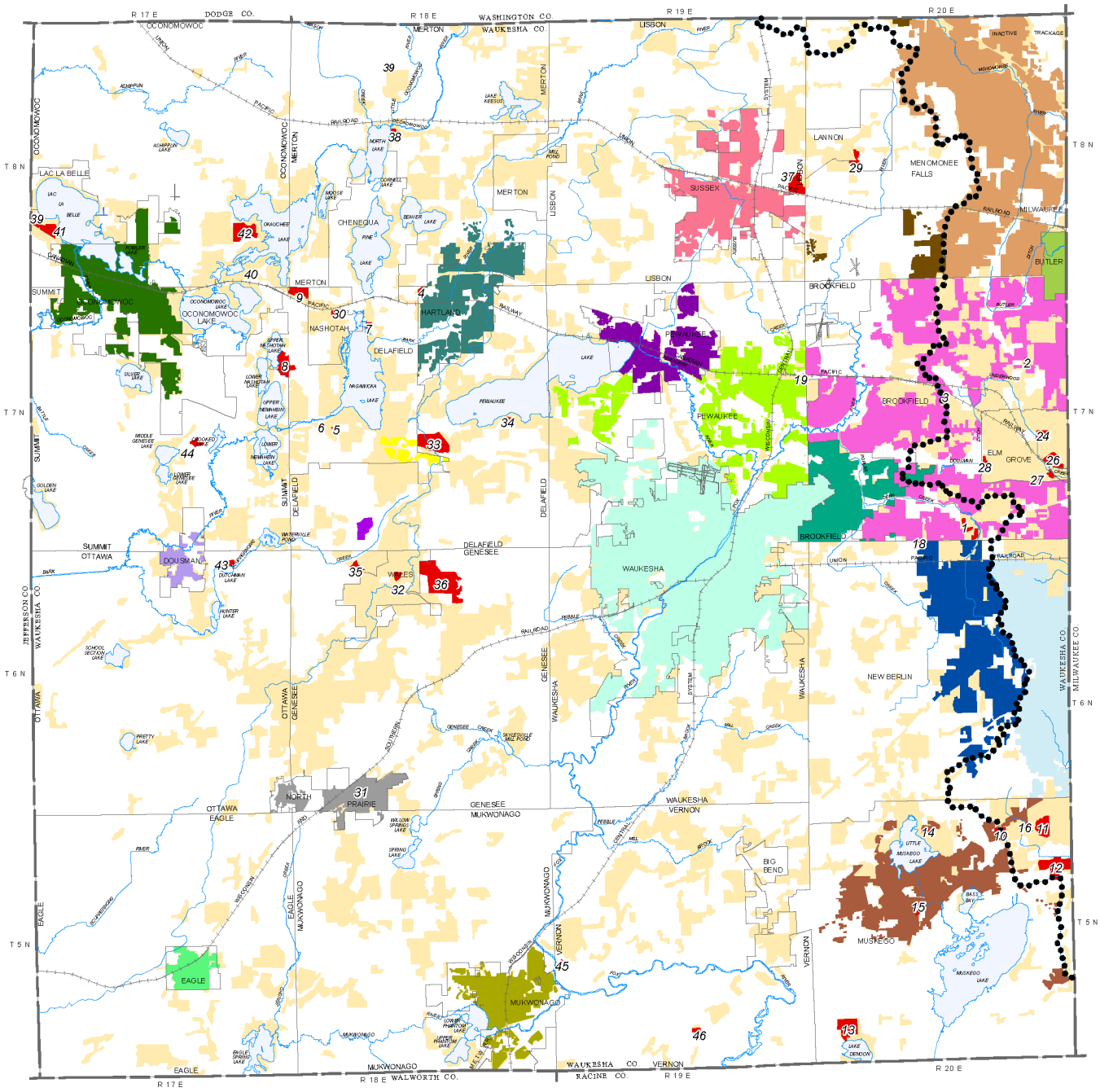
Existing Municipal Water Supply Systems
In 2005, 16 municipal water supply utility systems provided water to about 88 square miles of service area, or about 16 percent of the area of Waukesha County. These systems served a 2005 population of about 234,200 persons, or about 62 percent of the residential population in Waukesha County. Most of the water supply systems in Waukesha County rely on groundwater as the source of supply. The exceptions include 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 purchase treated Lake Michigan surface water which is returned to the Lake Michigan Basin via the Metropolitan Milwaukee Sewerage District. The existing service areas of these systems are shown on Map 44 and selected characteristics of each system are presented in Table 44.

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 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 “municipal, community water system” by the WDNR. Neither of these systems is required to provide annual reports to the Public Service Commission of Wisconsin, and, therefore, information about their usage is excluded from Table 44.

In 2005, the total storage capacity for the seven municipal water systems operating in Waukesha County was approximately 45.8 million gallons, divided among the 40 elevated tanks and standpipes and 43 reservoirs, as listed in Table 44. 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 (see Table 44). As shown on Table 45,

Map 44

PUBLIC AND PRIVATE COMMUNITY WATER SUPPLY SYSTEMS IN WAUKESHA COUNTY: 2005



GROUNDWATER SUPPLIED SYSTEMS

- 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
- SUBCONTINENTAL DIVIDE
- VILLAGE OF MENOMONEE FALLS WATER UTILITY
- MUKWONAGO MUNICIPAL WATER UTILITY
- PRAIRIE VILLAGE WATER TRUST
- VILLAGE OF PEWAUKEE WATER UTILITY
- SUSSEX VILLAGE HALL AND WATER UTILITY
- BROOKFIELD SANITARY DISTRICT NO. 4

SURFACE WATER SUPPLIED SYSTEMS

- VILLAGE OF BUTLER PUBLIC WATER UTILITY
- VILLAGE OF MENOMONEE FALLS WATER UTILITY
- CITY OF NEW BERLIN WATER UTILITY

28 AREA SERVED BY PRIVATE WATER SYSTEMS USING GROUNDWATER. IDENTIFICATION NUMBER CORRESPONDS WITH APPENDIX E

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
Wells	93
Gravity Storage Facilities	41
Repump Storage Facilities	41
Private Systems	46
Number of Private System Wells	95

N

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 44

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
Delafield Municipal Water Utility	D	0.3	400	G	1	- -	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	- -	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	S	- -	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
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
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	3.12	S, SH	- -	G, P, F	- -	10	8,025	4.18	7.60	7.60	Lake Michigan
Mukwonago Municipal Water Utility	AB	2.4	6,500	G	4	- -	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
Sussex Village Hall and Water Utility	AB	4.1	9,800	G	5	4.39	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	73.37	- -	- -	- -	- -	85	46,839	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] *Make up code for treatment types, such as:*

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

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

Table 45

SUMMARY OF MUNICIPAL WATER USE IN WAUKESHA 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]			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)	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)	
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	134	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 which 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 five 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.

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 ranged from 5 to 15 percent, with an average of 8 percent of the water pumped. 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.

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 east of the divide, as well as small portions of the Menomonee Falls service area west of the divide are supplied by purchased surface water. The small portions of the Village of Menomonee Falls water service area 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 within each utility system.

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 public educational efforts. In 2006, the City of Waukesha Water Utility adopted a water conservation and protection plan.[33] 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, implementing a lawn sprinkling restriction ordinance, and conducting building fixture replacement demonstration projects. In addition, while not specifically reported, all of the utilities are likely to be continually working to improve efficiency and minimize water losses in their systems. In addition, all communities are governed by plumbing codes which limit 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 include:

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.

[33] *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, there were 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 have ongoing maintenance activities and planned urban service areas documented in plans and related documents. Those plans are summarized in the subsequent paragraphs.

It should be noted that the 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 (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 is taking measures to protect water quality and ensure quantity and availability within its service area. As of 2006, several residential areas within the City of Brookfield still rely on private wells; the City Municipal Water Utility is currently continuing efforts to expand water service to its residents. 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 City Utility is currently conducting geophysical surveys to determine potential locations for additional wells within the service area. The City Utility has assessed water quantity issues to resolve the radium issue which affects some of the City's wells which are finished in the deep sandstone aquifer within different pressure zones and projected a tentative schedule for the addition of four

to five shallow aquifer wells over a period of time from 2002 to 2022, and possibly beyond, depending upon water usage. One of the wells was installed in 2002 at a site near the Brookfield Academy north of River Road.

During 2006, the City enhanced the capacity of an existing shallow aquifer well near the existing well in the vicinity of Capital Drive and Mountain Drive. That well will 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 the water at Well Nos. 15 and 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 for the Delafield Municipal Water Utility water system indicates that the Utility is proposing a new well to be located along Vettleson Road in the southwest quadrant of STHs 83 and 16. The well is planned to serve new development in the same 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 the Utility's 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 for the City of Muskego Public Water Utility water system 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 are being made to develop two additional wells. One elevated tank and one repump storage facility are also anticipated, but plans for each have not yet been finalized and storage capacity has not yet been determined. The well construction and modifications carried out by the City have resolved the radium problems, as the well (Well No. 5) which had the problem radium levels can be taken out of service.

Plans for system expansion are ongoing within the City of Muskego, and include the anticipated conversion of one 'other than municipal, community' system by mid-2006 (Lake Lore/Tudor Oaks water trust system). It is anticipated that this private residential system will be connected to the City of Muskego system in 2006, and that the two 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 Oconomowoc*, 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 utilize treated surface water purchased from the City of Milwaukee, and portions west of the divide currently 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 the alternative means of resolving this issue. The options which are being considered include obtaining Lake Michigan surface water to serve the remainder of the 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 for the City of Pewaukee Water Utility indicates that, in 2000, the City of Pewaukee updated a comprehensive study to determine which improvements would be necessary to ensure that

the water utility system would be able to meet projected population growth and demand within the City of Pewaukee. Based on growth projections to the year 2020, recommended improvements cited in the plan include the addition of wells and storage facilities, 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 proposed wells and reservoirs which are to be phased in over time includes nine new wells and five reservoirs, each with 200,000 gallons of storage. 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, adopted by the City of Waukesha in February 2006. The plan can be accessed at the following web address: http://www.ci.waukesha.wi.us/WaterUtility/waterConservationAndProtectionPlan.html

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 on the City of Waukesha Water Utility water system indicates that the utility is planning for both short term and long term changes to the system, due to radium problems and groundwater level concerns 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 8th, 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.

The Waukesha Water Utility has recently added two new shallow aquifer wells to its system and has plans to construct additional wells. 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. 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 shallow aquifer blending wells, and purchasing Lake Michigan surface water. The Utility plans to minimize its water supply needs by implementation of its water conservation plan as previously noted.

Village of Butler Public Water Utility
Plans for the Village of Butler Public Water Utility system were documented in the following reports:

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 on the Village of Dousman Water Utility 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 storage capacity to ensure current system and growth needs.

Village of Eagle Water Utility
Two new shallow aquifer wells were constructed and placed into operation in 2003, and a review of available information on the Village of Eagle Water Utility water system indicates no major infrastructure changes are currently anticipated. In 2005, the Village of Eagle tested for lead in 10 homes, and discovered that five of the 10 samples tested contained amounts which exceed the maximum contaminant level. The Utility is currently looking at methods to correct this 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 plan entitled *Wellhead Protection Plan for the Village of Hartland Municipal Well Field,* prepared by Ruekert & Mielke, Inc., dated October 1999.

3. A letter to the Hartland Municipal Water Utility regarding the North Side Water Study Update prepared by Ruekert & Mielke, Inc., dated November 2001.

4. A letter to the Hartland Municipal Water Utility 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 on the Village of Hartland Water Utility water system 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 sets of infrastructure. This study provided the basis for further planning and system evaluation, and at the time, the determination was made that an additional well was required to meet increasing demand, and improvements such as the addition of boosters be made to enhance pressure in higher elevation areas. As recommended in the 1993 study, a third elevated tank was constructed in 1995. The 1993 study also recommended that future well planning should consider well placement in the shallow aquifer as it is considerably more cost effective and a more efficient source of water. However, because the shallow aquifer is more susceptible to contamination than the deep aquifer, the study recommends careful well siting and development of well head protection areas. One of the older Utility wells, constructed in 1973, in the Village was finished in the shallow sand and gravel aquifer and was contaminated with trichloroethylene (TCE). This well is still active, and a process involving a stripping tower has successfully removed TCE levels to below detectable levels.

The Village of Hartland completed construction of Well No. 6 in 2006. That well was found to have a high capacity and will serve areas in the northern portion of the service area.

The Village of Hartland 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 Milwaukee Water Works to serve the largest portion of its area. The subcontinental divide passes through the Village of Menomonee, creating two distinct and separated water supply systems: the contiguous portion east of the divide and a few small areas west of the divide utilize treated surface water purchased from the City of Milwaukee, and two portions 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 on the Village of Menomonee Falls Water Utility water system 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 in and around areas currently served by groundwater, and continued expansion within the existing surface water area. Recommendations in the 2005 southeast 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 Village of Menomonee Falls construct a storage facility and several wells by 2010. Concerns about radium levels in 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 on the Mukwonago Municipal Water Utility water system 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 for the Village of Pewaukee Water Utility water system indicates that the Utility has conducted modeling analysis in order to identify potential flow and pressure problems within its distribution system. A well construction project to blend water from the shallower sand and gravel aquifer with water from Well No. 4 is under construction. This will allow Well No. 4 to lower its radium levels in order to achieve compliance with the radium maximum contamination levels. In addition, in order to meet radium compliance requirements, 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 on the Village of Sussex Water Utility water system indicates that two new wells and one new reservoir are currently being constructed 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 reports:

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 is estimated to be $3.0 million. The source of supply would be groundwater wells. The issue is to be considered binding Village referendum to be held on November 7, 2006. 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, the Village of Elm Grove officials were evaluating the possibility of developing a municipal water supply system to serve the downtown area and other properties in the southeastern portion of the Village. The source of supply would be purchased water from the City of Wauwatosa, which obtains water on a wholesale basis from the City of Milwaukee Water Works. As initially proposed, on a preliminary basis, the system would serve five condominium complexes, six apartment buildings, 14 single-family residences, and about 70 nonresidential buildings.

Existing Residential and Other than Municipal, Community Systems
In 2005, there were 46 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 an area of about 4.1 square miles and served a population of about 10,000 persons, or less than 3 percent of the Waukesha County population. Of the 46 systems, 38 were high-capacity and eight were low-capacity systems. All of these 46 systems utilized groundwater as a source of supply through 48 low-capacity wells, 24 high-capacity wells, and 23 wells of unknown capacity. The

existing service areas of these systems are shown on Map 44. Selected characteristics of each system are presented in Table E-1 in Appendix E.

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 most other typical other than municipal, community systems within southeastern Wisconsin. It serves nearly the entire Village population of 2,000, maintains infrastructure throughout nearly the entire geographic boundary of the municipality, serves other land uses besides residential use, and consists of three high-capacity wells. Based solely on population, 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 is about 120,000 gallons per day. The Prairie Village Water Trust system is, however, privately held in 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 11 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 45. Selected characteristics of each system are presented in Table E-2 in Appendix E.

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 45. Selected characteristics of each system are presented in Table E-3 in Appendix E.

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. The locations of these systems are shown on Map 45. Selected characteristics of each system are presented in Table E-4 in Appendix E.

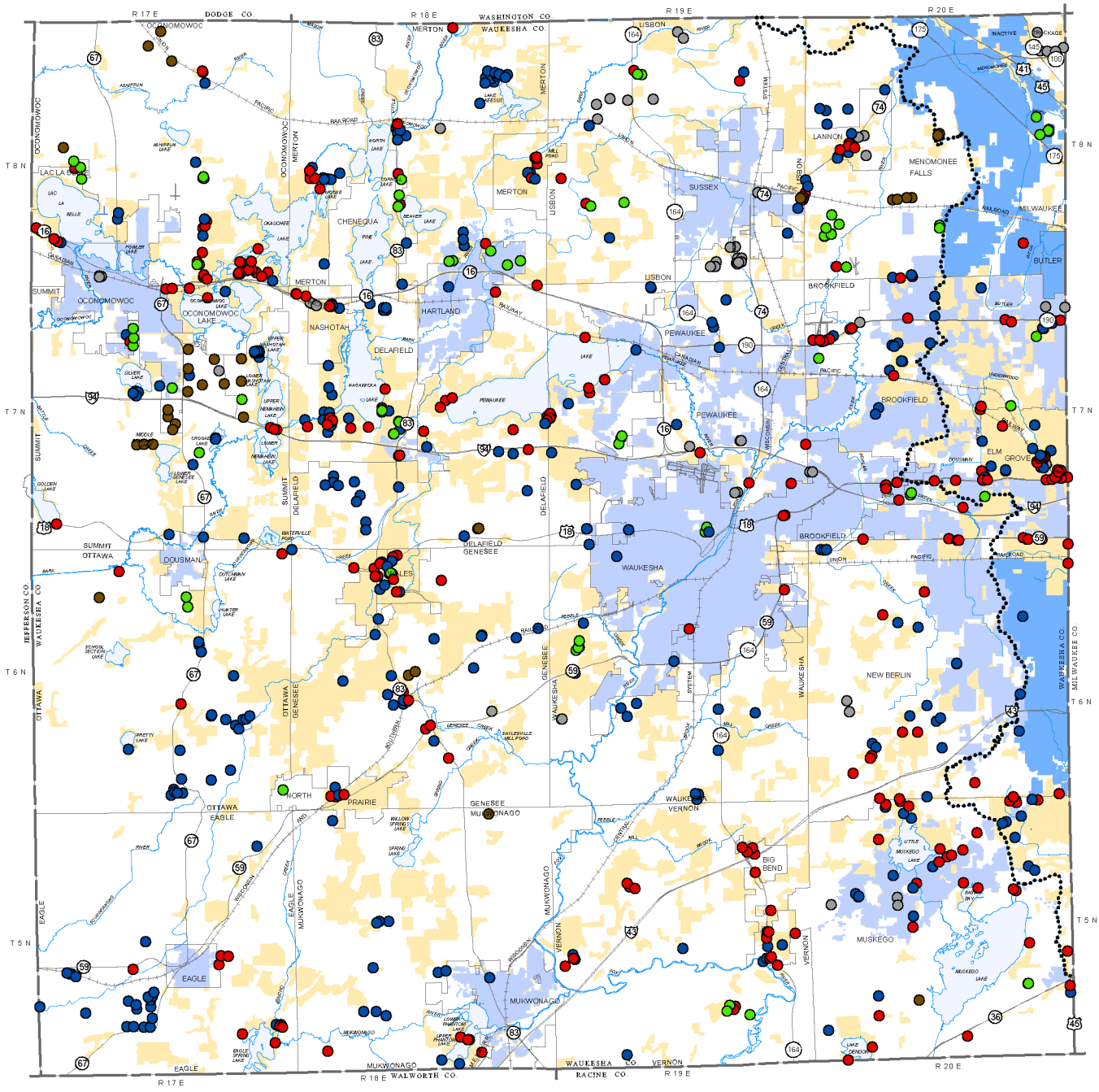
Existing Agricultural Water Supply Systems
In 2005, there were 12 existing privately owned, self-supplied, water systems operating in Waukesha County which provided water for irrigation and other purposes for agricultural land uses. All 12 systems are high-capacity systems and all utilized groundwater as a source of supply through eight low-capacity and 29 high-capacity wells. The locations of these systems are shown on Map 45. Selected characteristics of each system are presented in Table E-5 in Appendix E.

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 45. Selected characteristics of each system are presented in Table E-6 in Appendix E.

Existing Self-Supplied Residential Water Systems
As of the year 2005, there were about 138,700 persons, or about 37 percent of the total resident year 2005 population of Waukesha County, served by private domestic wells. As shown on Map 44, approximately 96.8

Map 45

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



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

N

GRAPHIC SCALE

0 0.75 1.5 2.25 3 Miles

0 5,250 10,500 15,750 21,000 Feet

NOTE: THE SELF-SUPPLIED WATER SYSTEMS INDICATED ON THE MAP INCLUDE ALL ACTIVE WELLS DEFINED AS NON-COMMUNITY TRANSIENT AND NON-TRANSIENT, AND ALL NON-COMMUNITY HIGH CAPACITY WELLS.

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

square miles outside of the municipal water utility service within Waukesha County were classified as having urban-density development, and were served by private wells. Of this, about 12.9 square miles lies east of the subcontinental divide, and the remaining 83.8 square miles is west. Much of this includes areas within the City of Brookfield that are, as of 2005, still outside of the water service area boundary. It also includes large portions of western Waukesha County, including the Village of Wales, the Town of Genesee, and the Town of Delafield. Assuming an average use of 65 gallons per capita per day, these private domestic wells would withdraw about 9.0 million gallons per day from the shallow groundwater aquifer. It is estimated that 30 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 30 percent of the private domestic wells, or about 2.7 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 5.7 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[34] was conducted by the Cities of Brookfield and Mequon and Villages of Bayside, Germantown, Menomonee Falls, River Hills, and Thiensville to evaluate alternative sources of water supply. This action was precipitated primarily by the groundwater aquifer level declines affecting municipal and some residential wells. The study gave a high consideration to fire protection needs. Cost factors considered included public infrastructure 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 would rely on continued use of 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 and operate and administer the system.
- Plan No. 3, Independent Lake Michigan Water Supply—Under this alternative plan, the communities involved 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 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

[34] *Consoer, Townsend & Associates,* Engineering Report on Sources of Water Supply for Mequon, Brookfield, Bayside, River Hills, Thiensville, Menomonee Falls, and Germantown, Wisconsin*, March 1976.*

The estimated annual payments and water rates to the communities involved under the three alternative plans were estimated to be as follows:

Alternative	Minimum Annual Payment for 1980 and 1990	Average Cost of Water per Thousand Gallons
Plan No. 1–Well 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 to be expanded and upgraded to meet 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 into the early 1930s. The Linnwood Avenue treatment plant in the City of Milwaukee was placed into operation in 1934. The City of Cudahy 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 City of Elkhorn in Walworth County, the City of Oconomowoc in Waukesha County, and the City of Cedarburg in Ozaukee County, all of which began operation between 1890 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, switched 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 continue 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 many of the water utilities in the Region was used to estimate historic water levels in 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 sallow 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 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 northern parts of Washington and Ozaukee Counties and the western part of Waukesha and Walworth Counties. 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 beyond the western edge 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 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, 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 as to safeguard against microorganisms, such as *Cryptosporidium* and *Giardia*.

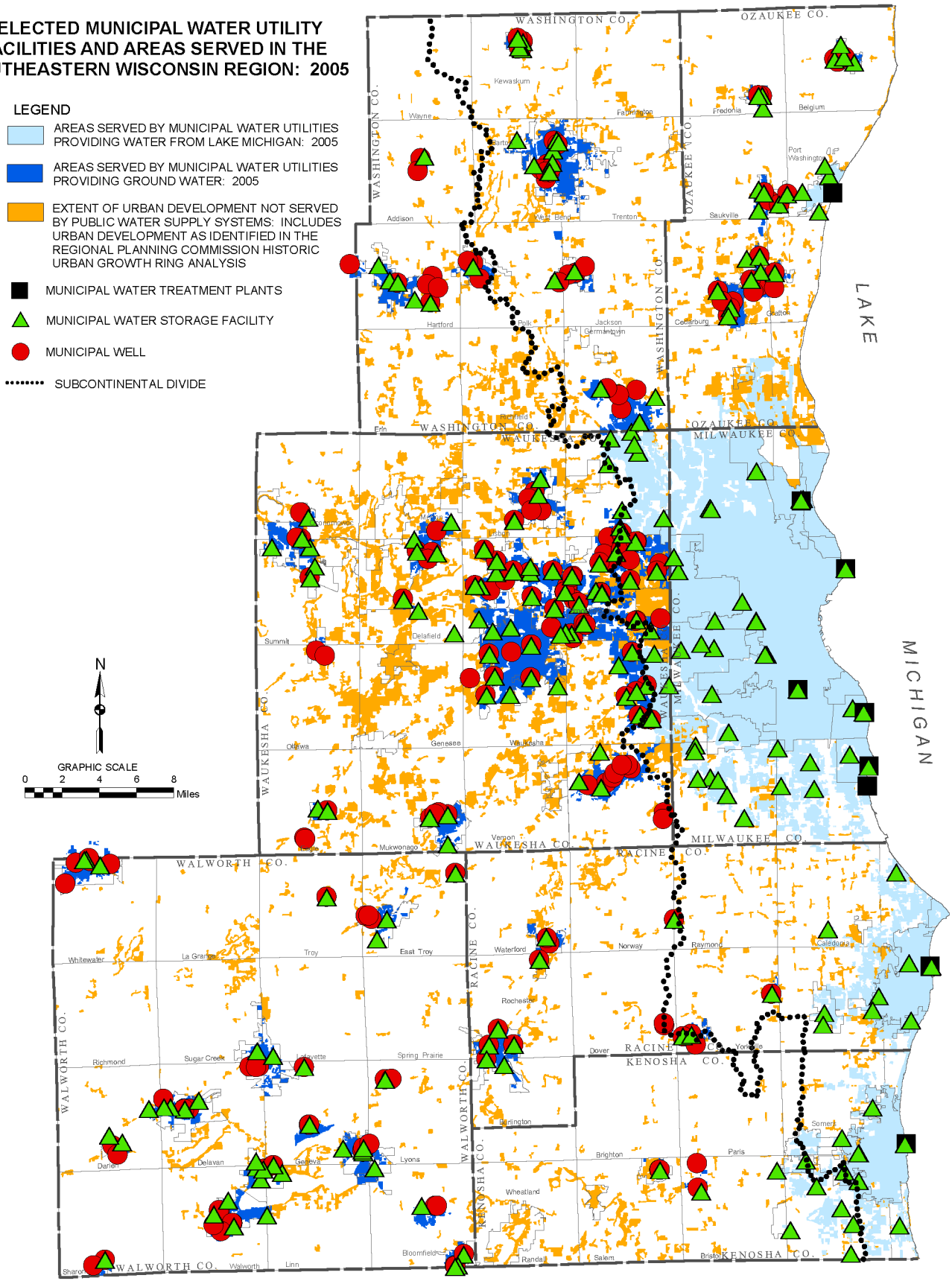
Existing Municipal Water Supply Systems

In 2005, 78 municipal water supply utility systems provided water to about 418 square miles of service area, or about 16 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 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 46 and selected characteristics of the systems are presented in Table 46. The inventory information illustrated on Map 46 and listed in Table 46 is intended to illustrate, in summary form, the basis for the evaluation of the capabilities of the existing systems to meet current and probable future water supply needs. That evaluation will be described in Chapter VII. In addition, similar maps and tabular data, along with text, will be presented in Chapter VIII to describe, in summary form, the alternative and recommended water supply plans for the Southeastern Wisconsin Region.

In 2005, the total storage capacity for the 78 municipal water systems operating in the Region was approximately 296 million gallons, divided among the 257 storage facilities, as listed in Table 46. Based on Wisconsin Public Service Commission annual reports for the year 2005, approximately 261 million gallons per day of water were pumped for use in the 78 municipal systems concerned (see Table 46). As shown on Table 47, the water use totaled about 193 mgd for residential, commercial, industrial, institutional, or other urban uses, with the remaining 68 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 12 mgd, or about 6 percent, was used for other municipal purposes. Based upon the population served

Map 46

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 46

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[b]	Source of Supply[c]	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	116,900	G, S, SP	4	2.1	1	2, plus 1 emergency	42	17	31,760	17.6	28.0
Milwaukee	14	195.9	920,800	S, SP	- -	- -	6	8	432	45	167,092	160.8	248.4
Ozaukee.....	7	17.7	49,200	G, SP	20	17.6	1	2	4	23	6,311	6.7	11.8
Racine	12	38.3	147,000	G, S, SP	12	14.2	1	3	40	23	20,554	29.7	48.5
Walworth	16	22.2	59,100	G	44	35.2	- -	- -	- -	38	13,500	8.4	17.1
Washington	7	21.8	73,400	G	32	9.8	- -	- -	- -	26	10,040	8.2	14.1
Waukesha	16	87.7	234,200	G, SP	93	73.4	- -	- -	- -	85	46,839	29.3	54.3
Total	78	418.0	1,600,600	- -	201	152.3	9	15, plus 1 emergency	518	255	295,046	260.7	422.2

[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 47

SUMMARY OF MUNICIPAL WATER USE IN THE SOUTHEASTERN WISCONSIN REGION: 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	85,391	68	910	50,889	4,010	53,595	1,054	10,077	199,952	128	10
2004[h]	85,027	67	873	39,761	3,049	49,959	959	10,866	185,612	117	12
2005[I]	89,904	70	916	39,731	3,003	51,055	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 which 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 five 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.

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. 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 78 municipal utility systems in 2005 was about 4 percent less than used in 2000 and about 4 percent more than used 2004. The decrease between 2000 and 2005 was due largely to a decrease of about 21 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 is 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, 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.

Self-Supplied Private Water Supply Systems

In 2005, there were 169 existing privately owned water, self-supplied, systems operating in the Southeastern Wisconsin Region 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 Wisconsin Department of Natural Resources as "other than municipal, community systems." These systems serve a residential population of about 29,600 persons, or about 1.5 percent of the 2005 Region resident population. These systems are served by 312 wells and appurtenant equipment. Selected characteristics of each system are presented in Table E-1 in Appendix E.

In 2005, there were 108 existing privately owned, self-supplied, water systems operating in the Region which provide water for industrial land uses. These systems all utilize groundwater as a source of supply through 186 wells and appurtenant equipment. Selected characteristics of each system are presented in Table E-2 in Appendix E.

In 2005, there were 941 existing privately owned, self-supplied, water systems operating in the Region which provide water for commercial land uses. These systems all utilized groundwater as a source of supply through 1,008 wells and appurtenant equipment. Selected characteristics of each system are presented in Table E-3 in Appendix E.

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 835 wells and appurtenant equipment. Selected characteristics of each system are presented in Table E-4 in Appendix E.

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 E-5 in Appendix E.

In 2005, there were 96 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 150 wells and appurtenant equipment. Selected characteristics of each system are presented in Table E-6 in Appendix E.

In 2005, there were six 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 combustion turbine, 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 and intermittent-load, natural gas facility in Ozaukee County; and the Germantown combustion turbine gas-fired, intermittent-use facility in Washington County. These facilities are reported to use nearly two billion gallons of water per day in 2000. Most of that water is utilized by the Menomonee 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 away from Lake Michigan, 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 cooling the towers. We Energies reports that nearly 75 percent of the water used at that plant 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 on an intermittent-use basis.

Existing Self-Supplied Residential Water Systems

As of the year 2005, there were about 337,000 persons, or about 17 percent of the total year 2005 residential population of the Region, served by private domestic wells. Assuming an average use of 65 gallons per capita per day,[35] the private domestic well within the Region would withdraw about 22 million gallons per day from the shallow groundwater aquifer. It is estimated that 37 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 37 percent of the private domestic wells, or about 8.1 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 12.5 million gallons per day, was returned to the groundwater aquifer via onsite sewage disposal systems.

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[35] *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 expected to be lower in areas served by private wells than is areas served by public water supply systems.*