Consumptive Water-Use Coefficients for the Great Lakes Basin and Climatically Similar Areas

By Kimberly H. Shaffer and Donna L. Runkle

National Water Availability and Use Program

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Conversion Factors and Abbreviations

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch per year (in/yr)	25.4	millimeter per year (mm/yr)
	Area	
square mile (mi^2)	259.0	hectare (ha)
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
gallon (gal)	3.785	liter (L)
million gallons (Mgal)	3,785	cubic meter (m^3)
billion gallons (Ggal)	0.3785	cubic hectometer (hm^3)
cubic meter (m^3)	0.0008107	acre-foot (acre-ft)
million cubic meters (Mm^3)	810.7	acre-foot (acre-ft)
	Rate	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
gallon per day (gal/d)	0.003785	cubic meter per day (m^3/d)
gallon per kilowatthour (gal/kWh)	0.003785	cubic meter per day (m^3/kWh)
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)
billion gallons per day (Ggal/d)	43.81	cubic meter per second (m^3/s)
cubic kilometer per year (km^3/yr)	0.2399	cubic mile per year (mi^3/yr)
million liters per hectare (ML/ha)	0.1069	million gallons per acre (Mgal/acre)

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

$$°C = (°F-32)/1.8$$

Electricity-generation rates are given in kilowatthours (kWh) and gigawatthours (GWh).

Additional abbreviations used in this report

Circular	Refers to one or a group of U.S. Geological Survey reports titled "Estimated Water use in the United States in [year]" that were published every 5 years from 1950 to 2000.
GLC	Great Lakes Commission
HUC	Hydrologic Unit Code
IJC	International Joint Commission
NAICS	North American Industrial Classification System
SIC	Standard Industrial Classification
USGS	U.S. Geological Survey

Consumptive Water-Use Coefficients for the Great Lakes Basin and Climatically Similar Areas

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Abstract

Consumptive water use is the portion of water withdrawn (for a particular use) that is evaporated, transpired, incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the immediate water environment. This report, which is organized by water-use categories, includes consumptive-use coefficients for the Great Lakes Basin (including Canada) and for areas climatically similar to the Great Lakes Basin. This report also contains an annotated bibliography of consumptive water-use coefficients. Selected references are listed for consumptive-use data from elsewhere in the world.

For the industrial water-use category, the median consumptive-use coefficients were 10 percent for the Great Lakes Basin, climatically similar areas, and the world; the 25th and 75th percentiles for these geographic areas were comparable within 6 percent. The combined domestic and public-supply consumptive-use statistics (median, 25th and 75th percentiles) were between 10 to 20 percent for the various geographic areas. Although summary statistics were similar for coefficients in the livestock and irrigation water-use categories for the Great Lakes Basin and climatically similar areas, statistic values for the world on a whole were substantially lower (15 to 28 percent lower). Commercial and thermoelectric power consumptive-use coefficient statistics (median, 25th, and 75th percentile) also were comparable for the Great Lakes Basin and climatically similar areas, within 2 percent. References for other countries were not found for commercial and thermoelectric power water-use categories. The summary statistics for the mining consumptive-use coefficients varied, likely because of differences in types of mining, processes, or equipment.

Introduction

This report is part of a series of reports by the U.S. Geological Survey National Assessment of Water Availability and Use Program for the **Great Lakes Basin**[1], a program designed to gain a clearer understanding of water-use, land-use, and climatic trends in our Nation's water resources. Preliminary discussions with state agencies have indicated that refinement of consumptive-use data and coefficients is an area of great interest and value to water-supply managers (Grannemann and Reeves, 2005). These consumptive-use coefficients were compiled and an annotated bibliography was prepared for the Great Lakes Basin and **climatically similar areas**.

Consumptive use is water that is evaporated, transpired, incorporated into products or crops, consumed by humans or livestock, or otherwise removed from an immediate water environment (water body, surface- or ground-water source, basin). Water-resource planners and managers use consumptive water use to understand the effect of human use of water on the hydrologic system. When the hydrologic system includes an area shared by two countries, as is the Great Lakes Basin, it is important to thoroughly understand how water is consumed and unavailable for use. It is equally important to understand the measures needed to document current levels of consumptive use and develop policies that will optimize the use and reuse of water as much as possible.

Two common methods of computing consumptive use are with a water-balance equation or a consumptive-use coefficient. Because more detailed data are needed to use a water-balance equation, consumptive use frequently is estimated with coefficients. A consumptive-use coefficient, as defined for this report, is the percentage of water removed from the immediate environment by **evaporation**, **transpiration**, incorporation into products or crops, or consumption by humans or livestock.

[1] Bolded terms are defined in the glossary.

Purpose and Scope

The purpose of this report is to present a compilation of consumptive-use coefficients for the Great Lakes Basin and climatically similar areas. The report can serve as a starting point for facility managers, water managers, and scientists to compute water consumption and **return flow**. The data and coefficients were assembled by **water-use category** to address the following questions:

- Within a given water-use category, is there a small range of coefficients reported in most references?
- How do the coefficients for the Great Lakes Basin and climatically similar areas compare to each other and to world coefficients?
- What methods and data were used in previous studies to calculate consumptive use?
- What consumptive-use data and coefficients are available?

The report contains

- consumptive-use coefficients for domestic and public-supply, industrial, industrial use by major **standard industrial classification codes**, thermoelectric power, irrigation, livestock, commercial, and mining water-use categories;
- a selected statistical analysis;
- summary tables by geographic area and water-use category;
- an annotated bibliography of references with consumptive-use coefficients; and
- an appendix with detailed consumptive-use coefficient tables from selected references

for the Great Lakes Basin and areas climatically similar to the Great Lakes Basin, and selected references for elsewhere in the world.

Overview of Report

The different parts of the report are designed to work together. Overall summaries of consumptive-use coefficients by geographic area (table 9) and water-use category (table 43) provide an overview of the coefficient ranges. More detailed discussions about the consumptive-use coefficients are in the water-use categories sections (domestic and public-supply, industrial, industrial use by major standard industrial classification codes, thermoelectric power, irrigation, livestock, commercial, and mining). The water-use categories sections include coefficient summary tables and boxplots showing the distribution of the coefficients. More information about the coefficients presented in each water-use category summary table can be found in the annotated consumptive-use bibliography, which contains about 100 references. Tables from references with multiple tables or references that are part of a series of publications are in the appendixes (a guide to the appendixes is shown in table 1).

The intent of this report is to compile consumptive-use coefficients from publications, rather than determine the validity of the coefficients. The information in the annotated bibliography describes the coefficients and presents some of the methods and assumptions used by the source to determine the coefficients. Many references did not include an approach or methodology for their consumptive-use data or coefficients.

Table 1. Appendix guide.

Appendix table(s)	Reference(s)	Water-use categories	Description
1-1 to 1-16	Murray, 1968 Murray and Reeves, 1972 Murray and Reeves, 1977 Solley and others, 1983 Solley and others, 1988 Solley and others, 1993 Solley and others, 1998	Domestic 1-1 and 1-2 Industrial 1-3 and 1-4 Thermoelectric 1-5 and 1-6 Irrigation 1-7 and 1-8 Livestock 1-9 and 1-10 Animal specialties 1-11, 1-12 Commercial 1-13, 1-14 Mining 1-15, 1-16	Consumptive-use coefficients from USGS 5-year compilation reports aggregated by water-use categories for the (1) Great Lakes Basin and Great Lakes States and (2) water resources regions and states climatically similar to the Great Lakes States
2-1 to 2-5	U.S. Bureau of Census, 1986	Industrial 2-1 to 2-5	Consumptive-use coefficients, and water use and consumptive use data from the 1983 Census of Manufacturing.
3-1 to 3-9	Pebbles, 2003b Great Lakes Commission, Annual Reports, 2005a	Public supply 3-1, 3-2, and 3-6 Domestic 3-1, 3-2, and 3-7 Industrial 3-1, 3-2, and 3-3 Thermoelectric 3-1, 3-2, 3-4, 3-5 Irrigation 3-1, 3-2, and 3-8 Livestock 3-1, 3-2, and 3-9	Consumptive-use coefficients by Great Lakes jurisdictions and water use and consumptive use data for annual reports 1998 to 2002.
4-1 to 4-2	Tate and Harris, 1999a	Public supply 4-2 Industrial 4-1 Thermoelectric power 4-2 Agriculture 4-2	Consumptive-use coefficients and water intake and consumption data for water-use categories in the Canadian portion of the Great Lakes Basin.
5-1 to 5-4	Water Resources Council (U.S.), 1978	Domestic 5-3 Industrial 5-2 Thermoelectric 5-2 Irrigation 5-1 Livestock 5-1 Commercial 5-3 Mining 5-4	Consumptive-use coefficients, and water intake and consumptive use data for water resources regions in the United States.

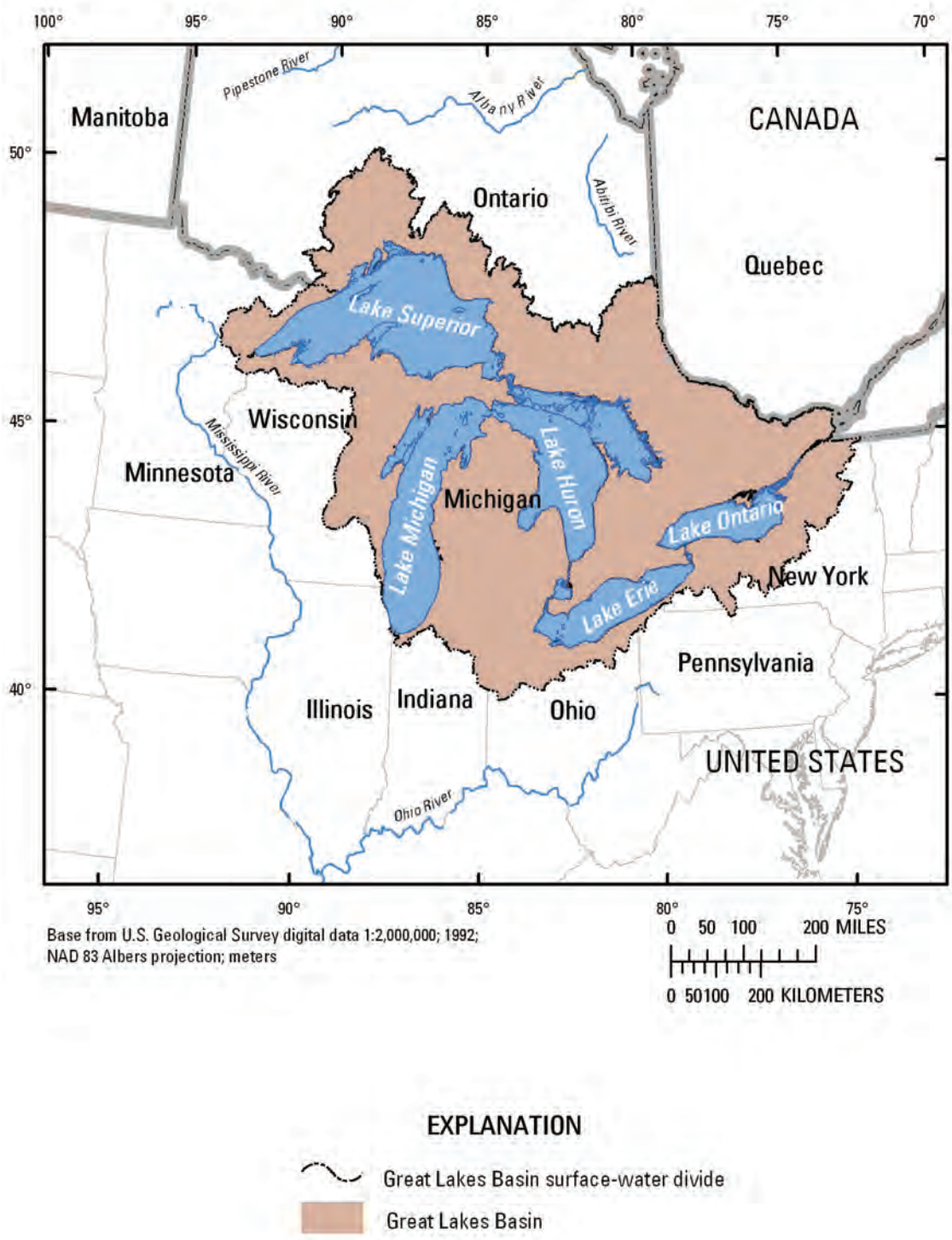
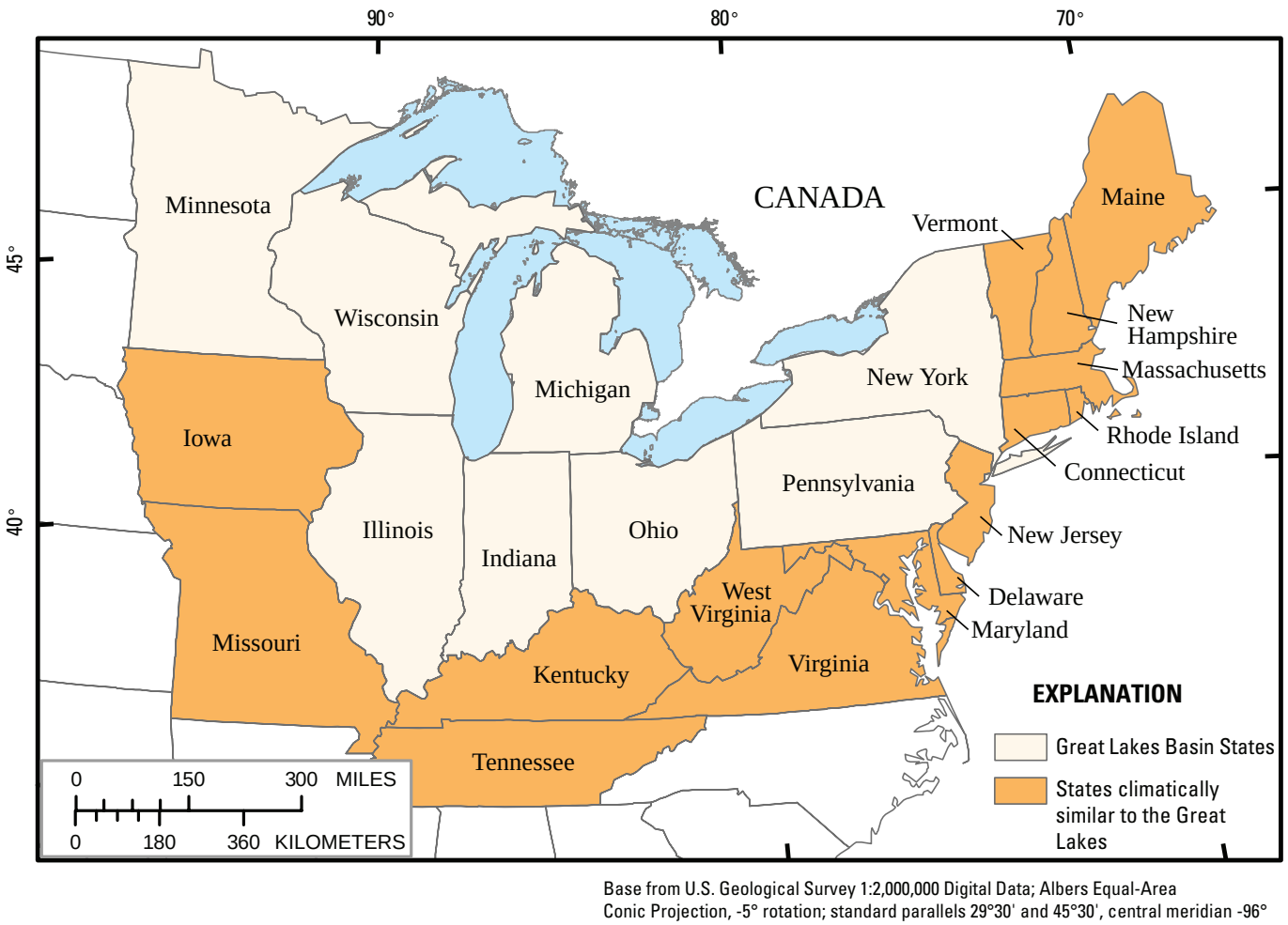


Figure 1. The Great Lakes surface-water basin.

This report compares two main areas: the Great Lakes Basin and climatically similar areas to the Great Lakes Basin in North America. The Great Lakes Basin (fig. 1) includes parts of Illinois, Indiana, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin, the entire state of Michigan, and parts of Ontario and Quebec.

In many publications, consumptive-use values or coefficients have been determined for the entire state or province and not just the Great Lakes Basin portion. The coefficients from these publications were assumed to be representative of the Great Lakes Basin because they could not be separated by river basin or water-resources region. The state- or province-based coefficients were identified as such in the text, figures, and tables.



Base from U.S. Geological Survey 1:2,000,000 Digital Data; Albers Equal-Area Conic Projection, -5° rotation; standard parallels 29°30' and 45°30', central meridian -96°

Figure 2. States considered climatically similar to the Great Lakes States.

Consumptive use and consumptive-use coefficients are a function of climate, economics, and culture. Choice of the climatically similar states (fig. 2) was based on patterns of temperature and precipitation (Prism Group, 2006a, b), water-resources regions (Solley and others, 1998), comparable percent consumptive loss for water-resources regions (fig. 3), and water use in the state. Hutson and others (2004b) found that six water-resources regions (Great Lakes, mid-Atlantic, New England, Ohio, Tennessee, and Upper Mississippi) had comparable percent consumptive losses (fig. 4).

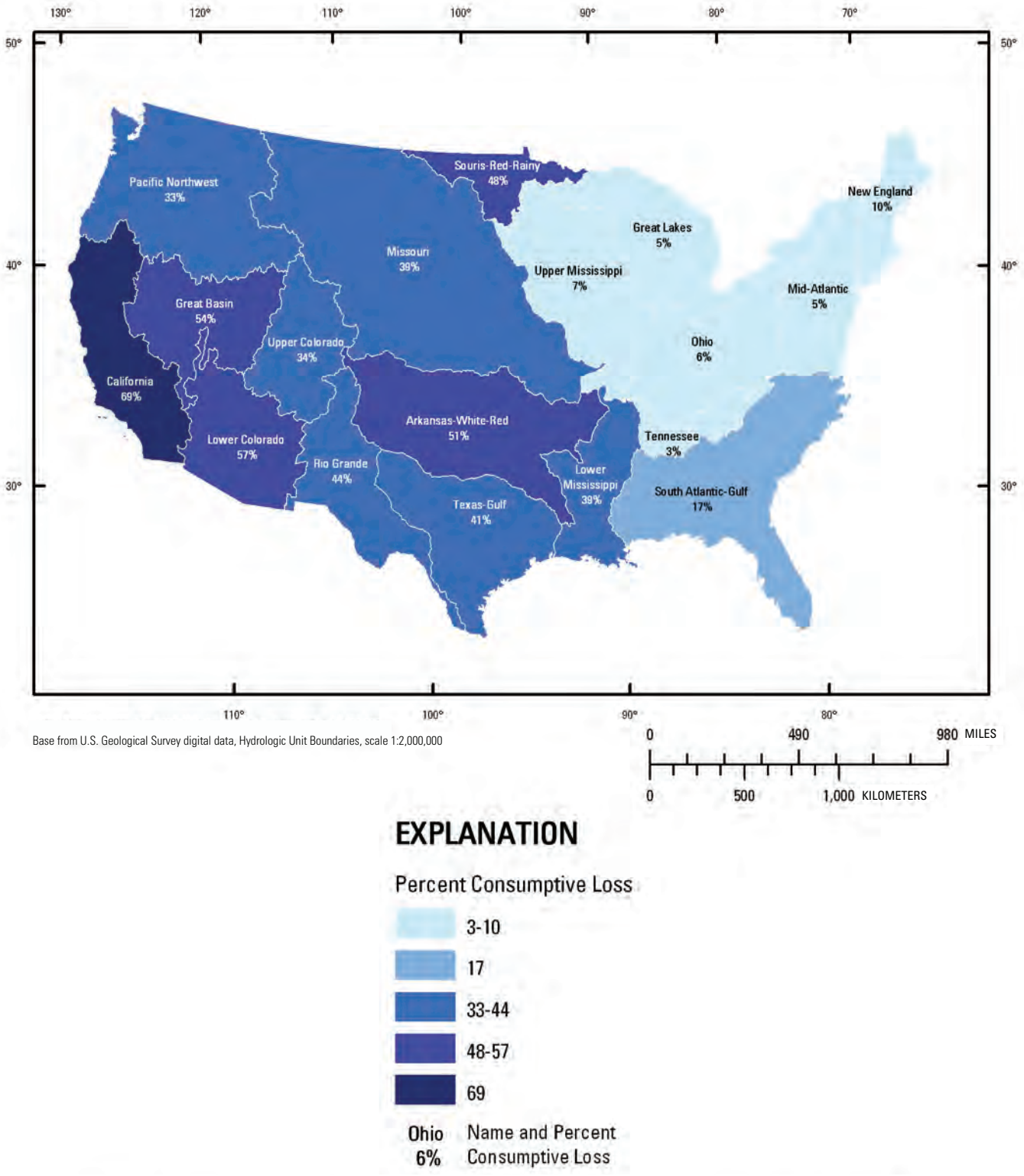


Figure 3. Percent consumptive loss in the conterminous United States, by water-resources region, in 1995. (From Hutson and others, 2004b and Solley and others, 1996)

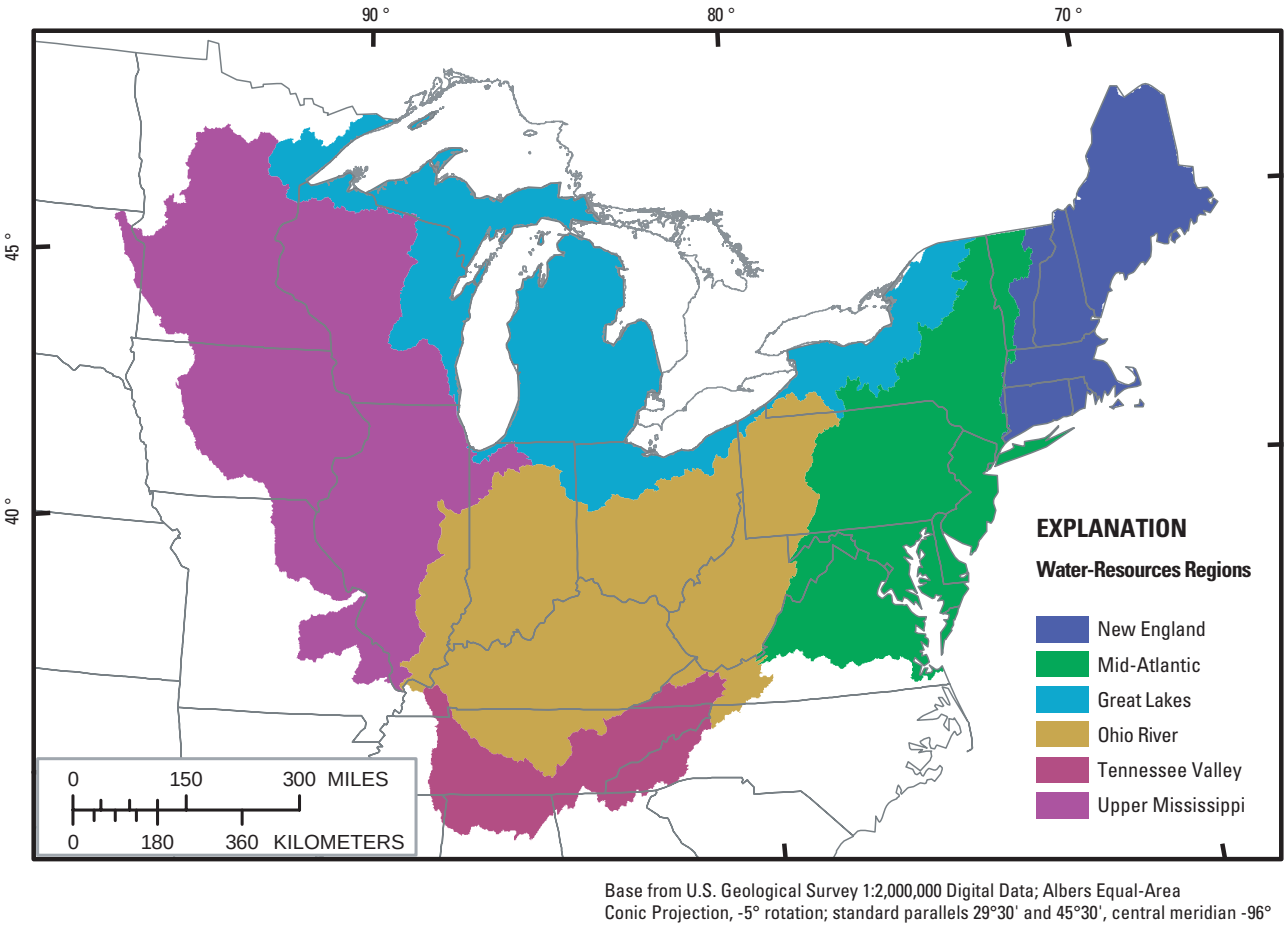


Figure 4. Water-resources regions used in selection of climatically similar States.

These water-resources regions (fig. 4) and the major states in these regions (fig. 2) are considered part of the scope of this report. These states have annual precipitation of 28–60 in. (1971–2000) and average minimum temperatures of 21 to 49°F (1971 to 2000); (Prism Group, 2006a, b). States south of Missouri, Tennessee, and Virginia had average minimum temperatures greater than 49°F (Prism Group, 2006a). States west of Minnesota, Iowa, and Missouri have areas with annual precipitation of less than 24 in. (from 1971 to 2000; Prism, 2006b) and many of these states reported irrigation as the primary water-use category (excluding thermoelectric power; Hutson and others, 2004a).

As part of this report, a search for world, continent, and country consumptive-use coefficients was conducted. Only a few references were found, and they are included in this report as a basis of comparison with the coefficients of Great Lakes Basin and climatically similar areas. Most of these coefficients were geographically broad (large countries, continents, or the world), in areas of the world not climatically similar, and in countries with economic and cultural differences. Therefore, these references though not included with the climatically similar references, were kept in the report to broaden the understanding of the Great Lakes Basin and climatically similar areas consumptive-use coefficients.

The terms “consumptive-use coefficient” and “consumptive crop irrigation coefficient” are used in relation to coefficients used in agriculture modeling to estimate evaporation and transpiration in crop irrigation (American Society of Civil Engineers, 1973; Kite and Droogers, 2000). These coefficients are not included in this document because almost all the references were in areas not climatically similar to the Great Lakes Basin and the primary water-use category for these areas was irrigation (excluding thermoelectric). Stream, lake, and reservoir evaporation losses were not addressed in this report.

Many publications included consumptive-use coefficients derived from another reference. References not adding value to the understanding of consumptive-use coefficients were not included in the report. References using a coefficient from another reference or combination of other references to compute consumptive use were included in the report and statistical computations if they fit the geographic area and timeframe of the statistics.

Some publications use the words “consumptive use” to mean “water use” (or water **withdrawals**). In this report, water use is defined as water that is withdrawn for a specific purpose like irrigation, industrial processing, public supply, or thermoelectric power.

Methods

Table 2 includes consumptive-use definitions from multiple references. For the most part, these definitions show agreement that consumptive use is water that is evaporated, transpired, or incorporated into products or crops, consumed by humans or livestock or otherwise removed from an immediate water environment (water body, surface or ground water source, basin, Great Lakes Basin). The consumptive-use processes are described in greater detail in table 3.

Table 2. Consumptive-use definitions.

[Reference is the publication that contains the consumptive-use definition.]

Reference	Consumptive-use definition
Solley and others, 1998	That part of water withdrawn that is evaporated, transpired, or incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the immediate water environment.
Great Lakes Commission, 2003	That portion of water withdrawn or withheld from the Great Lakes Basin and assumed to be lost or otherwise not returned to the Great Lakes Basin due to evapotranspiration, incorporation into products, or other processes.
International Joint Commission, 2004	That portion of water withdrawn which is evaporated, transpired from plants, incorporated into products, or otherwise lost, and thus is not available for further use in the basin.
Government of Canada and the U.S. Environmental Protection Agency, 1995	The permanent removal of water from a water body. Consumptive use may be due to evaporation or incorporation of water into a manufactured product.
Water Resources Council, 1978	Portion of surface or ground water withdrawn for off-stream uses that is lost by evapotranspiration or by incorporation into a manufactured product.

Table 3. Consumptive-use processes.

Consumptive-use processes	Definitions and examples
Evaporation	Water that is changed from a liquid form into a vapor state such as water evaporating from pools, large bodies of water, runoff from car washing or irrigation systems, evaporation through dehumidifiers, heating and cooling processes in industrial facilities and thermoelectric plants.
Transpiration	The process where water is absorbed by plants, usually from the roots and evaporated into the atmosphere from the plant surface. Transpiration occurs in all types of plants including crops, grass (lawns, golf courses), landscaping plants, and nursery plants.
Evapotranspiration	The collective term used to include water discharged to the atmosphere as a result of plant transpiration and evaporation from soil and surface-water bodies.
Product incorporation	Water is used to make industrial, food, and beverage products. A few examples are canned food, frozen food, soda, beer, wine, bottled water, juice, chemical and cleaning products, and pharmaceutical products.
Livestock and human consumption	Water that hydrates humans and livestock and is not returned. Livestock includes chickens, cows, horses, beef cattle, sheep, goats, pigs, and other animals.

Evaporation from heating and cooling processes in industrial facilities is an example of consumptive use.

Water-use activities begin when water is diverted or withdrawn from surface- or ground-water sources and conveyed to a place of use. A withdrawal is made by a self-supplied user or by a public supply facility (also known as a community water system).

Water use by a self-supplied user can be from a single user, or aggregate of users (group of users in a specific geographic area), and it refers to water that is actually used for a specific purpose, such as irrigation, industrial processing, or domestic activities in a household (such as drinking or bathing) to name a few. All the water-use categories except public supply are for self-supplied users. Public-supply facilities typically need a more complex equation to calculate consumptive use depending on the withdrawals, transfers (imports and exports), unaccounted-for water, return flow, infiltration and inflow. Consumptive use for self-supplied users (typically) can be calculated using the simple equation (fig. 5):

$$\textit{Consumptive use} = \textit{Withdrawal} - \textit{Return flows} \quad (1)$$

This is a condensed version of the equation from LaTour (1991):

$$\begin{aligned}&\textit{Consumptive use} = \\ &(\textit{Deliveries} + \textit{self-supplied withdrawals}) \\ &- (\textit{Releases to sewage-treatment plants} \\ &+ \textit{direct returns to surface- and ground-water sources}) \end{aligned} \quad (2)$$

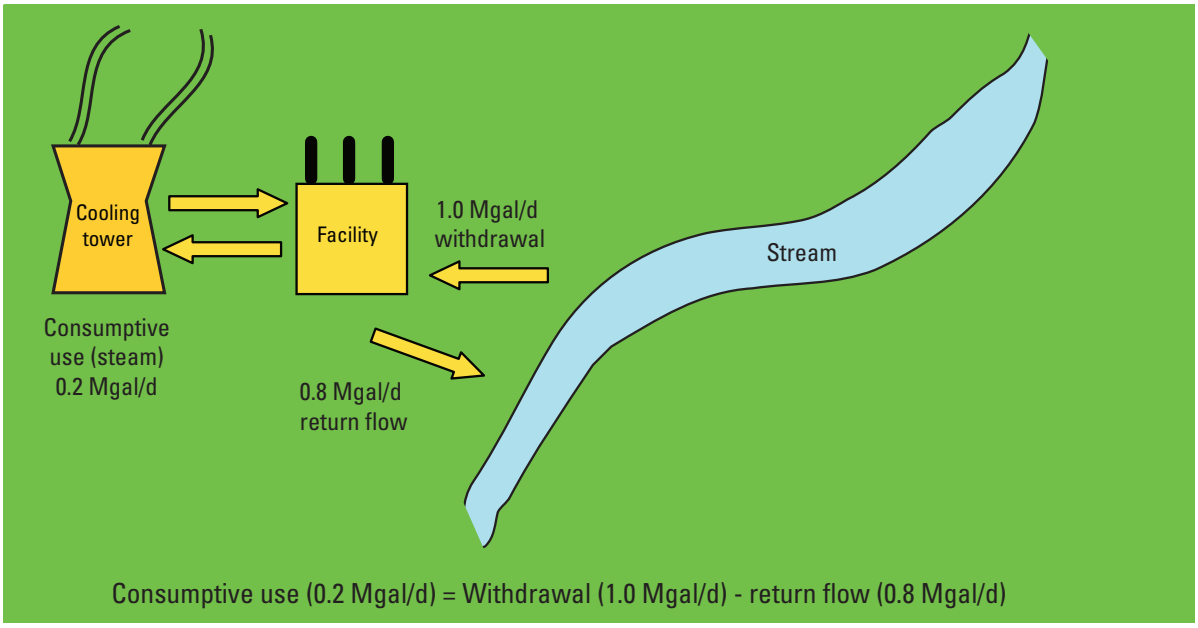


Figure 5. Representation of consumptive use by a single facility where consumptive use is equal to withdrawal minus return flow. (Mgal/d, million gallons per day)

LaTour (1991) also assumed that "**conveyance losses** or gains" (unaccounted-for water or inflow and infiltration) were zero for self-suppliers.

Consumptive use can be computed as a measurement at a self-supplied facility using these equations, or more commonly, is based on a coefficient that is a percentage of the withdrawal rates. Table 4 lists methods to determine consumptive use—the accuracy decreases and uncertainty increases by the methods down the table.

The availability and quality of data limit the use of the balancing equations and limit the research and refinement of consumptive-use coefficients. Additional complexities of consumptive use are discussed in table 5.

Unaccounted-for water includes conveyance losses and public uses.

Table 4. Consumptive-use computation methods.

Consumptive-use computation methods	Explanation
Facility level	Consumptive use is calculated at the facility level by subtracting return flow and release to the sewer system from withdrawal and delivery from a community water system.
Similar facilities	Consumptive use can be estimated by applying information such as meter readings and observations from a few facilities to an entire group of facilities (for example, car washes) to determine a consumptive-use coefficient.
Water-use categories	Consumptive use can be estimated by water-use category, such as commercial use, by applying a very general consumptive-use coefficient.
Groups of water-use categories	Consumptive use can be estimated by groups of water-use categories, such as public supply, which is a combination of domestic, commercial, industrial, and unaccounted-for water.

Table 5. Consumptive-use complexities.

Consumptive-use complexities	Explanation
Data availability	By jurisdictions, water use data and the data quality differ significantly. This hinders the ability to compare data by jurisdictions and truly analyze water availability and consumptive use.
Time and area	Water is in the hydrologic cycle in different locations on earth as liquid, precipitation, or condensation. Water removed from an environment might take days, months, years, or millions of years to return to that location, if it ever returns. At what specific timeframe is the water considered "consumed" versus still being used and returnable for reuse?
Water transfer	Water that is withdrawn might be returned to a different water body, or basin (a transfer). This becomes complex because the water is no longer available for use at the original environment (body of water, basin) but is available for use elsewhere (water was transferred).
Water quality	The degradation of quality of the returned water could also limit its reuse.

Two methods are commonly used to compute consumptive use. The first is by using a balancing equation (fig. 6). Withdrawal and return flow data are needed to use this balancing equation. The second method to compute consumptive use is to use consumptive-use coefficients (table 6).

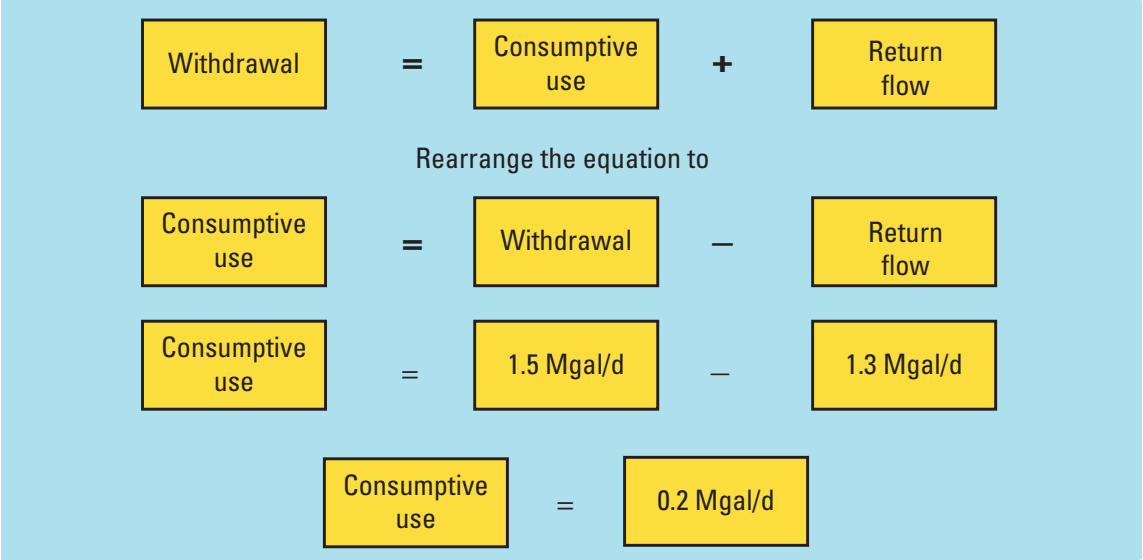


Figure 6. An example of calculating consumptive use with a water-use balancing equation. (Mgal/d, million gallons per day)

Table 6. Examples of calculating consumptive use and return flow using a consumptive-use coefficient for self supplied facilities.

[Consumptive use is calculated by multiplying the coefficient times withdrawals and dividing by 100. Return flow is calculated by subtracting the consumptive use from the withdrawals. Mgal/d, million gallons per day]

Water-use category	Consumptive-use coefficients (in percent)	Withdrawals (Mgal/d)	Consumptive use (Mgal/d)	Return flow (Mgal/d)
Irrigation	90	1.60	1.44	0.16
Domestic	15	3.20	.48	2.72
Industrial	10	2.22	.22	2.00

Data availability, time and areal aspects, water transfers, and water quality make understanding and computing consumptive use complex. For example, the mobility of livestock, limited data, and animals' impact on water quality make livestock water use difficult to assess.

The consumptive-use coefficients compiled in this report were determined by three techniques:

- The first technique is to find references listing a consumptive-use coefficient, identified by "coefficient" in the "Coefficient or other" column in the water-use category summary tables. The summary tables are explained in figure 7. Coefficients listed as ratios rather than percentages are multiplied by 100 for presentation in this report. In many references, this coefficient was used to estimate consumptive use by multiplying it by total withdrawals of a geographic area. The origins of the consumptive-use coefficients or data (withdrawals, consumptive use, and (or) return flow) were not always known or reported by the author(s). If the author referenced another source, that source is listed in the annotated bibliography. Some of these coefficients were derived in consumptive-use studies, whereas other coefficients were assumed in order to calculate consumptive use. References with consumptive-use analysis are discussed in more detail in the water-use categories sections of this report.

- The second technique uses references listing withdrawal data and consumption data, indicated by a "CW" in the "Coefficient or other" column in the water-use category summary tables in this report (fig. 7). From those data, a consumptive-use coefficient is computed using the following equation:

$$\textit{Consumptive-use coefficient}\ (\%) = (\textit{Water consumed} \div \textit{Water withdrawn}) \times 100 \quad (3)$$

- The third technique uses references having withdrawal and return flow data for self-supplied facilities indicated by a "RW" in the "Coefficient or other" column in the water-use category summary tables in this report (fig. 7). This technique was not used for public-supply facilities because of the complexities of service areas, unaccounted-for use, and inflows and infiltration. For the withdrawal and return-flow data for self-supplied facilities, a consumptive-use coefficient was computed by use of the following equation:

$$\textit{Consumptive-use coefficient}\ (\%) = [(\textit{Water withdrawn} - \textit{Water returned}) \div \textit{Water withdrawn}] \times 100 \quad (4)$$

In the water-use category summary tables, each reference is listed as one of the following:

- A **primary source** indicates the authors of the referenced work did most of the compilation, analysis, and computation of data. Often the primary source publication was completed in cooperation with multiple agencies, but the publication was the main product for the multiple agency effort.

- A **secondary source** is a publication primarily completed by some other person or organization, but the data or consumptive-use coefficient was used to discuss or estimate consumptive use for the current report.

- An **unknown source** indicates the source of the coefficient or data was not described in the reference.

After references were annotated and the coefficients determined,

- the coefficients were organized by water-use category, domestic and public supply were compiled together for analytical purposes;

- coefficients were compiled in water-use category summary tables;

- summary statistics of the more recent consumptive-use coefficients were computed (**Minimum**, **maximum**, **25th percentile**, **75th percentile**, and **median** statistics were computed. The median and 25th and 75th percentiles are in this report because they are less affected by data outliers than other statistical measures (minimums, means, and maximums).);

- boxplots were prepared for data in each water-use category to show the distributional characteristics of consumptive-use coefficients;

- the number of consumptive-use coefficients used in the statistical computations (N), are noted in the water-use summary tables, the boxplots, and the summary tables by geographic area and water-use category; and

- summary statistics are tabulated for references with multiple coefficients (Statistics include minimum, median, maximum, 25th percentile and 75th percentile. Some reference series had multiple years of data and multiple coefficients for different geographic areas, each of which were compiled by different people using different methods. Each observation was considered independent by geographic location and by year of compilation and used in the statistical computation.).

Reference listed alphabetically by author and publication year(s). Detailed information about reference is in the annotated bibliography.

Water-use term used in the reference for public-supply or domestic water-use categories.

Geographic area defines the lakes, states, provinces, countries, continents, and the world for the consumptive coefficient information listed.

Coefficients are in percent. Coefficients for references with multiple coefficients are in the appendix.

The **single coefficient** is listed if a reference reported only one coefficient.

The **median coefficient** is listed if the reference reported multiple coefficients.

N is the number of coefficients used in computing the statistical values shown in summary statistics tables and boxplots.

Statistics area lists whether the geographic area is in the Great Lakes Basin, in climatically similar areas (Clim sim), or neither (Other).

Used in statistics indicates whether the coefficient(s) were used in the statistical analysis.

Coefficient or other lists if the coefficient was reported in the reference or if the coefficient was derived from consumptive-use and withdrawal data (CW) or return flow and withdrawal data (RW).

Data source lists whether the coefficient was computed from data or through analysis (Primary), from another source (Secondary), or from a source that was not noted in the reference (Unknown).

Reference	Water-use term	Geographic area	Single coefficient	Median coefficient	N	Statistics area	Used in statistics	Coefficient or other	Data source
Barlow, 2003[1]	Domestic use	Rhode Island, Massachusetts	15		1	Clim sim	Yes	Coefficient	Secondary
Brill and others, 1977	Municipal water consumption	Illinois, Indiana, Kentucky, and Ohio	20		-	Clim sim	No	Coefficient	Primary
College of Exploration, 2006	Domestic	World	17		-	Other	No	CW	Unknown
Cosgrove and Rijsberman, 2000	Municipal water use	World							
1900			25		-	Other	No	CW	Secondary
1950			17		-	Other	No	CW	Secondary
1995			14		-	Other	No	CW	Secondary
Delaware River Basin Commission, 2005	Public-water-supply facilities	Delaware River Basin (Pennsylvania, Delaware, New Jersey)	10		1	Clim sim	Yes	Coefficient	Primary
Endreny, 2004	Domestic	New York	5		1	Great Lakes	Yes	CW	Secondary
European Environmental Agency, 2005	Domestic	Europe	20		-	Other	No	Coefficient	Primary
Great Lakes Commission, Annual Reports, 1998-2002[1]	Self-supply domestic	Great Lakes Basin		11	50	Great Lakes	Yes	CW	Secondary
	Public supply			10	45	Great Lakes	Yes	CW	Secondary
Government of Canada and the U.S. Environmental Protection Agency, 1995	Municipal	By Country and Great Lake							
		Canada, Lake Superior	25		1	Great Lakes	Yes	CW	Secondary
		Canada, Lake Huron	17		1	Great Lakes	Yes	CW	Secondary
		Canada, Lake Erie	16		1	Great Lakes	Yes	CW	Secondary
		Canada, Lake Ontario	15		1	Great Lakes	Yes	CW	Secondary
		United States, Lake Superior	14		1	Great Lakes	Yes	CW	Secondary
		United States, Lake Michigan	6		1	Great Lakes	Yes	CW	Secondary
		United States, Lake Huron	55		1	Great Lakes	Yes	CW	Secondary
		United States, Lake Erie	10		1	Great Lakes	Yes	CW	Secondary
		United States, Lake Ontario	18		1	Great Lakes	Yes	CW	Secondary
Horn and others, 1994	Domestic	Rhode Island	15		1	Clim sim	Yes	Coefficient	Secondary
Horn, 2000	Domestic	Massachusetts	15		1	Clim sim	Yes	Coefficient	Primary
Hutson, 1998	Domestic	Tennessee	10		1	Clim sim	Yes	CW	Primary
Hutson, and others, 2004	Public supply	Tennessee	43		1	Clim sim	Yes	RW	Primary

Figure 7. Schematic of the summary tables of consumptive-use coefficients for the Great Lakes Basin, climatically similar areas, and the world.

Consumptive-Use Coefficients by Water-Use Category

The four water-use categories with the largest water withdrawals for the United States part of the Great Lakes in 1995 were (in decreasing order) thermoelectric, industrial, domestic and public supply, and commercial (table 7, fig. 8). However, the largest consumptive-use categories were industrial, thermoelectric, irrigation, and domestic and public supply (fig. 8). These four largest consumptive-use categories accounted for 89 percent of the total consumptive use for the U.S. part of the Great Lakes Basin (Solley and others, 1998) but differed in consumptive-use coefficients.

In comparison, the Great Lakes Commission (GLC) (2005a) compiled water-use and consumptive-use data for both the U.S. and Canadian parts of the Great Lakes Basin in 2002 (table 8, fig. 8). The Great Lakes Commission (2005a) and Solley and others (1998) did not define water-use categories identically. The Great Lakes Commission (2005a) included the mining and commercial categories as part of other water-use categories, whereas the USGS (Solley and others, 1998) considered them individual categories. The Great Lakes Commission (2005a) reported separate withdrawals and consumptive use for both the self-supplied domestic and public-supply categories whereas Solley and others (1998) reported only the consumptive use for self-supplied domestic and publicly-supplied domestic water combined. Even with these differences, the same four water-use categories were highest in consumptive use, but their rankings differed (fig. 8). These four categories for the GLC represented 95 percent of the total consumptive use (mining was included in industrial).

Table 7. Water use and consumptive use in the U.S. part of the Great Lakes Basin in 1995.

[Modified from Solley and others (1998). Withdrawals and deliveries and consumptive use are in million gallons per day. Consumptive-use coefficients are in percentage of withdrawal and are rounded]

Water-use category	Withdrawals and deliveries	Consumptive use	Consumptive-use coefficient
Industrial	4,950	436	9
Thermoelectric power	22,800	429	2
Irrigation	315	295	94
Domestic	1,760	248	14
Commercial	752	82	11
Livestock	70	55	79
Mining	398	37	9

Table 8. Water use and consumptive use in the Great Lakes Basin in the United States and Canada, 2002.

[Modified from Great Lakes Commission (2005a). Withdrawals and consumptive use are in million gallons per day. Consumptive-use coefficients are in percent and are rounded. Self-supplied domestic and public-supply data are combined in one category]

Water-use category[1]	Total withdrawals	Consumptive use	Consumptive-use coefficient
Public supply and domestic	6,450	660	10
Thermoelectric power	30,820	390	1
Irrigation	510	380	94
Industrial	4,380	370	8
Livestock	140	90	64

[1] The Great Lakes Commission document does not include mining or commercial as independent water-use categories. Mining is included in industrial. Commercial facilities, depending on the facility, could be under multiple water-use categories, the most likely of which is public supply or self-supplied domestic. Also, the domestic, thermoelectric power, irrigation, industrial, and livestock categories are only from self-supplied facilities, and the public-supply category includes all the withdrawals regardless of how the water is being used (domestic, commercial, industrial, etc.).

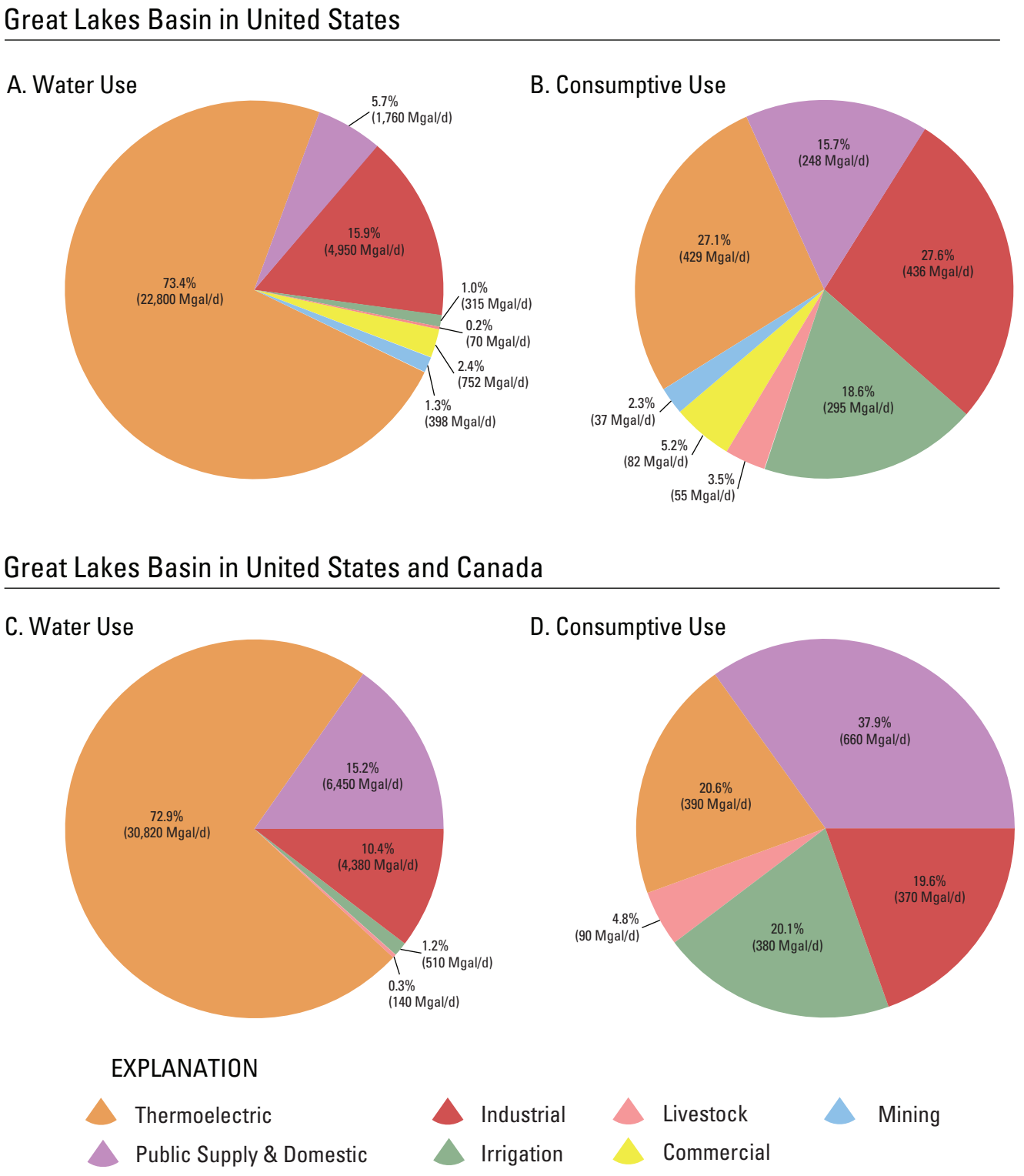


Figure 8. *A*, Water use, and *B* consumptive use in the United States part of the Great Lakes Basin in 1995 (adapted from Solley and others, 1998). *C*, Water use, and *D* consumptive use in the United States and Canadian parts of the Great Lakes Basin in 2002 (adapted from the Great Lakes Commission, 2005). Category percentages may not add to 100 percent because of independent rounding; Mgal/d, million gallons per day.

As evident from tables 7 and 8, consumptive-use coefficients ranged from 1 to 94 percent, depending on the water-use category. Although the consumptive-use coefficients varied widely between water-use categories, the coefficients were similar within water-use categories for Solley and others (1998) and the GLC (2005) (irrigation, both 94 percent; industrial, 9 and 8 percent; thermoelectric power, 2 and 1 percent; domestic, 14 and 10 percent (tables 7 and 8)). Because consumptive-use coefficients were similar within water-use categories, the references were compiled and summarized by water-use category. The water-use category coefficients in more recent references are statistically summarized by four groups in table 9:

- The **Great Lakes Basin** includes the eight U.S. states and two Canadian provinces that are either all or partly in the Great Lakes Basin. Data also may be included for areas in the eight states and two provinces but outside the Great Lakes Basin (fig. 1).
- **Climatically similar areas** are basins and states that have climates similar to the Great Lakes Basin (figs. 2 and 4).
- **Great Lakes Basin and climatically similar areas** combined include the data for Great Lakes Basin references and the climatically similar area references together (figs. 1, 2, and 4).
- **World** represents single coefficients that have worldwide applicability for particular water-use categories.

Table 9. Consumptive-use coefficient statistics for water-use categories for the Great Lakes Basin, climatically similar areas, and the world.

[Great Lakes Basin refers to basins, parts of states, and states in the Great Lakes Basin. Climatically similar areas are basins and states that are climatically similar in the Great Lakes Basin but not in the Great Lakes Basin. Great Lakes and climatically similar references are the combination of references from these two areas. References are only from publications after either 1975 (mining and commercial), 1980 (industrial, irrigation, thermoelectric, livestock), or 1985 (domestic and public supply) and do not include all the Canada coefficients, all the United States coefficients, or continent coefficients because these include areas that are not climatically similar to the Great Lakes. Minimum (min), median, maximum (max), the 25th percentile, and the 75th percentile are in percent. N is the number of references used in the statistical analysis]

Water-use category	Statistics					
	Min	25th	Median	75th	Max	N
Great Lakes Basin						
Domestic and Public Supply	0	**10**	**12**	**15**	74	161
Industrial	0	**7**	**10**	**14**	35	122
Thermoelectric Power	0	**1**	**2**	**2**	21	141
Irrigation	70	**90**	**90**	**96**	100	95
Livestock	0[1]	**80**	**83**	**90**	100	85
Commercial	4	**8**	**10**	**15**	26	29
Mining	0	**7**	**10**	**25**	58	58
Climatically similar areas						
Domestic and Public Supply	6	**10**	**15**	**20**	70	68
Industrial	0	**4**	**10**	**13**	34	97
Thermoelectric Power	0	**0**	**2**	**4**	75	75
Irrigation	37	**90**	**100**	**100**	100	75
Livestock[2]	10[2]	**86**	**100**	**100**	100	73
Commercial	3	**8**	**10**	**13**	33	61
Mining	0	**10**	**14**	**20**	86	83
Great Lakes Basin and climatically similar areas						
Domestic and public supply	0	**10**	**13**	**15**	74	229
Industrial	0	**6**	**10**	**13**	35	219
Thermoelectric power	0	**1**	**2**	**3**	75	216
Irrigation	37	**90**	**91**	**100**	100	170
Livestock[1,2]	0[1,2]	**80**	**90**	**100**	100	158
Commercial	3	**8**	**10**	**13**	33	90
Mining	0	**8**	**13**	**22**	86	141
World						
Domestic and public supply	14	**16**	**16**	**18**	19	4
Industrial	9	**10**	**10**	**11**	11	4
Agriculture	65	**65**	**68**	**72**	78	4

[1] The livestock low coefficient minimum (0 percent) is from Great Lakes Commission (2005a) in which Minnesota reported 0.25 Mgal/d total withdrawn in 1998 and 0.0 Mgal/d consumptive use. The next lowest coefficient for the Great Lakes Basin was 66 percent.

[2] The livestock low minimum coefficients are from Solley and others (1988) and may be the result of their adding animal specialties, including fish farming, into the livestock water-use category. In previous and subsequent USGS reports, fish farming was in different water-use categories.

Domestic and Public Supply

The USGS defines public-supply water use as water withdrawn by private and public water suppliers and delivered to customers who, in turn, use the water for purposes such as **domestic**, commercial, thermoelectric power, industrial, and public water use (Solley and others, 1998). Self-supplied **domestic water use** is water used for drinking, bathing, food preparation, washing clothes and dishes, flushing toilets, and watering lawns and gardens that is not obtained from a public-supply facility (Solley and others, 1998). Domestic consumptive use occurs primarily during outdoor watering of lawns and gardens, sidewalk and car washing, filling and maintaining pools, and to a lesser extent, during indoor cooking, cleaning, showering, and clothes washing (Marilee Horn, U.S. Geological Survey, written commun. February, 2007).

Domestic and public-supply consumptive-use coefficients are grouped because references in the annotated bibliography used a variety of terms for the domestic and public-supply categories (municipal, domestic, self-supplied domestic and public supply, among others). For example, some references reported one consumptive-use coefficient for domestic use, whereas others reported two (self-supplied and publicly supplied domestic). It was not always clear whether the single coefficient was for self-supplied domestic use, publicly supplied domestic use, all public-supply use (including other categories such as industrial and commercial), or a combination of all three.

Self-supplied domestic ground-water use can include consumptive uses like swimming pools.

The ambiguity of the terms "public supply" and "municipal water use" also made it difficult to separate categories. These terms are sometimes defined as just the domestic portion of the public-supplied water use, and sometimes as all categories that public suppliers might serve: domestic, commercial, thermoelectric power, industrial, agriculture, and public water use.

A few publications in a series grouped or split the water-use or consumptive-use categories differently between editions, making compilation for this report difficult. Specifically, in 1985, the USGS changed the aggregation of the public-supply and domestic water-use categories: "consumptive use" was changed to include consumptive use from both the self-supplied domestic withdrawals and the publicly supplied domestic deliveries (Solley and others, 1998). Therefore, because of these changes, only USGS references from 1985 to the present are used in the statistical summary (table 9) for the domestic and public-supply category.

Figure 7 and table 10 were created to help readers navigate through the water-use category summary tables like table 11, which lists the domestic water-use terminology used in each reference.

Table 10. Summary-table terms and descriptions.

Reference	Description
Coefficient	Term used to identify consumptive-use coefficients that were found in references as coefficients or ratios.
CW	References that list withdrawal data and consumption data and for which a consumptive-use coefficient was computed from the equation (coefficient = (consumptive use/ water withdrawal) x 100).
RW	References that list withdrawal and return flow data for self-supplied facilities (or a group of self-supplied facilities) and for which a consumptive-use coefficient was computed from the following equation (coefficient =((water withdrawn – water returned)/ water withdrawn) x 100).
Primary source	A primary source indicates the authors of the referenced work did most of the compilation, analysis, and computation of data. Often the primary-source publication was completed in cooperation with multiple agencies, but the publication was the main product for the multiple-agency effort.
Secondary source	A secondary source is a publication that was primarily completed by some other person or organization, but the data or consumptive-use coefficient was used to discuss or estimate consumptive use for the current report.
Unknown source	An unknown source indicates that the source of the coefficient or data was not described in the reference.
Clim Sim	Refers to Connecticut, Delaware, Iowa, Kentucky, Maine, Maryland, Massachusetts, Missouri, New Hampshire, New Jersey, Rhode Island, Tennessee, Vermont, Virginia, West Virginia, or other study areas climatically similar to the Great Lakes Basin.
Great Lakes	Refers to states, jurisdictions, or study areas that are fully or partly in the Great Lakes Basin.
Other	Refers to references that do not discuss the Great Lakes Basin or climatically similar areas: often used for world or large-country coefficients.

Table 11. Summary of domestic and public-supply consumptive-use coefficients for the Great Lakes Basin, climatically similar areas, and the world.

[See fig. 7 and table 10 for explanation of column headings. All computed numbers are rounded to the whole number, and reported numbers are as listed in reference.]

Reference	Water-use term	Geographic area	Single coefficient	Median coefficient	N	Statistics area	Used in statistics	Coefficient or other	Data source
Barlow, 2003[1]	Domestic use	Rhode Island, Massachusetts	15		1	Clim sim	Yes	Coefficient	Secondary
Brill and others, 1977	Municipal water consumption	Illinois, Indiana, Kentucky, and Ohio	20		-	Clim sim	No	Coefficient	Primary
College of Exploration, [n.d.]	Domestic	World	17		-	Other	No	CW	Unknown
Cosgrove and Rijsberman, 2000	Municipal water use	World							
1900			25		-	Other	No	CW	Secondary
1950			17		-	Other	No	CW	Secondary
1995			14		-	Other	No	CW	Secondary
Delaware River Basin Commission, [n.d]	Public water-supply facilities	Delaware River Basin (Pennsylvania, Delaware, New Jersey)	10		1	Clim sim	Yes	Coefficient	Primary
Endreny, 2005	Domestic	New York	5		1	Great Lakes	Yes	CW	Secondary
European Environment Agency, 2005	Domestic	Europe	20		-	Other	No	Coefficient	Primary
Great Lakes Commission, 2005a	Self-supply domestic	Great Lakes Basin		11	50	Great Lakes	Yes	CW	Secondary
	Public supply			10	45	Great Lakes	Yes	CW	Secondary
Government of Canada and the U.S. Environmental Protection Agency, 1995	Municipal	Great Lakes:							
		Canada, Lake Superior	25		1	Great Lakes	Yes	CW	Secondary
		Canada, Lake Huron	17		1	Great Lakes	Yes	CW	Secondary
		Canada, Lake Erie	16		1	Great Lakes	Yes	CW	Secondary
		Canada, Lake Ontario	15		1	Great Lakes	Yes	CW	Secondary
		United States, L. Superior	14		1	Great Lakes	Yes	CW	Secondary
		United States, L. Michigan	6		1	Great Lakes	Yes	CW	Secondary
		United States, L. Huron	55		1	Great Lakes	Yes	CW	Secondary
		United States, L. Erie	10		1	Great Lakes	Yes	CW	Secondary
		United States, L. Ontario	18		1	Great Lakes	Yes	CW	Secondary
Horn and others, 1994	Domestic	Rhode Island	15		1	Clim sim	Yes	Coefficient	Secondary
Horn, 2000	Domestic	Massachusetts	15		1	Clim sim	Yes	Coefficient	Primary
Hutson, 1998	Domestic	Tennessee	10		1	Clim sim	Yes	CW	Primary
Hutson and others, 2004b	Public supply	Tennessee	43		1	Clim sim	Yes	RW	Primary
International Great Lakes Diversions and Consumptive Use Study Board, 1981a, b[2]	Municipal water consumption		20		1	Great Lakes	Yes	Coefficient	Primary
	Rural residential		60		1	Great Lakes	Yes	Coefficient	Primary
Kay, 2002[3]	Rural domestic	By state:							
		Kentucky	10-15		-	Clim sim	No	CW	Secondary
		Indiana	10-15		-	Great Lakes	No	CW	Secondary
		Michigan	10-15		-	Great Lakes	No	CW	Secondary
		Iowa	40		-	Clim sim	No	CW	Secondary
		Missouri	25		-	Clim sim	No	CW	Secondary
		Illinois	10		-	Great Lakes	No	CW	Secondary
		Wisconsin	20		-	Great Lakes	No	CW	Secondary
LaTour, 1991[4]	Domestic	Illinois	6		-	Great Lakes	No	Coefficient	Primary
Loper and others, 1989	Public supply	Pennsylvania	10		1	Great Lakes	Yes	Coefficient	Secondary
	Self-supplied domestic use		10		1	Great Lakes	Yes	Coefficient	Secondary
Ludlow and Gast, 2000	Public supply	Pennsylvania	37		1	Great Lakes	Yes	CW	Primary
	Domestic		10		1	Great Lakes	Yes	CW	Primary
Marcuello and Lallana, 2003[5]	Urban use	Europe	20		-	Other	No	Coefficient	Secondary

Table 11. Summary of domestic and public-supply consumptive-use coefficients for the Great Lakes Basin, climatically similar areas, and the world. —Continued

[See fig. 7 and table 10 for explanation of column headings. All computed numbers are rounded to the whole number, and reported numbers are as listed in reference.]

Reference	Water-use term	Geographic area	Single coefficient	Median coefficient	N	Statistics area	Used in statistics	Coefficient or other	Data source
Medalie, 1996	Domestic use	New England	14		1	Clim sim	Yes	Coefficient	Secondary
Mullaney, 2004	Public supply	Connecticut, New York	20		1	Clim sim	Yes	Coefficient	Primary
Nawyn, 1997[6]	By category	New Jersey							
By category:									
Public-supply deliveries									
Domestic			18		1	Clim sim	Yes	Coefficient	Secondary
Commercial			4		-	Clim sim	No	Coefficient	Secondary
Industrial			8		-	Clim sim	No	Coefficient	Secondary
Public water use			20		-	Clim sim	No	Coefficient	Secondary
Self-supply withdrawals									
Domestic			20		1	Clim sim	Yes	Coefficient	Secondary
Nimiroski and Wild, 2005	Domestic, publicly supplied	Rhode Island	15		1	Clim sim	Yes	Coefficient	Secondary
	Domestic, self-supplied		15		1	Clim sim	Yes	Coefficient	Secondary
Ohlsson, 1997	Domestic	World	17		-	other	No	Coefficient	Secondary
Paulson and others, 1988	Domestic	United States	19.5		-	other	No	Coefficient	Secondary
Pebbles, 2003b	Self-supply domestic	By state and province:							
Self-supply domestic		Illinois	10-15[7]		1	Great Lakes	Yes	Coefficient	Secondary
		Indiana	15		1	Great Lakes	Yes	Coefficient	Secondary
		Michigan	10-15[7]		1	Great Lakes	Yes	Coefficient	Secondary
		Minnesota	10-15[7]		1	Great Lakes	Yes	Coefficient	Secondary
		New York	10		1	Great Lakes	Yes	Coefficient	Secondary
		Ohio	10-15[7]		1	Great Lakes	Yes	Coefficient	Secondary
		Ontario	15		1	Great Lakes	Yes	Coefficient	Secondary
		Pennsylvania	10		1	Great Lakes	Yes	Coefficient	Secondary
		Quebec	10-15[7]		1	Great Lakes	Yes	Coefficient	Secondary
		Wisconsin	10-15[7]		1	Great Lakes	Yes	Coefficient	Secondary
Public supply	Public supply								
		Illinois	10-15[7]		1	Great Lakes	Yes	Coefficient	Secondary
		Indiana	15		1	Great Lakes	Yes	Coefficient	Secondary
		Michigan	10-15[7]		1	Great Lakes	Yes	Coefficient	Secondary
		Minnesota	10-15[7]		1	Great Lakes	Yes	Coefficient	Secondary
		New York	10		1	Great Lakes	Yes	Coefficient	Secondary
		Ohio	10-15[7]		1	Great Lakes	Yes	Coefficient	Secondary
		Ontario	15		1	Great Lakes	Yes	Coefficient	Secondary
		Pennsylvania	10		1	Great Lakes	Yes	Coefficient	Secondary
		Quebec	10-15[7]		1	Great Lakes	Yes	Coefficient	Secondary
		Wisconsin	10-15[7]		1	Great Lakes	Yes	Coefficient	Secondary
Pennsylvania Department of Environmental Resources, 1975-83	Municipal	Pennsylvania	10		-	Great Lakes	No	Coefficient	Primary
Postel, 1996	Municipalities	World	17		-	Other	No	CW	Secondary
Postel and others, 1996	Municipalities	World	17		-	Other	No	CW	Primary
Shiklomanov and Rodda, 2003	Domestic	Europe	12		-	Other	No	CW	Primary
		World, 1995	19		-	Other	No	CW	Primary
		World, 1900 - 1995	22		-	Other	No	CW	Secondary
Sholar and Lee, 1988	Domestic	Kentucky	26		1	Clim sim	Yes	CW	Primary
		Kentucky River Basin	38		-	Clim sim	No	CW	Primary
Sholar and Wood, 1995	Domestic	Kentucky	18		1	Clim sim	Yes	CW	Primary
Snavely, 1987	Domestic use	Great Lakes	26		1	Great Lakes	Yes	Coefficient	Secondary

Table 11. Summary of domestic and public-supply consumptive-use coefficients for the Great Lakes Basin, climatically similar areas, and the world. —Continued

[See fig. 7 and table 10 for explanation of column headings. All computed numbers are rounded to the whole number, and reported numbers are as listed in reference.]

Reference	Water-use term	Geographic area	Single coefficient	Median coefficient	N	Statistics area	Used in statistics	Coefficient or other	Data source
Snavely, 1988[8]:		Great Lakes							
Domestic	Domestic								
		1975 Study Board	60		-	Great Lakes	No	CW	Secondary
		1975 USGS	21		-	Great Lakes	No	CW	Secondary
		1980 Study Board	64		-	Great Lakes	No	CW	Secondary
		1980 USGS	27		-	Great Lakes	No	CW	Secondary
		1985 Study Board	62		1	Great Lakes	Yes	CW	Secondary
		1985 USGS	74		1	Great Lakes	Yes	CW	Secondary
Public supply	Public supply								
		1975 Study Board	11		-	Great Lakes	No	CW	Secondary
		1975 USGS	13		-	Great Lakes	No	CW	Secondary
		1980 Study Board	11		-	Great Lakes	No	CW	Secondary
		1980 USGS	8		-	Great Lakes	No	CW	Secondary
		1985 Study Board	11		1	Great Lakes	Yes	CW	Secondary
		1985 USGS	--		-	Great Lakes	No	CW	Secondary
Sweat and Van Til, 1988	Public supply	Michigan	10		1	Great Lakes	Yes	CW	Secondary
Tate and Harris, 1999a	Municipal	Canadian part of Great Lakes Basin	20		1	Great Lakes	Yes	Coefficient	Secondary
U.S. Department of Agriculture, 1994	Public and rural supplies	United States	17		-	Other	No	Coefficient	Secondary
U.S. Department of Agriculture, 1997	Public and rural supplies	United States	17		-	Other	No	Coefficient	Secondary
U.S. Department of Agriculture, 2003	Public and rural supplies	United States	17		-	Other	No	Coefficient	Secondary
USGS Circulars, 1988, 1993, 1998[9]:	Domestic water use (includes publicly and self-supplied)	By state:							
		Great Lakes States		14	24	Great Lakes	Yes	CW	Secondary
		Climatically similar states		15	48	Clim sim	Yes	CW	Secondary
		By basin or region:							
		Great Lake		14	-	Great Lakes	No	CW	Secondary
		Mid-Atlantic		11	-	Clim Sim	No	CW	Secondary
		New England		16	-	Clim Sim	No	CW	Secondary
		Ohio		14	-	Clim Sim	No	CW	Secondary
		Tennessee		15	-	Clim Sim	No	CW	Secondary
		Upper Mississippi		21	-	Clim sim	No	CW	Secondary
USGS and Tennessee Department of Environment and Conservation, 2003	Domestic and public losses	Tennessee	24		1	Clim sim	Yes	Coefficient	Primary
Veeger and others, 2003	Domestic	Rhode Island	15		1	Clim Sim	Yes	Coefficient	Secondary
Water Resources Council (U.S), 1978[10]	Domestic	By region or basin:							
		New England	15		-	Clim Sim	No	CW	Secondary
		Mid-Atlantic	18		-	Clim Sim	No	CW	Secondary
		Great Lakes	15		-	Great Lakes	No	CW	Secondary
		Ohio	19		-	Clim Sim	No	CW	Secondary
		Tennessee	22		-	Clim sim	No	CW	Secondary
		Upper Mississippi	19		-	Clim sim	No	CW	Secondary
	Domestic, central	New England	9		-	Clim Sim	No	CW	Secondary
		Mid-Atlantic	14		-	Clim Sim	No	CW	Secondary
		Great Lakes	10		-	Great Lakes	No	CW	Secondary
		Ohio	11		-	Clim Sim	No	CW	Secondary
		Tennessee	12		-	Clim sim	No	CW	Secondary
		Upper Mississippi	14		-	Clim sim	No	CW	Secondary
	Domestic, non-central	New England	61		-	Clim Sim	No	CW	Secondary
		Mid-Atlantic	61		-	Clim Sim	No	CW	Secondary
		Great Lakes	61		-	Great Lakes	No	CW	Secondary
		Ohio	62		-	Clim Sim	No	CW	Secondary
		Tennessee	62		-	Clim sim	No	CW	Secondary
		Upper Mississippi	61		-	Clim sim	No	CW	Secondary

Table 11. Summary of domestic and public-supply consumptive-use coefficients for the Great Lakes Basin, climatically similar areas, and the world. —Continued

[See fig. 7 and table 10 for explanation of column headings. All computed numbers are rounded to the whole number, and reported numbers are as listed in reference.]

Reference	Water-use term	Geographic area	Single coefficient	Median coefficient	N	Statistics area	Used in statistics	Coefficient or other	Data source
Wild and Nimiroski, 2004	Domestic, publicly supplied	Rhode Island, Connecticut	9		1	Clim sim	Yes	Coefficient	Secondary
	Domestic, self-supplied		21		1	Clim sim	Yes	Coefficient	Secondary
Wild and Nimiroski, 2005	Domestic, publicly supplied	Rhode Island	6		1	Clim sim	Yes	Coefficient	Secondary
	Domestic, self-supplied		46		1	Clim sim	Yes	Coefficient	Secondary
Woldorf, 1959	Rural home	Ohio	3		-	Great Lakes	No	CW	Primary

[1] The consumptive-use coefficient is noted as "New England traditional rates."

[2] Two consumptive-use coefficients were listed; however, 20 percent was used in this report for statistical analysis. The other coefficient was the sum of 15 percent plus water uses and estimated losses.

[3] Numbers were estimated from a graph and were not used in the statistical analysis. The numbers were not tabulated in the report. In Solley and others (1998), it appears that these numbers are the total domestic freshwater consumptive use and withdrawals (includes self-supplied withdrawals and public-supply deliveries).

[4] LaTour found domestic consumptive-use coefficients ranging among specific areas but overall stated that domestic consumptive uses amounted to 6 percent ± 2 percent. This range was not used in the statistical analysis.

[5] Marcuello and Lallana (2003) said that the consumptive-use coefficients were "widely accepted."

[6] Nawyn (1997) stated that "coefficients of consumptive water use that were developed in other studies were modified and applied to data on water users in Camden County."

[7] For the summary statistics, the average of the consumptive-use coefficient range was used.

[8] The USGS 1975 and 1980 domestic consumptive-use coefficients were based on self-supplied water use only, whereas the 1985 consumptive-use coefficient represented both self-supplied and publicly supplied water use.

[9] The median numbers and numbers used to calculate statistics in the statistical summary are from appendix 1.

[10] Domestic central is from the U.S. Department of Interior (U.S. Geological Survey) and Water Resources Council. Domestic non-central is from the U.S. Department of Agriculture (formerly, Soil Conservation Service; currently National Resources Conservation Service).

With the exception of Hutson and others (2004b), the domestic and public-supply consumptive-use coefficients in table 11 are either **coefficients** or computed values from consumptive use and withdrawal data (*CW*). Direct measurement of consumptive use (withdrawals – return flow (*RW*)) may not work at the public supply/wastewater-discharge level for the following reasons:

- The customer base may not be the same. (For instance, a large municipal public supplier serves 100,000 people, but the municipal wastewater facility serves 125,000; the difference of 25,000 people results from a combination of small public supply facilities and private wells.)
- Withdrawals and discharges by individual facilities may be unequal. (A city has multiple large industrial facilities that use self-supplied water, but the facilities discharge large amounts of water into the municipal wastewater system.)
- Infiltration or inflows into the sewer pipes may be misinterpreted as return flow, thus making the consumptive use of the customers seem less than it is. (Water from surface runoff or through storm drains (termed "inflow") and ground water (infiltration) can be entering the wastewater system and making the return flow appear higher than it really is. Quantifying the proportion of inflow and infiltration can be difficult.)
- **Unaccounted-for use** (public uses and conveyance losses) may be unknown.

If the customer base of the public supplier and wastewater treatment plant are the same, any imports and exports are quantifiable; therefore withdrawals, return flow, infiltration, inflow, and unaccounted for water are known, and consumptive use can be computed from the following equation:

$$\textit{Consumptive use} = (\textit{Withdrawals} + \textit{Imports} + \textit{Infiltration} + \textit{Inflow}) - (\textit{Unaccounted-for water} + \textit{Exports} + \textit{Return flow}) \quad (5)$$

During the research for this study, several references were found that discussed unaccounted-for water (conveyance losses and public uses) in public-supply systems. Unaccounted-for water is important locally and at the facility level. In order to use the complex equation above, unaccounted-for water needs to be considered. As water becomes scarce and the cost of water increases, minimizing losses becomes more important to municipalities. Information about unaccounted-for water is given in tables 12 and 13.

Table 12. References that include discussions on unaccounted-for water (conveyance losses and public uses).

Reference	Discussion
Barlow, 2003	Barlow (2003) found that losses ranged from 0.007 to 0.944 Mgal/d in Rhode Island and Massachusetts; 62 percent of the water lost was from leakage, 12 percent in fighting fires, 6.4 percent because of major waterline breaks, and the remainder for a variety of other reasons.
Environment Canada, 2004	Environment Canada (2004) found that about 20 percent of total daily municipal water use in Canada is lost in the distribution system or is unaccounted for.
European Environment Agency, 2005	The European Environment Agency (2005) stated that reducing leakage rates in water-distribution systems has the greatest potential for saving water. Water losses (through leakage) accounted for more than a third of the withdrawals in some older cities in Europe. Although some of this water recharges ground water and can be pumped and used again, in other locations the water cannot be used again because the water beneath the city is too contaminated.
Hutson, 1998	Hutson (1998) found that, for public utilities in Tennessee, about 10 percent of the withdrawals was either used for public uses (parks, fire fighting, and municipal swimming pools) or lost in conveyance.
LaTour, 1991	LaTour (1991) noted that the national median for conveyance loss was 11 percent and that for most northern Illinois cities, public-supply conveyance loss ranged from 0.5 to 40.0 percent of public-supply withdrawals. LaTour (1991) also noted that the public-supply conveyance losses are affected by the age and the size of the public-supply conveyance systems and public-supply maintenance programs. Conveyance losses were 12 percent (Rockford, Ill. area) and 17 percent (Kankakee, Ill. area).
Nawyn, 1997	Using water-use reports from public-supply facilities in New Jersey Nawyn (1997) found that unaccounted-for water was 12 percent; however, because a loss reported by one public-supply facility was unusually high and skewed the average, 10 percent was used to estimate losses for facilities that did not submit a report in New Jersey.
Sholar, 1988	For Kentucky, Sholar (1988) noted that 10 percent of the public-supply deliveries was either lost in the distribution systems or was used for public uses such as firefighting.
Sholar and Wood, 1991	For the Kentucky River Basin, Sholar and Wood (1991) found that 21 percent of water was either lost in the distribution system or used in public uses such as firefighting.

Table 13. Selected state standards for unaccounted-for water (water losses).

[Modified from Beecher (2002). Standard is in percent.]

State[1]	Agency	Standard
Indiana	Department of Environmental Management	10 to 20
Kentucky	Department of Energy, Water and Sewer Branch	15
Massachusetts	Department of Environmental Protection	15
Minnesota	Department of Natural Resources	10
Missouri	Department of Natural Resources	10
Ohio	Public Utility Commission and Environmental Protection Agency	15
Pennsylvania	Public Utility Commission	10-15
Pennsylvania	Bureau of Water and Wastewater Management	10-15
Rhode Island	Water Resources Board	10-15
West Virginia	Public Service Commission	15
Wisconsin	Public Service Commission	15 (large) 25 (small)
Delaware River Basin Commission	Delaware River Basin Commission	15

[1] Original table included many states; only Great Lakes Basins states or climatically similar states are listed above. Delaware River Basin Commission is based on facilities in New Jersey, Pennsylvania, and Virginia.

LaTour (1991) noted that public-supply conveyance systems are under pressure and water is typically lost, not gained; but when conveyance systems are not adequately pressurized (for example when water-main breaks are being repaired), they may gain water. LaTour (1991) also estimated sewer-conveyance gains (inflow and infiltration) by determining the difference between sewage-treatment returns and releases, but he stated that unrecognized releases or significant meter errors could result in erroneous estimates. The sewer-conveyance gains for the Rockford and Kankakee, Ill., areas were 35 percent of the public-supply withdrawals.

Although many references were considered **primary sources**, only a few gave details about computing consumptive-use coefficients for domestic and public-supply categories. LaTour (1991) used three methods to derive consumptive-use ratios for domestic water use:

- types of use,
- maximum lawn-watering, and
- winter base-rate methods.

Of these three methods, LaTour concluded that the winter base-rate method was a reasonable means of estimating domestic consumptive use. The winter base-rate method focuses on outdoor water use (specifically, lawn watering), which LaTour assumed to make up most of domestic consumptive use. Outdoor water use is predominantly consumptive use because of evapotranspiration (LaTour, 1991). Other outdoor domestic water uses include landscape and garden irrigation, car washing, and swimming pool filling.

The winter-base rate method involves the following steps:

- Determine the winter base rate by averaging the domestic use during November through April. (During this time, outside water use is minimal in Illinois.)
- Calculate outside domestic water by subtracting the winter base rate from the domestic use for May through October,
- Multiply the outside domestic water use by 80 percent to determine consumptive use. (LaTour assumed that 80 percent of the water applied to lawns was domestic consumptive use due to evapotranspiration and whereas the remaining 20 percent was direct return to ground water.)

Mullaney (2004) using a method similar to the winter-base rate method, estimated consumptive use (outdoor water use) by subtracting the winter water-use data from the average daily water use.

Mullaney (2004) and LaTour (1991) are two of many references listed in table 11 and further described in the annotated bibliography. The coefficients noted as used in the statistics (table 11) were statistically analyzed as shown in table 9 and figure 9. The statistics (median, 25th and 75th percentiles) for the domestic and public-supply consumptive-use coefficients were similar for the Great Lakes Basin and climatically similar areas.

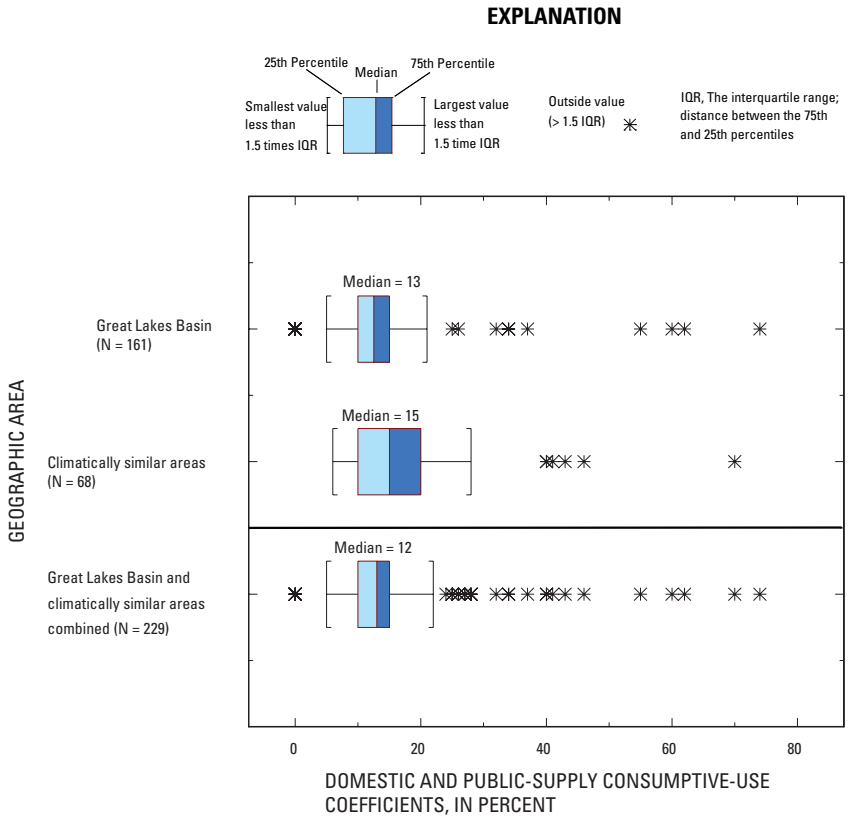


Figure 9. Distribution of domestic and public-supply consumptive-use coefficients for the Great Lakes Basin and climatically similar areas.

Table 14 lists summary statistics for references or groups of references that reported multiple domestic and public-supply coefficients from 1985 to 1995. An attempt was made in table 15 to subdivide the domestic and public-supply consumptive-use coefficients:

- Only coefficients that were used in the statistics in table 9 (noted in table 11 with "Yes" under the column heading "Used in statistics" or "N" equal to 1 (or more)) were used.
- Coefficients that used the water-use terms "rural residential," and "rural domestic" were not used.
- Any coefficients that were called "domestic-publicly supplied" were considered domestic coefficients.
- Coefficients with the water-use term "municipal" were considered "public supply."

For the domestic and public-supply consumptive-use-coefficient statistics listed in table 15, the 25th and 75th percentile were the same (10 and 15 percent), and the medians were similar (15 and 12).

Domestic consumptive-use coefficients for the Great Lakes States from two data sources are compared in figure 10. Coefficients for 1995 from Solley and others (1998) were calculated from the amount of water withdrawn and consumed for domestic use (CW) and are listed in Appendix table 1-1. Coefficients from Pebbles (2003b) were reported by state agencies for domestic and public-supply water use (often, a range was given). The coefficients from Pebbles (2003b) can be found in many other GLC documents and are listed in appendix table 3–1.

Solley and others (1998) reported data for the entire state, whereas the states included by Pebbles (2003b) reported coefficients for only the part of the state in the Great Lakes drainage basin. The range of coefficients from Solley and others (1998) was larger than that from Pebbles (2003b) but the medians were similar.

Table 14. Summary statistics of domestic and public-supply consumptive-use coefficients from Great Lakes Commission annual reports, 1998–2002 and USGS Circulars, 1988–98.

[Reference refers to the annotated-bibliography reference. The geographic area is defined by states or water-resources regions (or river basins). N is the number of coefficients used in the summary-statistics tables (tables 9 and 43) and shown in the boxplots. References with more than one coefficient are listed in the appendix. The minimum (min), 25th percentile, median, 75th percentile, and maximum (max) numbers are rounded to the nearest whole number.]

Reference	Domestic water-use term	Geographic area	N	Coefficient statistics				
				Min	25th	Median	75th	Max
Great Lakes Commission, 2005a	Public supply	Great Lakes States and Provinces	50	0	10	11	15	21
	Domestic		45	0	10	10	15	15
USGS Circulars, 1988, 1993, and 1998 Data from 1985, 1990, and 1995	Domestic water use (includes publicly supplied and self-supplied)	By state:						
		Great Lakes States	24	5	10	14	15	34
		Climatically similar states	48	10	10	15	20	70
		By river basin or region:						
		Great Lake	-	12	13	14	14	14
		Mid-Atlantic	-	9	10	11	12	13
		New England	-	14	15	16	21	26
		Ohio	-	13	14	14	14	15
		Tennessee	-	14	14	15	15	15
		Upper Mississippi	-	19	20	21	21	21

Table 15. Consumptive-use-coefficient statistics for domestic and public-supply water-use categories for the Great Lakes Basin and climatically similar areas.

[Great Lakes Basin and climatically similar references are the combination of references from these two areas. References are only from publications after 1985 (domestic and public supply) and do not include all Canada coefficients, all U.S. coefficients, or continent coefficients because they include areas that are not climatically similar to the Great Lakes Basin. Minimum (min), median, maximum (max), 25th percentile, and 75th percentile are in percent and rounded to the nearest whole number. N is the number of references used in the statistical analysis.]

Water-use category	Statistics					
	Min	25th	Median	75th	Max	N
Domestic	0	10	15	15	74	149
Public supply	0	10	12	15	55	78

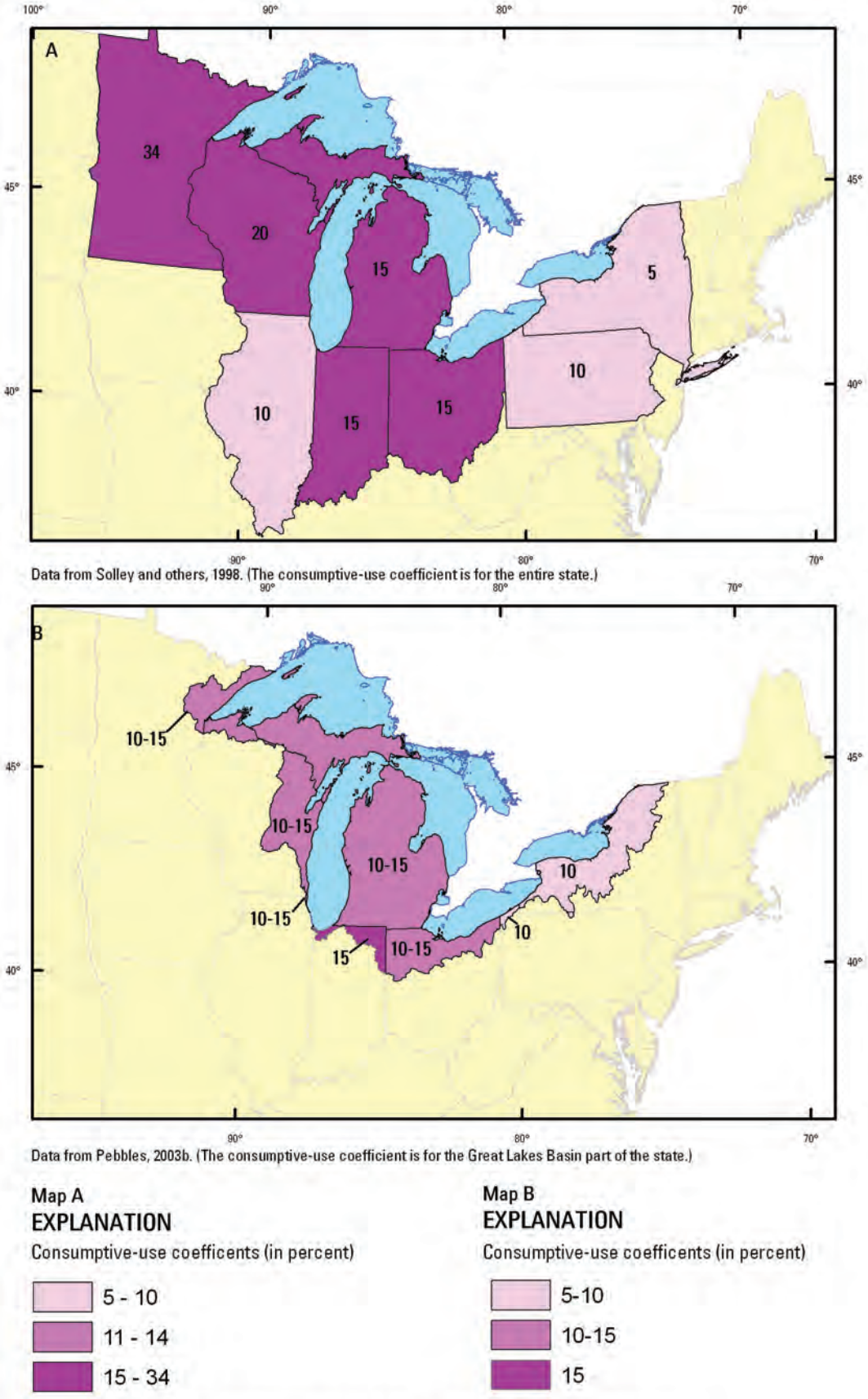


Figure 10. Domestic consumptive-use coefficients from various sources for the Great Lakes States.

Consumptive-use coefficients for the world, countries, and continents also are included in this report to serve as a basis for comparison by

- showing how comparable regional coefficients are to world and other regional coefficients,
- broadening the understanding of the coefficients (if definitions and use are similar), and
- showing whether climatic or economic factors may contribute to coefficients.

Shiklomanov and Rodda (2003) compiled domestic and public-supply consumptive-use coefficients for eight years of data between 1900 and 1995 (1900, 1940, 1950, 1960, 1970, 1980, 1990, 1995); these coefficients are listed in table 16 and grouped by continent. Units in table 16 and subsequent tables based on Shiklomanov and Rodda's work are in cubic kilometers per year, as reported in the original document. The derived consumptive-use coefficient is unitless and is comparable to coefficients derived from inch-pound units. From 1900 to 1995, the domestic and public supply consumptive-use coefficients ranged from 11 to 77 percent; in the 1995 assessment, the range was 12 to 68 percent. The maximum values (68 and 77) are listed for rural use for North America and may be describing a different type of water use than on the other continents. Rural use is self-supplied domestic use that may or may not include livestock water use. Most livestock withdrawals are considered consumed and not returned to the immediate environment. If the North America rural-use category is excluded and the public-supply category is used for North America, the range of consumptive-use coefficients is 11 to 67 percent for 1900 to 1995 and 12 to 19 for 1995 (Shiklomanov and Rodda, 2003). All the consumptive-use coefficients decreased from 1900 to 1980. Coefficients for 1990 and 1995 are very similar within a continent. The largest consumptive-use coefficients listed in table 16 are for the earliest assessments (1900), when less water was withdrawn. The water withdrawals for domestic and public supply have steadily increased over the last 95 years, but the consumptive-use coefficients have decreased. This decrease may be attributed to

- more water being returned to wastewater-treatment plants and then released, and
- more water being used (indoor plumbing, water technology is more widespread, or population increases), but consumptive use staying constant, decreasing, or increasing at a smaller rate than water use.

Additional consumptive-use coefficients for the world, continents, and major countries are listed in table 17. The domestic and public-supply water use and consumptive use for the world, continents, and major countries were examined to confirm that the definitions, "water use" and "consumptive use" were similar to those used for the Great Lakes Basin and that consumptive-use coefficients were therefore similar.

Table 18 lists water withdrawals, consumptive use, and consumptive-use coefficients by European regions for 1980, 1990 and 1995 (Shiklomanov and Rodda, 2003).

Table 16. Public-supply or domestic water withdrawals, consumptive use, and consumptive-use coefficients listed by continent, for selected years from 1900 through 1995.

[Modified from Shiklomanov and Rodda (2003). Total withdrawn and consumptive use are in cubic kilometers per year and are as listed in reference; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use figures and rounded to the nearest whole number.]

Statistic	1900	1940	1950	1960	1970	1980	1990	1995	1900–1995
Europe (Public supply)[1]									
Total withdrawn	8.5	12.7	15.6	21.0	33.7	58.5	67.1	69.9	287
Consumptive use	1.8	2.3	2.7	3.0	4.2	7.2	8.4	8.6	38.2
Coefficient	21	18	17	14	12	12	13	12	13
Asia (Domestic)[2]									
Total withdrawn	2	6	11	20	38	65	143	160	445
Consumptive use	1	3	5	9	14	18	29	31	110
Coefficient	50	50	45	45	37	28	20	19	25
Africa (Domestic)[3]									
Total withdrawn	.3	.7	1.3	3.1	5.8	11.4	12.8	17.2	52.6
Consumptive use	.2	.3	.5	.9	1.2	1.8	1.7	2.1	8.7
Coefficient	67	43	38	29	21	16	13	12	17
North America (Public supply)[4]									
Total withdrawn	4.8	-	22.0	33.0	44.0	56.3	67.1	72.5	299.7
Consumptive use	1.0	-	4.8	5.8	9.8	12.0	9.1	10.9	53.4
Coefficient	21	-	22	18	22	21	14	15	18
North America (Rural use)[4]									
Total withdrawn	3.5	-	6.1	7.3	9.6	12.4	16.8	17.7	73.4
Consumptive use	2.7	-	4.7	5.4	7.0	8.6	11.5	12.0	51.9
Coefficient	77		77	74	73	69	68	68	71
South America (Domestic)[5]									
Total withdrawn	.25	.8	1.9	4.4	6.9	12.4	28.1	32.6	87.35
Consumptive use	.14	.4	.7	1.2	1.5	2.5	4.9	5.3	16.64
Coefficient	56	50	37	27	22	20	17	16	19
Australia and Oceania (Public supply)[6]									
Total withdrawn	.14	.33	.75	1.10	1.50	2.80	3.10	3.30	13.02
Consumptive use	.03	.08	.16	.21	.25	.30	.36	.38	1.77
Coefficient	21	24	21	19	17	11	12	12	14
Total									
Total withdrawn	19.49	20.53	58.65	89.9	139.5	218.8	338	373.2	1,258.07
Consumptive use	6.87	6.08	18.56	25.51	37.95	50.4	64.96	70.28	280.61
Coefficient	35	30	32	28	27	23	19	19	22
Total without North America (Rural use)									
Total withdrawn	15.99	20.53	52.55	82.6	129.9	206.4	321.2	355.5	1,184.67
Consumptive use	4.17	6.08	13.86	20.11	30.95	41.8	53.46	58.28	228.71
Coefficient	26	30	26	24	24	20	17	16	19

[1] Shiklomanov and Rodda (2003; p. 85, from table 4.19).

[2] Ibid., p. 135, from table 5.25.

[3] Ibid., p. 192, from table 6.18.

[4] Ibid., p. 258, from table 7.22.

[5] Ibid., p. 316, from table 8.19.

[6] Ibid., p. 346, from table 9.21.

Table 17. Domestic and public-supply consumptive-use coefficients for major countries, continents, and the world.

[Coefficient is in percent and rounded to the nearest whole number]

Reference	Geographic area	Coefficient
College of Exploration [n.d]	World	17
Cosgrove and Rijsberman, 2000	World	14
European Environment Agency, 2005	Europe	20
Marcuello and Lallana, 2003	Europe	20
Postel and others, 1996	World	17
Shiklomanov and Rodda, 2003 (1995 assessment only)[1]	World	16
	By continent:	
	Europe	12
	Asia	19
	Africa	12
	N. America (public supply)	15
	N. America (public supply and domestic)	25
	S. America	16
	Australia and Oceania	12
Solley and others, 1998[2]	United States	26

[1] The world coefficient excludes North American rural domestic. If this included, the world consumptive-use coefficient is 19 percent, and the North America consumptive-use coefficient is 25 percent instead (22.9 divided by 90.2).

[2] Includes both self-supplied domestic and publicly supplied domestic.

Table 18. Public-supply water withdrawals, consumptive use, and consumptive-use coefficients listed by European regions for selected years from 1980 through 1995.

[Modified from Shiklomanov and Rodda (2003), page 88. Total withdrawn and consumptive use are in cubic kilometers per year and are as listed in reference; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use figures and rounded to the nearest whole number.]

Statistic	1980	1990	1995	1980–1995
Northern Europe				
Total withdrawn	2.72	2.98	3.01	8.71
Consumptive use	.22	.24	.22	.68
Coefficient	8	8	7	8
Central Europe				
Total withdrawn	21.9	25.1	26.5	73.5
Consumptive use	1.7	2.0	2.1	5.8
Coefficient	8	8	8	8
Southern Europe				
Total withdrawn	38.3	40.5	45.1	123.9
Consumptive use	3.1	2.8	2.9	8.8
Coefficient	8	7	6	7
Northern slope of European territory of former Soviet Union				
Total withdrawn	2.10	2.60	2.55	7.25
Consumptive use	.60	.60	.60	1.8
Coefficient	29	23	24	25
Southern slope of European territory of former Soviet Union				
Total withdrawn	11.8	14.7	14.7	41.2
Consumptive use	2.8	3.8	3.8	10.4
Coefficient	24	26	26	25
Total				
Total withdrawn	76.82	85.88	91.86	254.46
Consumptive use	8.42	9.44	9.62	27.48
Coefficient	11	11	10	11

Industrial

Industrial water use is water used for industrial fabrication, washing, processing, and cooling and includes industries such as chemical and allied products, paper and allied products, steel, and petroleum refining (Hutson and others, 2004a). Industrial consumptive use may occur through **product incorporation**, evaporation from cooling and heating processes, cleaning, and lawn watering.

Growing public awareness and concern for water pollution led to the Federal Water Pollution Control Act Amendments of 1972, amended in 1977 and otherwise known as Clean Water Act of 1977. This act established regulation of discharges of pollutants into the waters of the United States and brought changes to industrial facilities and their use of water (including consumptive use). As is evident from figure 11, the median industrial consumptive-use coefficients from **USGS circular reports** for the Great Lakes States and climatically similar states show how the industrial coefficients increased between 1970 and the 1990s. Because of the changes in data-collection methods (under the new USGS National Water-Use Information Program (NWUIP) authorized by Congress in 1977) and the possible changes caused by the Clean Water Act in how water was used in industrial facilities, only consumptive-use coefficients from the 1980s to the present were used to calculate the statistics used in this report.

The type of industrial facilities (defined by the Standard Industrial Classification (SIC) code or the North American Industrial Classification (NAICS) code), the geographic area, and the type of processes and equipment in an industrial facility all affect the amount of water consumed. Information on the consumptive use by major SIC codes are presented in the section "Industrial by major groups." This information shows the variance of the consumptive-use coefficient by major SIC codes in comparison to general industrial consumptive-use coefficients found in this section. Table 19 lists industrial consumptive-use coefficients not associated with a specific SIC code but rather, with a geographic area. These general industrial coefficients may be based on a mixture of industrial facility types (SIC codes), and these mixtures are not known.

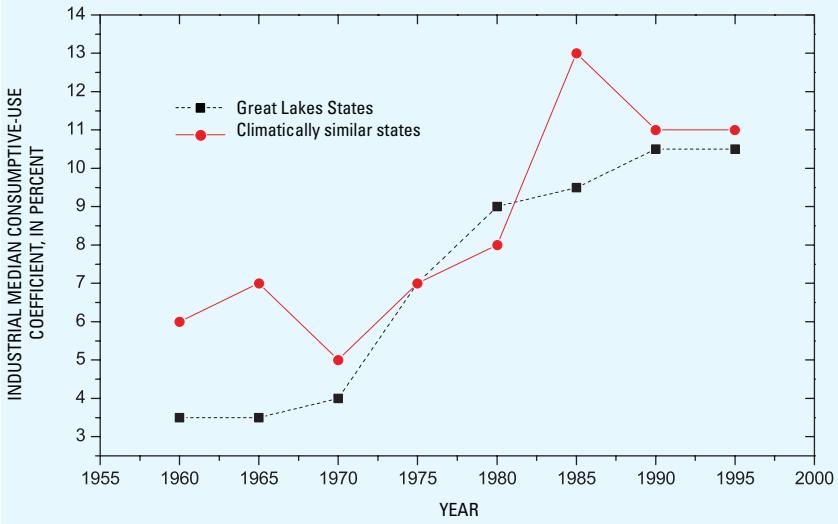


Figure 11. Median industrial consumptive-use coefficients for the Great Lakes States and climatically similar states from 1960 to 1995, from USGS Circulars.

Table 19. Summary of industrial consumptive-use coefficients for the Great Lakes Basin, climatically similar areas, and the world.

[See fig. 7 and table 10 for explanation of column headings. All computed numbers are rounded to the whole number, and reported numbers are as listed in reference.]

Reference	Geographic area	Single coefficient	Median coefficient	N	Statistics Area	Used in statistics	Coefficient or other	Data source
Barlow, 2003[1]	Rhode Island, Massachusetts	10		1	Clim sim	Yes	Coefficient	Secondary
Brill and others, 1977	Illinois, Indiana, Kentucky, Ohio	6		-	Clim sim	No	Coefficient	Primary
College of Exploration, [n.d]	World	9		-	Other	No	CW	Unknown
Cosgrove and Rijsberman, 2000	World	11		-	Other	No	CW	Secondary
Delaware River Basin Commission, [n.d]	Pennsylvania, Delaware, New Jersey	4[2]		1	Clim sim	Yes	CW	Primary
Ellefson and others, 1987	Wisconsin	20[3]		1	Great Lakes	Yes	Coefficient	Primary
		10[3]		1	Great Lakes	Yes	Coefficient	Primary
Endreny, 2005	New York	10		1	Great Lakes	Yes	Coefficient	Secondary
European Environment Agency, 2005	Europe	20		-	Other	No	Coefficient	Primary
Great Lakes Commission and U.S. Army Corps of Engineers, 1999	Great Lakes	10		1	Great Lakes	Yes	Coefficient	Primary
Great Lakes Commission, 2005a	Great Lakes		10	50	Great Lakes	Yes	CW	Secondary
Government of Canada and the U.S. Environmental Protection Agency, 1995	Great Lakes:							
	Canada, Lake Superior	2		1	Great Lakes	Yes	CW	Secondary
	Canada, Lake Huron	5		1	Great Lakes	Yes	CW	Secondary
	Canada, Lake Erie	4		1	Great Lakes	Yes	CW	Secondary
	Canada, Lake Ontario	4		1	Great Lakes	Yes	CW	Secondary
	United States, Lake Superior	15		1	Great Lakes	Yes	CW	Secondary
	United States, Lake Michigan	9		1	Great Lakes	Yes	CW	Secondary
	United States, Lake Huron	3		1	Great Lakes	Yes	CW	Secondary
	United States, Lake Erie	16		1	Great Lakes	Yes	CW	Secondary
	United States, Lake Ontario	8		1	Great Lakes	Yes	CW	Secondary
Horn and others, 1994	Rhode Island	4		1	Clim sim	Yes	Coefficient	Secondary
Horn, 2000	Massachusetts	10		1	Clim sim	Yes	Coefficient	Primary
Hutson, 1998	Tennessee	11		1	Clim sim	Yes	CW	Primary
Hutson and others, 2004b	Tennessee	22		1	Clim sim	Yes	RW	Primary
International Great Lakes Diversions and Consumptive Use Study Board,1981	Great Lakes	By SIC Code		-	Great Lakes	No	CW	Secondary
Kay, 2002	By state:							
	Kentucky	4		1	Clim sim	Yes	CW	Secondary
	Indiana	7		1	Great Lakes	Yes	CW	Secondary
	Michigan	7		1	Great Lakes	Yes	CW	Secondary
	Iowa	10		1	Clim sim	Yes	CW	Secondary
	Missouri	10		1	Clim sim	Yes	CW	Secondary
	Illinois	15		1	Great Lakes	Yes	CW	Secondary
	Wisconsin	15		1	Great Lakes	Yes	CW	Secondary
LaTour, 1991[4]	Illinois	12		1	Great Lakes	Yes	CW	Primary
		By SIC Code						
Loper and others, 1989	Pennsylvania	9[5]		1	Great Lakes	Yes	CW	Secondary
Ludlow and Gast, 2000	Pennsylvania	8		1	Great Lakes	Yes	CW	Primary
Marcuello and Lallana, 2003	Europe	20[6]		-	Other	No	Coefficient	Secondary
Nawyn, 1997	New Jersey	8[7]		1	Clim Sim	Yes	Coefficient	Secondary
Nimiroski and Wild, 2005	Rhode Island	10		1	Clim Sim	Yes	Coefficient	Secondary

Table 19. Summary of industrial consumptive-use coefficients for the Great Lakes Basin, climatically similar areas, and the world. —Continued

[See fig. 7 and table 10 for explanation of column headings. All computed numbers are rounded to the whole number, and reported numbers are as listed in reference.]

Reference	Geographic area	Single coefficient	Median coefficient	N	Statistics Area	Used in statistics	Coefficient or other	Data source
Ohlsson, 1997	World	9		-	Other	No	Coefficient	Secondary
Paulson and others, 1988	United States	16[8]		-	Other	No	Coefficient	Secondary
Pennsylvania Department of Environmental Resources, 1975–83	Pennsylvania		7.5	1	Great Lakes	Yes	CW	Primary
Pebbles, 2003b	By state/province:							
	Illinois	Varies[9]		-	Great Lakes	No	Coefficient	Secondary
	Indiana	6		1	Great Lakes	Yes	Coefficient	Secondary
	Michigan	10-15[10]		1	Great Lakes	Yes	Coefficient	Secondary
	Minnesota	Varies[9]		-	Great Lakes	No	Coefficient	Secondary
	New York	25		1	Great Lakes	Yes	Coefficient	Secondary
	Ohio	10		1	Great Lakes	Yes	Coefficient	Secondary
	Ohio (salt mining)	90		-	Great Lakes	No	Coefficient	Secondary
	Ontario	Varies[11]		-	Great Lakes	No	Coefficient	Secondary
	Pennsylvania	Varies[9]		-	Great Lakes	No	Coefficient	Secondary
	Quebec (pulp and paper industry)	10		-	Great Lakes	No	Coefficient	Secondary
	Wisconsin	10.2		1	Great Lakes	Yes	Coefficient	Secondary
Postel, 1996	World	10		-	Other	No	CW	Secondary
Postel and others, 1996	World	10		-	Other	No	CW	Primary
Sholar and Lee, 1988	Kentucky	4		1	Clim Sim	Yes	CW	Primary
Sholar and Wood, 1995	Kentucky	4		1	Clim Sim	Yes	CW	Primary
Shiklomanov and Rodda, 2003	World	Continents		-	Other	No	CW	Primary
	World, 1995	11		-	Other	No	CW	Primary
	World, 1900–1995	9		-	Other	No	CW	Primary
Snavely, 1987	Great Lakes	6.5		1	Great Lakes	Yes	Coefficient	Secondary
Snavely, 1988	Great Lakes							
	1975 Study Board	11		-	Great Lakes	No	CW	Secondary
	1975 USGS	6.5		-	Great Lakes	No	CW	Secondary
	1980 Study Board	13		1	Great Lakes	Yes	CW	Secondary
	1980 USGS	6.5		1	Great Lakes	Yes	CW	Secondary
	1985 Study Board	14		1	Great Lakes	Yes	CW	Secondary
	1985 USGS	9.4		1	Great Lakes	Yes	CW	Secondary
Suder and Lessing, 1984	West Virginia	4		1	Clim sim	Yes	CW	Secondary
Suder and Lessing, 1985	West Virginia	4		1	Clim sim	Yes	CW	Secondary
Suder and Lessing, 1986	West Virginia	3		1	Clim sim	Yes	CW	Secondary
Suder and Lessing, 1987	West Virginia	3		1	Clim sim	Yes	CW	Secondary
Sweat and Van Til, 1988	Michigan	10		1	Great Lakes	Yes	CW	Secondary
Tate, 1988	Canada:							
	1966 Manufacturing	4		-	Other	No	CW	Secondary
	1972 Manufacturing	4		-	Other	No	CW	Secondary
	1976 Manufacturing	5		-	Other	No	CW	Secondary
Tate and Harris, 1999a	Great Lakes Basin-Canada	5		1	Great Lakes	Yes	CW	Secondary
Todd, 1970	United States	By SIC Code		-	Other	No	Coefficient	Secondary
U.S. Business and Defense, 1967	United States	6.3		-	Other	No	RW	Secondary
U.S. Bureau of the Census, 1986		By SIC Code						
	1954–1983	8		-	Other	No	RW	Primary
	By state:			-	Other	No	RW	Primary
	1983 Great Lake States		10	8	Great Lakes	Yes	RW	Primary
	1983 Climatically Similar		8	14	Clim sim	Yes	RW	Primary
U.S. Department of Agriculture, 1994	United States	16		-	Other	No	Coefficient	Secondary
U.S. Department of Agriculture, 1997	United States	16		-	Other	No	Coefficient	Secondary

Table 19. Summary of industrial consumptive-use coefficients for the Great Lakes Basin, climatically similar areas, and the world. —Continued

[See fig. 7 and table 10 for explanation of column headings. All computed numbers are rounded to the whole number, and reported numbers are as listed in reference.]

Reference	Geographic area	Single coefficient	Median coefficient	N	Statistics Area	Used in statistics	Coefficient or other	Data source
U.S. Department of Agriculture, 2003	United States	22		-	Other	No	Coefficient	Secondary
USGS Circulars, 1961, 1968, 1972, 1977, 1983, 1988, 1993, 1998	By state:							
	Great Lakes States		9	32	Great Lakes	Yes	CW	Secondary
	Climatically Similar States		9	63	Clim sim	Yes	CW	Secondary
	By basin or region:							
	Great Lake Basin		6	-	Great Lakes	No	CW	Secondary
	Mid-Atlantic Region		6	-	Clim sim	No	CW	Secondary
	New England Region		6	-	Clim sim	No	CW	Secondary
	Ohio Region		7	-	Clim sim	No	CW	Secondary
	Tennessee Region		12	-	Clim sim	No	CW	Secondary
	Upper Mississippi Region		5	-	Clim sim	No	CW	Secondary
USGS and Tennessee Department of Environment and Conservation, 2003	Tennessee	11		1	Clim sim	Yes	Coefficient	Primary
van der Leeden, 1975	Belgium	By major categories		-	Other	No	CW	Secondary
Water Resources Council (U.S.), 1978	By Basin:	By major categories						
	New England	9		-	Clim sim	No	CW	Secondary
	Mid-Atlantic	11		-	Clim sim	No	CW	Secondary
	Great Lakes	11		-	Great Lakes	No	CW	Secondary
	Ohio	8		-	Clim sim	No	CW	Secondary
	Tennessee	7		-	Clim sim	No	CW	Secondary
	Upper Mississippi	12		-	Clim sim	No	CW	Secondary
Wild and Nimiroski, 2004	Rhode Island, Connecticut	10		1	Clim sim	Yes	Coefficient	Secondary
Wild and Nimiroski, 2005	Rhode Island	10		1	Clim sim	Yes	Coefficient	Secondary
Woldorf, 1959	Ohio	5		-	Great Lakes	No	CW	Primary

[1] The consumptive-use coefficient is noted as “New England traditional rates.”

[2] Single coefficient computed by the fraction of the total water consumed of the total water withdrawn.

[3] Consumptive-use coefficients for Ellefson and others was 20 percent for ground-water industrial water use and 10 percent of surface-water industrial withdrawals.

[4] In LaTour (1991) this was the “minimum consumptive-use ratio” for the industrial category (table 12); the “minimum consumptive-use ratio” method was used to estimate consumptive use for the municipal and commercial categories.

[5] The self-supplied industry coefficient of 9 percent might be artificially high because some of the facilities used both self-supplied and public-supplied water.

[6] Marcuello and Lallana (2003) said that the consumptive-use coefficients were “widely accepted.”

[7] Nawyn (1997) stated that “coefficients of consumptive water use that were developed in other studies were modified and applied to data on water users in Camden county.” Both self-supplied withdrawals and public-supplied deliveries for industrial use had the same consumptive use coefficient.

[8] Consumptive-use coefficient for industrial-mining.

[9] Both manufacturing and mining varies by plant and Standard Industrial Code (SIC).

[10] For the summary statistics, the average of the consumptive-use coefficient range was used.

[11] Facility measured; varies by plant and facility.

The industrial consumptive-use coefficients in table 19 are organized by reference. Statistical values for references with multiple consumptive-use coefficients are listed in table 20. The industrial consumptive-use coefficients medians for the Great Lakes Basin and climatically similar areas were the same (10 percent; table 9, fig. 12). The 25th and 75th percentiles also were similar (7 to 14 percent for the Great Lakes Basin and 4 and 13 percent for climatically similar areas; fig. 12).

Table 20. Summary statistics of industrial consumptive-use coefficients from selected references.

[Reference refers to the annotated bibliography references. Consumptive-use coefficients are in percent. N is the number of coefficients used in the summary statistics tables (tables 9 and 43) and shown in the boxplots. References are listed in the appendix. All computed numbers (median, 25th and 75th percentiles) are rounded to the whole number, and reported numbers (minimum and maximum) are as listed in reference. The area referred to under "geographic area" may be the entire geographic area or a small study area.]

Reference	Geographic area	N	Coefficient statistics				
			Min	25th	Median	75th	Max
Delaware River Basin Commission [n.d]	Pennsylvania, Delaware, New Jersey	1	0.1	1	6	36	100
Great Lakes Commission, 2005a	Great Lakes States and Provinces	50	0	6	10	15	25
Pennsylvania Department of Environmental Resources, 1975–83	Pennsylvania	-	6.2	7	7	8	11.4
U.S., Bureau of the Census, 1986	By state:						
	1983 Great Lake States	8	5	8	10	12	16
	1983 climatically similar states	14	0	4	8	12	21
USGS Circulars, 1961, 1968, 1972, 1977, 1983, 1988, 1993, 1998	By state:						
	Great Lakes States	32	2	4	9	10	35
	Climatically similar states	63	0	5	9	12	39
	By basin or region:						
	Great Lakes Basin	-	4	6	6	8	9
	Mid-Atlantic Region	-	4	6	6	9	10
	New England Region	-	5	5	6	9	20
	Ohio Region	-	4	5	7	10	15
	Tennessee Region	-	5	10	12	14	16
	Upper Mississippi Region	-	2	4	5	14	24

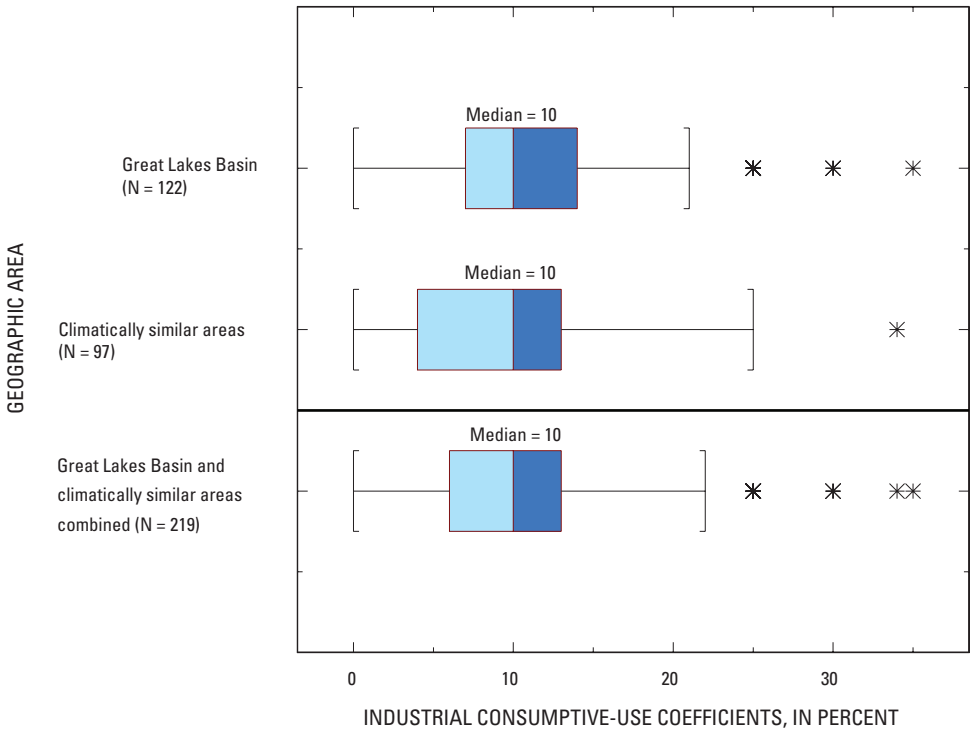


Figure 12. Distribution of industrial consumptive-use coefficients for the Great Lakes Basin and climatically similar areas. (An explanation of boxplot components is given in figure 9.)

Figure 13 shows the industrial consumptive-use coefficients for the Great Lakes. Map *A* shows 1982 manufacturing coefficients from the U.S. Bureau of Census (1986) and is based on water withdrawals and water returned that industries reported to the Bureau for the entire state (appendix table 2-1). The census of 1982 data was the last U.S. Bureau of Census (1986) census of manufacturing prepared. Prior to 1986, the report was prepared about every 5 years between 1954 to 1983. More detailed information from this report is in appendix tables 2–1 to 2–5. The range of consumptive use coefficients is 5–16 percent for the Great Lakes states, and the median is 10 percent (table 20).

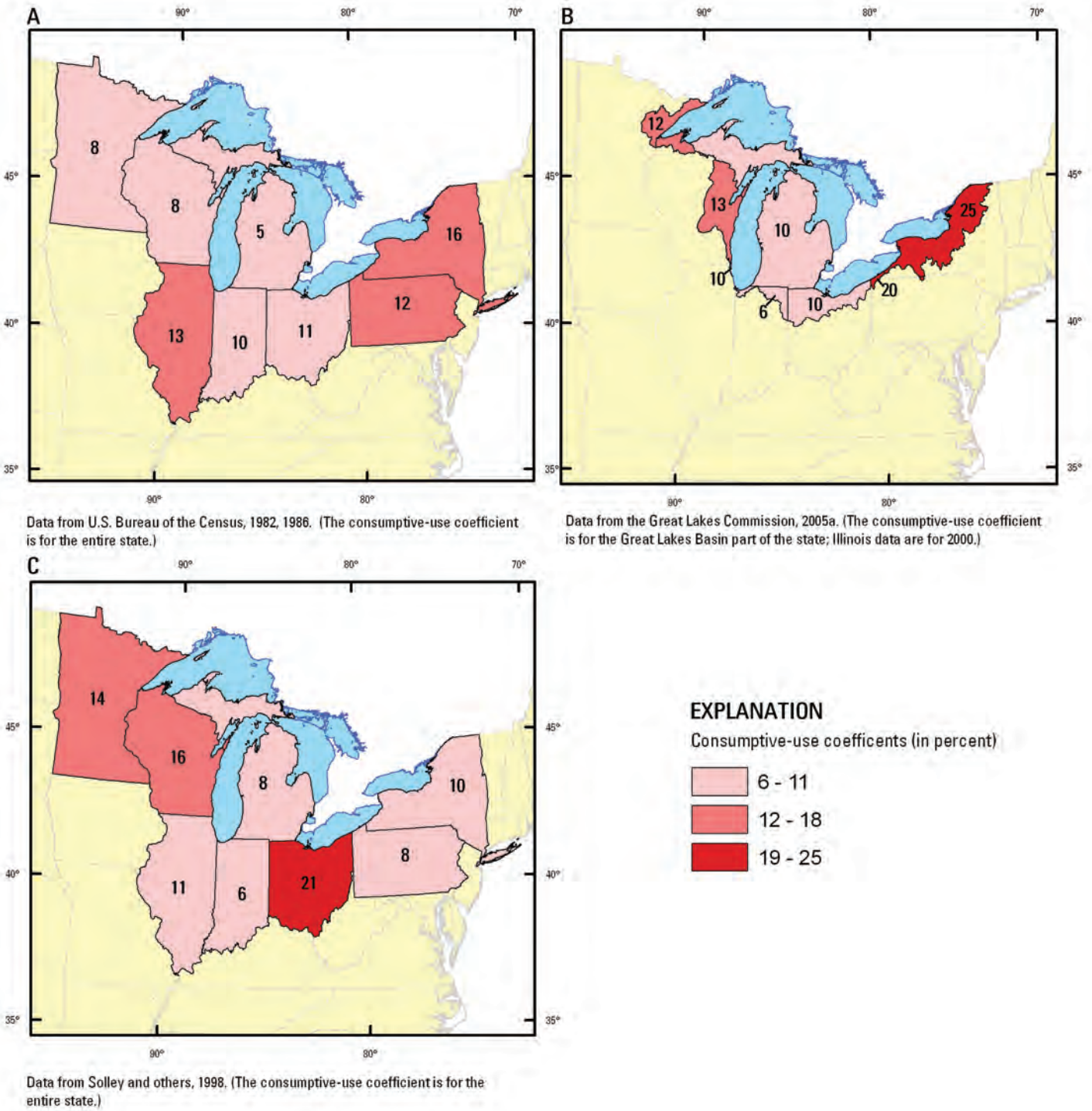


Figure 13. Industrial consumptive-use coefficients from various sources for the Great Lakes States.

In Pebbles (2003b) and other GLC publications, a table (appendix table 3–1) is included that lists the consumptive-use coefficients used by each jurisdiction and water-use category. As can be seen in this table, many states did not list a single coefficient to estimate consumptive use, so coefficients calculated from the GLC annual reports (1998–2002) (appendix table 3–3) were used in figure 13, Map *B*. The GLC data are the average of 5 years of data for each state, except for Illinois, whose coefficient is only for 2000. The GLC annual report coefficients are for the part of the Great Lakes drainage basin in each state. (The annual-report coefficients are also available for the Great Lakes Basin parts of Ontario and Quebec in Appendix table 3-3.) Withdrawal and consumptive-use data for each state are based on a variety of water-use programs and methods for compiling data. The Map *B* industrial consumptive-use coefficients range from 6 to 25 percent with a median of 10 (fig. 13*B*).

Map *C* shows the consumptive use of the Great Lakes Basin states from Solley and others (1998). Data were estimated by USGS water-use study chiefs in each state, many of whom were assisted by state and local agencies. Sources of information varied, but many study chiefs included data that were collected for individual facilities through permit programs. Industrial withdrawals also were estimated using the number of employees classified by industry group and per employee water-use coefficients (Hutson and others, 2004a). Others states estimated consumptive use by means of coefficients, most ranging from 10 to 40 percent of the withdrawals and deliveries, depending on the type of industry (Solley and others, 1998). For the Great Lakes States, the USGS coefficients were for the entire state in 1995, and they range from 6 to 21 percent; the median was 10 percent (appendix table 1–3).

Despite large ranges of consumptive-use coefficients for the Great Lakes States, the medians for each dataset were the same (10, U.S. Bureau of the Census; 10, GLC annual reports; 10, USGS Circulars). Each of the maps in figure 13 represents a different time period, and the GLC coefficients are only for the part of the Great Lakes drainage basin in each state.

Among the multiple reasons why coefficients between Maps *A*, *B*, and *C* (fig. 13) may differ are the following:

- Different time periods
- Different geographic areas
- Types of facilities active during the time of study
- Changes in processes at industrial facilities
- Differences in estimating methods
- Ways in which data are reported
- Differences in data-compilation methods

With respect to worldwide statistics (Shiklomanov and Rodda, 2003; table 21) industrial-use coefficients range from 3 to 25 percent (in 1900) and from 5 to 18 percent in 1995. The 1995 assessment had a consumptive-use coefficient median of 11 percent (table 22). From 1940 to 1980, there was a large increase in industrial water withdrawals in the world. Since 1980, the industrial water use has remained fairly steady for the world even though there may have been changes for individual continents.

Table 21. Industrial water withdrawals, consumptive use, and consumptive-use coefficients, by continent, for selected years from 1900 through 1995.

[Modified from Shiklomanov and Rodda (2003). Total withdrawn and consumptive use are in cubic kilometers per year and are as listed in reference; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data and rounded to the nearest whole number.]

Statistic	1900	1940	1950	1960	1970	1980	1990	1995	1900–1995
					Europe[1]				
Total withdrawn	9.3	23.4	36.3	104	168	206	214	228	989
Consumptive use	1.1	2.2	3.2	7.0	11.6	22.3	26.9	28.5	102.8
Coefficient	12	9	9	7	7	11	13	13	10
					Asia[2]				
Total withdrawn	4	18	33	51	107	153	176	184	726
Consumptive use	1	4	6	9	13	19	29	30	111
Coefficient	25	22	18	18	12	12	16	16	15
					Africa[3]				
Total withdrawn	.4	.8	1.4	2.7	5.8	9.7	9.0	9.6	39.4
Consumptive use	.1	.1	.2	.5	.8	1.4	1.6	1.7	6.4
Coefficient	25	13	14	19	14	14	18	18	16
					North America[4]				
Total withdrawn	21.8	-	104	165	246	293	259	266	1,354.8
Consumptive use	.7	-	3.9	6.4	10.2	13.4	13.8	14.6	63
Coefficient	3	-	4	4	4	5	5	5	5
					South America[5]				
Total withdrawn	1.3	2.2	3.0	4.9	8.4	13.3	15.9	19.0	68
Consumptive use	.26	.4	.6	.8	.9	1.1	1.2	1.6	6.86
Coefficient	20	18	20	16	11	8	8	8	10
					Australia and Oceania[6]				
Total withdrawn	1.00	3.00	4.10	6.20	8.30	10.5	6.70	7.20	47
Consumptive use	.20	.45	.50	.64	.69	.78	.46	.62	4.34
Coefficient	20	15	12	10	8	7	7	9	9
					Total				
Total withdrawn	37.8	47.4	181.8	333.8	543.5	685.5	680.6	713.8	3,224.2
Consumptive use	3.36	7.15	14.4	24.34	37.19	57.98	72.96	77.02	294.4
Coefficient	9	15	8	7	7	8	11	11	9

[1] Shiklomanov and Rodda (2003) page 85, from table 4.

[2] Ibid., p. 135, from table 5.25.

[3] Ibid., p. 192, from table 6.18.

[4] Ibid., p. 258, from table 7.22.

[5] Ibid., p. 316, from table 8.19.

[6] Ibid., p. 346, From table 9.21.

Table 22. Industrial consumptive-use coefficients for major countries, continents, and the world.

[Coefficient is in percent and rounded to the nearest whole number]

Reference	Geographic area	Coefficient
College of Exploration [n.d.]	World	9
Cosgrove and Rijsberman, 2000	World	11
Environment Canada, 2004	Canada	9
European Environment Agency, 2005	Europe	20
Marcuello and Lallana, 2003	Europe	20
Postel and others, 1996	World	10
Shiklomanov and Rodda, 2003 (1995 assessment)	World	11
	By continent:	
	Europe	13
	Asia	16
	Africa	18
	North America	5
	South America	8
	Australia and Oceania	9
Solley and others, 1998	United States	15

The four references with industrial consumptive-use coefficients for the world listed in table 22 (9 to 11 percent) were similar to coefficients reported by Shiklomanov and Rodda (2003). Coefficients from other references for large countries or continents also were comparable to the coefficients published in Shiklomanov and Rodda (2003). Table 23 lists industrial withdrawals, consumptive use, and consumptive-use coefficients for European regions (Shiklomanov and Rodda, 2003); coefficients range from 6 to 22 percent.

Table 23. Industrial water withdrawal, consumptive use, and consumptive-use coefficients for European regions for selected years from 1980 through 1995.

[Modified from Shiklomanov and Rodda (2003) p. 88. Total withdrawn and consumptive use are in cubic kilometers per year and are as listed in reference; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data and rounded to the nearest whole number.]

Statistic	1980	1990	1995	1980–1995
Northern Europe				
Total withdrawn	6.64	6.29	7.01	19.94
Consumptive use	.60	.57	.67	1.84
Coefficient	9	9	10	9
Central Europe				
Total withdrawn	94.3	93.8	102.0	290.1
Consumptive use	7.5	8.4	9.8	25.7
Coefficient	8	9	10	9
Southern Europe				
Total withdrawn	38.3	40.5	45.1	123.9
Consumptive use	3.1	2.8	2.9	8.8
Coefficient	8	7	6	7
Northern slope of European territory of former Soviet Union				
Total withdrawn	11.2	13.00	12.20	36.4
Consumptive use	1.30	1.60	1.60	4.5
Coefficient	12	12	13	12
Southern slope of European territory of former Soviet Union				
Total withdrawn	55.9	60.0	60.5	176.4
Consumptive use	9.8	13.4	13.4	36.6
Coefficient	18	22	22	21
Total				
Total withdrawn	206.34	213.59	226.81	646.74
Consumptive use	22.3	26.77	28.37	77.44
Coefficient	11	13	13	12

Industrial Use by Major Standard Industrial Classification Codes

The U.S. Bureau of the Census (1986) formerly reported industrial water use for water-resource regions by major SIC code groups. In the Great Lakes region, approximately 93 percent of the industrial water withdrawals were from six major groups, which are listed in table 24 and appendix table 2–3. The remaining 7 percent of withdrawals are distributed among 12 other major categories (appendix table 2–3). The three largest industrial water-use groups were primary metal industries, chemicals and allied products, and paper and allied products. These three industrial groups made up 84 percent of the total industrial withdrawals for the Great Lakes Basin in 1983 (U.S. Bureau of Census, 1986) and 82 percent of the total withdrawals in Canada in 1996 (Environment Canada, 2004).

Consumptive-use coefficients in table 25 are organized by type of industry listed for the six major groups on the basis of reports with industrial water-use data. The consumptive-use coefficients vary by region. The differences in coefficients may in part be due to differences in the mix of industry types in each geographic area.

Table 24. Industrial consumptive use for six industrial major-group categories with the largest consumptive use in the Great Lakes Basin in 1983.

[Modified from U.S. Bureau of the Census (1986). Water withdrawn, water discharged, and water consumed are in billion gallons and are rounded to one decimal place as in the reference. Water consumed is calculated by subtracting the water discharged from the water withdrawn. The coefficient, in percent, is the consumptive-use coefficient derived by dividing the calculated water consumed by the water withdrawn and rounded to the nearest whole number.]

Industrial category	Water withdrawn	Water discharged	Water consumed	Coefficient (%)
SIC code 33: Primary metal industries	1,218.2	1,119.6	98.6	8
SIC code 26: Paper and allied products	228.5	181.1	47.4	21
SIC code 28: Chemicals and allied products	183.6	174.3	9.3	5
SIC code 20: Food and kindred products	70.8	62.4	8.4	12
SIC code 32: Stone, clay, and glass products	49.2	46.7	2.5	5
SIC code 37: Transportation equipment	48.8	44.6	4.2	9

Table 25. Industrial consumptive-use coefficients, by industrial category, for six industry groups.

[Reference refers to the annotated bibliography reference. Year of data refers to the year that data was compiled. Industrial group or Standard Industrial Code (SIC) is either the group name or the SIC major industry code that the reference used to define the type of water use. The coefficient is the percentage of the water consumed out of the water withdrawn. All numbers are rounded. – denotes that there was no consumptive-use coefficient either because of census masking or because water returned was greater than the water intake.]

Reference	Geographic area	Year of data	Industry group or SIC code	Coefficient (%)
SIC code 20: Food and kindred products				
Environment Canada, 2004	Canada	1996	Food	11
		1996	Beverages	23
International Great Lakes Diversions and Consumptive Use Study Board, 1981	Canada	1971	Food and beverages	9
Snavely, 1986	New York	1979	20	16
U.S. Bureau of the Census, 1986	United States	1983	20	15
		1983	Food	13
		1983	Beverages	23
		1978	20	12
		1973	20	7
		1968	20	7
		1964	20	9
		1959	20	8
		1954	20	11
	Great Lakes	1983	20	12
	New England	"		45
	Middle Atlantic	"		18
	Ohio	"		23
	Upper Mississippi	"		8
	Tennessee	"		22
Water Resources Council (U.S.), 1978	New England Region	1978	Food	16
	Mid-Atlantic Region	"		17
	Great Lakes Region	"		11
	Ohio Region	"		14
	Tennessee Region	"		5
	Upper Mississippi Region	"		12
van der Leeden, 1975	Belgium	1974	Food	12

Table 25. Industrial consumptive-use coefficients, by industrial category, for six industry groups.—Continued

[Reference refers to the annotated bibliography reference. Year of data refers to the year that data was compiled. Industrial group or Standard Industrial Code (SIC) is either the group name or the SIC major industry code that the reference used to define the type of water use. The coefficient is the percentage of the water consumed out of the water withdrawn. All numbers are rounded. – denotes that there was no consumptive-use coefficient either because of census masking or because water returned was greater than the water intake.]

Reference	Geographic area	Year of data	Industry group or SIC code	Coefficient (%)
SIC code 26: Paper and allied products				
Environment Canada, 2004	Canada	1996	Paper and allied products	9
International Great Lakes Diversions and Consumptive Use Study Board, 1981	Canada	1971	Paper and allied products	5
Snavely, 1986	New York	1979	26	8
U.S. Bureau of the Census, 1986	United States	1983	26	7
		1978	26	10
		1973	26	5
		1968	26	8
		1964	26	6
		1959	26	6
		1954	26	9
	Great Lakes	1983	26	21
	New England	"		4
	Middle Atlantic	"		15
	Ohio	"		2
	Upper Mississippi	"		10
	Tennessee	"		4
Water Resources Council (U.S.), 1978	New England Region	1978	Paper	9
	Mid-Atlantic Region	"		10
	Great Lakes Region	"		15
	Ohio Region	"		10
	Tennessee Region	"		11
	Upper Mississippi Region	"		6
van der Leeden, 1975	Belgium	1974	Paper	10

Table 25. Industrial consumptive-use coefficients, by industrial category, for six industry groups.—Continued

[Reference refers to the annotated bibliography reference. Year of data refers to the year that data was compiled. Industrial group or Standard Industrial Code (SIC) is either the group name or the SIC major industry code that the reference used to define the type of water use. The coefficient is the percentage of the water consumed out of the water withdrawn. All numbers are rounded. – denotes that there was no consumptive-use coefficient either because of census masking or because water returned was greater than the water intake.]

Reference	Geographic area	Year of data	Industry group or SIC code	Coefficient (%)
SIC code 28: Chemicals and allied products				
Environment Canada, 2004	Canada	1996	Chemicals and chemical products	8
International Great Lakes Diversions and Consumptive Use Study Board, 1981	Canada	1971	Chemicals and chemical products	5
Snavely, 1986	New York	1979	28	4
U.S. Bureau of the Census, 1986	United States	1983	28	12
		1978	28	10
		1973	28	6
		1968	28	7
		1964	28	5
		1959	28	6
		1954	28	5
	Great Lakes	1983	28	5
	New England	"		0
	Middle Atlantic	"		4
	Ohio	"		3
	Upper Mississippi	"		15
	Tennessee	"		22
Water Resources Council (U.S.), 1978	New England Region	1978	Chemicals	14
	Mid-Atlantic Region	"		10
	Great Lakes Region	"		4
	Ohio Region	"		5
	Tennessee Region	"		5
	Upper Mississippi Region	"		14
van der Leeden, 1975	Belgium	1974	Chemical	6

Table 25. Industrial consumptive-use coefficients, by industrial category, for six industry groups.—Continued

[Reference refers to the annotated bibliography reference. Year of data refers to the year that data was compiled. Industrial group or Standard Industrial Code (SIC) is either the group name or the SIC major industry code that the reference used to define the type of water use. The coefficient is the percentage of the water consumed out of the water withdrawn. All numbers are rounded. – denotes that there was no consumptive-use coefficient either because of census masking or because water returned was greater than the water intake.]

Reference	Geographic area	Year of data	Industry group or SIC code	Coefficient (%)
SIC code 32: Stone, clay, and glass products				
Snavely, 1986	New York	1979	32	9
U.S. Bureau of the Census, 1986	United States	1983	32	14
		1978	32	12
		1973	32	12
		1968	32	13
		1964	32	12
		1959[1]	32	-
		1954	32	9
	Great Lakes	1983	32	5
	New England	"		15
	Middle Atlantic	"		7
	Ohio	"		12
	Upper Mississippi	"		14
	Tennessee	"		-
SIC code 33: Primary metal industries				
Environment Canada, 2004	Canada	1996	Primary Metals	8
International Great Lakes Diversions and Consumptive Use Study Board, 1981	Canada	1971	Iron&Steel and other primary metals	2
Snavely, 1986	New York	1979	33	1
U.S. Bureau of the Census, 1986	United States	1983	33	11
		1978	33	8
		1973	33	4
		1968	33	6
		1964	33	6
		1959	33	4
		1954	33	4
	Great Lakes	1983	33	8
	New England	"		8
	Middle Atlantic	"		12
	Ohio	"		11
	Upper Mississippi	"		37
	Tennessee	"		-

Table 25. Industrial consumptive-use coefficients, by industrial category, for six industry groups.—Continued

[Reference refers to the annotated bibliography reference. Year of data refers to the year that data was compiled. Industrial group or Standard Industrial Code (SIC) is either the group name or the SIC major industry code that the reference used to define the type of water use. The coefficient is the percentage of the water consumed out of the water withdrawn. All numbers are rounded. – denotes that there was no consumptive-use coefficient either because of census masking or because water returned was greater than the water intake.]

Reference	Geographic area	Year of data	Industry group or SIC code	Coefficient (%)
SIC code 33: Primary metal industries—Continued				
Water Resources Council (U.S.), 1978	New England Region	1978	Primary metals	3
	Mid-Atlantic Region	"		15
	Great Lakes Region	"		14
	Ohio Region	"		7
	Tennessee Region	"		16
	Upper Mississippi Region	"		13
Van der Leeden, 1975	Belgium	1974	Iron & steel and non-ferrous	9
SIC code 37: Transportation equipment				
Environment Canada, 2004	Canada	1996	Transportation Equipment	29
International Great Lakes Diversions and Consumptive Use Study Board, 1981	Canada	1971	Transportation Equipment	3
Snavely, 1986	New York	1979	37	<1
U.S. Bureau of the Census, 1986	United States	1983	37	9
		1978	37	6
		1973	37	6
		1968	37	6
		1964	37	4
		1959	37	1
		1954	37	7
	Great Lakes	1983	37	9
	New England	"		-
	Middle Atlantic	"		5
	Ohio	"		15
	Upper Mississippi	"		13
	Tennessee	"		7
Water Resources Council (U.S.), 1978	New England Region	1978	Transportation	8
	Mid-Atlantic Region	"		9
	Great Lakes Region	"		12
	Ohio Region	"		24
	Tennessee Region	"		-
	Upper Mississippi Region	"		19

With the exception of Environment Canada (2004), **all references** were for data collected more than 20 years ago (1954 to 1983). Consumptive-use coefficients from 20 or more years ago may not accurately reflect current consumptive-use coefficients because the industrial water-use processes might have changed over time. Summary statistics of the consumptive-use coefficients for the six largest industrial water-use SIC groups (table 24) are presented in table 26.

Paper and allied products, chemicals and allied products, and primary metal industries had a median within 2 percent of the most recent coefficient, that from Environment Canada (2004) (table 26).

Table 26. Summary statistics for industrial consumptive-use coefficients listed in table 25 for six industrial groups.

[Industry refers to the products produced for six major Standard Industrial Classification code categories. Environment Canada (2004) is the source for the consumptive-use coefficient for each of the major categories from this reference and is in percent. The minimum, median, maximum, 10th percentile, 25th percentile, 75th percentile and the 90th percentile are in percent. N is the number of references used in the statistical analysis.]

Industry	N	Min	10th percentile	25th percentile	Median	75th percentile	90th percentile	Max	Environment Canada (2004)
Food and kindred products	22	5	7	9	12	16	22	45	11 & 23[1]
Paper and allied products	23	2	4	6	9	10	14	21	9
Chemicals and allied products	23	0	4	5	6	10	14	22	8
Stone, clay, and glass products	12	5	7	9	12	13	14	15	-
Primary metal industries	22	1	3	4	8	12	15	37	8
Transportation equipment	19	1	4	6	8	12	20	29	29

[1] In the publication for Environment Canada (2004), food and kindred products are separated into Food (11 percent) and Beverages (23 percent). This same comparison was possible with the U.S. Bureau of the Census reference (1986), where food was 13 percent and beverages were 23 percent.

Environment Canada (2004) and U.S. Bureau of the Census (1986) separated the food and kindred products into two categories: food and beverages. For the food category, the consumptive-use coefficients from these two references were similar (11 and 13 percent), and both references listed a consumptive-use coefficient of 23 percent for beverages.

The bottled-water industry is omitted in both references, but it has increased sales in both Canada and the United States over the last 10 years (Canadian Environmental Law Association, 2004). Fahrenthold (2006) cites Robert Glennon (a law professor at the University of Arizona) as saying that 100 percent of bottled water is consumptive use and that once the water is put in the bottle, the water is gone. Similarly, the Canadian Bottled Water Association (n.d.) stated (in a response to the Ontario Ministry on watershed-based source protection planning) that more than 97 percent of the water for the bottling industry is intended for human consumption, implying that 97 percent of bottled water is consumed.

The ethanol fuel industry has been increasing since 1980 in the United States, but with 79 plants under construction and 7 plant expansions, the current capacity of ethanol production will more than double from 5,750.4 to 12,088.3 Mgal/yr (Renewable Fuels Association, 2007). In ethanol plants water is evaporated; recycled into plant-process streams; incorporated into plant by-products; used for sanitation, cleaning, and emergencies; and discharged from the plant as nonprocess wastewater (U.S. Department of Energy, 2005). New process technology has minimized both the volume of water use required in ethanol plants and the water discharge (Clean Fuels Development Coalition and Nebraska Ethanol Board, 2006), which increases the consumptive-use coefficient. Three site-specific references were found with water use and return flow estimates for ethanol plants, but consumptive-use coefficients varied (table 27). More data (water use and consumptive use) and further studies are needed on ethanol plants for water managers to better understand and plan for the water and consumptive use in ethanol plants.

Environment Canada (2004) found that the consumptive-use coefficient for the Transportation Equipment industrial category was 29 percent. This coefficient is substantially higher than the median transportation equipment coefficient of 8 percent (computed from 19 references, 18 of which are more than 20 years old) and the median industrial coefficients of 10 percent for the GLB, climatically similar areas, and the world (table 9). Interestingly, General Motors (2001) stated that in 2000, the global operations purchased and used 6 percent less water than in 1999 and the North American plants decreased water use on a per vehicle basis by 8 percent between 1999 and 2000.

Table 27. Ethanol-production water use, return flow, and consumptive-use coefficients.

[Water use and return flow are in million gallons per day. Coefficient (calculated by subtracting return flow from water use divided by water use) is in percent and rounded to the nearest whole number]

Reference	Water use	Return flow	Coefficient
Minnesota Pollution Control Agency, 2006 Existing Ethanol Plant[1]	0.402	0.178	56
Mark Muller, Institute for Agriculture and Trade Policy, written commun., 2007[2]	.0540	.0125	77
U.S. Department of Energy, 2005[3]	.576	.144	75

[1] Water use based on 2005 water reporting. Return flow is the "current discharge volume" "based on 2005 average flows." The return flow includes reverse-osmosis reject water/iron-filter backwash and cooling-tower blowdown.

[2] Water use and return flow based on external process **water balance** "water in" and "water out" for one ethanol plant in Wisconsin.

[3] Proposed withdrawal and discharge from an environmental assessment of a proposed fuel ethanol plant in Indiana. "Approximately one-quarter of this drawdown (100 gpm) would be discharged from the plant as non-process wastewater."

The medians of the SIC specific coefficients (table 26) (ranging from 6 to 12 percent) were similar to the median industrial coefficients for the Great Lakes Basin, climatically similar areas, and the world (table 9) (10 percent). Additionally, in the most recent water-availability publication of Environment Canada (2004), SIC coefficients were comparable to the median SIC specific coefficients (table 26) except for the transportation-equipment industrial category (8 versus 29 percent), implying that either the 8 percent coefficient may not reflect current consumptive-use coefficients for the transportation-equipment industry or the Environment Canada coefficient reflects facilities with a larger rate of consumption than most other transportation–equipment facilities. The median consumptive-use coefficients (23) for the beverage and bottle industries were also significantly higher than the median industrial coefficients (10 percent) for the Great Lakes Basin, climatically similar areas, and the world (table 9).

Appendix table 2–5 lists consumptive use coefficients from the Census of Manufacturing in 1983 by SIC and NAICS codes (U.S. Bureau of the Census, 1986). Table 28 includes a list of industries with consumptive-use coefficients greater than 30 percent. Industries that have a higher consumptive-use coefficient may have a greater percent of the water being either incorporated into products or evaporated. Many of these industries reported small withdrawal amounts, as noted in the table 28. Some industrial groups were withheld to avoid disclosing data for individual companies, and it is unknown what their consumptive-use coefficient was. (These industries are noted in appendix table 2–5).

Table 28. Industries with a consumptive-use coefficient greater than 30 percent in 1983.

[Modified from U.S. Bureau of the Census, 1986.]

SIC	Industry	Coefficient
2041	Flour and other grain mill products[1]	38
2043	Cereal breakfast foods	36
2044	Rice milling[1]	33
2051	Bread, cake, and related products[1]	42
2063	Beet sugar	34
2077	Animal and marine fats and oils	46
2086	Bottled and canned soft drinks	45
2296	Tie cord and fabric[1]	33
2297	Nonwoven fabrics[1]	33
2435	Hardwood veneer and plywood[1]	67
2436	Softwood veneer and plywood	43
2813	Industrial gases	36
2831	Biological products[1]	38
284	Soaps, cleaners, and toilet goods[2]	40
2873	Nitrogenous fertilizers	36
2874	Phosphatic fertilizers	34
2895	Carbon pack[1]	81
2992	Lubricating oils and greases[1]	50
2999	Petroleum and coal products	46
325	Structural clay products[1,2]	50
3264	Porcelain electrical supplies[1]	33
3275	Gypsum products	59
3293	Gaskets, packing, and sealing devices[1]	50
3332	Primary lead[1]	57
3433	Heating equipment, except electric[1]	33
351	Engines and turbines[2]	35
3563	Air and gas compressors[1]	50
3764	Space propulsion units and parts	30

[1] Coefficient based on less than 2 billion gallons of water withdrawn.

[2] Industrial group used due to census masking.

Thermoelectric Power

Thermoelectric-power water use is water used in the process of generating electric power by means of fossil-fuel, nuclear, and geothermal power sources. The amount of consumptive use (or evaporation) that occurs during the process of condenser and reactor cooling associated with the generation of electric power depends on the engineering at the plant. For condenser and reactor cooling, thermoelectric plants can use once-through cooling, cooling towers and ponds, or a combination of both. A **once-through thermoelectric power facility** is a facility that uses water only once in the condenser– and reactor–cooling process before returning the water to a surface-water source. Once-through cooling requires large amounts of water, but evaporation is small (usually less than 3 percent) (Solley and others, 1998). Thermoelectric plants that do not use once-through cooling (open-loop) are called "other than once-through cooling thermoelectric plants" (closed-loop or recirculating). **An other than once-through thermoelectric power facility** uses cooling towers or cooling ponds to recycle water repeatedly for condenser and reactor cooling; the water withdrawals are smaller, but consumptive use is larger, typically greater than 60 percent (Solley and others, 1998). Facilities that combine once-through cooling with cooling towers and cooling ponds can have varying consumptive-use coefficients depending on the characteristics of their operation.

The engineering at a thermoelectric plant depends on many factors including water availability. Facilities that have access to an abundant water supply may have once-though cooling and therefore will have a lower consumptive-use coefficient. Facilities with limited water availability may have cooling towers or cooling ponds to reuse their water until most (if not all) of the water is evaporated.

Table 29 is a compilation of thermoelectric consumptive-use coefficients listed by reference, and table 30 is a statistical summary for references with multiple coefficients and geographic areas. In many references, the thermoelectric consumptive-use coefficients reported had large ranges—as much as 0.1 to 100 percent in one source (table 30 and annotated bibliography). The medians also ranged significantly because of the number of facilities and the various types of engineering at the facilities (once-through in contrast to cooling ponds or cooling towers) (table 30). The overall consumptive-use coefficients (total water consumed divided by total water withdrawals for all sites) for these references in table 30 were all less than 2 percent (table 29) because the once-through cooling systems use significantly more water than the facilities with cooling towers and ponds.

Most of the thermoelectric consumptive-use coefficients were computed from the amount of water consumed divided by water withdrawals. However, coefficients calculated from the amount of water (gallons) consumed per kilowatt-hour (kWh) were given in two reports. Torcellini and others (2003) compiled thermoelectric consumptive-use coefficient by states and found that the total weighted average water consumption for the United States was 0.47 gal/kWh and 0.49 gal/kWh for the Eastern Electric grid (which includes the Great Lakes area). For Great Lakes States, the water consumption range was from 0.41 gal/kWh for Indiana to 1.05 gal/kWh for Illinois (Torcellini and others, 2003). The International Great Lakes diversions and consumptive-use study board (1981) found a range of consumptive-use coefficients from 0.21 to 0.33 million gallons per day per gigawatt hour per year (Mgal/d/gWh/yr) for fossil-fuel thermoelectric plants and 0.35 to 0.56 Mgal/d/gWh/yr for nuclear plants.

Table 29. Summary of thermoelectric power consumptive-use coefficients for the Great Lakes Basin and climatically similar areas.

[See fig. 7 and table 10 for explanation of column headings. All computed numbers are rounded to the whole number, and reported numbers are as listed in reference. Gal/kwh is gallons per kilowatt hour.]

Reference	Geographic area	Single coefficient (in percent)	Median coefficient (in percent)	N	Statistics area	Used in statistics	Coefficient or Other	Data source
Barlow, 2003[1]	Rhode Island, Massachussetts	100		-	Clim sim	No	CW	Secondary
Brill and others, 1977	Illinois, Indiana, Kentucky, Ohio	.1		-	Clim sim	No	CW	Secondary
Delaware River Basin Commission [n.d.][2]	Pennsylvania, Delaware, New Jersey	1		1	Clim sim	Yes	CW	Primary
Ellefson and others, 1987	Wisconsin	1		1	Great Lakes	Yes	Coefficient	Primary
Endreny, 2005:	New York							
Fossil fuel		2		1	Great Lakes	Yes	CW	Secondary
Nuclear		3.6		1	Great Lakes	Yes	CW	Secondary
European Environment Agency, 2005	Europe	5		-	Other	No	Ceofficient	Primary
Great Lakes Commission, 2005a								
Annual reports 1998–2002:	Great Lakes							
Fossil fuel			1	45	Great Lakes	Yes	CW	Secondary
Nuclear			1	30	Great Lakes	Yes	CW	Secondary
Great Lakes Commission and U.S. Army Corps of Engineers, 1999	Great Lakes	<2		-	Great Lakes	No	Coefficient	Primary
Government of Canada and the U.S. Environmental Protection Agency, 1995	Great Lakes:							
	Canada:							
	Lake Superior	0		1	Great Lakes	Yes	CW	Secondary
	Lake Huron	1		1	Great Lakes	Yes	CW	Secondary
	Lake Erie	1		1	Great Lakes	Yes	CW	Secondary
	Lake Ontario	1		1	Great Lakes	Yes	CW	Secondary
	United States:							
	Lake Superior	1		1	Great Lakes	Yes	CW	Secondary
	Lake Michigan	2		1	Great Lakes	Yes	CW	Secondary
	Lake Huron	2		1	Great Lakes	Yes	CW	Secondary
	Lake Erie	1		1	Great Lakes	Yes	CW	Secondary
	Lake Ontario	2		1	Great Lakes	Yes	CW	Secondary
Hutson and others, 2004b	Tennessee	1		1	Clim sim	Yes	RW	Primary
International Great Lakes Diversions and Consumptive Use Study Board,1981[3]	Great Lakes	Gal/kwh		-	Great Lakes	No	Coefficient	Secondary
Kay, 2002	Kentucky, Indiana, Michigan, Iowa, Missouri, Illinois, Wisconsin	<4		-	Clim sim	No	CW	Secondary
Loper and others, 1989	Pennsylvania	1.7		1	Great Lakes	Yes	CW	Secondary
Ludlow and Gast, 2000	Pennsylvania	4		1	Great Lakes	Yes	CW	Primary
Marcuello and Lallana, 2003[4]	Europe	5		-	Other	No	Coefficient	Secondary
Paulson and others, 1988	United States	3.3		-	Other	No	Coefficient	Secondary
Pennsylvania Department of Environmental Resources, 1975–83	Pennsylvania		1.23	-	Great Lakes	No	CW	Primary

Table 29. Summary of thermoelectric power consumptive-use coefficients for the Great Lakes Basin and climatically similar areas. —Continued

[See fig. 7 and table 10 for explanation of column headings. All computed numbers are rounded to the whole number, and reported numbers are as listed in reference. Gal/kwh is gallons per kilowatt hour.]

Reference	Geographic area	Single coefficient (in percent)	Median coefficient (in percent)	N	Statistics area	Used in statistics	Coefficient or Other	Data source
Pebbles, 2003b	By state/province:							
	Fossil fuel:							
	Illinois	By water[5]		-	Great Lakes	No	Coefficient	Secondary
	Indiana	2		1	Great Lakes	Yes	Coefficient	Secondary
	Michigan	1-2[6]		1	Great Lakes	Yes	Coefficient	Secondary
	Minnesota	2		1	Great Lakes	Yes	Coefficient	Secondary
	New York	2		1	Great Lakes	Yes	Coefficient	Secondary
	Ohio	By water[5]		-	Great Lakes	No	Coefficient	Secondary
	Ontario	.9		1	Great Lakes	Yes	Coefficient	Secondary
	Pennsylvania	-		-	Great Lakes	No	Coefficient	Secondary
	Quebec	10		1	Great Lakes	Yes	Coefficient	Secondary
	Wisconsin	.5-1[6]		1	Great Lakes	Yes	Coefficient	Secondary
	Nuclear:							
	Illinois	By water[5]		-	Great Lakes	No	Coefficient	Secondary
	Indiana	-		-	Great Lakes	No	Coefficient	Secondary
	Michigan	1-2[6]		1	Great Lakes	Yes	Coefficient	Secondary
	Minnesota	-		-	Great Lakes	No	Coefficient	Secondary
	New York	5		1	Great Lakes	Yes	Coefficient	Secondary
	Ohio	14		1	Great Lakes	Yes	Coefficient	Secondary
	Ontario	.9		1	Great Lakes	Yes	Coefficient	Secondary
	Pennsylvania	-		-	Great Lakes	No	Coefficient	Secondary
	Quebec	-		-	Great Lakes	No	Coefficient	Secondary
	Wisconsin	.5-1[6]		1	Great Lakes	Yes	Coefficient	Secondary
Sholar and Lee, 1988	Kentucky	4		1	Clim sim	Yes	CW	Primary
	Kentucky Basin	5		1	Clim sim	Yes	CW	Primary
Sholar and Wood, 1995	Kentucky	6		1	Clim sim	Yes	CW	Primary
Snavely, 1987	Great Lakes	.3		1	Great Lakes	Yes	Coefficient	Secondary
Snavely, 1988:	Great Lakes							
1975 Study Board		1.2		-	Great Lakes	No	CW	Secondary
1975 USGS		.21		-	Great Lakes	No	CW	Secondary
1980 Study Board		1.7		1	Great Lakes	Yes	CW	Secondary
1980 USGS		.34		1	Great Lakes	Yes	CW	Secondary
1985 Study Board		2.1		1	Great Lakes	Yes	CW	Secondary
1985 USGS		4.9		1	Great Lakes	Yes	CW	Secondary
Stevens and others, 1984	West Virginia	13.85		1	Clim Sim	Yes	RW	Primary
Suder and Lessing, 1984	West Virginia	10.7		1	Clim Sim	Yes	RW	Primary
Suder and Lessing, 1985	West Virginia	16		1	Clim Sim	Yes	RW	Primary
Suder and Lessing, 1986	West Virgina	12.7		1	Clim Sim	Yes	RW	Primary
Suder and Lessing, 1987	West Virgina	15.6		1	Clim Sim	Yes	RW	Primary
Sweat and Van Til, 1988	Michigan	1.3		1	Great Lakes	Yes	CW	Secondary
Tate, 1988:	Canada							
1966 Manufacturing		1		-	Other	No	CW	Secondary
1972 Manufacturing		1		-	Other	No	CW	Secondary
1976 Manufacturing		1		-	Other	No	CW	Secondary
Tate and Harris, 1999a[7]	Great Lakes Basin–Canada	.09		1	Great Lakes	Yes	Coefficient	Secondary
Torcellini and others, 2003[8]	United States	gal/kWh		-	Other	No	Coefficient	Secondary

Table 29. Summary of thermoelectric power consumptive-use coefficients for the Great Lakes Basin and climatically similar areas. —Continued

[See fig. 7 and table 10 for explanation of column headings. All computed numbers are rounded to the whole number, and reported numbers are as listed in reference. Gal/kwh is gallons per kilowatt hour.]

Reference	Geographic area	Single coefficient (in percent)	Median coefficient (in percent)	N	Statistics area	Used in statistics	Coefficient or Other	Data source
U.S. Department of Agriculture, 1994	United States	3		-	Other	No	Coefficient	Secondary
U.S. Department of Agriculture, 1997	United States	3		-	Other	No	Coefficient	Secondary
U.S. Department of Agriculture, 2003	United States	3		-	Other	No	Coefficient	Secondary
U.S. Department of Energy, 2004[9]	United States	By plant		-	Other	No	CW	Primary
USGS Circulars, 1961, 1968, 1972, 1977, 1983, 1988, 1993, 1998	By states:							
	Great Lakes States		2	32	Great Lakes	Yes	CW	Secondary
	Climatically similar states		2	4	Clim sim	Yes	CW	Secondary
	By basin or region:							
	Great Lake		2	-	Great Lakes	No	CW	Secondary
	Mid-Atlantic		2	-	Clim sim	No	CW	Secondary
	New England		2	-	Clim sim	No	CW	Secondary
	Ohio		4	-	Clim sim	No	CW	Secondary
	Tennessee		0	-	Clim sim	No	CW	Secondary
	Upper Mississippi		2	-	Clim sim	No	CW	Secondary
USGS and Tennessee Department of Environment and Conservation, 2003	Tennessee	.5		1	Clim sim	Yes	Coefficient	Primary
Water Resources Council (U.S.), 1978	By region or basin:	By major categories						
	New England	2		-	Clim sim	No	CW	Secondary
	Mid-Atlantic	1		-	Clim sim	No	CW	Secondary
	Great Lakes	1		-	Great Lakes	No	CW	Secondary
	Ohio	2		-	Clim sim	No	CW	Secondary
	Tennessee	1		-	Clim sim	No	CW	Secondary
	Upper Mississippi	2		-	Clim sim	No	CW	Secondary
van der Leeden, 1975	Belgium	0		-	Clim sim	No	CW	Secondary
Van Til and Scott, 1986	Michigan	1.3		1	Great Lakes	Yes	CW	Primary
Woldorf, 1959	Ohio	1		-	Great Lakes	No	CW	Primary

[1] Based on one facility and not used in the statistical analysis.

[2] This number is based on a couple of facilities and not used in the statistical analysis.

[3] Consumption based on using a coefficient based on the energy that is created. For fossil-fuel plants, the range was 0.21 to 0.33 million gallons per day per gigawatt-hour per year. For nuclear plants, the range was 0.35 to 0.56 Mgal/d/GWh/yr.

[4] Marcuello and Lallana (2003) said that the consumptive-use coefficients were “widely accepted.”

[5] Individually estimated based on the quantity of makeup water.

[6] For the summary statistics, the average of the consumptive-use coefficient range was used.

[7] This is for once-through thermoelectric power generation.

[8] Consumption based on water consumed per kilowatt.

[9] Reference is by each thermoelectric plant.

Table 30. Summary statistics of thermoelectric power consumptive-use coefficients from selected references.

[Reference refers to the annotated bibliography references. Consumptive-use coefficients are in percent. N is the number of coefficients used in the summary statistics tables (tables 9 and 43) and shown in the boxplots. References with more than one coefficient are listed in the appendix. All computed numbers are rounded to the whole number, and reported numbers are as listed in reference. The geographic area is defined by states, basins, or regions—it can be for the entire geographic area to a small study area within the geographic area.]

Reference	Geographic area	N	Coefficient statistics				
			Min	25th	Median	75th	Max
Delaware River Basin Commission [n.d][1]	Pennsylvania, New Jersey, Delaware	-	0.1	0.4	11	44	100
Pennsylvania Department of Environmental Resources, 1975–83[2]	Pennsylvania	-	.02	.2	.7	.8	8.6
USGS Circulars, 1983, 1988, 1993, 1998	By states:						
	Great Lakes States	32	0	1	2	3	21
	Climatically similar states	64	0	0	2	3	75[1]
	By basin or region:						
	Great Lakes Basin	-	0	2	2	3	5
	Mid-Atlantic Region	-	1	1	2	3	6
	New England Region	-	0	1	2	2	2
	Ohio Region	-	2	4	4	4	4
	Tennessee Region	-	0	0	0	0	0
	Upper Mississippi Region	-	2	2	2	2	4

[1] Delaware River Basin Commission is considered climatically similar and used the single coefficient in table 29. Single coefficient computed by the fraction of the total water consumed of the total water withdrawn.

[2] Some volumes of this reference were published before and after 1980 and therefore were not used in the summary analysis in tables 9 and 43.

The U.S. Department of Energy (2004) Web site reports site-specific facility data for thermoelectric plants and includes the average annual rate of cooling-water withdrawals, the average annual rate of cooling-water discharge, and the average annual rate of cooling-water consumption to the nearest 0.1 ft^3/s per facility in the United States. Data for 2001, 2002, 2003, and 2004 are currently available and can serve as a starting point for determining the consumptive use or consumptive-use coefficient for a facility or a group of facilities.

Figure 14 shows the thermoelectric consumptive-use coefficients for the Great Lakes States and Basin for 1995 from Solley and others (1998) (Appendix table 1–5) and Great Lakes Commission (2005a) annual reports 1998–2002 (appendix table 3–4 and 3–5 combined). The ranges of coefficients from both references are similar, 1 to 4 percent and 1 to 3 percent, even though the references are for different years and different geographic areas. Four states—Indiana, Illinois, Wisconsin, and Minnesota—had the same thermoelectric consumptive-use coefficient. The coefficient differences for the other states may be from the variance of the number and type of thermoelectric plants in each area by year. Thermoelectric consumptive-use coefficients from both Solley and others (1998) and the Great Lakes Commission (2005a) annual reports (1998–2002) had a median of 2 percent (from fig. 14).

Although boxplots show many data outliers (fig. 15), the medians for the Great Lakes Basin and climatically similar areas (table 9) are consistent with the median of the references shown in figure 14 (2 percent). The 25th and 75th percentiles for the Great Lakes Basin (1 to 2 percent) and climatically similar areas (0 to 4 percent) compared closely (table 9).

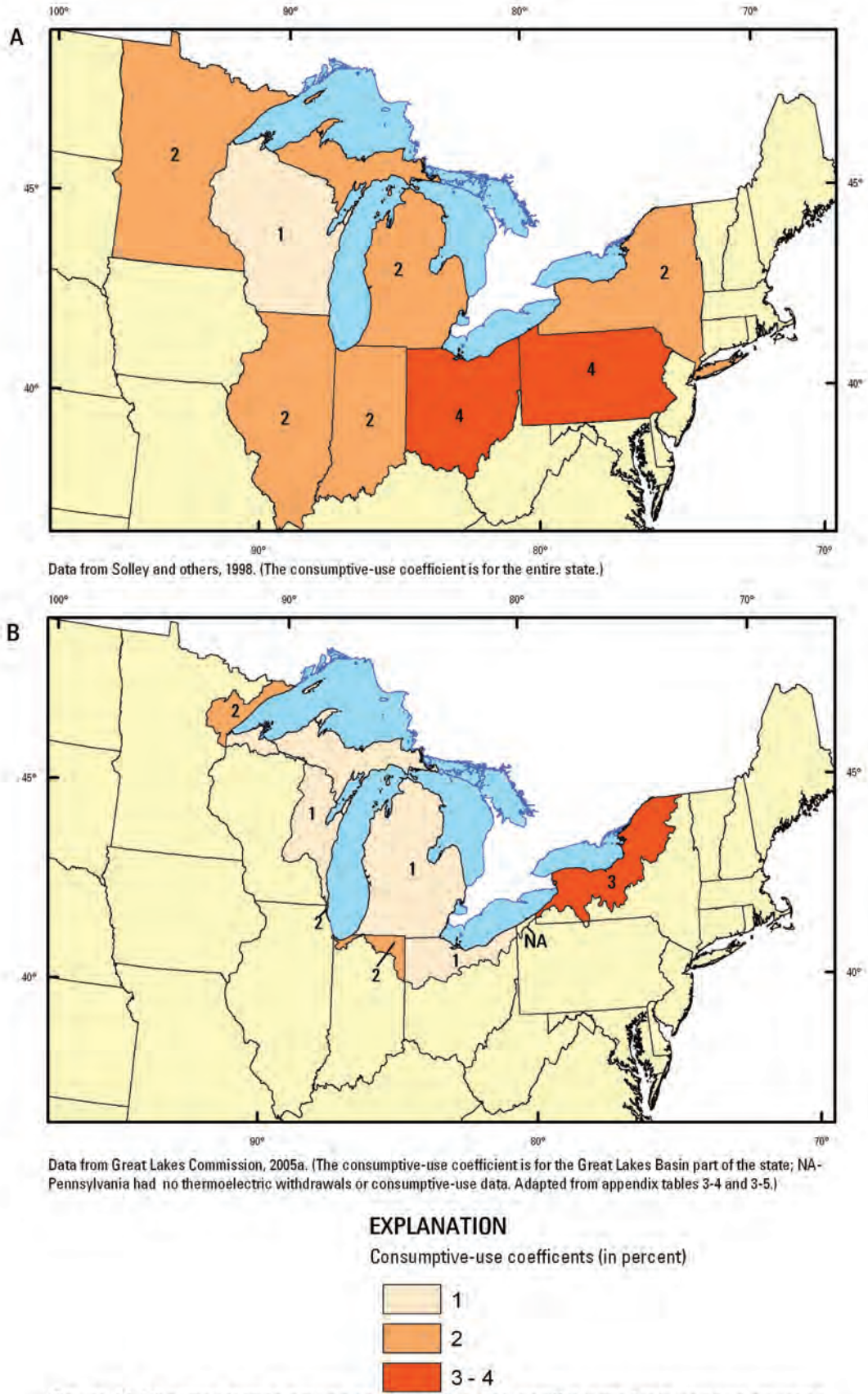


Figure 14. Thermoelectric power consumptive-use coefficients from various sources for the Great Lake States.

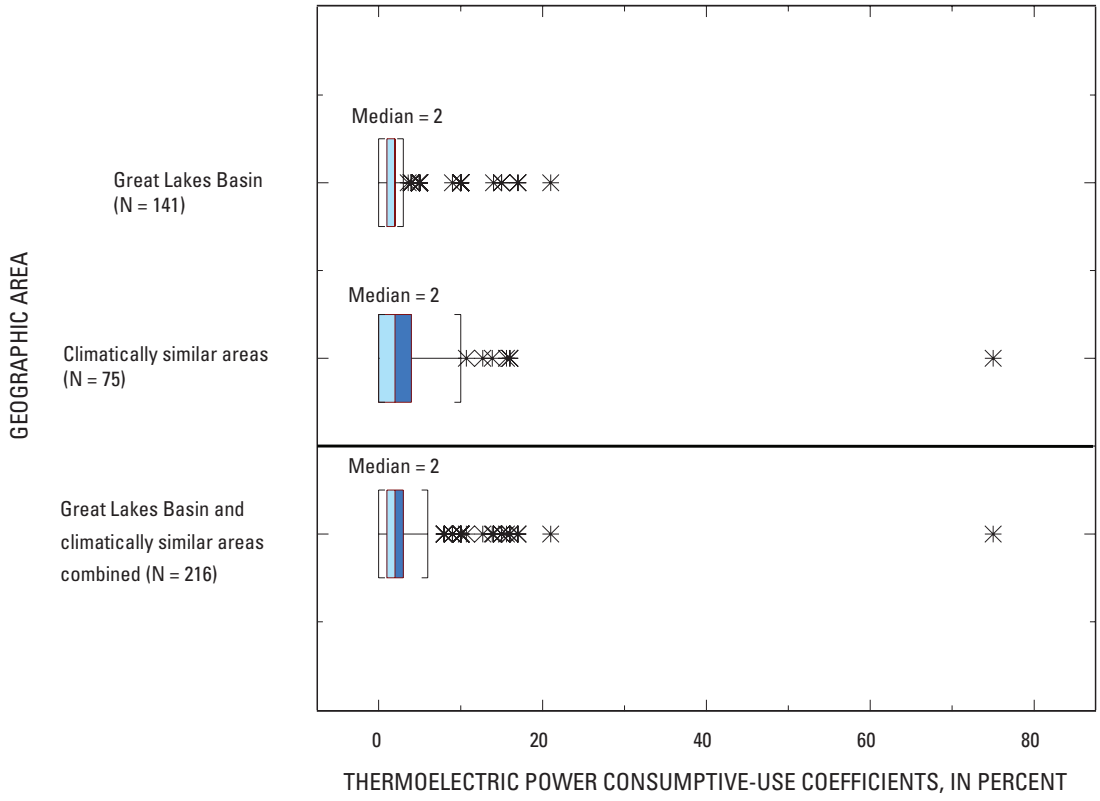


Figure 15. Distribution of thermoelectric power consumptive-use coefficients for the Great Lakes Basin and climatically similar areas. (An explanation of boxplot components is given in figure 9.)

Irrigation

Irrigation water use is the application of water on lands to assist in the growing of crops, pastures, or nurseries or to maintain vegetative growth in recreational lands such as parks and golf courses. Water use and consumptive use in crop irrigation are affected by annual rainfall, crops grown, soil type, and irrigation methods. Irrigation consumptive use is from evapotranspiration (the combination of evaporation and transpiration from watering vegetation). Irrigation in the eastern United States is used to supplement natural precipitation. During droughts, crops are irrigated to reduce the risk of crop failures. Additionally, irrigation helps increase crop yields and the number of plantings per year. Irrigation in the western United States developed as the West was settled because natural precipitation was not sufficient to raise many crops. Therefore, much larger amounts of water are withdrawn for irrigation in the western United States than in the eastern United States and the Great Lakes Basin.

Irrigation methods also affect water consumption. Depending on technology, irrigation methods range in consumption from 30 to 40 percent for flood irrigation to 90 percent for drip irrigation (Cosgrove and others, 2000).

Table 31 lists irrigation consumptive-use coefficients by reference. The consumptive-use coefficient may be listed as a single coefficient or the median for references with multiple coefficients. Summary statistics for references with multiple coefficients are listed in table 32.

Many references used the terms “agriculture withdrawals” and “agriculture consumptive use.” These terms represent both irrigation and livestock withdrawals and are listed in both the irrigation and livestock summary tables (tables 31 and 36). The statistical analysis was computed using coefficients from 1980 to 2005 because irrigation methods changed and compilation methods changed in the USGS National Water-Use Information Program (Solley and others, 1983). References that were not specific—for example, those that reported consumptive-use coefficients of “almost all” or “more than 90 percent”—were not used in the statistical summary (table 9).

Irrigation water and consumptive use at a day lily farm with microirrigation.

Table 31. Summary of irrigation consumptive-use coefficients for the Great Lakes Basin, climatically similar areas, and the world.

[See fig. 7 and table 10 for explanation of column headings. All computed numbers are rounded to the whole number, and reported numbers are as listed in reference.]

Reference	Geographic area	Single coefficient	Median coefficient	N	Statistics area	Used in statistics	Coefficient or other	Data source
Barlow, 2003	Rhode Island, Massachusetts	76		1	Clim sim	Yes	Coefficient	Secondary
College of Exploration [n.d][1]	World	65		-	Other	No	CW	Unknown
Cosgrove and Rijsberman, 2000	World	70		-	Other	No	CW	Secondary
Ellefson and others, 1987	Wisconsin	100		1	Great Lakes	Yes	Coefficient	Primary
Endreny, 2005	New York	87		1	Great Lakes	Yes	CW	Secondary
European Environment Agency, 2005[1]	Europe	80		-	Other	No	Coefficient	Primary
Great Lakes Commission, 2005a	Great Lakes		90	42	Great Lakes	Yes	CW	Secondary
Horn and others, 1994	Rhode Island	100		1	Clim sim	Yes	Coefficient	Primary
Hutson, 1998	Tennessee	Almost all		-	Clim sim	No	CW	Primary
Hutson and others, 2004b	Tennessee	100		1	Clim sim	Yes	RW	Primary
International Great Lakes Diversions and Consumptive Use Study Board, 1981	Great Lakes	75[2]		1	Great Lakes	Yes	Coefficient	Secondary
Kay, 2002	Kentucky, Indiana, Iowa, Wisconsin, Minnesota	>90[3]		-	Clim sim	No	CW	Secondary
	Missouri	75		-	Clim sim	No	CW	Secondary
LaTour, 1991	Illinois	80[4]		1	Great Lakes	Yes	Coefficient	Primary
Loper and others, 1989	Pennsylvania	100		1	Great Lakes	Yes	Coefficient	Secondary
Ludlow and Gast, 2000	Pennsylvania	100		1	Great Lakes	Yes	Coefficient	Primary
Marcuello and Lallana, 2003[1]	Europe	80[5]		-	Other	No	Coefficient	Secondary
Medalie, 1997a	Vermont	90		1	Clim sim	Yes	Coefficient	Secondary
Medalie, 1997b	New Hampshire	90		1	Clim sim	Yes	Coefficient	Secondary
Nawyn, 1997	New Jersey	90		1	Clim sim	Yes	Coefficient	Secondary
Nimiroski and Wild, 2005[1]	Rhode Island	100[6]		1	Clim sim	Yes	Coefficient	Primary
Ohlsson, 1997[1]	World	65		-	Other	No	Coefficient	Secondary
Paulson and others, 1988	United States	53.9		-	Other	No	Coefficient	Secondary
Pebbles, 2003b	Great Lakes, By state or province:		87					
	Illinois	90		1	Great Lakes	Yes	Coefficient	Secondary
	Indiana	90		1	Great Lakes	Yes	Coefficient	Secondary
	Michigan	90		1	Great Lakes	Yes	Coefficient	Secondary
	Minnesota	90		1	Great Lakes	Yes	Coefficient	Secondary
	New York	90		1	Great Lakes	Yes	Coefficient	Secondary
	Ohio	90		1	Great Lakes	Yes	Coefficient	Secondary
	Ontario	78		1	Great Lakes	Yes	Coefficient	Secondary
	Pennsylvania	90		1	Great Lakes	Yes	Coefficient	Secondary
	Quebec	90		1	Great Lakes	Yes	Coefficient	Secondary
	Wisconsin	70		1	Great Lakes	Yes	Coefficient	Secondary

Table 31. Summary of irrigation consumptive-use coefficients for the Great Lakes Basin, climatically similar areas, and the world. —Continued

[See fig. 7 and table 10 for explanation of column headings. All computed numbers are rounded to the whole number, and reported numbers are as listed in reference.]

Reference	Geographic area	Single coefficient	Median coefficient	N	Statistics area	Used in statistics	Coefficient or other	Data source
Pennsylvania Department of Environmental Resources, 1975–83	Pennsylvania	100		-	Great Lakes	No	Coefficient	Primary
Postel, 1996[1]	World	65		-	Other	No	CW	Secondary
Postel and others, 1996[1]	World	65		-	Other	No	CW	Primary
Shiklamanov and Rodda, 2003[1]	World	70		-	Other	No	Coefficient	Primary
Sholar and Lee, 1988	Kentucky	96		1	Clim sim	Yes	CW	Primary
Sholar and Wood, 1995	Kentucky	95		1	Clim sim	Yes	CW	Primary
Snavely, 1988:	Great Lakes							
1975 Study Board		74		-	Great Lakes	No	CW	Secondary
1975 USGS		95		-	Great Lakes	No	CW	Secondary
1980 Study Board		76		1	Great Lakes	Yes	CW	Secondary
1980 USGS		100		1	Great Lakes	Yes	CW	Secondary
1985 Study Board		80		1	Great Lakes	Yes	CW	Secondary
1985 USGS		100		1	Great Lakes	Yes	CW	Secondary
Stevens and others, 1984[1]	West Virginia	100		1	Clim sim	Yes	RW	Primary
Suder and Lessing, 1984[1]	West Virginia	100		1	Clim sim	Yes	RW	Primary
Suder and Lessing, 1985[1]	West Virginia	100		1	Clim sim	Yes	RW	Primary
Suder and Lessing, 1986[1]	West Virginia	100		1	Clim sim	Yes	RW	Primary
Suder and Lessing, 1987[1]	West Virginia	100		1	Clim sim	Yes	RW	Primary
Sweat and Van Til, 1988	Michigan	96		1	Great Lakes	Yes	CW	Secondary
Tate, 1988[1]:	Canada							
1966 Agriculture		72		-	Other	No	CW	Secondary
1972 Agriculture		72		-	Other	No	CW	Secondary
1976 Agriculture		72		-	Other	No	CW	Secondary
USGS Circulars, 1983, 1988, 1993, 1998	By state:							
	Great Lakes States		100	32	Great Lakes	Yes	CW	Secondary
	Climatically similar states		100	58	Clim Sim	Yes	CW	Secondary
1961, 1968, 1972, 1977, 1983, 1988, 1993, 1998	By basin or region:							
	Great Lakes		97	-	Great Lakes	No	CW	Secondary
	Mid-Atlantic		92	-	Clim Sim	No	CW	Secondary
	New England		99	-	Clim Sim	No	CW	Secondary
	Ohio		94	-	Clim Sim	No	CW	Secondary
	Tennessee		98	-	Clim Sim	No	CW	Secondary
	Upper Mississippi		94	-	Clim Sim	No	CW	Secondary
USGS and Tennessee Department of Environment and Conservation, 2003[1]	Tennessee	100		1	Clim sim	Yes	Coefficient	Primary
Water Resources Council (U.S.), 1978	By basin or region:							
	New England	71		-	Clim Sim	No	CW	Secondary
	Mid-Atlantic	74		-	Clim sim	No	CW	Secondary
	Great Lakes	79		-	Great Lakes	No	CW	Secondary
	Ohio	79		-	Clim sim	No	CW	Secondary
	Tennessee	79		-	Clim sim	No	CW	Secondary
	Upper Mississippi	80		-	Clim sim	No	CW	Secondary

Table 31. Summary of irrigation consumptive-use coefficients for the Great Lakes Basin, climatically similar areas, and the world. —Continued

[See fig. 7 and table 10 for explanation of column headings. All computed numbers are rounded to the whole number, and reported numbers are as listed in reference.]

Reference	Geographic area	Single coefficient	Median coefficient	N	Statistics area	Used in statistics	Coefficient or other	Data source
Wild and Nimiroski, 2004	Rhode Island, Connecticut	100[6]		1	Clim sim	Yes	Coefficient	Secondary
Wild and Nimiroski, 2005	Rhode Island	100[6]		1	Clim sim	Yes	Coefficient	Secondary
Woldorf, 1959	Ohio	97		-	Great Lakes	No	CW	Primary

[1] Noted as "Agriculture."

[2] Golf-course irrigation.

[3] Includes Indiana, Iowa, Kentucky, Michigan, Wisconsin, and Missouri.

[4] LaTour (1991) estimated irrigation consumptive use by using a consumptive-use coefficient based on lawn watering.

[5] Marcuello and Lallana (2003) said that the consumptive-use coefficients were "widely accepted."

[6] "Consumptive water use for agriculture was assumed to be 100 percent."

Table 32. Summary statistics of irrigation consumptive-use coefficients from selected references.

[Reference refers to the annotated–bibliography references. Consumptive-use coefficients are in percent. If a reference had only one coefficient for the water-use category, it will be under the single coefficient column; and if the reference had multiple coefficients by regions or years, the minimum (min), median, maximum (max) statistics will be listed, as well as the 25th and 75th percentiles. N is the number of coefficients used in the summary statistics tables (tables 9 and 43) and shown in the boxplots. References with more than one coefficient are listed in the appendix. All computed numbers are rounded to the whole number, and reported numbers are as listed in reference. The geographic area is defined by lakes, states, provinces, regions and basins—it can be for the entire geographic area to a small study area within the geographic area.]

Reference	Geographic area	Single coefficient	N	Coefficient statistics				
				Min	25th	Median	75th	Max
Great Lakes Commission, 2005a	Great Lakes	-	42	70	89	90	90	100
Pebbles, 2003b	Great Lakes			70	90	90	90	90
	By state or province:							
	Illinois	90	1					
	Indiana	90	1					
	Michigan	90	1					
	Minnesota	90	1					
	New York	90	1					
	Ohio	90	1					
	Ontario	78	1					
	Pennsylvania	90	1					
	Quebec	90	1					
	Wisconsin	70	1					
USGS circulars, 1983, 1988, 1993, 1998	By state:							
	Great Lakes States		32	74	91	100	100	100
	Climatically similar states		58	37	90	100	100	100
	By basin or region:							
1961, 1968, 1972, 1977, 1983, 1988, 1993, 1998	Great Lakes		-	94	95	97	97	100
	Mid-Atlantic		-	68	86	92	97	100
	New England		-	63	93	99	100	100
	Ohio		-	87	93	94	100	100
	Tennessee		-	70	91	98	100	100
	Upper Mississippi		-	91	93	94	96	100

For irrigation consumptive-use coefficients, the median and 25th and 75th percentiles for the Great Lakes Basin (90, 90 and 96 percent) and climatically similar areas were similar (90, 100, and 100 percent) (table 9 and fig. 16). For the Great Lakes Basin and climatically similar area combined, 75 percent of the irrigation consumptive-use coefficients were between 90 and 100 percent (25th percentile and maximum) (table 4 and fig. 16).

Only a few references differentiated between crop and golf-course irrigation. The International Great Lakes Diversions and Consumptive Use Study Board (1981) used a consumptive-use coefficient of 75 percent for golf courses. The Pennsylvania Department of Environmental Resources (1983) stated that its 100 percent consumptive-use coefficient included golf courses. Often, 100 percent consumptive use is based on the assumption that best management practices are implemented.

Figure 17 shows the consumptive-use coefficients for the Great Lakes States from two references. Solley and others (1998) reported irrigation consumptive-use coefficients ranging from 87 to 100 percent (appendix table 1–7); coefficients in the Great Lakes Commission (2005a) annual reports (1998–2002) ranged from 70 to 90 for the Great Lakes drainage basin in each state, but only Wisconsin reported a value as low as 70 percent (tables 31 and 32, appendix table 3–1). The medians of irrigation consumptive-use coefficients from Solley and others (1998) and the GLC annual reports (1998–2002) are similar (92 and 90 percent from fig. 17).

Horticultural facilities are a special case of irrigation. The U.S. Department of Agriculture, National Agricultural Statistics Service (2001) reported on the number of horticulture facilities that do or do not recycle water. Those that recycle were further separated into groups based on the percentage of water recycled (1 to 4 percent, 5 to 9 percent, 10 to 24 percent, or 25 percent or more). For the Great Lakes States, 78 to 90 percent of the horticultural facilities reported no recycled water, and 91 to 97 percent reported that less than 9 percent of the withdrawal was recycled. Therefore, for most horticulture facilities, more than 91 percent of withdrawal was not recycled (U.S. Department of Agriculture, National Agricultural Statistics Service, 2001, and annotated bibliography). This is consistent with the irrigation consumptive-use coefficients 10th and 90th percentiles (80 and 100 percent).

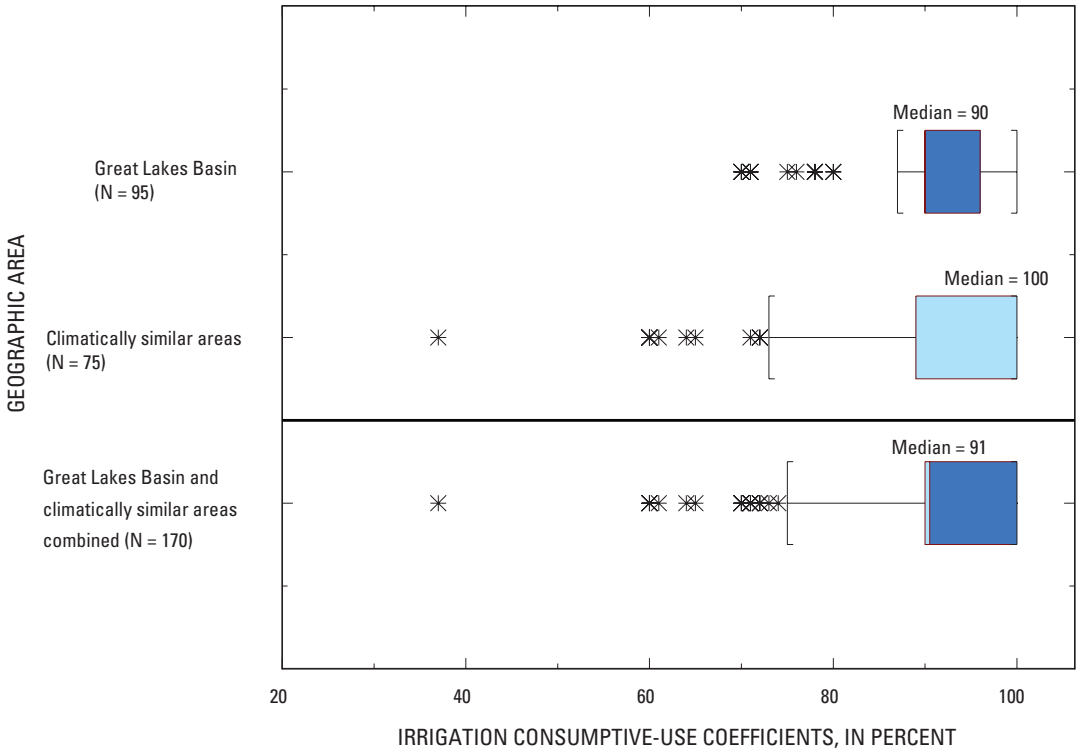


Figure 16. Distribution of irrigation consumptive-use coefficients for the Great Lakes Basin and climatically similar areas. (An explanation of boxplot components is given in figure 9.)

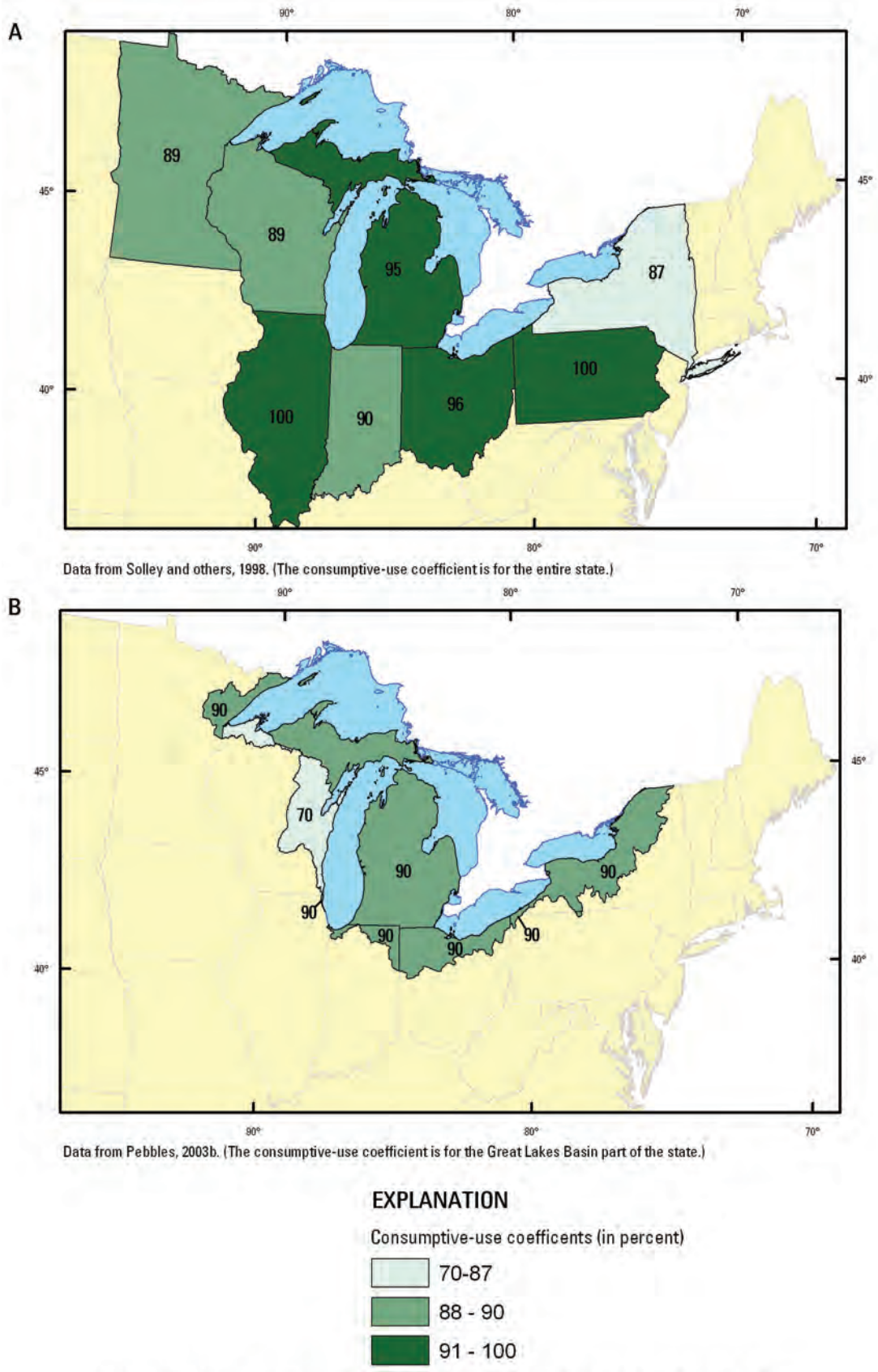


Figure 17. Irrigation consumptive-use coefficients from various sources for Great Lakes States.

For worldwide data, Shiklomanov and Rodda (2003) found that agriculture consumptive-use coefficients ranged from 58 to 84 percent for the 1900 to 1995 assessments for all the continents (table 33). In the most recent assessment (1995), the agriculture coefficients ranged from 60 to 82 percent, with a median of 76 percent.

Additional world, continent, and major-country agriculture coefficients are listed in table 35. The consumptive-use coefficients by European region (table 34) also were compiled for 1980, 1990, and 1995 (Shiklomanov and Rodda, 2003). Although the range of coefficients for these regions was broad—from 47 to 92 percent—the median of 67 percent is comparable to the 68 percent for the entire continent of Europe in 1995 (Shiklomanov and Rodda, 2003) and the 70 percent for Europe from Shiklomanov and Markova (1987).

The 1995 agriculture consumptive-use coefficient for North America from Shiklomanov and Rodda (2003) (table 33, 60 percent) is comparable to that of Solley and others (1998) (61 percent for the United States) but somewhat less than that of Environment Canada (2004) (71 percent for Canada).

Overall, for the world references, the agricultural consumptive-use coefficients ranged from 65 to 78 percent (table 35). Coefficients may differ because of differences in crops, climate, irrigation methods, and irrigation practices.

Table 33. Agricultural water withdrawals, consumptive use, and consumptive-use coefficients, by continent, for selected years from 1900 through 1995.

[Modified from Shiklomanov and Rodda (2003). Total withdrawn and consumptive use are in cubic kilometers per year and are as listed in reference; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data and rounded to the nearest whole number.]

Statistic	1900	1940	1950	1960	1970	1980	1990	1995	1900–1995
					Europe[1]				
Total withdrawn	19.6	34.5	40.9	53.9	82.2	169	195	198	793.1
Consumptive use	14.6	25.0	31.5	38.4	55.6	117	133	135	550.1
Coefficient	74	72	77	71	68	69	68	68	69
					Asia[2]				
Total withdrawn	408	665	816	1,144	1,331	1,526	1,688	1,743	9,321
Consumptive use	320	521	643	907	1,066	1,247	1,411	1,434	7,549
Coefficient	78	78	79	79	80	82	84	82	81
					Africa[3]				
Total withdrawn	40.8	47.7	53.5	79.4	89.0	106	127	134	677.4
Consumptive use	33.1	38.4	43.6	63.3	71.3	85.4	98.0	102	535.1
Coefficient	81	81	81	80	80	81	77	76	79
					North America[4]				
Total withdrawn	39.3	-	149	198	244	286	274	286	1,476.3
Consumptive use	24.6	-	86.3	114	143	171	166	173	877.9
Coefficient	63	-	58	58	59	60	61	60	59
					South America[5]				
Total withdrawn	13.6	24.6	54.3	58.6	65.9	77.3	96.7	99.9	490.9
Consumptive use	10.9	19.7	40.2	41.7	51.4	59.3	74.3	76.3	373.8
Coefficient	80	80	74	71	78	77	77	76	76
					Australia and Oceania[6]				
Total withdrawn	.46	3.50	5.20	9.40	12.5	13.0	14.7	15.5	74.26
Consumptive use	.35	2.80	4.10	7.50	9.90	10.2	11.6	12.2	58.65
Coefficient	76	80	79	80	79	78	79	79	79
					Total				
Total withdrawn	521.76	775.3	1,118.9	1,543.3	1,824.6	2,177.3	2,395.4	2,476.4	12,832.96
Consumptive use	403.55	606.9	848.7	1,171.9	1,397.2	1,689.9	1,893.9	1,932.5	9,944.55
Coefficient	77	78	76	76	77	78	79	78	77

[1] Shiklomanov and Rodda (2003), p. 85, from table 4.19.

[2] Ibid., p. 135, from table 5.25.

[3] Ibid., p. 192, from table 6.18.

[4] Ibid., p. 258, from table 7.22.

[5] Ibid., p. 316, from table 8.19.

[6] Ibid., p. 346, From table 9.21.

Table 34. Agricultural water withdrawals, consumptive use, and consumptive-use coefficients for European regions for selected years from 1980 through 1995.

[Modified from Shiklomanov and Rodda (2003), p. 88. Total withdrawn and consumptive use are in cubic kilometers per year and are as listed in reference; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data and rounded to the nearest whole number.]

Statistic	1980	1990	1995	1980–1995
Northern Europe				
Total withdrawn	1.23	1.57	1.63	4.43
Consumptive use	.70	.97	1.01	2.68
Coefficient	57	62	62	60
Central Europe				
Total withdrawn	26.3	29.7	30.7	86.7
Consumptive use	18.4	20.8	21.6	60.8
Coefficient	70	70	70	70
Southern Europe				
Total withdrawn	93.8	108.0	112.0	313.8
Consumptive use	66.6	73.6	75.0	215.2
Coefficient	71	68	67	69
Northern slope of European territory of former Soviet Union				
Total withdrawn	.68	.72	.71	2.11
Consumptive use	.32	.65	.65	1.62
Coefficient	47	90	92	77
Southern slope of European territory of former Soviet Union				
Total withdrawn	47.7	54.9	53.7	156.3
Consumptive use	30.9	36.5	36.1	103.5
Coefficient	65	66	67	66
Total				
Total withdrawn	169.71	194.89	198.74	563.34
Consumptive use	116.92	132.52	134.36	383.8
Coefficient	69	68	68	68

Table 35. Agriculture consumptive-use coefficients for large countries, continents, and the world.

[Coefficient is in percent and rounded to the nearest whole number.]

Reference	Geographic area	Coefficient
College of Exploration [n.d.]	World	65
Cosgrove, and Rijsberman, 2000	World	70
Environment Canada, 2004	Canada	71
European Environment Agency, 2005	Europe	80
Marcuello and Lallana, 2003	Europe	80
Postel and others, 1996	World	65
Shiklomanov and Rodda, 2003 (1995 assessment only)	World	78
	By continent:	
	Europe	68
	Asia	82
	Africa	76
	North America	60
	South America	76
	Australia and Oceania	79
Solley and others, 1998[1]	United States	61

[1] It is also noted that 19 percent of the withdrawals was lost through conveyance.

Livestock

Livestock water use is water used for stock watering, feedlots, dairy operations, fish farming, and other on-farm needs. Livestock includes sheep, goats, cattle, hogs, poultry, horses, rabbits, bees, pets, fur-bearing animals in captivity, and fish in captivity (except fish hatcheries). Livestock consumptive use occurs through processes such as stock watering and facility and animal cleaning. Many references use the terms "agricultural withdrawals" and "agriculture consumptive use," which may describe both the irrigation and livestock withdrawals and consumptive use. Thus, the agriculture consumptive-use coefficients are presented in both the irrigation and livestock categories. Table 36 is a summary of livestock consumptive-use coefficients by reference, and table 37 is summary statistics of livestock consumptive-use coefficients for references with multiple coefficients.

As with the other water-use categories, publications starting in 1980 were used in the summary statistics (tables 9, 36, 37). As is evident in tables 36 and 37, livestock consumptive-use coefficients range from 0 to 100 percent. The large range in livestock consumptive-use coefficients may be due to:

- the mixture of livestock and animal specialties in each state,
- a wide range of consumptive-use coefficients for fish farming by itself, (where a small coefficient represents a facility that returns most of its withdrawals and a large coefficient represents a facility that returns either a small amount or none of its withdrawals),
- time, evaporation, and water quality (water that is used for or by livestock that is not discharged into a waste-treatment system is more likely to be evaporated before it reaches the water table and therefore not available for reuse, and degradation of water quality may limit the reuse of the water), or
- differences in compilation methods.

For example, between 1980 and 2005, the classification of certain aspects of the livestock water-use category changed in the USGS Circulars. In Solley and others (1983), livestock water use was listed under the category "Rural Freshwater Use." In Solley and others (1988) and subsequent publications, livestock water use was its own category. Solley and others (1988) found that a large increase in livestock use was due to increases in fish farming; additionally states that previously reported fish farming under the industrial water-use category had begun reporting it as livestock water use. As can be seen in appendix tables 1–9 and 1–10, some states reported large livestock consumptive-use coefficients in 1980 and much lower coefficients in 1985, which may have been a result of adding fish-farming withdrawals to the livestock category.

Table 36. Summary of livestock consumptive-use coefficients for the Great Lakes Basin, climatically similar areas, and the world.

[See fig. 7 and table 10 for explanation of column headings. All computed numbers are rounded to the whole number, and reported numbers are as listed in reference.]

Reference	Geographic area	Single coefficient	Median coefficient	N	Statistics area	Used in statistics	Coefficient or other	Data source
College of Exploration [n.d.][1]	World	65		-	Other	No	CW	Unknown
Ellefson and others, 1987[2]	Wisconsin	80		1	Great Lakes	Yes	Coefficient	Primary
Endreny, 2004	New York	88		1	Great Lakes	Yes	CW	Secondary
European Environment Agency, 2005[1]	Europe	80		-	Other	No	Coefficient	Primary
Great Lakes Commission, 2005a	Great Lakes		80	32	Great Lakes	Yes	CW	Secondary
Horn and others, 1994	Rhode Island	80		1	Clim sim	Yes	Coefficient	Unknown
Hutson, 1998	Tennessee	Almost all		-	Clim sim	No	CW	Primary
International Great Lakes Diversions and Consumptive Use Study Board, 1981	Great Lakes	100		1	Great Lakes	Yes	Coefficient	Primary
Loper and others, 1989	Pennsylvania	75		1	Great Lakes	Yes	Coefficient	Secondary
Ludlow and Gast, 2000	Pennsylvania	74		1	Great Lakes	Yes	Coefficient	Primary
Marcuello and Lallana, 2003[1,3]	Europe	80		-	Other	No	Coefficient	Secondary
Nimiroski and Wild, 2005[4]	Rhode Island	100		1	Clim sim	Yes	Coefficient	Secondary
Ohlsson, 1997[1]	World	65		-	Other	No	Coefficient	Secondary
Paulson and others, 1988	United States	53.9		-	Other	No	Coefficient	Secondary
Pebbles, 2003b	Great Lakes, by state:							
	Illinois	80		1	Great Lakes	Yes	Coefficient	Secondary
	Indiana	80		1	Great Lakes	Yes	Coefficient	Secondary
	Michigan	80		1	Great Lakes	Yes	Coefficient	Secondary
	Minnesota	80		1	Great Lakes	Yes	Coefficient	Secondary
	New York	90		1	Great Lakes	Yes	Coefficient	Secondary
	Ohio	80		1	Great Lakes	Yes	Coefficient	Secondary
	Ontario	80		1	Great Lakes	Yes	Coefficient	Secondary
	Pennsylvania	80		1	Great Lakes	Yes	Coefficient	Secondary
	Quebec	80		1	Great Lakes	Yes	Coefficient	Secondary
	Wisconsin	90		1	Great Lakes	Yes	Coefficient	Secondary
Pennsylvania Department of Environment Resources, 1975–83	Pennsylvania	75		-	Great Lakes	No	Coefficient	Primary
Postel, 1996[1]	World	65		-	Other	No	CW	Secondary
Postel and others, 1996[1]	World	65		-	Other	No	CW	Primary
Shiklamanov and Rodda, 2003[1]	Europe	70		-	Other	No	Coefficient	Secondary
Sholar and Lee, 1988	Kentucky	100		1	Clim sim	Yes	CW	Primary
Sholar and Wood, 1995	Kentucky	100		1	Clim sim	Yes	CW	Primary
Snavely, 1988:	Great Lakes							
1975 Study Board		100		-	Great Lakes	No	CW	Secondary
1975 USGS		93		-	Great Lakes	No	CW	Secondary
1980 Study Board		100		1	Great Lakes	Yes	CW	Secondary
1980 USGS		92		1	Great Lakes	Yes	CW	Secondary
1985 Study Board		100		1	Great Lakes	Yes	CW	Secondary
1985 USGS		88		1	Great Lakes	Yes	CW	Secondary
Stevens and others, 1984[1]	West Virginia	100		1	Clim sim	Yes	RW	Primary

Table 36. Summary of livestock consumptive-use coefficients for the Great Lakes Basin, climatically similar areas, and the world. —Continued

[See fig. 7 and table 10 for explanation of column headings. All computed numbers are rounded to the whole number, and reported numbers are as listed in reference.]

Reference	Geographic area	Single coefficient	Median coefficient	N	Statistics area	Used in statistics	Coefficient or other	Data source
Suder and Lessing, 1984[1]	West Virginia	100		1	Clim sim	Yes	RW	Primary
Suder and Lessing, 1985[1]	West Virginia	100		1	Clim sim	Yes	RW	Primary
Suder and Lessing, 1986[1]	West Virginia	100		1	Clim sim	Yes	RW	Primary
Suder and Lessing, 1987[1]	West Virginia	100		1	Clim sim	Yes	RW	Primary
Sweat and Van Til, 1988	Michigan	96		1	Great Lakes	Yes	CW	Secondary
Tate, 1988[1]:	Canada							
1966 Agriculture		72		-	Other	No	CW	Secondary
1972 Agriculture		72		-	Other	No	CW	Secondary
1976 Agriculture		72		-	Other	No	CW	Secondary
Tate and Harris, 1999a[1,5]	Canadian portion of Great Lakes	78-80[5]		1	Great Lakes	Yes	Coefficient	Secondary
USGS Circulars, 1983, 1988, 1993, 1998	By state:							
	Great Lakes States		89	32	Great Lakes	Yes	CW	Secondary
	Climatically similar states		100	60	Clim sim	Yes	CW	Secondary
1961, 1968, 1972, 1977, 1983, 1988, 1993, 1998	By basin or region:		92	-	Great Lakes	No	CW	Secondary
	Great Lakes		84	-	Clim sim	No	CW	Secondary
	Mid-Atlantic		100	-	Clim sim	No	CW	Secondary
	New England		94	-	Clim sim	No	CW	Secondary
	Ohio		98	-	Clim sim	No	CW	Secondary
	Tennessee		96	-	Clim sim	No	CW	Secondary
	Upper Mississippi							
USGS and Tennessee Department of Environment and Conservation, 2003[1]	Tennessee	100		1	Clim sim	Yes	Coefficient	Primary
Veeger and others, 2003	Rhode Island	100		1	Clim sim	Yes	Coefficient	Secondary
Water Resources Council (U.S.), 1978	By basin or region:							
	New England	100		-	Clim sim	No	CW	Secondary
	Mid-Atlantic	100		-	Clim sim	No	CW	Secondary
	Great Lakes	100		-	Great Lakes	No	CW	Secondary
	Ohio	100		-	Clim sim	No	CW	Secondary
	Tennessee	100		-	Clim sim	No	CW	Secondary
	Upper Mississippi	100		-	Clim sim	No	CW	Secondary
Wild and Nimiroski, 2004[4]	Rhode Island, Connecticut	100		1	Clim sim	Yes	Coefficient	Secondary
Wild and Nimiroski, 2005[4]	Rhode Island	100		1	Clim sim	Yes	Coefficient	Secondary

[1] Noted as “Agriculture.”

[2] Noted as “non-irrigation agricultural uses.”

[3] Marcuello and Lallana (2003) said that the consumptive-use coefficients were “widely accepted.”

[4] “Consumptive water use for agriculture was assumed to be 100 percent.”

[5] Noted as a range; therefore, the average of the range (79) is used in the statistical analysis.

Table 37. Summary statistics of livestock consumptive-use coefficients for selected references.

[Reference refers to the annotated-bibliography references. Consumptive-use coefficients are in percent. N is the number of coefficients used in the summary statistics tables (tables 9 and 43) and shown in the boxplots. References are listed in the appendix. All computed numbers are rounded to the whole number, and reported numbers are as listed in reference. The geographic area is defined by lakes, states, provinces, basins and regions—it can be for the entire geographic area to a small study area within the geographic area.]

Reference	Geographic area	N	Coefficient statistics				
			Min	25th	Median	75th	Max
USGS Circulars, 1983, 1988, 1993, 1998	By state:						
	Great Lakes States	32	67	81	89	100	100
	Climatically similar states	60	10	84	100	100	100
	By basin or region:						
	Great Lakes	-	86	88	92	92	95
	Mid-Atlantic	-	60	80	84	86	91
1960–95	New England	-	68	89	100	100	100
	Ohio	-	84	90	94	100	100
	Tennessee	-	47	94	98	100	100
	Upper Mississippi	-	92	93	96	98	100
Great Lakes Commission, 2005a	Great Lakes Basin, by states and provinces	32	01	80	80	90	91

[1] The range of coefficient may reflect differences in the definition of livestock use. Livestock use may be limited to the watering of livestock or may include the maintenance operations associated with raising livestock. Including aquaculture changes the definition and activity and results in a different livestock consumptive-use coefficient. The livestock low coefficient minimum (0) for the Great Lakes Commission (2005a) is from Minnesota in 1998. Minnesota reported 0.25 Mgal/d total withdrawn in 1998 and 0.0 Mgal/d consumptive use. The next lowest consumptive-use coefficient for this reference is 66 percent.

Although coefficients for 1985 (Solley and others, 1988) were included in the statistical analysis, it should be noted that many of the outliers are for this year. To better see the effect of these outliers, two statistics summaries are included in this report (table 38). Table 38 has statistics for irrigation with and without irrigation coefficients from Solley and others (1988). The 10th and 90th percentiles were computed to highlight the range of consumptive-use coefficients. Most of the statistics in table 38 were similar except the minimum for the climatically similar areas, the minimum for all references, and the 10th percentile for the climatically similar areas. The coefficients from Solley and others (1988) have the six smallest coefficients for the 1980 to 2005 period of all the references (Appendix tables 1–9 and 1–10). Table 38 also shows the statistics if the "agriculture" coefficients are not used. This exclusion varied a few numbers within only a 2-percent range.

In Solley and others (1993), the livestock category definition changed again when livestock was divided into subcategories: livestock and animal specialties. The **animal specialties** subcategory is the water used for fish farming and fish in captivity, with the exception of fish hatcheries. Animal specialties also includes water used for fur-bearing animals in captivity such as horses, rabbits, and pets. Animal-specialties water use (Solley and others, 1993, 1998) is in the back of this report in Appendix tables 1–11 and 1–12.

Although a wide range of livestock consumptive-use coefficients has been reported, 75 percent of all the livestock consumptive-use coefficients are between 80 and 100 percent (25th percentile and maximum) (fig. 18). Most of the livestock consumptive-use coefficients are based on assumptions and definitions, not studies for the most part. The major exception to this would be aquaculture, where water may either be continuously run through the hatchery or fish farm (low consumptive use coefficient) or be allowed to remain in a pond long enough for evaporation to become a significant factor (higher consumptive-use coefficient). The few world coefficients were noted on "agricultural" and not livestock. These coefficients tended to be lower than the livestock coefficients for the Great Lakes Basin.

Table 38. Livestock consumptive-use coefficient statistics for the Great Lakes Basin, climatically similar areas, and all references including and excluding Solley and others (1998) and excluding agriculture coefficients.

[Great Lakes Basin refers to basins and states in the Great Lakes Basin. Climatically similar areas are basins, states, and countries that are climatically similar to the Great Lakes Basin. All references are the combined references of the Great Lakes Basin and climatically similar areas. References used in the statistical analysis are only from publications printed after 1980 and do not include world coefficients, coefficients for all of Canada, or coefficients for all of the United States because they include areas that are not climatically similar to the Great Lakes. The minimum, median, maximum, 25th percentile, and the 75th percentile are in percent. N is the number of coefficients used in the statistical analysis.]

Type of reference	Statistics							
	Min	10th	25th	Median	75th	90th	Max	N
Including coefficients in Solley and others (1998)								
Great Lakes Basin	0[1]	76	80	83	90	100	100	85
Climatically similar areas	10	61	86	100	100	100	100	73
All references	0[1]	75	80	90	100	100	100	158
Excluding coefficients in Solley and others (1998)								
Great Lakes Basin	0[1]	75	80	80	90	100	100	77
Climatically similar areas	50	82	88	100	100	100	100	57
All references	0[1]	78	80	90	100	100	100	134
Excluding agriculture coefficients								
Great Lakes Basin	0[1]	76	80	85	90	100	100	85
Climatically similar areas	10	56	85	100	100	100	100	72
All references	0[1]	75	80	89	100	100	100	157

[1] The livestock low coefficient minimum (0) for the Great Lakes Commission (2005a) is from Minnesota in 1998. Minnesota reported 0.25 Mgal/d total withdrawn in 1998 and 0.0 Mgal/d consumptive use. The next lowest consumptive-use coefficient for this reference is 66 percent.

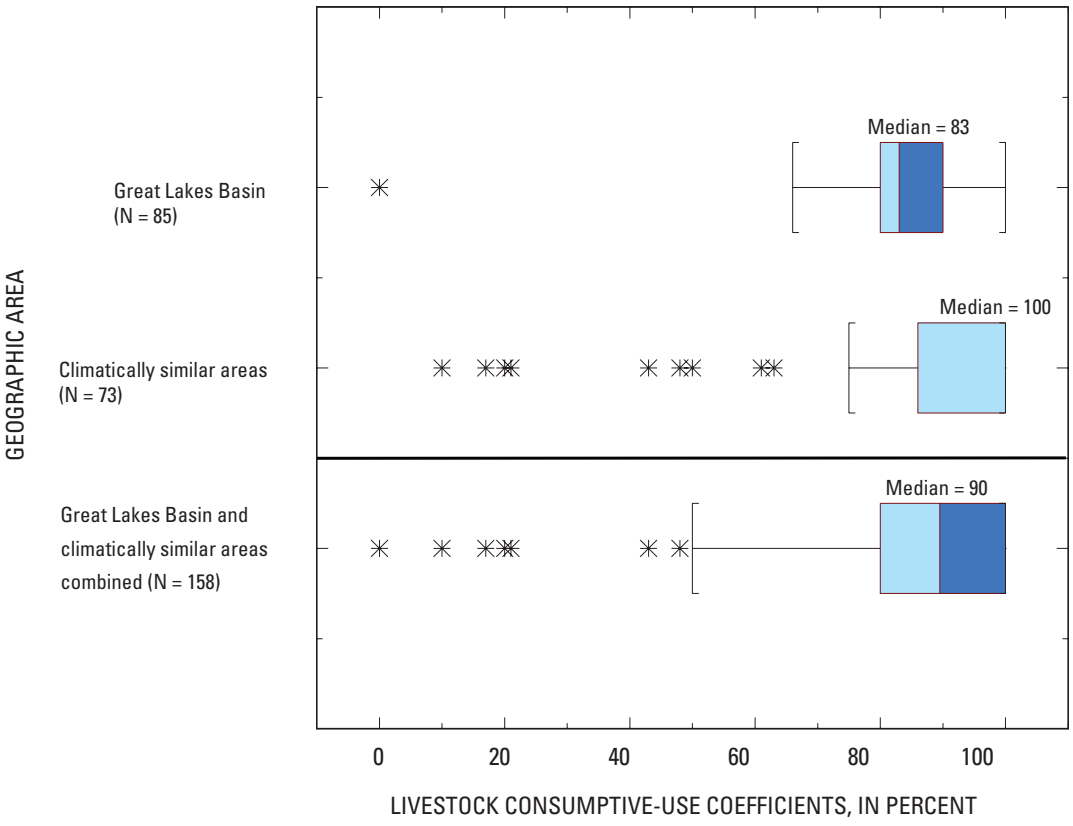


Figure 18. Livestock consumptive-use coefficients for the Great Lakes Basin and climatically similar areas. (An explanation of boxplot components is given in figure 9.)

Commercial

Commercial water use is water used in restaurants, motels, hotels, office buildings, military and nonmilitary institutions, snow making, and other commercial facilities; also, Solley and others (1993 and 1998) included water for offstream fish hatcheries. Processes that contribute to consumptive use of commercial water use would be lawn and landscape watering, sidewalk and car washing, snow making, evaporation from offstream fish hatcheries, and a lesser extent cooking, cleaning, showering, and clothes washing. Table 39 is a compilation of commercial consumptive-use coefficients listed by references, and table 40 lists summary statistics for references with multiple consumptive-use coefficients.

No world references were located for the commercial category, and most of the coefficients were from USGS reports. All the references were used for the summary statistics; the earliest coefficient was from 1975. Most of the commercial consumptive-use coefficients were from 1980 to 2005.

The commercial consumptive-use coefficients were similar between the Great Lakes Basin and climatically similar areas (fig. 19). Fifty percent of all coefficients from the references were between 8 and 13 percent (table 9 and fig. 19). Both the Great Lakes Basin and climatically similar areas had the same commercial consumptive-use coefficient median (10 percent; table 9 and fig. 19).

Schools, office buildings, and hospitals are commercial water- and consumptive-use facilities.

Table 39. Summary of commercial consumptive-use coefficients for the Great Lakes Basin and climatically similar areas.

[See fig. 7 and table 10 for explanation of column headings. All computed numbers are rounded to the whole number, and reported numbers are as listed in reference.]

Reference	Geographic area	Single coefficient	Median coefficient	N	Statistics area	Used in statistics	Coefficient or other	Data source
Barlow, 2003	Rhode Island, Massachusetts	10[1]		1	Clim sim	Yes	Coefficient	Secondary
Endreny, 2005	New York	10		1	Great Lakes	Yes	CW	Secondary
Horn and others, 1994	Rhode Island	8		1	Clim sim	Yes	Coefficient	Primary
Horn, 2000	Massachusetts	10		1	Clim sim	Yes	Coefficient	Primary
Hutson, 1998	Tennessee	10		1	Clim sim	Yes	CW	Primary
LaTour, 1991	Illinois	9.6[2]		1	Great Lakes	Yes	CW	Primary
Ludlow and Gast, 2000	Pennsylvania	5		1	Great Lakes	Yes	CW	Primary
Nawyn, 1997	New Jersey	4		1		Yes	Coefficient	Secondary
Nimiroski and Wild, 2005	Rhode Island	10		1	Clim sim	Yes	Coefficient	Secondary
Paulson and others, 1988	United States	19.5[3]		-	Other	No	Coefficient	Secondary
Pennsylvania Department of Environmental Resources, 1975–83	Pennsylvania	10[4]		1	Great Lakes	Yes	Coefficient	Primary
Sholar and Lee, 1988	Kentucky	4		1	Clim sim	Yes	CW	Primary
Sholar and Wood, 1995	Kentucky	3		1	Clim sim	Yes	CW	Primary
USGS Circulars, 1988, 1993, 1998	By states:							
	Great Lakes States		10	24	Great Lakes	Yes	CW	Secondary
	Climatically similar states		10	45	Clim sim	Yes	CW	Secondary
	By basin or region:							
	Great Lakes		9	-	Great Lakes	Yes	CW	Secondary
	Mid-Atlantic		9	-	Clim sim	Yes	CW	Secondary
	New England		12	-	Clim sim	Yes	CW	Secondary
	Ohio		10	-	Clim sim	Yes	CW	Secondary
	Tennessee		10	-	Clim sim	Yes	CW	Secondary
	Upper Mississippi		10	-	Clim sim	Yes	CW	Secondary
USGS and Tennessee Department of Environment and Conservation, 2003	Tennessee	11[5]		-	Clim sim	No	Coefficient	Primary
Veeger and others, 2003	Rhode Island	10		1	Clim sim	Yes	Coefficient	Secondary
Water Resources Council (U.S.), 1978	By basin or region:							
	New England	13		1	Clim sim	Yes	CW	Secondary
	Mid-Atlantic	14		1	Clim sim	Yes	CW	Secondary
	Great Lakes	11		1	Great Lakes	Yes	CW	Secondary
	Ohio	13		1	Clim sim	Yes	CW	Secondary
	Tennessee	12		1	Clim sim	Yes	CW	Secondary
	Upper Mississippi	12		1	Clim sim	Yes	CW	Secondary
Wild and Nimiroski, 2004	Rhode Island and Connecticut	10		1	Clim sim	Yes	Coefficient	Secondary
Wild and Nimiroski, 2005	Rhode Island	10		1	Clim sim	Yes	Coefficient	Secondary

[1] The commercial consumptive-use coefficient is from “New England traditional rates.”

[2] Although LaTour (1991) reported a large range of consumptive-use coefficients for commercial, the “minimum consumptive-use ratio” 9.6 percent was used to estimate consumptive use when data were not available.

[3] Commercial and domestic are grouped together in this coefficient.

[4] Noted as 10 percent for “other self-supplied institutions.”

[5] Not used because this coefficient is from an octopus diagram where commercial, industrial, and mining consumptive use are combined.

Table 40. Summary statistics of commercial consumptive-use coefficients for selected references.

[Reference refers to the annotated bibliography references. Consumptive-use coefficients are in percent. N is the number of coefficients used in the summary statistics tables (tables 9 and 43) and shown in the boxplots. References are listed in the appendix. All computed numbers are rounded to the whole number, and reported numbers are as listed in reference. The geographic area is defined by lakes, states, provinces, countries, continents, and the world—it can be for the entire geographic area to a small study area within the geographic area.]

Reference	Geographic area	N	Coefficient statistics				
			Min	25th	Median	75th	Max
USGS Circulars, 1988, 1993, 1998[1]	By states:						
	Great Lakes States	24	4	8	10	15	26
	Climatically similar states	45	4	7	10	13	33
	By basin or region:						
	Great Lakes	-	9	9	9	10	11
	Mid-Atlantic	-	8	8	9	10	12
	New England	-	11	12	12	18	23
	Ohio	-	8	9	10	12	15
	Tennessee	-	9	10	10	11	12
	Upper Mississippi	-	10	10	10	11	12

[1] Solley and others (1988, 1993, 1998).

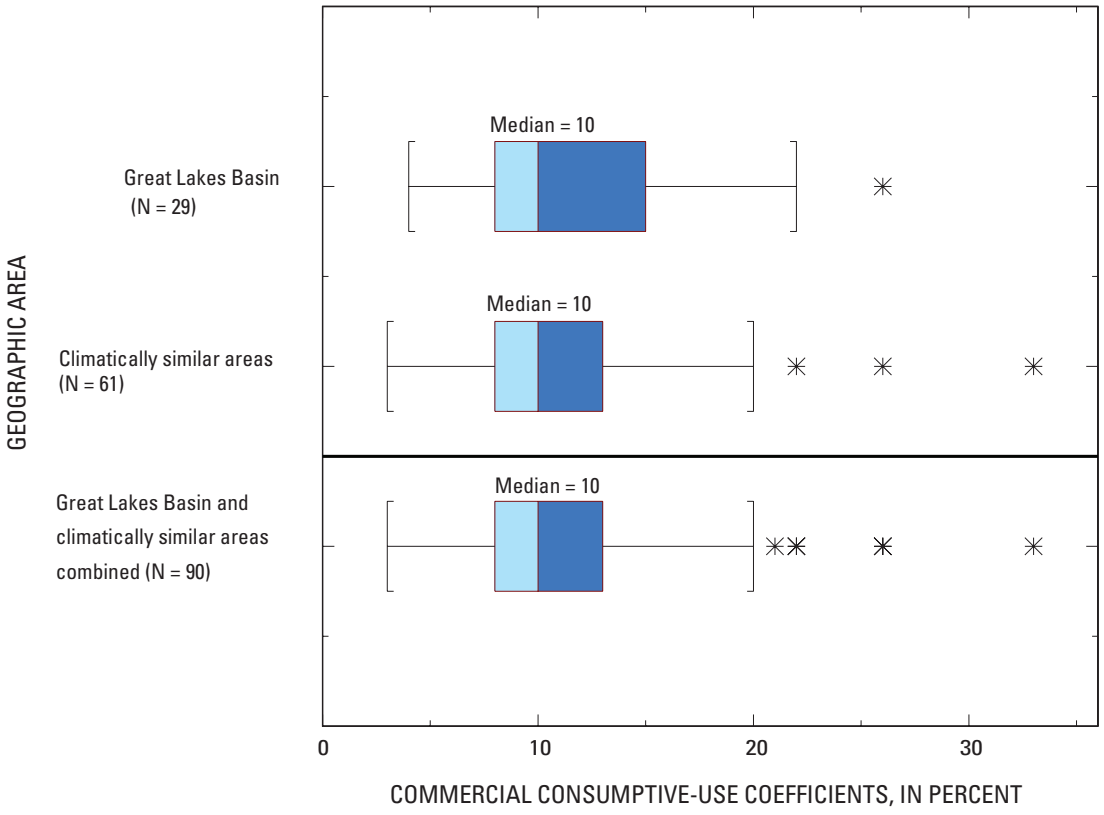


Figure 19. Commercial consumptive-use coefficients for the Great Lakes Basin and climatically similar areas. (An explanation of boxplot components is given in figure 9.)

Mining

Mining water use and consumptive use is the water withdrawn and the portion of water consumed during the extraction of minerals. Minerals may be metals or nonmetals, solid or liquid. Extraction of minerals includes the following activities: quarrying, milling (crushing, washing, screening, and flotation of mined materials), and other operations associated with mining activities (Hutson and others, 2004a).

Mining withdrawals, consumptive use, and consumptive-use coefficients in response vary to:

- the type of mining,
- the mining environment,
- the processes at the mining facility, and
- the methods used to estimate withdrawals and consumptive use.

In many documents, the authors noted that mining withdrawals were difficult to quantify. Solley and others (1998) stated that, with the exception of some washing and milling, water at mining sites tends to be an impediment to or a by-product of the extraction process. For many references, consumptive-use estimates were computed by use of consumptive-use coefficients specific to the type of mining. The consumptive-use coefficients were highly variable by type of mining. For example, Quan (1988) published a wide range of mining consumptive-use coefficients. For metal mining, the consumptive-use coefficients ranged from 1 (for lead) to 77 percent (for copper) and nonmetal mining ranged from 0 (for magnesium) to 100 percent (for diatomite) (Quan, 1988).

A few authors found that the water discharged was greater than the water withdrawn, for example the U.S. Bureau of the Census (1985). The reason for this discrepancy may be because of mine dewatering. During the dewatering process, excess water is drained from the mine and is a by-product of the extraction process. The amount of water discharged in the mining operation includes the return flow plus the excess water drained from the mine. A representative consumptive-use coefficient could not be computed from such references.

The references by Quan (1988), Kaufman and Nadler (1966), and the Water Resources Council 1978) contain detailed mining water use data. More information on these sites is in the annotated bibliography section.

Table 41 is a compilation of mining consumptive-use coefficients listed by reference and illustrates the range in the mining consumptive-use coefficients. Table 42 is the statistical summary for selected references that had multiple mining consumptive-use coefficients. As is evident in figure 20, there are many outliers in the boxplot.

Table 41. Summary of mining consumptive-use coefficients for the Great Lakes Basin, climatically similar areas, and Canada from 1975 through 2004.

[See fig. 7 and table 10 for explanation of column headings. All computed numbers are rounded to the whole number, and reported numbers are as listed in reference.]

Reference	Geographic area	Single coefficient	Median coefficient	N	Statistics area	Used in statistics	Coefficient or other	Data source
Endreny, 2005	New York	27		1	Great Lakes	Yes	CW	Secondary
Hutson, 1998	Tennessee	11		1	Clim sim	Yes	CW	Primary
International Great Lakes Diversions and Consumptive Use Study Board, 1981[1]	Canada	11		-	Other	No	CW	Secondary
Kaufman and Nadler, 1966	United States	16		-	Other	No	CW	Primary
	Great Lakes States	6		-	Other	No	CW	Primary
	By state:							
	Illinois	5		-	Great Lakes	No	CW	Primary
	Indiana	5		-	Great Lakes	No	CW	Primary
	Michigan	3		-	Great Lakes	No	CW	Primary
	Minnesota	4		-	Great Lakes	No	CW	Primary
	New York	10		-	Great Lakes	No	CW	Primary
	Ohio	12		-	Great Lakes	No	CW	Primary
	Pennsylvania	9		-	Great Lakes	No	CW	Primary
	Wisconsin	3		-	Great Lakes	No	CW	Primary
	By basin or region:							
	Chesapeake Bay	7		-	Clim Sim	No	CW	Primary
	Cumberland	11		-	Clim Sim	No	CW	Primary
	Delaware and Hudson	6		-	Clim Sim	No	CW	Primary
	Great Lakes[2]	5		-	Great Lakes	No	CW	Primary
	Upper Mississippi	7		-	Clim sim	No	CW	Primary
	New England	7		-	Clim sim	No	CW	Primary
	Ohio	12		-	Clim sim	No	CW	Primary
	Tennessee	32		-	Clim sim	No	CW	Primary
Loper and others, 1989	Pennsylvania	14		1	Great Lakes	Yes	CW	Secondary
Ludlow and Gast, 2000	Pennsylvania	8		1	Great Lakes	Yes	CW	Primary
Nawyn, 1997	New Jersey	8		1	Clim sim	Yes	Coefficient	Secondary
Paulson and others, 1988	United States	16		-	Other	No	Coefficient	Secondary
Pebbles, 2003b	By state:							
	Ohio (salt mining)[3]	90		-	Great Lakes	No	Coeffiicent	Secondary
	Wisconsin	10		1	Great Lakes	Yes	Coefficient	Secondary
Pennsylvania Department of Environmental Resources, 1975–83	Pennsylvania		7	19	Great Lakes	Yes	CW	Primary
Quan, 1988	By states:							
	Great Lakes States		21	8	Great Lakes	Yes	CW	Primary
	Climatically similar states		26	16	Clim Sim	Yes	CW	Primary
Sholar and Lee, 1988	Kentucky	3		1	Clim sim	Yes	CW	Primary
Sholar and Wood, 1995	Kentucky	3		1	Clim sim	Yes	CW	Primary
Tate, 1988:								
1966 Manufacturing		24	Canada	-	Other	No	CW	Secondary
1972 Manufacturing		24		-	Other	No	CW	Secondary
1976 Manufacturing		16		-	Other	No	CW	Secondary

Table 41. Summary of mining consumptive-use coefficients for the Great Lakes Basin, climatically similar areas, and Canada from 1975 through 2004. —Continued

[See fig. 7 and table 10 for explanation of column headings. All computed numbers are rounded to the whole number, and reported numbers are as listed in reference.]

Reference	Geographic area	Single coefficient	Median coefficient	N	Statistics area	Used in statistics	Coefficient or other	Data source
USGS Circulars, 1988, 1993, 1998	By states:							
	Great Lakes States		14	23	Great Lakes	Yes	CW	Secondary
	Climatically similar states		11	42	Clim sim	Yes	CW	Secondary
	By basin or region:							
	Great Lakes		24	-	Great Lakes	No	CW	Secondary
	Mid-Atlantic		12	-	Clim sim	No	CW	Secondary
	New England		12	-	Clim sim	No	CW	Secondary
	Ohio		22	-	Clim sim	No	CW	Secondary
	Tennessee		12	-	Clim sim	No	CW	Secondary
	Upper Mississippi		21	-	Clim sim	No	CW	Secondary
USGS and Tennessee Department of Environment and Conservation, 2003	Tennessee	11		1	Clim sim	Yes	Coefficient	Primary
van der Leeden, 1975:	Belgium							
Coal mines		7		1	Clim sim	Yes	CW	Secondary
Quarries		5		1	Clim sim	Yes	CW	Secondary
Water Resources Council (U.S.), 1978	By basin or region:							
	Minerals							
	New England	12		1	Clim sim	Yes	CW	Secondary
	Mid-Atlantic	15		1	Clim sim	Yes	CW	Secondary
	Great Lakes	22		1	Great Lakes	Yes	CW	Secondary
	Ohio	18		1	Clim sim	Yes	CW	Secondary
	Tennessee	14		1	Clim sim	Yes	CW	Secondary
	Upper Mississippi	14		1	Clim sim	Yes	CW	Secondary
	Nonmetals							
	New England	13		1	Clim sim	Yes	CW	Secondary
	Mid-Atlantic	13		1	Clim sim	Yes	CW	Seondary
	Great Lakes	14		1	Great Lakes	Yes	CW	Secondary
	Ohio	11		1	Clim sim	Yes	CW	Secondary
	Tennessee	14		1	Clim sim	Yes	CW	Secondary
	Upper Mississippi	13		1	Clim sim	Yes	CW	Secondary
	Fuels							
	New England	-		-	Clim sim	No	CW	Secondary
	Mid-Atlantic	57		1	Clim sim	Yes	CW	Secondary
	Great Lakes	57		1	Great Lakes	Yes	CW	Secondary
	Ohio	31		1	Clim sim	Yes	CW	Secondary
	Tennessee	12		1	Clim sim	Yes	CW	Secondary
	Upper Mississippi	20		1	Clim sim	Yes	CW	Secondary
	Metals							
	New England	-		-	Clim sim	No	CW	Secondary
	Mid-Atlantic	14		1	Clim sim	Yes	CW	Secondary
	Great Lakes	37		1	Great Lakes	Yes	CW	Secondary
	Ohio	-		-	Clim sim	No	CW	Secondary
	Tennessee	12		1	Clim sim	Yes	CW	Secondary
	Upper Mississippi	16		1	Clim sim	Yes	CW	Secondary

[1] Noted as “Mines & Mineral Fuels.”

[2] Great Lakes includes Eastern Great Lakes—St. Lawrence River and Western Great Lakes.

[3] This is only for salt mining and was not used in the statistical analysis.

[4] This is noted as being the consumptive-use coefficient for industrial-mining.

Table 42. Summary statistics for mining consumptive-use coefficients from selected references.

[Reference refers to the annotated bibliography references. Consumptive-use coefficients are in percent. N is the number of coefficients used in the summary statistics tables (tables 9 and 43) and shown in the boxplots. References are listed in the appendix. All computed numbers are rounded to the whole number, and reported numbers are as listed in reference. The geographic area is defined by lakes, states, provinces, countries, continents, and the world—it can be for the entire geographic area to a small study area within the geographic area.]

Reference	Geographic area	N	Coefficient statistics				
			Min	25th	Median	75th	Max
Pennsylvania Department of Environmental Resources, 1975–83	Pennsylvania	19	5	6	7	8	17.6
Quan, 1988	By states:						
	Great Lakes States	8	14	20	21	28	34
	Climatically similar states	16	11	23	26	33	86
USGS Circulars, 1988, 1993, 1998							
	By states:						
	Great Lakes States	23	0	6	14	36	58
	Climatically similar states	42	0	8	11	19	70
	By basin or region:						
	Great Lakes	-	9	16	24	25	26
	Mid-Atlantic	-	11	12	12	16	19
	New England	-	11	12	12	14	16
	Ohio	-	16	19	22	37	52
	Tennessee	-	10	11	12	12	13
	Upper Mississippi	-	17	19	21	28	36

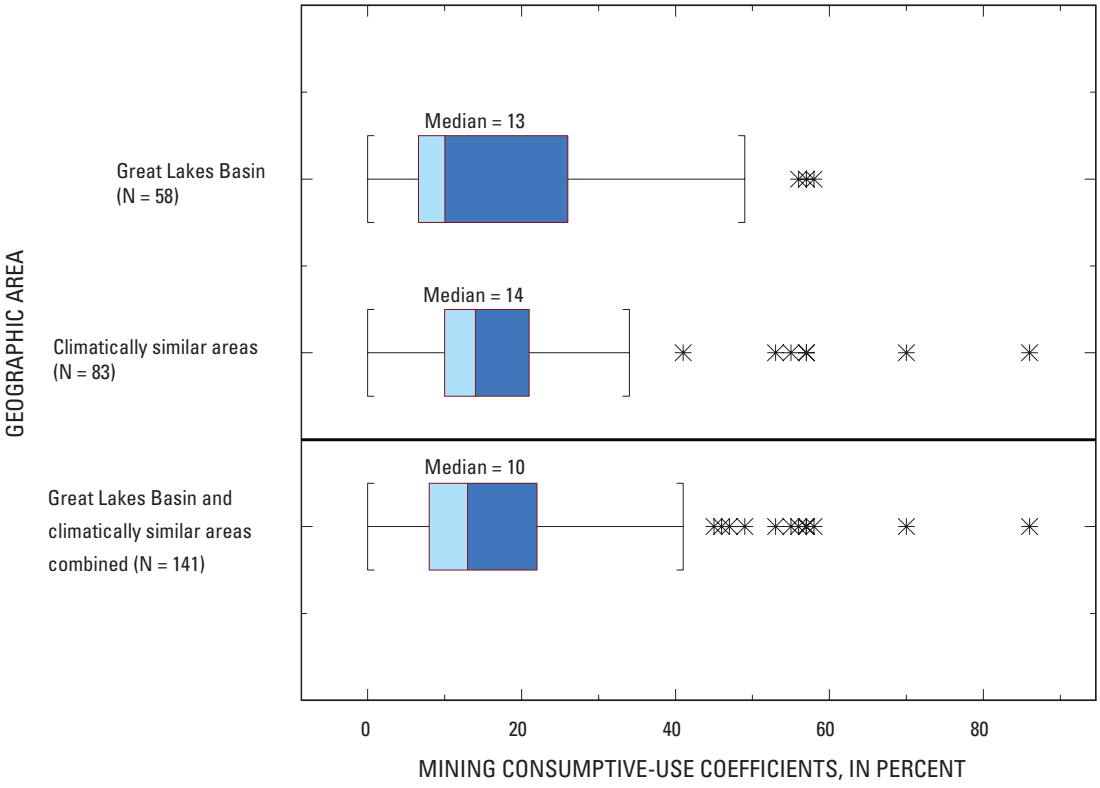


Figure 20. Distribution of mining consumptive-use coefficients for the Great Lakes Basin and climatically similar areas. (An explanation of boxplot components is given in figure 9.)

Comparison of Consumptive-Use Coefficients by Area

This section of the report compares the Great Lakes Basin, climatically similar areas, and the world consumptive-use coefficients for domestic and public supply, industrial, irrigation and livestock water-use categories; it also compares consumptive-use coefficients in the Great Lakes Basin and climatically similar areas for the thermoelectric power, commercial, and mining water-use categories. The dataset for the world statistics is small—only four numbers were found among all the references examined for this study.

The range of the world domestic and public-supply consumptive-use coefficients (14 to 19) was similar to the 25th and 75th percentiles for the Great Lakes Basin (10, 15) and climatically similar references (10, 20) (table 43). The domestic and public-supply consumptive-use coefficient medians were comparable: world, 16 percent; the Great Lakes Basin, 12 percent; and climatically similar areas, 15 percent.

The world industrial consumptive-use coefficients ranged from 9 to 11 percent, comparable to the medians for the Great Lakes Basin and climatically similar areas (10 percent) (table 43). The medians, 25th percentiles, and 75th percentiles of the Great Lakes Basin and the climatically similar areas also were similar.

Both the irrigation and livestock consumptive-use coefficients were compared to the world agriculture consumptive-use coefficients. Typically, irrigation withdrawals and consumptive use for agriculture are much larger than livestock withdrawals and consumptive use. Hutson and others (2004a) estimated that irrigation made up 34 percent of the total water withdrawn in the United States in 2000, whereas that for livestock was less than 1 percent. These proportions suggest that world consumptive-use coefficients for agriculture are more representative of irrigation than livestock water use even though both irrigation and livestock coefficients were compared.

The world agriculture consumptive-use coefficients (median 68 percent) are less than those for the Great Lakes Basin and climatically similar area combined for both irrigation (median 91 percent) and livestock (median 90 percent). These differences are reasonable because agricultural consumptive use is dependent on climate, crop type, and livestock mix. For example, the irrigation consumptive-use coefficients from Solley and others (1998) ranged from 33 percent in the Upper Colorado River Basin to 100 percent in the Tennessee River Basin, with an overall national average of 61 percent. It should also be noted that 19 percent of the withdrawals for irrigation in the United States in 1995 were lost during conveyance (Solley and others, 1998).

World consumptive-use coefficients for thermoelectric power were not available. The median, 25th percentile, and 75th percentile for the Great Lakes Basin and climatically similar areas were small, even though the maximum coefficients were high. Thermoelectric power facilities with small consumptive-use coefficients (once-through cooling) typically use much larger amounts of water but consume very little. The median (2 percent) for the Great Lakes Basin and climatically similar areas compared to the following thermoelectric-power consumptive-use coefficients:

- 5 percent of thermoelectric power withdrawals in Europe (European Environment Agency, 2005; Marcuello and Lallana, 2003)
- 2.5 percent of the freshwater withdrawn for thermoelectric power in the entire United States (Solley and others, 1998),
- 1.8 percent for thermoelectric power withdrawals in all of Canada (Environment Canada, 2004).

World commercial consumptive-use coefficients were not available, perhaps because commercial withdrawals are accounted for in the industrial or municipal coefficients. All the references were for the United States. The Great Lakes Basin and the climatically similar areas had the same consumptive-use coefficient median (10 percent), the same 25th percentile (8 percent), and similar 75th percentiles (15 and 13 percent). For the entire United States in 1995, the commercial consumptive-use was 14 percent of the commercial withdrawals (Solley and others, 1998).

No world references were found for mining consumptive-use coefficients. As previously mentioned, consumptive-use coefficients for mining vary greatly depending on the type of mining, the mining environment, the processes at the mining facility, and methods used to estimate withdrawals and consumptive use. The range between the 25th and 75th percentile was fairly large, as was the minimum and maximum for both the Great Lakes Basin and climatically similar areas (table 43). In 1995, the United States mining consumptive-use coefficient was 27 percent compared to 9 percent for the Great Lakes Basin (Solley and others, 1998).

Table 43. Consumptive-use coefficient statistics for the Great Lakes Basin, climatically similar areas, and the world, by water-use category.

[Great Lakes Basin refers to basins, parts of states, and states in the Great Lakes Basin. Climatically similar areas are basins and states with areas climatically similar to the Great Lakes Basin. Great Lakes and climatically similar references are the combination of references from these two areas. References are only from publications after either 1975 (mining and commercial), 1980 (industrial, irrigation, thermoelectric, and livestock), or 1985 (domestic and public supply) and do not include all of Canada coefficients, all of the United States coefficients, or continent coefficients because these have areas that are not climatically similar to the Great Lakes Basin. Minimum (min), median, maximum (max), 25th percentile, and 75th percentile are in percent and rounded to the nearest whole number. N is the number of references used in the statistical analysis.]

Geographic Area	Statistics					
	Min	25th	Median	75th	Max	N
Domestic and Public Supply						
Great Lakes Basin	0	10	12	15	74	161
Climatically similar areas	6	10	15	20	70	68
Great Lakes and climatically similar areas combined	0	10	13	15	74	229
World	14	16	16	18	19	4
Industrial						
Great Lakes Basin	0	7	10	14	35	122
Climatically similar areas	0	4	10	13	34	97
Great Lakes and climatically similar areas combined	0	6	10	13	35	219
World	9	10	10	11	11	4
Thermoelectric						
Great Lakes Basin	0	1	2	2	21	141
Climatically similar areas	0	0	2	4	75	75
Great Lakes and climatically similar areas combined	0	1	2	3	75	216
Irrigation						
Great Lakes Basin	70	90	90	96	100	95
Climatically similar areas	37	90	100	100	100	75
Great Lakes and climatically similar areas combined	37	90	91	100	100	170
World	65	65	68	72	78	4
Livestock						
Great Lakes Basin	0[1]	80	83	90	100	85
Climatically similar areas	10[2]	86	100	100	100	73
Great Lakes and climatically similar areas combined	0[1,2]	80	90	100	100	158
World (Agriculture)	65	65	68	72	78	4
Commercial						
Great Lakes Basin	4	8	10	15	26	29
Climatically similar areas	3	8	10	13	33	61
Great Lakes and climatically similar areas combined	3	8	10	13	33	90
Mining						
Great Lakes Basin	0	7	10	25	58	58
Climatically similar areas	0	10	14	20	86	83
Great Lakes and climatically similar areas combined	0	8	13	22	86	141

[1] The livestock low coefficient minimum (0 percent) is from Great Lakes Commission (2005a), where Minnesota reported 0.25 Mgal/d total withdrawn in 1998 and 0.0 Mgal/d consumptive use. The next lowest coefficient for the Great Lakes basin was 66 percent.

[2] The livestock low minimum coefficients are from Solley and others (1988) and may result from adding animal specialties (including fish farming) into the livestock water-use category. In previous and subsequent USGS reports, fish farming was in different water-use categories.

Summary and Conclusions

State agencies with jurisdiction within the Great Lakes Basin have indicated that refinement of consumptive-use data and coefficients for all water-use categories were of greatest interest and value to water-supply managers. As part of the USGS National Assessment of Water Availability and Use Program, consumptive-use coefficients were compiled and an annotated bibliography was prepared for the Great Lakes Basin and climatically similar areas. The consumptive-use coefficients are statistically summarized by water-use category and compared, where possible to coefficients from other parts of the world. This assembly of data and coefficients in this report addressed the following objectives:

- summarizing the range of coefficients by water-use categories listed in most bibliographic references
- comparing coefficients for the Great Lakes Basin and climatically similar area, to each other and to world coefficients
- summarizing methods and data used in previous studies to calculate consumptive use
- compiling available consumptive-use data and consumptive-use coefficients

The domestic and public-supply water-use categories were combined because inconsistent terminology among references made it unclear, in some cases, whether uses other than strictly domestic received deliveries from a public supply. Domestic and public-supply consumptive-use coefficient statistics (median and 25th and 75th percentile) were within 6 percent for the aggregated worldwide data, the Great Lakes Basin, and climatically similar areas.

Although industrial consumptive-use coefficients may differ substantially by industry and facility, the statistics for the Great Lakes Basin, climatically similar areas, and the world were similar: the 25th percentile ranged from 4 to 10 percent, the median was 10 percent for all three areas, and the 75th percentile ranged from 11 to 14 percent. Additionally, median consumptive-use coefficients for six industry groups compared well with the statistics for the general industrial coefficients. Industries that departed substantially from the norm are the beverage and bottled-water industries, which had higher consumptive-use coefficients than most other industrial categories. More data on consumptive use and consumptive-use coefficients for the ethanol and transportation equipment industries are needed for water managers to better understand and plan for the water and consumptive use for these industries.

The thermoelectric power consumptive-use coefficients differ by the type of cooling at each facility. Overall, the thermoelectric power consumptive-use coefficient median between 1980 and 2005 was 2 percent for the Great Lakes Basin and climatically similar areas. More than half of the thermoelectric coefficients were in the 0- to 5-percent range.

Irrigation consumptive-use coefficients for 1980 to 2005 for the Great Lakes and climatically similar areas references were similar: both had a 25th percentile of 90 percent and 75th percentile of 100 percent; the medians ranged from 91 to 100 percent. Irrigation coefficients for the Great Lakes Basin and climatically similar areas were typically higher than those for entire continents, some countries (Canada and United States), and the world as a whole. Differences may be due to climate, crop type, irrigation methods, and various ways of defining the category.

Three-fourths of the references on livestock reported consumptive-use coefficients between 80 and 100 percent. Median coefficients for livestock in the Great Lakes Basin and climatically similar areas were within 13 percent.

The commercial consumptive-use coefficients between 1975 and 2005 were almost identical for the Great Lakes Basin and climatically similar areas: 25th percentiles of 8 percent, medians of 10 percent, and 75th percentiles of 15 and 13 percent. More than half of the commercial consumptive-use coefficients were between 8 and 15 percent.

The range of mining consumptive-use coefficients was wide (0 to 86 percent). Although a little over half of the consumptive-use coefficients were between 7 to 25 percent, there was a large difference among mining types.

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Wild, E.C., and Nimiroski, M.T., 2005, Estimated water use and availability in the South Coastal Drainage Basin, southern Rhode Island, 1995–99: U.S. Geological Survey Scientific Investigations Report 2004–5288, 46 p.

Woldorf, A.F., 1959, Irrigation and rural water use in Ohio: Ohio Department of Natural Resources, Division of Water, Ohio Water Plan Inventory Report 7, 57 p.

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Glossary

The terms in this glossary were compiled from numerous sources. Some definitions have been modified specifically in reference to this report and are not the only valid ones for those terms.

25th percentile The value in a rank of values below which one-fourth (25 percent) of the values fall. The 25th and 75th percentile together bracket half of the values.

75th percentile The value in a rank of values below which three-fourths (75 percent) of the values fall. The 25th and 75th percentile together bracket half of the values.

A

B

C

climatically similar areas (clim sim) Basins, states, or countries that have climates similar to the Great Lakes Basin.

commercial water use Water for motels, hotels, restaurants, office buildings, other commercial facilities, military and nonmilitary institutions—and in USGS water-use circulars for 1990 and 1995, water for offstream fish hatcheries.

community water system A public water system that delivers water for human consumption through pipes and other constructed conveyances if such a system regularly serves at least 25 year-round residents or has at least 15 service connections used by year-round residents. Community water systems might serve towns, cities, military bases, apartment complexes, or mobile home parks (U.S. Environmental Protection Agency, 1999).

consumptive use The part of water withdrawn [for a particular use] that is evaporated, transpired, incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the immediate water environment.

consumptive-use coefficient Percentage of water removed from the immediate environment by evaporation, transpiration, incorporation into products or crops, or consumption by humans or livestock.

conveyance loss Water that is lost in transit from a pipe, canal, conduit, or ditch by leakage or evaporation. Generally, the water is not available for further use; however, leakage from an irrigation ditch, for example, may percolate to a ground-water source and be available for further use.

D

domestic water use Water used for all such indoor household purposes as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, and such outdoor purposes as watering lawns and gardens.

E

evaporation The change of water from a liquid form into a vapor state such as water evaporating from pools, large bodies of water, and runoff from car-washing or irrigation systems; also includes evaporation through dehumidifiers, heating and cooling processes in industrial facilities and thermoelectric plants.

evapotranspiration A collective term used to include water discharged to the atmosphere as a result of plant transpiration and evaporation from soil and surface-water bodies.

F

G

Great Lakes Basin In this report, the eight United States and two Canadian provinces that have all or part of their states or provinces in the Great Lakes Basin. It also includes any areas in the eight states and two provinces that may or may not be in the Great Lakes Basin.

Great Lakes Basin and climatically similar areas The combination of bibliographic references for the Great Lakes Basin and climatically similar areas.

H

I

industrial water use Water used for fabrication, processing, washing, and cooling, and includes such industries as chemical and allied products, food, mining, paper and allied products, petroleum refining, and steel.

irrigation water use Water that is applied by an irrigation system to assist in the growing of crops and pastures or to maintain vegetative growth in recreational lands such as parks and golf courses.

J

K

L

M

maximum The largest number in a group of values.

median The point in a rank of values above and below which 50 percent of the values fall.

minimum The lowest number in a group of values.

mining water use Water used for the extraction of naturally occurring minerals including solids, such as coal, sand, gravel, and other ores; liquids, such as crude petroleum; and gases, such as natural gas. Also includes uses associated with quarrying, milling, and other preparations customarily done at the mine site or as part of a mining activity.

N

O

once-through thermoelectric power facility A facility that uses water only one time in the condenser-and reactor-cooling process before returning the water to a surface-water source. Although once-through cooling requires substantial water withdrawals, the consumption is low—usually less than 3 percent (Solley and others, 1998).

other than once-through thermoelectric power facility A facility that uses cooling towers or cooling ponds to recycle water repeatedly for condenser and reactor cooling. This type of facility typically uses less water than a once-through facility but has a higher percentage of consumptive use (evaporation), typically greater than 60 percent (Solley and others, 1998).

P

primary source A reference where the authors did most of the compilation, analysis, and computation of data. Often the primary source publication was completed in cooperation with multiple agencies, but the publication was the main product for the multiple agency effort.

product incorporation Inclusion of water as a component of industrial, food, and beverage products.

Q

R

return flow Water that reaches a ground-water or surface-water source after release from the point of use and thus becomes available for further use.

S

secondary source A reference that uses data or consumptive-use coefficients from another publication or person or organization to discuss or estimate consumptive use for the current report.

Standard industrial classification (SIC) codes Four-digit codes established by the Office of Management and Budget, published in 1987, and used in the classification of establishments by type of activity in which they are engaged.

T

thermoelectric-power water use Water used in the process of generating electricity with steam-driven turbine generators.

transfer Conveyance of water that occurs during distribution or collection of water and sewage.

transpiration The process in which water is absorbed by plants, usually from the roots and evaporated into the atmosphere from the plant surface. Transpiration occurs in all types of plants including crops, grass (lawns, golf courses), landscaping plants, and nursery plants.

U

unaccounted-for use Water that is either lost through conveyance losses or supplied from a public supplier and used for such purposes as firefighting, street washing, flushing of water lines, and maintaining municipal parks and swimming pools (public uses). Generally, public-use water is not billed by the public supplier.

unknown source A reference that does not indicate the publication, person, or organization where the coefficient or data came from.

V

W

water balance The mathematical equation of the inflows, outflows, and change in storage of water in a given area (Inflows = Outflows + Change in Storage).

water-use category The type of specific use (facility or consumer) for which water is withdrawn (for example, public supply, irrigation, industrial, thermoelectric power).

withdrawal Removal of water from either a surface-water or ground-water source.

world Represents single coefficients that have world-wide applicability for particualr water-use categories in this report.

X

Y

Z

Annotated Bibliography

Australian Academy of Technological Sciences and Engineering, 1999, Water and the Australian economy: Victoria, Australia, 127 p.

This document contains water-use information on Australia, but the only data on consumptive use are in a table listing gross water consumed per hectare of irrigated area for 1983–84, by region. Australia is divided into 18 regions, or spatial units. Consumptive-use estimates were computed by subtracting return flows from withdrawals. For each spatial unit (the Queensland coast, for example), the gross water consumed by pasture, crops, and horticulture is listed. For pastures, the gross water consumption is 2.5–13.8 million liters per hectare (ML/ha); for crops, 0.6–25.0 ML/ha; and for horticultural, 2.1–13.7 ML/ha (table 3.5, p. 37). Regionally, the gross water consumption is lowest in the areas with the highest rainfall, such as the southern and eastern coastal areas from south-east Victoria to the Burdekin region in Queensland, and Tasmania. In these areas, irrigation withdrawals from streams and ground water are usually used to supplement rather than replace rainfall and are typically less than 3 ML/ha (p. 38). For arid areas such as the Western Australian and Northern Territory irrigated areas, the South Australian part of the Murray-Darling Basin, and Burdekin in Queensland, gross water consumption is higher, 8–14 ML/ha. For other regions, including the southern and northwestern parts of the Murray-Darling Basin, an intermediate amount of water per hectare is consumed.

Avery, Charles, 1998, Water withdrawals in Illinois, 1995: U.S. Geological Survey Fact Sheet FS–063–98, 4 p., accessed May 15, 2006, at *http://il.water.usgs.gov/pubs/water_use95/wateruse95.html*

This document predominantly discusses water withdrawals in 1995 in Illinois and has a small section on consumptive use. For 1995, the water consumption in Illinois was 4 percent of all withdrawals in the State. The two categories in Illinois with the largest amount of water consumed were thermoelectric power and irrigation.

Barlow, L.K., 2003, Estimated water use and availability in the Lower Blackstone River Basin, northern Rhode Island and south-central Massachusetts, 1995–99: U.S. Geological Survey Water-Resources Investigations Report 2003–4190, 75 p., accessed July 30, 2006, at *http://pubs.usgs.gov/wri/wri034190/pdf/wrir034190.pdf*

Water-use data—including withdrawals, use, and return flows—were collected for the Lower Blackstone River Basin in northern Rhode Island and south-central Massachusetts. From these data, water availability (base flow plus safe-yield estimates minus streamflow criteria) was estimated for the low-flow period (June–September). As part of this study, consumptive use and unaccounted-for use were estimated. The study used consumptive-use coefficients of 15 percent for domestic use, 10 percent for commercial and industrial use, and 76 percent for irrigation (p. 26). Barlow states that the domestic, commercial and industrial consumptive-use coefficients are consistent with traditional consumptive-use rates in New England. The irrigation consumptive-use coefficient is in Solley and others (1993). The irrigation coefficient includes both conveyance losses and consumptive use. By subbasin, the water use not accounted for was 0.007–0.944 Mgal/d. The largest proportion consisted of leakage and exfiltration at 62 percent, followed by firefighting (12.0 percent) and major water-utility breaks (6.4 percent). Also of interest in this basin was a thermoelectric facility that withdrew water in one subbasin, used the water in a different subbasin, and trucked in water when the flows were too low in the river from which the water was withdrawn. The facility was classified as a zero-liquid-discharge facility; all water was consumed through evaporation and given a 100-percent consumptive-use coefficient (Gary Coutre, Etts Engineer, Ocean State Power, written commun., 2000).

Brill, E.D., Jr., Stout, G.E., Fuessle, R.W., Lyon, R.M., and Wojnarowski, K.E., 1977, Issues related to water allocation in the Lower Ohio River Basin: University of Illinois at Urbana-Champaign, Ohio River Energy Study, v.III–G, 81 p.

As part of a report projecting water use for Illinois, Indiana, Kentucky, and Ohio, this volume includes water-use data (withdrawals and water consumption) for 1970 from the Ohio River Basin Energy Study. Estimated municipal water consumption was 20 percent of the withdrawals and industrial water consumption was 6 percent. Thermoelectric power water consumption was about 0.1 percent for the four states (p. III-G-6).

College of Exploration [n.d.], Global water cycle: Global Hydrology and Climate Center, 12 p., accessed May 1, 2006, at *http://www.coexploration.org/howsthewater/html/body_earth.html*

In addition to data from Solley and others (1998), this document includes a table of global water demand and consumption (source of data is unknown). By sector, agriculture has a consumptive-use coefficient of 65 percent (1,870 km^3/yr divided by 2,880 km^3/yr); industry, 9 percent (90 km^3/yr divided by 975 km^3/yr); and domestic, 17 percent (50 km^3/yr divided by 300 km^3/yr; p. 7).

Cosgrove, W.J., and Rijsberman, F.R., 2000, The use of water today, *chap. 2 of* World wide vision, making water everybody's business: World Water Council, p. 4–21, accessed April 28, 2006, at *http://www.worldwatercouncil.org/fileadmin/wwc/Library/WWVision/Chapter2.pdf*

A comprehensive document on world water use, this report includes consumptive-use data and numerous figures. In 1995, about 10 percent of the available blue water—renewable surface-water runoff and ground-water recharge—was withdrawn, and approximately 5 percent of the available blue water was consumed (p. 6). Although this amount might seem low, other factors play a role in water availability for use and consumption.

Some of the world's water resources are in areas not readily accessible and where human demands are small, such as Canada, Alaska, and the Amazon Basin. In some arid and semiarid areas of the world, the human water use is reaching 80–90 percent of the water available. Timing and location of rainfall also contribute to the accessibility of water, such as the sometimes limited accessibility of large amounts of rain falling in a short period. Many areas of the world do not have the storage facilities (tanks, reservoirs, and aquifers) to hold water from intermittent storms until it is needed.

Another water-availability concern is the quality of water: water might be reused so many times that the quality of the water degrades to the point that safe reuse is impossible (p. 7).

About 70 percent of total withdrawals for 1995 are used for irrigation, 20 percent for industrial, and 10 percent for municipalities (Shiklomanov, 1999). For 1995, consumptive use for irrigation was 70 percent, industrial was 11 percent, and municipal was 14 percent (Shiklomanov, 1999). It also is noted that, depending on technology, irrigation methods range in consumption from 30 to 40 percent for flood irrigation and as high as 90 percent for drip irrigation (p. 8). Also of interest is that between 1961 and 1997, the irrigated area or the world has doubled, the greatest increases being in the United States and Asia (fig. 2.1, p. 8).

A figure depicting the annual renewable water resources by region on each continent shows the annual water resources in cubic kilometers by source of water (either local resources and inflows; p. 13). Another concern with water availability is that "worldwide, 20 percent of freshwater fish are vulnerable, endangered, or extinct" (box 2.4, p. 16) and "half the rivers and lakes in Europe and North America are seriously polluted, though their condition has improved in the past 30 years" (p. 16). Another concern given is that many streams will dry up before they reach the ocean (p. 17).

[Withdrawal and consumption are in cubic kilometers. Coefficient is in percent. Source is Shiklomanov (1999).]

Statistic	1900	1950	1995
		Agriculture	
Withdrawal	500	1,100	2,500
Consumption	300	700	1,750
Coefficient	60	64	70
		Industry	
Withdrawal	40	200	750
Consumption	5	20	80
Coefficient	12	10	11
		Municipalities	
Withdrawal	20	90	350
Consumption	5	15	50
Coefficient	25	17	14
		Reservoirs	
Evaporation	0	10	200
		Totals	
Withdrawal	600	1,400	3,800
Consumption	300	750	2,100
Coefficient	50	54	55

Delaware River Basin Commission [n.d.], Year 2004 water withdrawal and consumptive use by large users on the tidal Delaware River: Accessed September 28, 2006, at *http://www.state.nj.us/drbc/wateruse/ largeusers_04.htm*

This Web page is a large table showing the large water users in the Delaware River Basin by state and water-use category. Included in this table are the surface-water withdrawals, ground-water withdrawals, purchased-water amounts, total water use, and consumptive use. Consumptive use is shown in million gallons per year and as a percentage of the total for the power, industry, and public-water-supply facilities in the Delaware River Basin in Pennsylvania, Delaware, and New Jersey. For public-water-supply facilities, the consumptive-use coefficient was 10 percent and was estimated by the Delaware River Basin Commission staff. For the power water-use category, the consumptive use was from 0.1 to 100 percent, most likely because of various types of facilities (once through versus other than once through). Overall, the thermoelectric power consumptive-use coefficient for all facilities was 1 percent. The industrial consumptive-use coefficients were from 0.1 to 100 percent, most likely reflecting the wide variety of industrial uses of the water. Overall, the industrial consumptive use for all facilities was 4 percent.

DeSimone, L.A., 2002, Simulation of ground-water flow and evaluation of water-management alternatives in the Assabet River Basin, eastern Massachusetts: U.S. Geological Survey Scientific Investigations Report 2004–5114, 133 p.

Water quality in the Assabet River Basin in Massachusetts is adversely affected by wastewater discharges and streamflow depletion from ground-water withdrawals. Ground-water-flow models were developed to simulate the flow in the Assabet River Basin during altered withdrawals

and discharges. The results of three scenarios are presented. Conditions were based on 1997–2001 data.

Consumptive use in 11 of 20 towns in the basin was estimated from analysis of seasonal water use. "Consumptive use was assumed to result from irrigation or other water use during the high-use months of spring, summer, and fall [April–October] . . . Months were identified as low- or high-use months based on the seasonal patterns of public-supply withdrawals in 1997–2001." Consumptive use was computed for each town by first determining the mean withdrawal rate for the low-water-use months of November through March (summing the withdrawals for each of the five months and dividing by 5). Then, for each high-water-use month (April–October), the mean withdrawal rate was subtracted from each month's total withdrawal, as follows:

$$\textit{June consumptive use} = \textit{June withdrawals} - \textit{Sum of low water-use months withdrawals}\ (\textit{Nov.} + \textit{Dec.} + \textit{Jan.} + \textit{Feb.} + \textit{Mar. withdrawals})/5$$

Within the extent of the public-water systems, the areas in the town were identified as areas of residential, commercial, industrial, or urban public land use. Next, areal rates were computed by applying consumptive-use coefficients to each of the identified areas of residential, commercial, industrial, or urban public land use. "Monthly areal rates of consumptive water use ranged from 0.4 in/yr in April to 2.59 in/yr in July; the mean annual rate was 0.92 in/yr. These rates were applied to developed land-use areas in privately supplied towns to estimate a mean annual consumptive use for privately supplied parts of the basin of 0.72 Mgal/d. This volume is a net outflow from the ground-water system in privately supplied, developed areas . . . Consumptive use in publicly supplied parts of the basin was estimated similarly at 0.71 Mgal/d."

Ellefson, B.R., Rury, K.S., and Krohelski, J.T., 1987, Water use in Wisconsin, 1985: U.S. Geological Survey Open-File Report 87–699 [poster].

Water-use and water-disposition information for Wisconsin in 1985 are displayed on this poster, which contains 15 illustrations. For the State, only 4.8 percent of the total amount of withdrawals was consumed. Coefficients used to compute consumptive use by water-use categories were 1 percent for thermoelectric, 100 percent for irrigation, 80 percent for nonirrigation agricultural uses, 20 percent for industrial ground-water use, and 10 percent for industrial surface-water withdrawals.

Endreny, T.A., 2005, New York State water and hydrology, *in* The encyclopedia of New York State: Syracuse University Press, p. 1664–1670.

This article is an overview of water-resource supply and demand in New York State, as well as issues concerning water quality and quantity. For 2000, a total volume of 16,800 Mgal/d of water was withdrawn from the State's water resources. Of this, 54 percent was from fresh surface water and 6 percent was from ground water. The remaining 40 percent was saline water used primarily for thermoelectric power generation. Total water withdrawal and consumption per water-use category per day in New York State are presented in a table reproduced below. The data source for this table is from *New York State Water Quality 2000*, published by the New York State Department of Environmental Conservation, Division of Water, in October 2000.

[Mgal/d, million gallons per day.]

Category	Water consumed (Mgal/d)	Withdrawal (Mgal/d)	Coefficient (in percent)
Domestic	107	1,954	5.48
Commercial	61	609	10
Industrial	62	615	10
Public use	0	424	0
Irrigation	26	30	86.7
Livestock	30	34	88.2
Mining	17	62	27.4
Fossil fuel	212	10,600	2
Nuclear	88	2,440	3.6
Total	603	16,800	3.59

Environment Canada, 2004, Threats to water availability in Canada, Burlington, Ontario, National Water Research Institute, Scientific Assessment Report Series no. 3 and Atmospheric and Climate Science Directorate Science Assessment Series no. 1, 128 p., accessed June 15, 2006, at
http://www.nwri.ca/threats2full/intro-e.html

Chapter 5, "Municipal Water Supply and Urban Developments" has a diagram showing "Water use in Canada, 1996," which includes the intake from a water supply, gross water, recirculated water, consumed water, and discharged water for thermal power, manufacturing, municipal, agriculture, and mining categories. Also of interest is that "on average, about 20 percent of total daily municipal water use is attributed mostly to distribution losses and also to unaccounted-for-water" (p. 38). Municipal water use accounts for only 11 percent of the total water use (withdrawals) for Canada (p. 37).

In Chapter 6, "Manufacturing and Thermal Energy Demands," water use and consumptive use for Canada are discussed. "Paper and allied products, primary metals, chemicals and chemical products industries made up 82 percent of total water intake in 1996 " (p. 41). Also, 82 percent of the water supply for the manufacturing sector was from self-supplied freshwater surface sources (p. 41). "Nationally, water consumption was 9 percent of total withdrawals in 1996, up from 7 percent in 1991 (p. 42). Whereas consumption rates have been increasing, total water intake withdrawals decreased from 1981 (p. 41). Although the purpose of water use will vary by manufacturing sector, on the whole, 49 percent of the total intake was used for process water, 47 percent for cooling, condensing, and steam generation, and 2 percent for sanitary uses (p. 41).

Chapter 7, "Land Use Practices and Changes—Agriculture," states that approximately 7 percent of the land in Canada is used for agriculture, but only 13 percent of this total is in Ontario and Quebec (82 percent is in the Prairie provinces) (p. 49). Agriculture comprises 9 percent of the total water withdrawals for Canada but had a consumptive-use coefficient of 71 percent and is the largest consumer of water. Most of the irrigation in Canada uses sprinkler irrigation systems (p. 50).

Chapter 9, "Land-Use Practices and Changes—Mining and Petroleum Production" has a note in a table that "no reliable mining water consumption values can be estimated due to a high level of discrepancies between intake and discharge, probably due to unaccounted for tailings pond losses to evaporation and subsurface seepage (p. 68)."

[Modified from table 1, Environment Canada (2004), chapter 6, "Selected Characteristics of Manufacturing and Thermal Energy Water Use (million cubic meters water/year, MCM per year), by Parameter and Industry Group, 1996." Total water intake and water consumption are in million cubic meters.]

Industry	Total water intake	Water consumption	Consumptive-use coefficient[1] (percent)
Food	269.5	29.5	10.9
Beverages	73.1	16.9	23.1
Rubber products	12.3	1.0	7.8
Plastic products	13.3	1.3	9.4
Primary products	86.7	2.1	2.4
Textiles products	15.0	2.1	14.1
Wood products	45.1	12.1	26.9
Paper & allied products	2,421.3	214.3	8.9
Primary metals	1,423.0	120	8.4
Fabricated metals	19.4	1.1	5.6
Transportation equipment	65.4	19.0	29.0
Non-metallic mineral products	102.3	19.2	18.7
Petroleum & coal products	370.5	22.5	6.1
Chemicals & chemical products	1,121.3	90.7	8.1
Total manufacturing	6,038.3	551.6	9.1
Total thermal power generation	28,749	508	1.8

[1] Coefficients from Environment Canada (not computed by authors of this bibliography).

European Environment Agency, 2005, The European environment—State and outlook 2005: Luxembourg, 570 p., accessed on June 19, 2006, at *http://reports.eea.europa.eu/state_of_environment_report_2005_1/en/tab_content_RLR*

About one-third of the water withdrawal in Europe is used to irrigate crops, a little less than one-third is used in cooling towers for thermoelectric power, 25 percent is used for domestic purposes (taps and toilets), and 13 percent is used in manufacturing. The amount of water used by each water-use category (domestic, manufacturing, thermoelectric, and irrigation) varies across the continent. For example, in most of the northern Europe countries, less than 10 percent of water withdrawals are used for irrigation, whereas in southern Europe more than 60 percent of withdrawals are used for irrigation. Two-thirds of the water withdrawals for Belgium and Germany are used for thermoelectric power. With regard to consumption, reported coefficients are 80 percent of the water withdrawals for agriculture (absorption by crops or evaporation from fields), 20 percent of manufacturing and domestic water withdrawals, and 5 percent of thermoelectric power water withdrawals. It also is noted that the 95 percent of the thermoelectric withdrawal that is returned to the environment is typically warmer than before it is used and can negatively affect local ecosystems. Also, the 80 percent of the industrial and domestic withdrawals returned are often contaminated and are returned at a different location than the withdrawals. Of special note is that "the greatest potential for water saving lies in reducing leakage rates in water distribution systems, particularly for domestic use (p. 3)." Water losses (through leakage) account for over one-third of the withdrawals in some older cities in Europe. Although some of this leakage recharges ground water and can be pumped and used again, in other locations the water cannot be reused because the water beneath the city is too contaminated.

Government of Canada and the U.S. Environmental Protection Agency, Great Lakes National Program Office, 1995, The Great Lakes—An environmental atlas and resource book (3d ed.): Toronto, Ontario, and Chicago, Ill., 46 p.

This publication describes the physical characteristics of the Great Lakes water system, as well as the settlement and industrialization of the area. Climate, hydrologic cycle, and water resources are described. Water levels, effects of diversions, and outcomes from consumptive-use studies are also given. Tables included in this report (summarized below) list Great Lakes municipal, manufacturing, and power production water withdrawals and consumption per lake.

Consumptive use per category per lake (in cubic feet per second) for Great Lake Basins, 1985.

[Modified from Michigan State University (1985); %, percent; coefficient is calculated and rounded to the nearest whole number.]

Category and Country		Superior	Michigan	Huron	Erie	Ontario	Totals
Municipal:							
Canada							
	Withdrawn	40		120	190	660	1,010
	Consumed	10		20	30	100	160
	Coefficient	25%		17%	16%	15%	16%
United States							
	Withdrawn	70	2,940	310	2,820	380	6,520
	Consumed	10	190	170	280	70	720
	Coefficient	14%	6%	55%	10%	18%	11%
Manufacturing:							
Canada							
	Withdrawn	860		1,360	1,900	2,760	6,880
	Consumed	20		70	80	100	270
	Coefficient	2%		5%	4%	4%	4%
United States							
	Withdrawn	410	9,650	1,060	9,110	530	20,760
	Consumed	60	880	30	1500	40	2510
	Coefficient	15%	9%	3%	16%	8%	12%
Power production:							
Canada							
	Withdrawn	70		2,870	1,160	8,370	12,470
	Consumed	0		20	10	60	90
	Coefficient	0%		1%	1%	1%	1%
United States							
	Withdrawn	760	13,600	2,570	13,180	6,520	36,360
	Consumed	10	240	50	190	120	610
	Coefficient	1%	2%	2%	1%	2%	2%
Total withdrawn		2,210	26,190	8,290	28,360	19,220	84,270
Total consumed		110	1,310	360	1,990	490	4,260
Coefficient		5%	5%	4%	7%	3%	5%

Grannemann, N.G. Hunt, R.J., Nicholas, J.R., Reilly, T.E., and Winter, T.C., 2000, The importance of ground water in the Great Lakes Region: U.S. Geological Survey Water-Resources Investigations Report 00–4008, 14 p.

This report states that the total ground-water withdrawal in the Great Lakes Region was estimated to be about 1,510 Mgal/d (from Solley and others, 1998) with an additional 200 Mgal/d withdrawn in the Chicago area just outside the basin. About 5 percent of the ground water withdrawn in the Great Lakes Basin was consumed. Irrigation is identified as the largest consumptive use of water in the Great Lakes Basin. The irrigation withdrawals were equally supplied by ground water and surface water; but if new irrigation systems are installed in areas where surface-water sources are not available, ground water would be used as the water source. This report gives an example water budget for Lake Michigan.

Great Lakes Commission, 2003, Water Resources Management Decision Support System for the Great Lakes—Status of data and information on water resources, water use, and related ecological impacts: Ann Arbor, Mich., final report, chap. 3, p. 49–68, accessed July 30, 2006, at *http://www.glc.org/wateruse/wrmdss/finalreport/pdf/WR-Ch.3-2003.pdf*

Chapter 3 of this report discusses the commission's inventory of water-withdrawal and water-use data and related information for the Great Lakes. This chapter includes the following tables: a self-assessment by jurisdiction for "Fulfilling Data Collection Commitments Under the Great Lakes Charter" (table 3-1, p. 51), a "Summary of Water Use Reporting Programs by Jurisdiction" (table 3-2, p. 53), a "Summary Characterization of Water Use Permitting, Registration and Reporting Programs" (table 3-3, p. 54), "Consumptive Use Coefficients by Water Use Category," (table 3-4, p. 60) and

"Measured Processes for Consumptive Use Reporting by Facilities" (table 3-5, p. 61). Most of these tables are reproduced in or derived from other Great Lakes Commission documents. The table "Consumptive Use Coefficients by Water Use Category" is reproduced in this report in appendix table 3–1.

Great Lakes Commission, 2005a, Annual reports from the Great Lakes Regional Water Use Database Repository, representing 1998 to 2002 water-use data: Ann Arbor, Mich., accessed on May 31, 2006, at *http://www.glc.org/wateruse/database/downloads.html*

For each year from 1998 to 2002 there are three reports: Introduction, Summary Reports, and Jurisdictional (states or provinces) Analyses; Basin Tables; and Water Use Category Tables (each are available in gallons or liters). Water-use data (reported to the Great Lakes Commission by the individual agencies in states and provinces) are organized by jurisdiction, water-use category, and basin for each year of data. Also included in the more recent reports is a table of consumptive-use coefficients used by jurisdictions for each water use-category. (This table is repeated in several Great Lakes Commission documents.) For public supply and self-supplied domestic use, the consumptive-use coefficient used by jurisdiction is from 10 to 15 percent. Most jurisdictions use a 90-percent consumptive-use coefficient for self-supplied irrigation with the exceptions being Ontario (78 percent) and Wisconsin (70 percent, p. 10). For self-supplied livestock, eight jurisdictions use 80 percent as the consumptive-use coefficient and two (New York and Wisconsin) use 90 percent. Hydroelectric power has no consumptive use (0 percent). For the remainder of the categories—self-supplied industrial, self-supplied thermoelectric (fossil fuel or nuclear), self-supplied other, each jurisdiction has a different basis for estimating consumptive use, including a single coefficient, a range of coefficients, and plant and Standard Industrial Classification code (SIC), among others (p. 10). The table "Consumptive Use Coefficients by Water Use Category" is reproduced in this report in appendix table 3–1. Additionally, consumptive-use coefficients derived from the annual report data are in this report as tables 3–2 to 3–9.

Great Lakes Commission, 2005b, Great Lakes Regional Water Use Database: Ann Arbor, Mich., accessed May 31, 2006, at *http://www.glc.org/wateruse/database/search.html*

The database is a repository of water-use data published in annual reports of the commission and includes a search engine for 1998–2002 data. Users can search by geographic area: Lake Superior, Lake Michigan, Lake Huron, Lake Erie, Lake Ontario, St. Lawrence River, Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Ontario, Pennsylvania, Quebec, and Wisconsin. Additional searches include water-use category and type of water used (ground water, Great Lakes surface water, and other surface water). Data can be displayed as either million gallons or million liters per day. Users are advised to read the metadata sheet before using this database because the data from each jurisdiction were compiled differently and should not be directly compared. On the metadata page is a link to the table "Consumptive-Use Coefficients by water use category among Great Lakes Jurisdictions and USGS." This table is from a Great Lakes Commission Survey in the spring 2002, is found in other Great Lake Commission documents, and is reproduced in this report in appendix table 3–1.

Great Lakes Commission and U.S. Army Corps of Engineers, 1999, Living with the lakes—Understanding and adapting to Great Lakes water level changes: Ann Arbor, Mich., 39 p.

As part of this document on Great Lakes water-level fluctuations, consumptive use is discussed. It is noted that, owing to the large volume of the lakes, consumptive use has only a minor effect on water levels. It is further noted that the average household uses 100 gallons of water per person per day (p. 10). For industry, about 10 percent of the water used in industrial processes is consumed; for thermoelectric power, less than 2 percent of withdrawals is consumed (p. 10).

Guldin, R.W., 1989, An analysis of the water situation in the United States, 1989–2040: Ft. Collins, Colo., U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM–177, 178 p.

Mandated by the Forests and Rangelands Renewable Resources Planning Act of 1974, this document fulfills a requirement for a national analysis of water availability and quality, with emphasis on implications for forest and rangeland management. Social, environmental, and economic issues are considered in addition to quantity and quality issues. Much of the information used in the analysis was derived from previous publications. The regional tabulation of categorical consumptive-use data for (table 9, p. 44) was based on the USGS 5-year water-use circulars from 1960 through 1985; projections of consumptive use beyond 1985 were made by Soil Conservation Service personnel on the basis of "trends in the historical data."

Horn, M.A., 2000, Method for estimating water use and interbasin transfers of freshwater and wastewater in an urbanized basin: U.S. Geological Survey Water-Resources Investigations Report 99–4287, 34 p.

A 10-step method to estimate interbasin transfers of freshwater and wastewater was tested in the Ten Mile River Basin in southeastern Massachusetts. The method for estimating basin withdrawals, interbasin transfers or freshwater and wastewater, unaccounted-for uses, water use, consumptive use, inflow and infiltration, and basin return flow made use of available statewide data (p. 3). The study area covered 46 mi^2 and contained about 50 lakes and ponds, many of which are along the Ten Mile River.

Consumptive use was estimated by the author using a consumptive-use coefficient of 15 percent for domestic and 10 percent for the commercial and industrial. Horn also estimated unaccounted-for water public suppliers using an assumed average of 10 percent.

Horn, M.A., Craft, P.A., and Bratton, Lisa, 1994, Estimation of water withdrawal and distribution, water use, and wastewater collection and return flow in Cumberland, Rhode Island, 1988: U.S. Geological Survey Water-Resources Investigations Report 93–4023, 54 p.

This report is a case study demonstrating the integration of water-use data from different agencies and facilities in Cumberland, R.I. In this study, domestic consumptive use was estimated by use of a consumptive-use coefficient of 15 percent from Solley and others (1993). The domestic consumptive-use coefficient (15 percent) is primarily due to evaporation from lawn and garden watering, car and sidewalk washing, and pools (p. 27). Industrial consumptive use was estimated to be 4 percent of the withdrawals from estimation of evaporation and incorporation into the products estimated by the industries (p. 30). Horn and others (1994) applied an 8 percent consumptive-use coefficient to commercial withdrawals to get commercial consumptive use. For the study area, the authors stated, commercial consumptive use is less than domestic consumptive use because commercial use does not include as much lawn and garden watering, car or sidewalk washing, or as many pools (p. 31). Livestock consumptive use was estimated as 80 percent, where 60 percent was evaporated, 20 percent was consumed by livestock, and 20 percent was returned to the ground-water system (p. 32). Irrigation was virtually all consumptive use (100 percent) because of evaporation (p. 32).

Hutson, S.S., 1998, Water use in Tennessee, 1995: U.S. Geological Survey Fact Sheet 98–087, 4 p., accessed July 30, 2006, at *http://tn.water.usgs.gov/wustates/tn/factoffstream.html*

Data for the publication were compiled the U.S. Geological Survey and the Tennessee Department of Environmental and Conservation, Division of Water Supply. This fact sheet states that about 11 percent of industrial and mining water withdrawals in Tennessee were consumed in the production process, about 10 percent of the domestic and commercial water withdrawals were consumed, and virtually all the withdrawals for agriculture were consumed. Also of interest is that, for public utilities, about 10 percent of the withdrawals (78 Mgal/d divided by 777 Mgal/d) was either used for public uses (fire fighting, parks, and municipal swimming pools) or lost in conveyance.

Hutson, S.S., Koroa, M.C., and Murphree, C.M., 2004, Estimated use of water in the Tennessee River watershed in 2000 and projections of water use to 2030: U.S. Geological Survey Water-Resources Investigations Report 03–4302, 89 p., accessed July 30, 2006, at *http://pubs.usgs.gov/wri/wri034302/PDF/wrir034302part2.pdf*

This report presents water-use data for the Tennessee River watershed for 2000 and gives projections for 2030. Consumptive use, defined as the "difference between water withdrawals and return flow" (p. 1), was estimated as only 5 percent of the total withdrawals for the watershed. More specifically, consumptive use was less than 1 percent for all thermoelectric power water withdrawals, 22 percent for industrial withdrawals, 43 percent for public-supply withdrawals (based on comparison of community-water-system withdrawals and wastewater return flows), and 100 percent for irrigation withdrawals. Detailed tables list withdrawals, return flows, and the net water demand (consumptive use) by reservoir catchment areas as well as by Hydrologic Unit Code (HUC) and county. The report also includes a figure showing "cumulative consumptive use at major water-tabulation area junctures and net water demand for reservoir catchment areas in the Tennessee River watershed in 2000" (fig. 9, p. 13).

International Great Lakes Diversions and Consumptive Use Study Board, 1981a, Great Lakes diversions and consumptive uses: Ottawa, Ontario, and Chicago, Ill., Report to the International Joint Commission (under the Reference of February 21, 1977), main report plus 6 annexes and 3 appendixes.

International Great Lakes Diversions and Consumptive Use Study Board, 1981b, Great Lakes diversions and consumptive uses: Ottawa, Ontario, and Chicago, Ill., Annex F, Consumptive water use, 151 p.

In response to a reference from the governments of the United States and Canada, the International Joint Commission established the International Great Lakes Diversions and Consumptive Use Study Board to examine possibilities of diversion management to alleviate extreme high and low levels of the Great Lakes. The consumptive-use part of the study gathered available data to establish a baseline of water withdrawal, recirculation, and consumptive use for 1975, to be used in conjunction with economic and population data for projections through 2035. Forecasts for the U.S. part of the basin leaned heavily on water information from previous forecast efforts and data compilations, including the U.S. Water Resource Council's Second National Water Assessment, USGS 5-year water-use censuses, and the Great Lakes Basin Commission Framework Study. Forecasts for the Canadian part were done largely by computer simulation with available data because no national water-demand forecast had been done at the time of the study. Section 6 of the main report summarizes this work, and the separately bound Annex F presents descriptions and data in detail.

Despite the detail in Annex F, simple withdrawal/consumption ratios are reported only sparsely, in part because projection methods either used variable coefficients or arrived at consumption figures through more complicated avenues. Among the few reported coefficients for the Canadian part of the basin are

- municipal water consumption (assumed), 20 percent of total withdrawal (p. 26) or 15 percent of residential plus commercial water uses plus estimated losses (p. 25);
- rural residential, 60 percent of intake (assumed; p. 27);
- golf-course irrigation basinwide, 75 percent (p. 87; Great Lakes Basin Commission);
- and livestock, 100 percent (assumed; p. 81–82; rates by type of animal given on p. 84).

Other data related to standard consumptive-use coefficients are

- the U.S. percentage of municipal commercial withdrawals that are consumption, by lake basin (range, 11–54 percent; p. 11);
- U.S. ratios of manufacturing withdrawals to consumptive use for best available technology, by lake basin (range, 1.26–1.55; p. 39);
- consumption and water intake for Canadian SICs for 1975 (p. 50);
- 1975 Canadian withdrawal and consumption figures for the top five SICs, by lake basin (p. 62–63);
- and estimated water consumption for thermoelectric power categories, in million gallons per day per gigawatt-hour per year (Mgal/d/GWh/yr), 0.21–0.33 Mgal/d/GWh/yr for fossil-fueled plants and 0.35–0.56 Mgal/d/GWh/yr for nuclear plants (p. 114).

Extensive tables at the back of the annex list U.S. and Canadian and non-lake water withdrawals and consumption, in aggregate and by lake basin.

[Modified from Tate (1979) table 22. Total water intake and water consumption are in million gallons per day.]

Industry	Total water intake	Water consumption	Consumptive-use coefficient (percent)
Mines & mineral fuels	93.600	10.400	11.1
Food & beverages	103.335	9.279	9
Tobacco	0.568	0.278	49
Rubber & plastics	268.250	1.611	0.6
Leather	2.672	0.277	10
Textiles, knitting mills and clothing	44.508	1.189	3
Wood, furniture, & fixtures	5.276	0.476	9
Paper & allied products	463.053	20.978	4.5
Printing & publishing	1.525	0.064	4.2
Iron & steel	645.000	14.819	2.3
Other primary metals	42.155	0.969	2.3
Metal fabricating	13.543	0.737	5.4
Machinery	3.039	0.172	5.7
Transportation equipment	103.979	3.222	3.1
Electrical products	16.118	0.480	3.0
Non-metallic mineral products	27.611	3.610	13
Petroleum & coal	187.173	8.558	4.6
Chemicals & chemical products	713.167	37.960	5.3
Misc. manufacturing	5.230	0.216	4.1

Kaufman, Alvin, 1967, Water use in the mineral industry: Transactions of the Society of Mining Engineers, AIME, v. 238, p. 83–90.

In this eight-page document, data from the 1962 Bureau of Mines statistical canvass of water-use data are further analyzed for consumptive use, recirculated water, and concerns regarding water resources for the mineral industries. Consumptive-use coefficients for commodities and by major drainage basin region are reported as a percentage of gross water use, which is the total of recirculated water plus intake water. (These coefficients differ from those computed for this bibliography, which are based on the amount of water withdrawn (intake).) Kaufman postulated a relation between gross-water-based consumption, climate, and recirculation; results from multiple regression analysis using consumed water per river basin, recirculated water, and a 30-year average river-

basin temperatures and humidity showed a medium to high correlation between consumed water and recirculated water and a low correlation between consumed water and temperate and humidity.

Although consumptive-use coefficients based on gross water used are an interesting alternative, they cannot be computed unless gross water amounts are known. Many industries know and report volumes of water withdrawn (intake), but far fewer know and report water recirculated volumes. Also, in other documents examined for this bibliography, recirculated-water and gross-water volumes, where listed, are usually noted as being less accurate than water-withdrawn (intake) volumes.

Kaufman, Alvin, and Nadler, Mildred, 1966, Water use in the mineral industry: U.S. Bureau of Mines Information Circular 8285, 58 p.

In 1963, the U.S. Bureau of Mines canvassed mineral producers to determine water use in 1962. The major water-using mineral industries at the time were natural gas processing, phosphate rock, sand and gravel, and iron ore. As part of the questionnaire, two statistical forms were used: one for petroleum and natural gas drilling contractors, secondary recovery operators, and natural gas processing plants, and another for mineral and coal producers. For nonmetals, 80 percent of the value of production was represented in the questionnaire respondents, and 95 percent of all metals were represented (table 2, p. 9). Respondents were surveyed on how much new water was used, how the water was used, the amount of water discharged, and the water consumed. (Evaporation and the amount of water lost in products should equal the amount of wastewater subtracted from the amount of new water.) For the entire United States, 16 percent of the new water intake by the mineral industry was consumed either through evaporation or as loss in product (p. 20). For the Great Lakes States, the mining consumptive use was from 3 to 12 percent, with a mean of 6 percent. For the states climatically similar to the Great Lakes, the consumptive use was from 2 to 34 percent, with a mean of 20 percent; if West Virginia and Tennessee (consumptive-use coefficients of 23 and 34 percent) were omitted from the computation, the consumptive use would be 2–12 percent with a mean of 7 percent (computed from tables below). For water-use regions including the Great Lakes and climatically similar regions, the consumptive use was from 5 to 34 percent, with a mean of 11 percent. If the Tennessee region were excluded (34 percent consumptive use coefficient), the consumptive use would be 5–12 percent with a mean of 7 percent.

[Modified from Kaufman and Nadler (1966; tables 3 (p. 10) and 4 (p. 15)). New water withdrawn and water consumed are in gallons per year; coefficient is the percentage of water withdrawn that was consumed (computed from the new water-withdrawn and water-consumed figures).]

State	New water withdrawn	Water consumed	Coefficient (percent)	Total operations	Number replying	Response (percent)
Illinois	14,765	679	5	1,094	874	80
Indiana	8,920	431	5	616	419	68
Michigan	47,296	1,202	3	539	459	85
Minnesota	102,314	4,376	4	440	412	94
New York	20,172	2,108	10	466	393	84
Ohio	32,701	3,919	12	795	657	83
Pennsylvania	41,972	3,654	9	893	717	80
Wisconsin	1,870	52	3	452	396	88
Great Lakes States	270,010	16,421	6	5,295	4,327	82
Connecticut	2,274	169	7	117	92	79
Delaware	112	7	6	16	12	75
Iowa	2,011	45	2	344	319	93
Kentucky	9,612	746	8	373	326	87
Maine	206	11	5	101	99	98
Maryland	5,195	391	8	117	91	78
Massachusetts	2,614	172	7	179	144	80
Missouri	15,776	765	5	440	303	89
New Hampshire	643	34	5	74	70	95
New Jersey	12,890	439	3	154	120	78
North Carolina	7,898	674	9	321	223	69
Rhode Island	506	45	9	31	28	90
Tennessee	57,304	19,485	34	194	173	89
Vermont	582	57	10	80	66	83
Virginia	6,968	825	12	254	208	82
West Virginia	20,464	4748	23	346	265	77
Other States	145,055	28,613	20	3,141	2,539	81

[Modified from Kaufman and Nadler (1966, from table 5 (p. 16)). New water withdrawn and water consumed are in gallons per year; coefficient is the percentage of water withdrawn that was consumed (computed from the new-water-withdrawn and water-consumed figures).]

Water-use region	New water withdrawn	Water consumed	Coefficient (percent)
Chesapeake Bay	37,468	2,560	7
Cumberland	597	68	11
Delaware and Hudson	31,638	1,955	6
Great Lakes[1]	167,850	9,033	5
Mississippi, upper	34,322	2,262	7
New England	6,343	438	7
Ohio	66,110	7,859	12
Tennessee	61,926	19,953	32
Region	406,254	44,128	11

[1] Combined Eastern Great Lakes—St. Lawrence and Western Great Lakes regions.

[Modified from Kaufman and Nadler (1966, from table 6 (p. 17)). New water withdrawn and water consumed are in gallons per year; coefficient is the percentage of water withdrawn that was consumed (computed from the new-water-withdrawn and water-consumed figures).]

Commodities	New water withdrawn	Water consumed	Coefficient (percent)
Anthracite	16,938	1,353	8
Barite	4,855	414	9
Bituminous coal	31,814	5,679	18
Clays	7,118	836	12
Copper ores	81,035	30,328	37
Gold	54,566	645	1
Iron ores	112,575	6,903	6
Lead and zinc ores	22,885	1,535	7
Lignite	18	10	56
Natural gas processing plants	102,358	33,700	33
Petroleum and natural gas production	121,538	110,578	91
Phosphate rock	117,167	29,981	26
Potash, soda, and borate	7,325	2,891	39
Salt	28,933	6,921	24
Sand and gravel	217,601	11,365	5
Stone, crushed	50,415	3,378	7
Stone, dimension	3,207	128	4
Sulfur	17,604	4,648	26
Undistributed	25,201	2,230	9
Uranium, vanadium, and radium ores	7,243	3,042	42
Total or mean	1,030,396	256,565	25

[Modified from Kaufman and Nadler (1966, from table 7). New water withdrawn and water consumed are in gallons per year; coefficient is the percentage of water withdrawn that was consumed (computed from the new-water-withdrawn and water-consumed figures).]

Type of operation	New water withdrawn	Water consumed	Coefficient (percent)
Underground mines	84,131	15,656	19
Surface mines	426,304	71,618	17
Mills, preparation plants, sand and gravel washing plants, and natural gas processing plants	327, 098	47,542	15
Chemical or solution extraction	16,267	6,326	39
Petroleum and natural gas production	121,538	110,578	91
Other	55,058	4,845	9
Total or average	1,030,396	256,565	25

Kay, R.T., 2002, Estimated water withdrawals, water use, and water consumption in Illinois, Indiana, Iowa, Kentucky, Michigan, Missouri, and Wisconsin, 1950–95: U.S. Geological Survey Water-Resources Investigations Report 01–4116, 29 p.

Compiled from previously published USGS 5-year water-use reports, the data for the listed north-central states are presented graphically to highlight trends. The section on "Estimated Water Consumption" (p. 20–27) describes methods by which consumption data were manipulated to take into account, for example, losses from public-supply water, as well as self-supplied water where both sources are used. Consumption by various categories is graphed over the study period as consumption in million gallons per day and as a percentage of the total consumption for each state. Rural domestic use is the only category presented in terms of percentage consumed with respect to total withdrawal; the values graphed for 1995 appear to be near 10–15 percent for Illinois, Indiana, Kentucky, and Michigan; 20 percent for Wisconsin; 25 percent for Missouri; and 40 percent in Iowa. (None of the data are tabulated.) Percentages reported before 1985 ranged widely, apparently because of substantially different assumptions by the estimators. For these north-central states, more than 90 percent of all water withdrawn for irrigation was consumed; the exception is Missouri, for which the coefficient was 75 percent. For self-supplied industrial systems, the following consumptive-use coefficients since 1980 were reported: Kentucky, 4 percent; Indiana, 7 percent; Michigan, 7 percent; Iowa and Missouri, 10 percent; Illinois and Wisconsin, 15 percent. Less than 4 percent of the water withdrawn for thermoelectric power in these states from 1960 to 1995 was consumed. During 1960–1995, less than 4 percent of withdrawn water was consumed in the north-central states.

LaTour, J.K., 1991, Determination of water use in Rockford and Kankakee areas, Illinois:, U.S. Geological Survey Water-Resources Investigations Report 90–4166, 70 p.

Amounts of water withdrawn, delivered, released, consumed, and returned, as well as conveyance losses and gains, were determined for six communities in Illinois in the Rockford and Kankakee areas. Although consumptive-use data were not available for the communities, consumptive use was estimated with a consumption-budget method and a types-of-use method. The consumption budget uses the following equation to determine consumptive uses:

Consumptive use = (deliveries + self-supplied withdrawals) – (releases to sewage-treatment plants + direct returns to surface- and ground-water sources) (p. 24)

The types-of-use estimates involved taking a percentage of the water withdrawals for the categories of cooling systems, boilers, and lawn watering. In Illinois, the percentage for cooling systems and lawn watering was 80 percent, and for boilers, 90 percent.

If data were insufficient for these methods, consumptive use was estimated from a minimum consumptive-use ratio per category (commercial = 0.096 and municipal = 0.284). For outside domestic-use estimates, a winter base-rate method was used wherein water withdrawal from November to April is summed and divided by 6 to yield a monthly winter base. By subtracting the base rate from water use for each month from May through October, outdoor water use is determined. Outdoor water use is then aggregated, and an evapotranspiration factor of 80 percent is applied to determine the consumptive use.

This report also discusses the maximum lawn-watering method (MLW; p. 31), which is determined by taking May–October monthly potential evapotranspiration and subtracting the difference of the monthly precipitation and monthly runoff, then multiplying that number by the average lawn site:

$$MLW = \Sigma_i \, (PE - [P - R]) * LS_i$$

where

MLW is annual maximum lawn watering estimate per lawn,

i is months when lawns are typically watered (May through October),

PE is monthly potential evapotranspiration,

P is monthly precipitation,

R is monthly runoff,

and

LS is average lawn size.

For the six communities, domestic consumptive-use ratios (consumptive-use estimates divided by deliveries and self-supply withdrawals) were derived using the types-of-use, maximum lawn-watering, and the winter base-rate methods and were compared. “Because the maximum lawn-watering estimates represent maximum domestic consumptive use, reasonable domestic consumptive-use estimates should be less than or similar to estimates calculated from the maximum lawn-watering method” (p. 32). “The winter base-rate method seems to be a more reasonable means of estimating domestic consumptive use than the types-of-use method because its ratios do not exceed the maximum lawn-watering ratios” (p. 33).

[Modified from LaTour (1991, table 11). SIC, Standard Industrial Classification: Category: C, commercial; D, domestic; I, industrial; and M, municipal: Water user is an establishment or household: Mgal/yr, million gallons per year; DEL and SSWD, deliveries and (or) self-supply withdrawals.]

SIC code	Category	Sample (number of water users)	Consumptive-use ratio (average consumptive uses divided by DEL and SSWD)
15-17	C	2	0.798
20	I	12	.322
23	I	2	.192
24-26	I	6	.544
27	I	6	.364
28-29	I	9	.277
30	I	4	.266
32	I	2	.116
33	I	10	.318
34	I	23	.318
35	I	18	.350
36	I	8	.364
37	I	2	.454
38-39	I	4	.371
43	C	1	.096
48	C	1	.273
50-53, 55-57, 59	C	33	.271
54	C	11	.332
58	C	31	.266
60-65	C	14	.482
67	C	6	.313
70	C	5	.256
72	C	6	.096
73	C	2	.531
75	C	3	.172
79	M[1],C	6	.386
80	C	10	.267
81	C	2	.215
82	M[1],C	2	.434
83	M[1], C	5	.343
86	C	13	.174
88	D[1]	1,033	.423
89	C	2	.400
91-96	M[1], C	6	.284
Mean			.325

[1]Estimated from types-of-use method only.

[Modified from LaTour (1991, table 12). Categories from Rockford and Kankakee areas, Illinois, 1984. SIC, Standard Industrial Classification code; DEL and SSWD, deliveries and (or) self-supply withdrawals.]

Category	Sample (number of water users)	Range of consumptive-use ratios (by SIC code)	Consumptive-use ratio (average consumptive uses divided by DEL and SSWD)
Commercial	149	0.096 - .0798	0.292
Industrial	106	0.116 - 0.554	.336
Domestic[1]	1,033	--	.423
Municipal[1]	12	0.284 - 0.434	.336

[1] Estimated from types-of-use method only.

The above tables show consumptive-use coefficients (ratios) of SIC code and categories. LaTour states that although "these ratios may be used as coefficients to estimate consumptive uses for systems whose water uses and climate are similar, they should be used with caution. Some of the ratios were estimated from types-of-use data that probably represent the largest consumptive use in the study areas, and many were derived from a small number of water users sampled" (p. 26). LaTour found that the "winter base-rate method provided the best domestic consumptive-use estimates" and ranged from 0.030 (3 percent) to 0.136 (13.6 percent) and averaged 0.068 (6.8 percent).

[Modified from LaTour (1991, fig. 8). Consumptive-use coefficient is in percent and was presented in report.]

Category	Rockford area consumptive-use coefficient	Kankakee area consumptive-use coeffficient
Commercial and industrial	17.9	15.7
Domestic	7.4	3.8
Municipal	25.8	28.4
All categories	13.8	12.1

In addition, LaTour assumed that "conveyance losses or gains" were zero for self-suppliers, but he noted that the national median for conveyance-loss was 11 percent and that most northern Illinois cities had a public-supply conveyance loss ranging from 0.5 to 40.0 percent of public-supply withdrawals. LaTour also noted that the public-supply conveyance losses are affected by the age and the size of the public-supply conveyance systems and the public-supply maintenance programs. LaTour found that the conveyance losses were 12 percent (Rockford, Ill. area) and 17 percent (Kankakee, Ill. area).

LaTour (1991) noted that public-supply conveyance systems are under pressure and water is typically lost, not gained; but when conveyance systems are not adequately pressurized (when water-main breaks are being repaired, for example) they may gain water. LaTour (1991) also estimated sewer-conveyance gains (inflow and infiltration) by determining the difference between sewage-treatment returns and releases but stated that unrecognized releases or significant meter errors could result in erroneous estimates. The sewer conveyance gains for the Rockford and Kankakee, Ill., areas were 35 percent of the public-supply withdrawals.

Lee, D.H., ed., 1993, Basis of comparison—Great Lakes-St. Lawrence River system: Ann Arbor, Mich., National Oceanic and Atmospheric Administration, Great Lakes Environmental Research Laboratory, NOAA Technical Memorandum ERL GLERL–79, 119 p.

Consumptive-use data for the basins of the individual Great Lakes are included in this document, which describes a 90-year set of lake levels and flows developed as a basis of comparison for future regulation plans. This document defines consumptive use of water as "that portion of water withdrawn or withheld from the Great Lakes-St. Lawrence River system and assumed to be lost due to evaporation during use, transpiration from irrigated crops, leakage, incorporation into manufactured products, or similar occurrences during use." Other factors defining the hydraulic regime are diversion rates into and out of the system, "time series of water supplies to the system, outlet conditions of each lake, flow retardation due to ice or weeds in connecting channels, initial starting elevations for the simulation, and the hydraulic condition of the St. Lawrence River and tidal levels at its outlet." Consumptive use is referred to as "a small but significant component of the water balance of the Great Lakes" (p. 2).

[Modified from Lee (1993, table 2). Consumptive use is in cubic feet per second.]

Basin	1989 consumptive use	Rounded value
Lake Superior	128	100
Lake Michigan	893	900
Lake Huron	256	300
Lake St. Clair	184	200
Lake Erie	714	700
Lake Ontario	342	300
St. Lawrence River	325	300

Loper, C.A., Lent, S.D., and Wetzel, K.L., 1989, Withdrawals and consumptive use of water in Pennsylvania, 1984: U.S. Geological Survey Water-Resources Investigations Report 88–4095, 50 p.

Total water withdrawal in Pennsylvania in 1984 was 14,033.66 Mgal/d, of which 729.53 Mgal/d was from ground water and 13,304.12 Mgal/d was from surface water. Thermoelectric power generation accounted for 71 percent of total withdrawal, followed by self-supplied industry, 15 percent; public supply, 11 percent; and mining, supplied domestic use, livestock and poultry, and irrigation (collectively) about 3 percent. Consumptive use was computed for public supply, self-supplied domestic use, irrigation, and livestock by use of coefficients. Mining, power generation, and self-supplied

industry consumptive-use estimates were compiled from estimates received from facilities. For the industrial facilities that did not have facility estimates, consumptive-use totals were computed by use of Standard industrial Classification codes. The percentage of consumptive use to self-supplied withdrawals varied by county and hydrologic unit code (HUC). The table that follows lists derived consumptive-use coefficients based on withdrawal and consumption amounts tabulated in the report. The self-supplied industry coefficient of 9 percent might be artificially high because some of the facilities used both self-supplied and public-supplied water.

Public supply	10 percent
Self-supplied domestic use	10 percent consumptive-use factor multiplied by the total withdrawals to obtain consumptive use for individual counties
Agriculture:	
Irrigation	100 percent
Livestock	75 percent
Self-supplied industry	9 percent
Mining	13.5 percent
Power generation:	
Thermoelectric	1.7 percent
Hydroelectric	0

"Water consumed through evaporation or incorporation into a manufactured product totaled 615.22 Mgal/d. Self-supplied industry was responsible for 30 percent of total consumptive use followed by power generation (28 percent), public supply (26 percent), livestock (10 percent), mining (3 percent), self-supplied domestic use (2 percent), and irrigation (less than 1 percent)" (p. 48).

Ludlow, R.A., and Gast, W.A., 2000, Estimated water withdrawals and use in Pennsylvania, 1995: U.S. Geological Survey Fact Sheet 174–99, 4 p.

This fact sheet gives a brief summary of Pennsylvania's water use, by category. Most of the data used by the USGS are collected by the Pennsylvania Department of Environmental Protection (DEP), which receives annual reports of water use and consumptive use from public suppliers, power-generation facilities, and some industries. In addition, the DEP surveys other industrial, commercial, and mining facilities on a cyclical schedule. Consumptive use is one of the statistics compiled in each category. Irrigation and livestock are computed by the authors (Russ Ludlow, USGS, oral commun, October 5, 2006). The fact sheet includes a graphic (fig. 1) showing amounts of consumptive use and total use (self-supplied plus public-supply deliveries). Those data and the derived consumptive-use coefficients are the following:

[Modified from Ludlow and Gast (2000). Water consumed and withdrawn are in million gallons per day (Mgal/d). Coefficient is in percent.]

Water-use category	Consumed	Withdrawn	Coefficient
Industrial	158	1,870	8.4
Irrigation	15.9	15.9	100
Mining	14.0	182	7.7
Commercial	11.5	247	4.6
Public supply	574[1]	1,550	37
Domestic	74.0	740	10
Livestock	41.0	55.3	74
Thermoelectric power	239	5,930	4

[1] Public use and losses.

MacKichan, K.A., 1957—See listing under 'USGS Circulars' near the end of this section.

MacKichan, K.A, and Kammerer, J.C., 1961—See listing under 'USGS Circulars' near the end of this section.

Marcuello, Conchita, and Lallana, Concha, 2003, Water exploitation index: European Environment Agency, accessed May 24, 2006, at *http://themes.eea.europa.eu/Specific_media/water/indicators/WQ01c%2C2003.1001/WEI_101003v2.pdf*

This document includes consumption and exploitation indexes in European countries. The water consumption index is the total water consumed divided by the long-term freshwater resources of a country. Indexes ranged from about 0 for Iceland to about 27 percent for Cyprus, with an average of 3 percent. The water exploitation index (WEI) or withdrawal ratio is the mean annual total withdrawal of freshwater divided by the long-term average freshwater resources. The exploitation index is used to classify countries as non-stressed (less than 10 percent), low-water stress (between 10 and 20 percent), or water stressed (greater than 20 percent). Cyprus, Malta, Italy, and Spain have 18 percent of Europe's population and are considered water stressed. For this assessment, it was assumed that the consumptive use was 80 percent of the total water withdrawals for agriculture, 20 percent for urban use, 20 percent for industry, and 5 percent for energy production. The authors note that these consumptive use coefficients are "widely accepted, though they may vary by about 5 to 10 percent depending on the sectors and other factors." As an example, actual consumption of water for agriculture depends on climate, crops, and irrigation methods.

Medalie, Laura, 1996, Wastewater collection and return flow in New England, 1990: U.S. Geological Survey Water-Resources Investigations Report 95–4144, 79 p.

A compilation of state and drainage-basin site-specific data on municipal wastewater-collection systems, municipal wastewater-treatment facilities, and municipal wastewater return, this document is a source of information for state and municipal planners. For some facilities that did not have return-flow data, return-flow amounts were estimated by

multiplying the per capita water-use coefficient of 65 gal/d and the population served. The per capita water-use coefficient was determined by taking the average self-supplied per capita domestic use of 76 gal/d in New England and subtracting 14 percent for consumptive use (p. 11; Solley and others, 1993).

Medalie, Laura, 1997a, Estimated water withdrawals and use in Vermont, 1995: U.S. Geological Survey Water-Resources Investigations Report 97–4178, 14 p.

Water withdrawals by county and by Hydrologic Unit Code for Vermont are tabulated for 1995 in this document. Although the report does not present consumptive-use information, it states that "about 90 percent of the water used for irrigation is lost through evapotranspiration" (p. 11) and cites the University of Vermont Cooperative Extension as a source.

Medalie, Laura, 1997b, Estimated water withdrawals and use in New Hampshire, 1995: U.S. Geological Survey Water-Resources Investigations Report 97–4177, 13 p.

Water withdrawals by county and by Hydrologic Unit Code for New Hampshire are tabulated for 1995 in this document. Although the report does not present consumptive-use information, it states that "about 90 percent of the water used for irrigation is lost through evapotranspiration" (p. 9) and cites the University of Vermont Cooperative Extension as a source.

Mullaney, J.R., 2004, Water use, ground-water recharge and availability, and quality of water in the Greenwich area, Fairfield County, Connecticut and Westchester County, New York, 2000–2002: U.S. Geological Survey Water-Resources Investigations Report 03–4300, 64 p.

This document reports on a detailed study of the wealthy Greenwich area of Connecticut and New York, which may be atypical of the rest of the two states in its apparently greater residential use of water: 113–416 gal/person/d, depending on residential lot size, in contrast to an estimated 76 gal/person/d statewide. Public-supply data were used to develop regression models for estimating ground-water withdrawals for year-round, summer, and winter water use on self-supplied lots; model variables included unforested area, swimming-pool size, and total footprint of buildings. Detailed water-use estimates are tabulated for 32 zones (small basins) in the Greenwich area. Also estimated was return flow of public-supply water via septic systems. Consumptive water use was estimated to be the outdoor water use "by subtracting the winter water-use data from the average daily water use." Consumptive use for Greenwich properties with public supply averaged 20 percent, consistent with previously published estimates for Connecticut (in Solley, 1998); the median was 19 percent, and the interquartile range was from 3 to 39 percent. A higher coefficient—29 percent—was estimated by use of the regression models.

Murray, C.R., 1968—See listing under 'USGS Circulars' near the end of this section.

Murray, C.R. and Reeves, E.B., 1972—See listing under 'USGS Circulars' near the end of this section.

Murray, C.R. and Reeves, E.B., 1977—See listing under 'USGS Circulars' near the end of this section.

National Land and Water Resources Audit Australia, 2001, 1985 review of Australia's water resources and water use: Accessed May 24, 2006, at *http://www.nlwra.gov.au/archive/full/20_products/05_by_subject/10_water_resources_and_mgt/00_Water_Review_1985/10_water_use/water_use.html*

Included in this fact sheet are maps showing the gross water consumed in Australia by total water, surface-water resources, and ground-water resources. Maps of drainage basins in Australia are color coded to show the water consumed (in gigaliters) between July 1, 1983, and June 30, 1984. Gross water consumed is defined as the "water supplied that was not returned to a stream or body of fresh water or diverted for use a second time (reclaimed water). It is the difference between gross water supplied and return flow plus reclaimed water."

Nawyn, J.P., 1997, Water use in Camden County, New Jersey, 1991: U.S. Geological Survey Open-File Report 97–12, 39 p.

The study described in this report examined water use (from withdrawal to return flow) during 1991 in Camden County, N.J. "Coefficients of consumptive water use that were developed in other studies were modified and applied to data on water users in Camden County" (p. 10). Consumptive use was estimated by use of coefficients for both publicly supplied and self-supplied water. Coefficients of consumptive use by category of water use—public supply, domestic, commercial, industrial, irrigation, and mining—are given for all water users in the county. Per capita use of domestic users also was computed. For public-supply facilities, 12 percent of withdrawal was unaccounted for by facilities that submitted a report. Because of unusually high losses in one public-supply facility, unaccounted-for water was estimated to be 10 percent (instead of 12 percent) of water deliveries for public suppliers who did not submit a report.

[Modified from Nawyn (1997). Distributed water/withdrawals and consumptive use are in million gallons per day; coefficient is in percent.]

Category of use	Coefficient	Distributed water/withdrawals	Consumptive use
Public-supply deliveries			
Domestic	18	44	8
Commercial	4	9	<1
Industrial	8	1	<1
Public water use[1]	20	3	1
Total	NA	57	9
Self-supply withdrawals			
Domestic	20	2	<1
Commercial	4	NA	<1
Industrial	90	2	2
Irrigation	90	2	2
Mining	8	1	<1
Total	NA	10	3

[1]Does not include distribution losses or bulk sales to other public suppliers.

Neff, B.P., and Killian, J.R., 2003, The Great Lakes water balance—Data availability and annotated bibliography of selected references: U.S. Geological Survey Water-Resources Investigations Report 02–4296, 37 p.

Although this document does not specifically list consumptive-use coefficients, it includes references to published and agency sources of consumptive-use information.

Neff, B. P., and Nicholas, J.R., 2005, Uncertainty in the Great Lakes water balance: U.S. Geological Survey Scientific Investigations Report 2004–5100, 42 p.

In this report, the water balance of the Great Lakes hydrologic system is discussed. Because consumptive use is a small component of the overall water balance, it is not addressed in this document; however, readers are referred to chapter 3 of the Great Lakes Commission report (2003; p. 19).

Nimiroski, M.T., and Wild, E.C., 2005, Water use and availability in the Woonasquatucket and Moshassuck River Basins, north-central Rhode Island: U.S. Geological Survey Scientific Investigations Report 2005–5031, 43 p.

Withdrawal, use, and return-flow data were collected for the Woonasquatucket and Moshassuck River Basins in north-central Rhode Island. This study used a consumptive use coefficient of 10 percent for commercial and industrial categories (tables 6 and 9, p. 11 and 25; Solley and others, 1998). For the basin, the domestic public-supplied and self-supplied domestic consumptive-use coefficient was 15 percent (Solley and others, 1998). The agricultural (livestock, crop irrigation and golf course irrigation) consumptive use coefficient was assumed to be 100 percent. The authors noted that Horn and others (1994) had a specific coefficient for livestock, but they did not use this coefficient because of negligible livestock water use in the study area.

Ohlsson, Leif, 1997, Water scarcity and conflict: University of Göteborg, Sweden, 25 p., accessed May 1, 2006, at *http://www.padrigu.gu.se/ohlsson/files/Bonn97.pdf*

As part of this document, water use is discussed by category and sector (p. 4). The largest water user in terms of global water withdrawals is agriculture at 65–70 percent, followed by industrial withdrawals at 20–25 percent, followed by domestic water use at 5–10 percent. For agriculture, 65 percent of total withdrawal is considered consumptive use (from Postel and others, 1996); for industrial and domestic use, the coefficients are 9 percent and 17 percent, respectively (p. 4). It should be noted that the actual water consumed in agriculture varies by water-use efficiency, climate, and types of harvests.

Paulson, R.W., Chase, E.B., and Carr, J.E., 1988, Water supply and use in the United States—U.S. Geological Survey National Water Summary 1987 *in* **Waterstone, Marvin, and Burt, J.R., eds., Proceedings of the Symposium on Water-Use Data for Water Resources Management, Tucson, Ariz., August 28–31, 1988: Bethesda, Md., American Water Resources Association, p. 41–49.**

This paper is a general overview of the U.S. Geological Survey 1987 National Water Summary, which was focused on the source, use, and disposition of water in the United States. In a diagram citing the U.S. Geological Survey National Water Data Storage and Retrieval System, this document shows consumption-to-withdrawal rates of 19.5 percent of domestic and commercial water use, 16 percent for industrial-mining, 3.3 percent for thermoelectric power generation, and 53.9 percent for irrigation.

Pebbles, Victoria, 2003a, Consumptive use in the Great Lakes Region and Basin—Annotated bibliography of selected references: Ann Arbor, Mich., Great Lakes Commission, 10 p.

Narrower in geographic scope than the current bibliography, this document reports consumptive-use coefficients in some of its annotations and served as a starting point for the current bibliography. In all, 27 publications and data sources are described.

Pebbles, Victoria, 2003b, Measuring and estimating consumptive use of the Great Lakes water: Ann Arbor, Mich., Great Lakes Commission, prepared in cooperation with the Water Withdrawal Subcommittee of the Water Resources Decision Support System Project, 18 p.

The purpose of this document was to describe the "current state of knowledge of consumptive use of water in the Great Lakes basin" as background for development of a decision-support system for water-resources management. It is based on a bibliography compiled by the author (see preceding listing), informal interviews and correspondence with water experts in the region, and results of a 2002 Great Lakes Commission (GLC) survey of the states and provinces

within the basin regarding consumptive-use information and estimating methods. The author begins by listing varied definitions of consumptive use over time and by different agencies, then follows with brief descriptions of estimating methods, comparisons of consumptive-use coefficients used by the USGS and the GLC, comparisons of USGS and GLC water-use categories and estimating procedures and consumptive-use reporting by jurisdictions, and recommended actions for consumptive-use estimating, calculating, and reporting. Of particular interest are a small summary table listing ranges of USGS consumptive-use coefficients in the 1985–95 water-use circulars (p. 5) and a large table listing ranges of coefficients by water-use category and jurisdiction (USGS included); the latter table is reproduced in this report as appendix table 3–1. An interesting side note is a discussion of how a general coefficient of 6.8 percent for all types of self-supplied industry in Ontario was largely substantiated by aggregating facility-measured data (p. 11).

Pennsylvania Department of Environmental Resources, Office of Resources Management, 1975–83, The State Water Plan: 20 v. [Planning Principles document plus 19 reports on individual subbasins].

Each individual subbasin volume of this series contains a table listing water withdrawals (surface water, ground water, and total), interbasin-transfer losses, and consumptive losses for 1970 (known or estimated), plus projections for 1980 and 1990. Consumptive-use coefficients used across the board were 10 percent for municipal, 100 percent for irrigation (including golf course), 75 percent for livestock, and 10 percent for "other self-supplied institutions." For mineral industries, manufacturing, and power production, however, consumptive-loss figures were varied and appear to have been based on reported data. Data for the 20 subbasins are tabulated below for these latter categories. Ranges of coefficients (in percent) are mineral industries, 5.0–17.6 (with a median of 8.1); manufacturing, 6.2–11.4 (with a median of 7.5); and power, <0.1–8.6 (with a median of 1.23).

[Modified from Pennsylvania Department of Environmental Resources (1975–1983). Wdl, total withdrawal, in million gallons per day; CL, consumptive losses, in million gallons per day; Coef, coefficient (CL/Wdl × 100)]

Type of use	Subbasin 1			Subbasin 2			Subbasin 3			Subbasin 4		
	Wdl	CL	Coef	Wdl	CL	Coef	Wdl	CL	Coef	Wdl	CL	Coef
Mineral	3.926	0.225	5.7	27.75	1.925	6.9	11.25	0.896	8.0	0.510	0.028	5.5
Manufacturing	3.752	0.374	10	650.2	43.97	6.8	0.369	0.026	7.0	23.03	1.666	7.2
Power	485.8	2.800	0.6	0	0	--	0	0	--	0	0	--

Type of use	Subbasin 5			Subbasin 6			Subbasin 7			Subbasin 8		
	Wdl	CL	Coef	Wdl	CL	Coef	Wdl	CL	Coef	Wdl	CL	Coef
Mineral	15.26	1.165	7.6	17.94	1.425	7.9	32.22	2.117	6.6	0.301	0.053	17.6
Manufacturing	23.20	1.757	7.6	0.887	0.068	7.7	96.65	6.594	6.8	0.486	0.031	6.4
Power	120.9	1.397	1.2	291.0	2.100	0.7	1119	7.855	0.7	425.2	3.100	0.7

Type of use	Subbasin 9			Subbasin 10			Subbasin 11			Subbasin 12		
	Wdl	CL	Coef	Wdl	CL	Coef	Wdl	CL	Coef	Wdl	CL	Coef
Mineral	1.300	0.087	6.7	0.249	0.014	5.6	0.691	0.048	6.9	9.578	0.519	5.4
Manufacturing	32.58	3.124	9.6	1.954	0.137	7.0	10.21	0.790	7.7	27.54	1.770	6.4
Power	44.70	0.030	0.1	0	0	--	84.67	0.667	0.8	0	0	--

Type of use	Subbasin 13			Subbasin 14			Subbasin 15			Subbasin 16		
	Wdl	CL	Coef	Wdl	CL	Coef	Wdl	CL	Coef	Wdl	CL	Coef
Mineral	1.626	0.165	10.1	0	0	--	0.020	0.001	5.0	2.999	0.156	5.2
Manufacturing	0.915	0.070	7.6	0	0	--	36.14	2.762	7.6	42.95	4.880	11.4
Power	0	0	--	0	0	--	299.9	0.155	0.052	89.00	0.210	0.2

Type of use	Subbasin 17			Subbasin 18			Subbasin 19			Subbasin 20		
	Wdl	CL	Coef	Wdl	CL	Coef	Wdl	CL	Coef	Wdl	CL	Coef
Mineral	2.280	0.191	8.4	8.201	0.824	10.0	3.626	0.638	17.6	6.273	0.414	6.6
Manufacturing	94.83	6.783	7.1	481.3	29.91	6.2	1651	102.0	6.2	726.2	46.28	6.4
Power	235.2	20.16	8.6	855.4	16.65	1.9	1688	7.43	0.4	1011	0.200	0.02

Postel, Sandra, 1996, Dividing the waters—Food security, ecosystem health, and the new politics of scarcity: Washington D.C., Worldwatch Paper 132, 76 p.

This book is a blueprint for using water more efficiently, sharing water equitably, and protecting freshwater ecosystems. This document includes estimated demand and estimated consumption by water-use sector for the world in 1990 from Postel and others (1996). For agriculture, the consumption was 1,870 cubic kilometers per year (km^3/yr) of a demand of 2,880 km^3/yr, yielding a consumption coefficient of 65 percent. For industrial uses, the consumption was 90 km^3/yr of a demand of 975 km^3/year, yielding a consumption coefficient of 10 percent. For municipalities, the consumption was 50 km^3/year of a demand of 300 km^3/yr, yielding a consumption coefficient of 17 percent. Also, reservoir losses constituted both a consumption and demand of 275 km^3/yr, yielding, in effect, a consumption coefficient of 100 percent (table 2, p. 14).

Postel, S.L., Daily, G.C., and Ehrlich, P.R., 1996, Human appropriation of renewable fresh water: Science, v. 271, no. 5250, p. 785–788.

This article includes an estimate of how much of Earth's renewable water is realistically accessible to humans; the portion of the renewable water that humans use, divert, or appropriate; and the likely expansion of human access to freshwater in the next 30 years (p. 785). Currently, humans use 26 percent of the total. As part of this analysis, the document includes estimated use and estimated consumption by water-use sector for the world for 1990. For agriculture, the consumption was 1,870 cubic kilometers per year (km^3/yr) of a demand of 2,880 km^3/yr with a consumption coefficient of 65 percent (p. 787, table 4). For industrial uses, the consumption was 90 km^3/yr of demand of 975 km^3/year with a consumption coefficient of 10 percent. For municipalities, the consumption was 50 km^3/year of a demand of 300 km^3/yr with a consumption coefficient of 17 percent. Reservoir losses had both a consumption and demand of 275 km^3/yr with a consumption coefficient of 100 percent (p. 787, table 4). Also of interest is the statement that humans now use "26 percent of total terrestrial evapotranspiration and 54 percent of runoff that is geographically and temporally accessible. Increased use of evapotranspiration will confer minimal benefits globally because most land suitable for rain-fed agriculture is already in production. New dam construction could increase accessible runoff by about 10 percent over the next 30 years, whereas population is projected to increase by more than 45 percent during that period" (p. 785).

Quan, C.K., 1988, Water use in the domestic nonfuel minerals industry: U.S. Bureau of Mines Information Circular 9196, 62 p.

Nonfuel mineral industries were canvassed, and the information gathered is presented in this report. Appendix B, tables B–1 and B–5 (p. 39, 42) list number of respondents; appendix C, tables C–1 and C–7 (p. 46, 52) list water consumed by type of metal and by state. With this information, as well as the amount of new water that is withdrawn, consumptive-use coefficients were computed. (See table that follows this entry.) Also of interest are tables listing water use by short ton of crude ore produced and water use per dollar of mined production. For the Great Lakes states (Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, Wisconsin), the mean consumptive use was 20 percent of the water withdrawn, and the range of consumptive-use coefficients was 14–34 (table C–7, p. 52). For the 16 climatically similar states (Connecticut, Delaware, Iowa, Kentucky, Maine, Maryland, Massachusetts, Missouri, New Hampshire, New Jersey, North Carolina, Rhode Island, Tennessee, Vermont, Virginia, West Virginia), the consumptive-use coefficient was 30 percent, but this figure is skewed by two states, New Jersey and West Virginia, that had high coefficients of 86 and 55, respectively (table C–7, p. 52). Consumptive-use figures for both states were based on a small number of facilities that reported water use, 9 and 15, respectively (table B–6, p. 43), so inaccurate reporting or an unusual type of facility mining process could be skewing the consumptive-use coefficient. Omitting these two states, the consumptive-use coefficient for the climatically similar states is 22 percent. If only New Jersey is omitted, the coefficient is 23 percent.

[Modified from Quan (1988). Total withdrawn and water discharged are in billion gallons; coefficient is the percentage of water withdrawn that was consumed (computed from the total withdrawn and water discharged numbers).]

Commodity	Water withdrawn	Water consumed	Coefficient	Respondents	Respondents with water use
			Metals		
Copper	81,460	62,590	77	20	18
Gold:					
Lode	6,220	4,240	68	27	21
Placer	3,490	250	7	17	13
Iron ore	67,740	10,720	16	19	12
Lead	2,500	30	1	10	8
Silver	2,490	1,010	41	16	14
Uranium-vanadium	6,980	1,020	15	55	24
Zinc	2,400	510	21	11	9
Other metals	6,250	2,480	40	21	12
Metal total	179,530	82,850	46	196	131
			Nonmetals		
Clays	22,600	7,790	34	181	48
Diatomite	520	520	100	5	5
Feldspar	1,430	350	24	10	10
Gypsum	560	530	95	47	10
Magnesium compounds	960	0	0	5	4
Mica, scrap	1,140	410	36	4	4
Phosphate rock	117,690	60,850	52	35	28
Potash	4,400	2,160	49	8	7
Salt					
Evaporated	22,580	1,990	9	23	19
Rock	3,570	170	5	13	4
Salt in brine	6,310	6,310	100	25	18
Sand and gravel					
Construction	100,500	32,780	33	10	9
Industrial	23,710	16,090	68	41	37
Sodium carbonate, natural	9,480	5,920	62	6	6
Stone, crushed	64,960	19,320	30	1,443	683
Sulfur, Frasch	7,550	2,000	26	6	6
Other nonmetals	3,510	2,710	77	52	33
Nonmetal total	391,470	159,900	41	1,894	931
Grand total	571,000	242,750	43	2,090	1,062

[Modified from Quan (1988, table C–7). Total withdrawn and water discharged are in billion gallons; coefficient is the percentage of water withdrawn that was consumed (computed from the total withdrawn and water discharged numbers)]

State	Total withdrawn	Water consumed	Coefficient
Great Lake States			
Illinois	13,610	4,590	34
Indiana	3,660	730	20
Michigan	26,910	3,740	14
Minnesota	65,000	11,420	18
New York	18,200	4,050	22
Ohio	9,220	2,540	28
Pennsylvania	11,240	2,280	20
Wisconsin	2,820	830	29
GL States, mean	150,660	30,180	20
Climatically Similar states to the Great Lake States			
Connecticut	1,140	300	26
Delaware	260	40	15
Iowa	2,650	640	24
Kentucky	1,850	380	21
Maine	1,030	340	33
Maryland	2,380	820	34
Massachusetts	2,500	640	26
Missouri	7,630	1,080	14
New Hampshire	730	240	33
New Jersey	8,670	7,420	86
North Carolina	27,320	7,060	26
Rhode Island	220	60	27
Tennessee	14,960	1,650	11
Vermont	490	160	33
Virginia	2,280	940	41
West Virginia	1,330	730	55
States mean	75,440	22,500	30

Shiklomanov, I.A., and Rodda, J.C., 2003, World water resources at the beginning of the 21st century: Cambridge U.K., Cambridge University Press [for] UNESCO, 435 p.

This comprehensive volume includes data on global water resources, water use, and water availability, by continent. Water use for domestic (urban and rural) was based on population totals, changes in population totals, and per capita use of water. Consumption of water was from published data and country analogues (38). Water consumption for irrigation ranged from 50 to 90 percent and varied by country and region, depending on physiographic conditions and irrigation techniques employed. Irrigation-water assessments were made by analyzing population, area irrigated by years (including specific values), and the annual gross national product expressed in U.S. dollars per capita from 1960 to 1994. Water abstracted and consumed was determined from national estimates or country analogues (p. 38). Industrial water use was determined by available industrial water use data or was calculated from industrial production trends in different regions (p. 39).

For Europe, industrial consumption (including thermal power production, processing, and mining) was 11 percent of withdrawals (p. 55), domestic consumption was about 12 percent (p. 58), and agricultural consumption was about 70 percent (p. 59). Also of interest are assessments of water use and consumptive use by type of economic activity in Europe, by region, and by economic activity for the regions of Europe. For parts of Asia, South America, Australia, Africa, and the world as a whole, water use and consumptive use are shown by regions and by water-use category. Unfortunately, the document is not segmented by both region and water-use category such that data for countries climatically similar to the Great Lakes region could be reviewed.

For Africa, water consumption in agriculture is largest (75–90 percent) in the developed countries in the northern and southern parts of the continent and in exceptionally dry countries in the Sahel and western Africa (South Africa, p. 191–192); in the central region, agriculture consumption coefficients are 65–70 percent (p. 192). For North America, there are three regions—south (Mexico), central (contiguous United States), and northern (Canada and Alaska) (p. 237)—and data are presented by region and water-use category. Also of interest are water-use forecasts for 2000, 2010, and 2025.

The consumptive-use coefficients for the Shiklomanov and Rodda report are summarized in appendix 4 (tables 4-1–4-6) of this report.

Sholar, C.J., 1988, Water use in Kentucky, 1985, with emphasis on the Kentucky River Basin, *in* Waterstone, Marvin, and Burt, J.R., eds., Proceedings of the Symposium on Water-Use Data for Water Resources Management, Tucson, Ariz., August 28–31, 1988: Bethesda, Md., American Water Resources Association, p. 85–92.

This paper presents 1985 water-use data for eight major water-use categories in Kentucky and the Kentucky River Basin. The total amount of consumptive use in 1985 was 260 Mgal/d for Kentucky (p. 85). For public-supply systems, 10 percent of the public-supply deliveries was either lost in the distribution systems or was used for public uses such as firefighting (p. 86). For the State, 4 percent of the water used in industry was consumed, and 3.6 percent of the water used for thermoelectric purposes was consumed. Most of the water consumed in the Kentucky River Basin was used for domestic, thermoelectric, and agricultural purposes. For domestic use in the Kentucky River Basin, 38 percent of the withdrawals were

consumed (see table below); and for thermoelectric use, 5 percent of the withdrawals were consumed (see table below). For agricultural purposes, both livestock and irrigation, the water consumed was estimated to be "almost 10 Mgal/d" (p. 90) for withdrawals that totaled 9.85 Mgal/day (see table below); therefore, 95–100 percent of the agricultural water withdrawal was consumed.

[Modified from Sholar (1988). Water withdrawn and water consumed in million gallon per day. Coefficient is in percent.]

Water-use category	Water withdrawn	Water consumed	Coefficient
Public supply:			
Domestic	70.1	15.4	38
Commercial	40.8		
Industrial	5.2		
Mining	37.7		
Thermoelectric Power generation	3.1	8	5
Hydroelectric Power generation	153	0	0
Agricultural	9.85	Almost 10	95-100
Livestock	7.35		
Irrigation	2.5		

Sholar, C.J. and Lee, V.D., 1988, Water use in Kentucky, 1985: U.S. Geological Survey Water-Resources Investigations Report 88–4043, 53 p.

This report presents 1985 water-use data for eight major water-use categories in Kentucky by county. Included are withdrawals and consumptive use data that are collected and presented in the report. Some of these data are also given in the proceedings from a "Symposium on Water-Use Data for Water Resources Management" (Sholar, 1988).

[Modified from Sholar and Lee (1988, tables 2– 8). Water withdrawn includes withdrawals and deliveries and is million gallons per day. Water consumed is also in million gallons per day. Consumptive use is in percent.]

Water-use category	Water withdrawn	Water consumed	Consumptive use
Domestic	226.21	59.68	26
Commercial	34.52	1.33	4
Industrial	407.69	17.20	4
Mining	25.37	.74	3
Thermoelectric power generation	3,407.39	123.52	4
Irrigation	7.67	7.33	96
Livestock	50.17	50.17	100

Sholar, C.J., and Wood, P.A., 1991, Evaluation of the drought susceptibility of water supplies used in the Kentucky River Basin in 1988: U.S. Geological Survey Water-Resources Investigations Report 91–4105, 34 p.

Of interest in this report is a table that ranks public-water facilities in the Kentucky River Basin by drought susceptibility. Another table includes method and frequency of leak-detection programs for public-supply facilities in the Kentucky River Basin. For public-supply systems, 21 percent of the withdrawals was either lost in the distribution system or used in public uses such as firefighting.

Sholar, C.J., and Wood, P.A., 1995, Water use in Kentucky, 1990: U.S. Geological Survey Water-Resources Investigations Report 95–4032, 51 p.

This report contains detailed county-by-county and statewide analysis of water use including withdrawals, deliveries, and consumptive use. Data for public supply, commercial, industrial, mining, and power generation were compiled and estimated through a cooperative program between the USGS and the Kentucky Natural Resources and Environmental Protection Cabinet, Division of Water. Irrigation (minus conveyance loss) and livestock withdrawals are assumed to be about 100 percent consumed. Thermoelectric-power figures are particularly interesting in that they show consumptive use ranging from 0 to 85 percent of withdrawals and deliveries.

[Modified from Sholar and Wood (1995). Water consumed and withdrawn is in million gallons per day. Consumptive use is in percent.]

Water-use category	Consumed	Withdrawn[1]	Coefficient
Domestic[2]	41.34	235.05	18
Commercial	1.26	36.66	3
Industrial	19.16	512.09	4
Irrigation	11.50	10.94	95
Livestock	32.85	32.85	100
Mining	0.54	18.22	3
Thermoelectric power	203.15	3443.92	6

[1]Withdrawals and deliveries.

[2] Self-supply plus public supply. Per capita use is 69.88 gal/d.

Snavely, D.S., 1986, Water-use data-collection programs and regional data base of the Great Lakes-St. Lawrence River Basin states and provinces: U.S. Geological Survey Open-File Report 86–546, 204 p.

This compilation contains results from a detailed survey of state, provincial, and national agencies regarding water-use data collection, estimation, and reporting. The survey was a mandate of the Great Lakes Charter of 1985 and provided background for construction of a Great Lakes regional water-use database. The second of the three main sections of the report describes water-use data-collection programs in each of the states and provinces, methods of estimation used by each for data categories for which records were unavailable, and inconsistencies among the respective programs at the time of writing. The report concludes with a comparison of database requirements and available data, as well as suggestions for future database refinements; among the suggestions are to "improve methods of estimation and techniques of collecting data and calculating consumptive use" and to"agree to some uniformity of methods within the region" (p. 58). Consumptive-use coefficients used or reported by each state are listed in the text and are too detailed and inconsistent for a short tabulation here. Also of interest in the report is a full-page table of water-use coefficients by Standard Industrial Classification (SIC) code and state (table 7B, p. 188).

Snavely, D.S., 1987, Great Lakes water-use data base—Planning for the 21st century: U.S. Geological Survey Yearbook, Fiscal Year 1987, p. 93–98.

A synopsis of the Great Lakes Charter, Great Lakes Project, and the regional water-use database, this document includes a graph of percentages of total water withdrawals that are returned in Great Lakes data for 1983. This data were from U.S. Geological Survey Circular 1001 (Solley and others, 1983). For thermoelectric power, 99.7 percent of withdrawal was returned and 0.3 percent consumed. For domestic use, 73.7 percent was returned and 26.3 percent consumed. Livestock and irrigation categories had the smallest proportion of withdrawals returned, 8.3 percent and 3.3 percent, respectively; and the largest portion consumed, 91.7 percent and 96.7 percent, respectively (fig. 14, p. 96). For public water supply, 92.1 percent of withdrawals was returned and 7.9 percent consumed. For industrial water use, 93.5 percent of withdrawals was returned and 6.5 percent consumed. Also of interest in this document is a pie chart of consumptive water use in the Great Lakes Basin in the United States in 1980. Industry, irrigation, and public water supply made up more than 80 percent of the consumptive use in the Great Lakes (fig. 15, p. 96).

[Modified from Snavely (1988). Data are as reported by the International Great Lakes Diversions and Consumptive Uses Study Board and the U.S. Geological Survey. Coefficient is the consumptive use as a percentage of the withdrawal; a dash indicates no data]

Water-use category	1975		1980		1985	
	Study Board[2]	USGS	Study Board	USGS	Study Board	USGS
Manufacturing[1]	11	6.5	13	6.5	14	9.4
Public water supply	11	13	11	8	11	--
Thermoelectric power	1.2	0.21	1.7	0.34	2.1	4.9
Irrigation	74	95	76	100	80	100
Domestic[3]	60	21	64	27	62	74
Livestock	100	93	100	92	100	88
Totals	6.6	3.3	7.4	3.3	7.8	6.8

[1] For manufacturing, the 1975 figures exclude mining, but the 1980 and 1985 figures include mining.

[2] The Study Board coefficient is from the International Joint Commission.

[3] The USGS 1975 and 1980 domestic consumptive-use coefficients were based on only self-supplied water use, whereas the 1985 consumptive-use coefficient represented both self-supplied and publicly supplied water use.

Snavely, D.S., 1988, Estimation, analysis, sources, and verification of consumptive water use data in the Great Lakes–St. Lawrence River Basin: U.S. Geological Survey Water-Resources Investigations Report 88–4146, 28 p.

This document is a review of consumptive water-use data (withdrawals and consumptive use) and consumptive-use coefficients from the International Joint Commission (IJC), the International Great Lakes Diversions and Consumptive Uses Study Board (Study Board), and the U.S. Geological Survey (USGS). Reasons for discrepancies in consumptive water-use estimates are discussed, as well as methods that could be used for future consumptive-use data compilation. Also as part of this report, the USGS analyzed the data and computed a range of projected consumptive use from 1980 to 2000. From 1975 to 1985, the Study Board's overall consumptive use totals increased from 6.6 to 7.8 (p. 10), whereas the USGS's overall consumptive-use total increased from 3.3 to 6.8 percent. The large increase in consumptive use for the USGS numbers could be attributed to an increase in percentage of water consumed, an increase in the accuracy of the USGS data, or a combination of both. Snavely states that the accuracy of USGS data improved in response to a more careful analysis of methods and use of reported data instead of estimated values.

Solley, W.B., Chase, E.B., and Mann, W.B., 1983—See listing under 'USGS Circulars' near the end of this section.

Solley, W.B., Merk, C.F., and Pierce, R.R., 1988—See listing under 'USGS Circulars' near the end of this section.

Solley, W.B., Pierce, R.R., and Perlman, H.A, 1993—See listing under 'USGS Circulars' near the end of this section.

Solley, W.B., Pierce, R.R., and Perlman, H.A., 1998—See listing under 'USGS Circulars' near the end of this section.

Stevens, H.C., Suder, K.E., and Lessing, Peter, 1984, Water use in West Virginia for 1981: West Virginia Geological and Economic Survey Circular C–33, 94 p.

This comprehensive inventory of withdrawals and instream uses of water for 1981 in West Virginia includes data that are aggregated on the state, county, and Hydrologic Unit Code (HUC) levels. In cooperation with the USGS, the West Virginia Geological and Economic Survey compiled and computed data for this report from Federal, and state sources, as well as from water users for the thermoelectric power and industrial categories. Water-use data included withdrawal and return-flow data. In the following table are the water-withdrawal and consumptive-use data that were reported in the document (p. 5) and the coefficients that were derived from the reported data.

[Modified from Stevens and others (1984). Water consumed and water withdrawn are in million gallons per day. Coefficient is in percent.]

Water-use category	Consumed	Withdrawn	Coefficient
Agriculture	6.03[1]	6.03	100
Industry	-	-	-
Irrigation	4.42[1]	4.42	100
Mining discharge	0	101.92	0
Public suppliers[1]	133.06[1]	133.06	100
Rural domestic	18.77[1]	18.77	100
Sewage treatment	N/A	220.74	N/A
Thermoelectric power	607.01	4,382.06	13.85

[1]Reported as "No water returned."

[2] Water returned. Reported as "No water withdrawn." Total exceeds reported withdrawals for public suppliers.

Suder, K.E., and Lessing, Peter, 1984, Water use in West Virginia in 1982: West Virginia Geological and Economic Survey Circular C–35, 96 p.

This comprehensive inventory of withdrawal and instream uses of water for 1982 was compiled by the West Virginia Geological and Economic Survey and the USGS. Data are summarized statewide and also by county and eight-digit hydrologic unit. Withdrawal and (or) return data are reported for withdrawal categories in the following table (coefficients computed from reported data).

[Modified from Suder and Lessing (1984). Water consumed and water withdrawn are in million gallon per day. Coefficient is in percent.]

Water-use category	Consumed	Withdrawn	Coefficient
Industry	27.9	783.62	3.56
Irrigation	2.21[1]	2.21	100
Mining discharge	0	101.92	0
Public suppliers[1]	103.91[1]	103.91	100
Rural domestic	18.77[1]	18.77	100
Sewage treatment	N/A	181.55[2]	N/A
Thermoelectric power	436.20	4,089.55	10.7

[1] Reported as "No water returned."

[2] Water returned. Reported as "No water withdrawn." Total exceeds reported withdrawals for public suppliers.

Suder, K.E., and Lessing, Peter, 1985, Water use in West Virginia in 1983: West Virginia Geological and Economic Survey, Circular C–37, 95 p.

This comprehensive inventory of withdrawals, return flows, and instream uses of water for 1983 in West Virginia includes data that are aggregated on the state, county, and Hydrologic Unit Code (HUC) levels. Data for this report were compiled from Federal and state sources, as well as from water users for the thermoelectric power and industrial categories, by the West Virginia Geological and Economic Survey in cooperation with USGS. In the following table are the water-withdrawal and consumptive-use data reported in the document (p. 7) and the coefficients derived from the reported data.

[Modified from Suder and Lessing (1985). Water consumed and water withdrawn are in million gallon per day. Coefficient is in percent.]

Water-use category	Consumed	Withdrawn	Coefficient
Agriculture	5.86[1]	5.86	100
Industry	27.92	786.38	3.55
Irrigation	3.64[1]	3.64	100
Mining discharge	0	101.92	0
Public suppliers	103.76[1]	103.76	100
Rural domestic	18.77[1]	18.77	100
Sewage treatment[2]	N/A	161.20	N/A
Thermoelectric power	691.48	4,303.92	16

[1]Reported as "No water returned."

[2] Water returned. Reported as "No water withdrawn." Total exceeds reported withdrawals for public suppliers.

Suder, K.E., and Lessing, Peter, 1986, Water use in West Virginia for 1984: West Virginia Geological and Economic Survey, Circular C–39, 99 p.

This comprehensive inventory of withdrawals, return flows, and instream uses of water for 1984 in West Virginia includes data aggregated on the state, county, and Hydrologic Unit Code (HUC) levels. Data for this report were compiled and computed from Federal and state sources, as well as from water users for the thermoelectric power and industrial categories, by the West Virginia Geological and Economic Survey in cooperation with USGS. In the following table are the water-withdrawal and consumptive-use data reported in the document (p. 10) and the coefficients computed from the reported data.

[Modified from Suder and Lessing (1986). Water consumed and water withdrawn are in million gallon per day. Coefficient is in percent.]

Water-use category	Consumed	Withdrawn	Coefficient
Agriculture	5.98[1]	5.98	100
Industry	30.4	890.06	3.4
Irrigation	3.64[1]	3.64	100
Mining discharge	0	101.92	0
Public suppliers	101.78	101.78	100
Rural domestic	18.77[1]	18.77	100
Sewage treatment[2]	N/A	191.40	N/A
Thermoelectric power	571.47	4,487.36	12.7

[1]Reported as "No water returned."

[2] Water returned. Reported as "No water withdrawn." Total exceeds reported withdrawals for public suppliers.

Suder, K.E., and Lessing, Peter, 1987, Water use in West Virginia for 1985: West Virginia Geological and Economic Survey, Circular C–41, 96 p.

This comprehensive inventory of withdrawals, return flows, and instream uses of water for 1985 in West Virginia includes data aggregated by the state, county, and Hydrologic Unit Code (HUC). Data for this report were compiled and computed from Federal and state sources, as well as from water users for the thermoelectric power and industrial categories, by the West Virginia Geological and Economic Survey in cooperation with USGS. In the following table are the water-withdrawal and consumptive-use data reported in the document (p. 9) and the coefficients computed from the reported data.

[Modified from Suder and Lessing (1987). Water consumed and water withdrawn are in million gallon per day. Coefficient is in percent.]

Water-use category	Consumed	Withdrawn	Coefficient
Agriculture	9.68[1]	9.68	100
Industry	38.44	1,170.07	3.4
Irrigation	2.52[1]	2.52	100
Mining discharge	0	101.92	0
Public suppliers[2]	—[2]	308.45[2]	N/A
Rural domestic	18.77[1]	18.77	100
Sewage treatment[2]	233.32	—[2]	N/A
Thermoelectric power	658.08	4,207.03	15.6

[1]Reported as "No water returned."

[2] For public suppliers, water withdrawn includes surface water distributed, surface water sold, ground-water distributed, ground water sold, and transfer water sold. It does not include transfer water purchased because this would be counting the transfer water twice. It was noted that no water was returned for public suppliers, and there were no withdrawals for sewage treatment.

Sweat, M.J., and Van Til, R.L., 1988, Water use and methods of data acquisition in Michigan, *in* Waterstone, Marvin, and Burt, J.R., eds., Proceedings of the Symposium on Water-Use Data for Water Resources Management, Tucson, Ariz., August 28–31, 1988: Bethesda, Md., American Water Resources Association, p. 133–141.

A summary of water use in Michigan, this paper includes withdrawal and consumptive-use data for 1985 from Solley and others (1988). From this information, consumptive-use coefficients can be computed. For thermoelectric power generation, the consumptive-use coefficient was 1.3 percent, whereas for irrigation, the consumptive-use coefficient was 96 percent (table 1, p. 35). For self-supplied industry and public supply, the consumptive-use coefficient was 10 percent (table 1, p. 35).

[Modified from Table 1, p. 35 of Sweat and Van Til (1988). Water withdrawn and water consumed are in million gallons per day (Mgal/day). Coefficient is in percent.]

Water-use category	Withdrawn	Consumed	Coefficient
Thermoelectric power generation	8,400	110	1.3
Self-supplied industry	1,300	130	10
Public supply	1,200	120	10
Irrigation	240	230	96

Tate, D.M., 1988, Industrial water use and structural change, *in* Waterstone, Marvin, and Burt, J.R., eds., Proceedings of the Symposium on Water-Use Data for Water Resources Management, Tucson, Ariz., August 28–31, 1988: Bethesda, Md. American Water Resources Association, p. 601–608.

As part of a study examining the effects on technological and structural change on industrial water use in Canada, water-intake and water-consumption data are presented in this paper for the agriculture, mineral extractions, manufacturing, thermal power, and trade water-use categories for Canada for 5-year intervals from 1966 to 1976. Data in the following table are from Environment Canada surveys from the water-intake and water-consumption data and used to compute the coefficients included.

[Modified from Tate (1988; table 1, p. 606). Water intake and consumption are in millions of cubic meters; coefficient is in percent.]

Category	Water intake	Water consumption	Coefficient
1966 industrial water use			
Agriculture	3,193	2,285	72
Mineral extraction	365	86	24
Manufacturing	8,049	329	4
Thermal power	6,559	71	1
Trade	771	0	0
Total	18,938	2,771	15
1972 industrial water use			
Agriculture	2,855	2,043	72
Mineral extraction	362	87	24
Manufacturing	8,409	330	4
Thermal power	9,320	101	1
Trade	987	0	0
Total	21,933	2,561	12
1976 industrial water use			
Agriculture	3,299	2,369	72
Mineral extraction	667	105	16
Manufacturing	8,672	457	5
Thermal power	13,163	160	1
Trade	1,091	0	0
Total	26,893	3,091	11

Tate, Donald, and Harris, Jeff, 1999a, Water demands in the Canadian section of the Great Lakes Basin, 1972–2021: Gaia Economic Research Associates, unpublished report to the Canadian Section, International Joint Commission, 57 p.

This report presents and evaluates water-use data collected by Environment Canada and the Great Lakes Commission and forecasts trends in water use for the Canadian part of the Great Lakes Basin. The document gives a history of water-use data collection and forecasting in Canada, describes forecasting methodology, presents scenarios used to project water demand and the results of models, and summarizes principal conclusions of the research, including recommendations for future studies. For the forecasts, a structural, input-output model study was used to estimate water intake and consumption for scenarios of low, medium, and high economic growth, as well as scenarios representing high and low change in consumptive-use coefficients and a technological-change scenario. In this model, “coefficients” were water intake and consumption per million dollars of economic output, not a simple relation between water withdrawn and water consumed. Water-use

coefficients for the base period 1986–96 (in percent) were agriculture, 0.5; mineral extraction, 2.2; manufacturing, -2.1; and municipal, -1.9. Some traditional consumptive-use coefficients mentioned in the historical overview are 78–80 percent for agriculture (based on Great Lakes Commission data from 1996), 20 percent for municipal (based on engineering estimates and Environment Canada survey results) and 0.09 percent for once-through thermoelectric power generation (based Environment Canada survey results), and 5 percent for manufacturing (1991 and 1996 water demand summaries, table 2.1).

Of special interest is a series of detailed summary tables that present data by type of economic activity for the six Canadian water-use censuses between 1972 and 1996. Coefficients for each activity type for each census year can be derived from the withdrawal and consumption data presented; those tables are further summarized in the appendix, tables 4–1 and 4–2 of this report.

Tate, Donald, and Harris, Jeff, 1999b, Water demands in the United States section of the Great Lakes Basin, 1985–2020: GeoEconomics Associates, unpublished report to the United States Section, International Joint Commission, 57 p.

A followup companion report to the preceding entry, this document describes a structural, input-output model study to estimate U.S. water intake and consumption for scenarios of low, medium, and high economic growth, as well as scenarios representing high and low change in consumptive-use coefficients and a conservation scenario. As in the model described above, "coefficients" were water intake and consumption per million dollars of economic output, not a simple relation between water withdrawn and water consumed. Water-use data used in the model were from the USGS water-use database for the years 1985, 1990, and 1995. Historical annual real growth rates for water consumption for the base period 1985–95 (in percent) were agriculture, 3.4; mineral extraction, -1.3; manufacturing, -1.0; municipal, -0.09; and thermal power, -1.3.

Thompson, S.A., 1999, Water use, management, and planning in the United States: San Diego, Calif., Academic Press, 371 p.

This comprehensive textbook covers historical, legal, economic, and technical aspects of water-resources development in the Nation. The chapter on offstream water use includes monthly consumptive-use coefficients for various crops in selected locations for use with the Blaney-Criddle method of estimating crop evapotranspiration. None of the locations, however, are near the Great Lakes; moreover, the coefficient is used in combination with air temperature and monthly daytime hours and does not represent a percentage of water withdrawal.

Titus, E.O., Clawges, R.M., and Qualls, C.L., 1990, Estimated demand for agricultural water for irrigation use in New Jersey, 1990: U.S. Geological Survey Open-Filer Report 90–156, 23 p.

"This report describes the results of an effort to estimate short-term consumptive demand for agricultural water for irrigation use in New Jersey in 1990" (p. 2). The focus of this report is consumptive demand for field-grown crops. This report does not examine greenhouse water use or nonconsumptive water use by crops. For example, cranberry bogs are considered a nonconsumptive water use. For the field-grown crops, the Thornthwaite method is used to compute the water deficit for irrigated crops.

Todd, D.K., ed., 1970, The water encyclopedia: Port Washington, N.Y., Water Information Center, 559 p.

This resource, as the name suggests, is a reference volume containing water data, facts, and statistics. Included in the consumptive-use sections of the reference are consumptive use by irrigated crops in the Western States, water requirements for farm animals and poultry, the 1965 USGS water-use data, water requirements for selected industries in the world, projected water requirements in the United States by the U.S. Water Resources Council, and a figure of use of water in an average home in Akron, Ohio. From the National Association of Manufacturers is a table with the percentage of water intake consumed by selected industries in the United States (reproduced below).

[In Todd (1970; table 5-25, p. 263). Source: National Association of Manufacturers, data as of 1959.]

Industry	Water consumption (percent of intake)
Automobile	6.2
Beet sugar	10.5
Chemicals	5.9
Coal preparation	18.2
Corn and wheat milling	20.6
Distillery	10.4
Food processing	33.6
Machinery	21.4
Meat	3.2
Petroleum	7.2
Poultry processing	5.3
Pulp and paper	4.3
Salt	27.6
Soap and detergents	8.5
Steel	7.3
Sugar, cane	15.9
Textiles	6.7

Torcellini, P., Long, N., and Judkoff, R., 2003, Consumptive water use for U.S. power production: Golden, Colo., U.S. Department of Energy, National Renewable Energy Laboratory, NREL/TP–550–33905, 12 p.

This document present the results of a study of water consumed by thermoelectric and hydroelectric power production, including loss by evaporation from reservoirs, compiled as a basis for evaluating energy-saving versus water-use potential of evaporative cooling systems for buildings. The authors estimated a coefficient of 2.5 percent evaporation or consumptive-use rate for thermoelectric plants nationwide, amounting to 0.47 gal of water used for each kilowatt-hour of electricity consumed at the point of end use. For thermoelectric plants in the Eastern electrical grid interconnect (which includes the Great Lakes area), the rate is 0.49 gal/kWh. Water-use data—including thermoelectric consumptive-use figures—are from the USGS (Solley and others, 1998). Evaporative losses in reservoirs behind hydroelectric dams were computed by the authors. Water-consumption figures for Great Lakes and climatically similar states are as follows (reproduced from table 3, p. 5):

[Modified from Torcellini and others (2003). Thermoelectric, hydroelectric, and weighted total are in gallons per kilowatt per hour.]

State	Thermoelectric	Hydroelectric	Weighted total
Connecticut	0.08	N/A	0.07
Delaware	0.01	N/A	0.01
Illinois	1.05	N/A	1.05
Indiana	0.41	N/A	0.41
Iowa	0.12	N/A	0.11
Kentucky	1.10	154.34	5.32
Maine	0.29	N/A	0.12
Maryland	0.03	6.72	0.21
Massachusetts	0	N/A	0
Michigan	0.50	N/A	0.48
Minnesota	0.44	N/A	0.41
Missouri	0.31	N/A	0.30
New Hampshire	0.12	N/A	0.10
New Jersey	0.07	N/A	0.07
New York	0.85	5.57	1.62
North Carolina	0.23	10.37	0.55
Ohio	0.95	N/A	0.94
Pennsylvania	0.54	N/A	0.53
Rhode Island	0	N/A	0
Tennessee	0	43.35	3.60
Vermont	0.35	N/A	0.25
Virginia	0.07	N/A	0.06
West Virginia	0.59	N/A	0.58
Wisconsin	0.49	136.96	4.15
U.S. totals, weighted average	0.47	18.27	2.00

Trotta, L.C., 1988, Water use for aquaculture in Minnesota, 1984: U.S. Geological Survey Water-Resources Investigations Report 88–4159, 6 p.

This resource describes aquaculture in Minnesota for 1984 and states that aquaculture withdrawals are nonconsumptive. The aquaculture withdrawals were small compared to withdrawals in other Minnesota water-use categories, and about 15 percent of the withdrawals for aquaculture came from municipal water systems (p. 4). Also of interest was one thermoelectric plant that began reusing water to raise catfish (p. 5).

U.S. Bureau of the Census, 1985, 1982 Census of mineral industries: Washington, D.C., Subject Series, Water Use in Mineral Industries: Washington, D.C., 32 p.

This publication describes water by intake and discharge for the mineral industries by state, by Standard Industrial Classification (SIC), and by water-resource regions. From these values, general consumptive coefficients could be derived; however for many of the states, SIC codes, and regions, reported amounts of water discharged were greater than reported amounts of water withdrawn by intake. It was noted that this may be caused by mine water that is drained and discharged. Therefore, computing a representative consumptive-use coefficient was not possible for the reported data.

U. S. Bureau of the Census, 1986, 1982 Census of manufactures: Washington, D.C., Subject series, Water Use in Manufacturing, MC82–S–6, 72 p.

This resource provides many tables on water information in industries in the United States in 1983. One table includes water-intake data and water-discharged data for major SIC codes 20 through 39 for the census years 1954, 1959, 1964, 1968, 1973, 1978, and 1983 (table 1c, p. 6–6 to 6–8). Also published were water-use statistics for industry groups and industries. Of interest are 1983 water-use statistics for states (water-intake and water-discharged data in table 2b, p. 6–13 to 6–17) and water-resource regions for the major SIC code groups (7c, p. 6–60 to 6–65). Table 2a includes a “Summary of Water Use Statistics for Industry Groups and Industries: 1983” (p. 6–8 to 6–13). The consumptive-use coefficients from the Census of Manufactures are summarized in Appendix 2 of this bibliography (tables 2–1 to 2–5).

U.S. Business and Defense Services Administration, 1967, Water use by Appalachian manufacturers, 1964: Water Industries and Engineering Services Division, U.S. Department of Commerce, 60 p.

Manufacturing in Appalachia accounted for 19 percent of the total water withdrawn for manufacturing in the United States in 1967 (p. vi). Although "Water use by Appalachian Manufacturers" includes withdrawal and discharge data, the data are from the "1963 Census of Manufactures." Appendix B includes the U.S. Bureau of Census tables "Water Use by Manufacturers," for both Appalachian and non-Appalachian areas (p. 33). The Appalachian area includes part of the states of Alabama, Georgia, Maryland, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, and West Virginia.

For the total United States, 14,045 Ggal was withdrawn and 13,157 Ggal of water was discharged, yielding a consumptive-use coefficient of 6.3 percent (table 1, Appendix B, p. 34). For non-Appalachian areas, the manufacturing consumptive-use coefficient was 6.6 percent (11,360 Ggal of water intake and 10,611 Ggal water discharged); and for Appalachia, the consumptive-use coefficient was 5.2 percent (2,686 Ggal water intake and 2,546 Ggal water discharged). Although many consumptive-use coefficients could be derived from these data, the U.S. Bureau of the Census (1986) reference includes more recent data and has a more thorough analysis.

U.S. Department of Agriculture, Economic Research Service, Natural Resources and Environment Division, 1994, Agricultural resources and environmental indicators: Washington, D.C., 205 p.

In the section "Water Use and Pricing in Agriculture," this report discusses water use as well as consumptive use. Most of the data referenced in this report are from the USGS (Solley and others, 1993). The percentage of the total withdrawals consumed varied by category: for irrigation, 56 percent of the withdrawals was consumed (p. 47), for public and rural supplies, 17 percent; for industrial other than thermoelectric, 16 percent; and for thermoelectric power, 3 percent (p. 47). Of interest are an illustration showing water consumption in irrigation and other uses by region (fig. 2.1.2, p. 49) and a table listing irrigation's share of total consumptive use for states with major irrigation water use (table 2.1.1, p. 48).

U.S. Department of Agriculture, Economic Research Service, Natural Resources and Environment Division, 1997, Agricultural resources and environmental indicators, 1996–97, Washington, D.C., 347 p.

In the section "Water Use and Pricing in Agriculture," this report discusses water use as well as consumptive use. Most of the data referenced in this report are from the USGS (Solley and others, 1993). The percentage of the total withdrawals that consumed varied by category: for irrigation, 81 percent of the withdrawals was consumed; for public and rural supplies, 17 percent; for industrial other than thermoelectric, 16 percent; and for thermoelectric power, 3 percent (p. 70).

U.S. Department of Agriculture, Economic Research Service, Natural Resources and Environment Division, 2003, Agricultural resources and environmental indicators, 2003, Washington, D.C., 347 p.

In the section "Water Use and Pricing in Agriculture," this report discusses water use as well as consumptive use. Most of the data referenced in this report are from the USGS (Solley and others, 1998). The percentage of the total withdrawals consumed varied by category: for irrigation, 81 percent of the withdrawals was consumed; for public and rural supplies, 17 percent; for industrial other than thermoelectric, 22 percent; and for thermoelectric power, 3 percent (p. 6). Of interest are some illustrations showing irrigated area by region for 1899, 1949, and 2000 (fig. 2.1.4, p. 9) and irrigated land in farms for 1949 and 1997 (figs. 2.1.6 and 2.1.7, p. 12).

U.S. Department of Agriculture, National Agricultural Statistics Service, 2001, 1998 Census of horticultural specialties: Accessed August 2, 2005, at *http://www.nass.usda.gov/census/census97/horticulture/horticulture.htm*

The Web page displays links to the horticulture specialties 1997 census data, which include a table of "Operations by Percent of Water Recycled by State: 1998" (table 53). The table subdivides horticultural operations into those that do or do not recycle water, as well as notes whether the amounts of recycled water are in the ranges of 1–4 percent, 5–9 percent, 10–24 percent, or 25 percent or more of water withdrawn or supplied. For the United States as a whole, 86 percent of the horticultural operations reported no recycling of water, and 93 percent of the horticultural operations reported recycling less than 9 percent of water withdrawn or supplied. The Great Lakes States compared fairly reasonably to the National average, ranging from 78 to 90 percent of horticultural operations reporting no recycled water and from 91 to 97 percent of horticultural operations reporting less than 9 percent recycled water.

U.S. Department of Energy, 2004, Year 2004 annual steam-electric plant operation and design data: Department of Energy Form EIA-767 data file: Accessed January 5, 2006, at *http://www.eia.doe.gov/cneaf/electricity/page/eia767.html*

From this Web page, spreadsheet files can be downloaded that include the average annual rate of cooling-water withdrawals, the average annual rate of cooling-water discharge, and the average annual rate of cooling-water consumption to the nearest 0.1 ft^3/s. Data for 2001, 2002, and 2003 also can be accessed through this Web page.

USGS Circulars

MacKichan, K.A., 1957, Estimated use of water in the United States, 1955: U.S. Geological Survey Circular 398, 18 p.

The USGS 1955 water-use circular includes state and regional water-withdrawal data for public-supply, rural, irrigation, self-supplied industrial, and fuel-electric power water-use categories. Water-use data (withdrawals and consumptive use) were compiled by USGS offices in each state and water-use project chiefs. For 1955, "only about a fourth of all withdrawn water was consumed" (p. 12). For public-supply consumptive use and the domestic fraction of rural use, approximately 10 percent of water was consumed; a larger percentage was consumed in the summer because of lawn watering. For irrigation, about 60 percent of irrigation water was used by crops; however, if a sprinkler irrigation system was used, a much greater percentage of the water applied was transpired or evaporated. For self-supplied industrial use, only about 2 percent of water used was consumed. The consumptive-use coefficients from the USGS circulars are summarized in appendix tables 1–1 to 1–16 of this report.

MacKichan, K.A, and Kammerer, J.C., 1961, Estimated use of water in the United States, 1960: U.S. Geological Survey Circular 456, 26 p.

The USGS 1960 circular includes state and regional water-withdrawal and consumptive use data for the following water-use categories: public supply, rural use (domestic use and livestock use), irrigation, self-supplied industrial, and fuel-electric power. Water-use data (withdrawals and consumptive use) were compiled by USGS offices in each state and water-use project chiefs. For public water-supply systems, 17 percent of water withdrawn was consumed (p. 3). Rural water use consisted of 2,000 Mgal/d withdrawals for domestic use, 1,200 Mgal/d or 60 percent of which was consumed; and 1,600 Mgal/d withdrawal for livestock, 1,500 Mgal/d or 94 percent of which was consumed (table 4, p. 16). For irrigation, about 60 percent of the water withdrawn was consumed (p. 4). Fuel-electric power water use consumed less than 1 percent of the water withdrawn (p. 6). For industrial water use, approximately 8 percent of the water withdrawn was consumed (table 8, p. 20). For the contiguous United States, 20 percent of the total amount of water consumed was in the 31 Eastern States, and 80 percent of the water consumed was in the 17 Western States (fig. 6, p. 7). The consumptive-use coefficients from the USGS circulars are summarized in appendix tables 1–1 to 1–16 of this report.

Murray, C.R., 1968, Estimated use of water in the United States, 1965: U.S. Geological Survey Circular 556, 53 p.

The USGS 1965 circular includes state and regional water-withdrawal data for public-supply, rural, irrigation, industrial, thermoelectric-power, and hydroelectric-power water-use categories. Water-use data (withdrawals and consumptive use) were compiled by USGS offices in each state and water-use project chiefs. It also includes trends from 1950 to 1965. For 1965, "about 22 percent of the total withdrawals for public supply is estimated to have been consumed" (p. 3). Rural use includes self-supplied domestic water and livestock water use. For self-supplied domestic use, 1,600 of 2,300 Mgal/d was consumed (approximately 70 percent). Livestock water use was 1,700 Mgal/d and the water consumed was 1,600 Mgal/d, approximately 94 percent. Irrigation water withdrawn for the United States was 120,000 Mgal/d, 24,000 Mgal/d of which was lost in conveyance and 66,000 Mgal/d of which was consumed (table 13, p. 28). An undetermined part of the conveyance loss was transpired or evaporated, and another undetermined part of the conveyance loss returned to ground water or surface water and was thus available for use. Because of these uncertainties, the consumptive use for irrigation could range from 55 to 75 percent. For industrial water use, about 7.5 percent was consumed (p. 4); and for thermoelectric water use, less than 0.5 percent was consumed (p. 4, under self-supplied industrial water). Only 15 percent of the water consumed in the contignous United States was in the 31 Eastern States, whereas 85 percent of the water consumed was in the 17 Western States (fig. 8, p. 8). The consumptive-use coefficients from the USGS circulars are summarized in appendix tables 1–1 to –16 of this report.

Murray, C.R. and Reeves, E.B., 1972, Estimated use of water in the United States in 1970: U.S. Geological Survey Circular 676, 37 p.

The USGS 1970 circular includes water-withdrawal and water-consumption data for 1970, as well as historical trends in water use from 1950 to 1970. Water-use data (withdrawals and consumptive use) were compiled by USGS offices in each state and water-use project chiefs. In 1970, 86 percent of the water consumed was in the 17 Western States, and 14 percent was in the 31 Eastern States (fig. 6). For public-supply systems, 22 percent of the withdrawals was consumed. Rural domestic and livestock water consumption were 65 and 90 percent, respectively (p. 4 and table 6, p. 20–21). Irrigation water consumption was 59 percent (p.4), and conveyance loss was an additional 17 percent (p. 4). For thermoelectric freshwater use, 0.67 percent was consumed (p. 5, under self-supplied industrial water). Water consumed for the industrial water-use category was about 10 percent of withdrawals (p. 5). The consumptive-use coefficients from the USGS circulars are summarized in appendix tables 1–1 to 1–16 of this report.

Murray, C.R. and Reeves, E.B., 1977, Estimated use of water in the United States in 1975: U.S. Geological Survey Circular 765, 39 p.

The USGS 1975 circular includes state and regional water-withdrawal and water-consumption data for 1975, as well as historical trends in water use from 1950 to 1975. Public-supply consumptive use was almost 23 percent of the water withdrawals (p. 4). Water-use data (withdrawals and consumptive use) were compiled by USGS offices in each state and water-use project chiefs. Fifty percent of the rural domestic water withdrawals and 95 percent of the livestock

withdrawals were consumed. For irrigation water use, 56.4 percent of the water withdrawn was consumed, and 16 percent was lost through conveyance (p. 5). Thermoelectric plants consumed about 1.5 percent of their freshwater withdrawals (p. 6, under self-supplied industrial water), and self-supplied industrial facilities consumed 11 percent of their freshwater withdrawals (p. 6). For the contiguous United States, 16 percent of the water consumed was in the Eastern States, and 84 percent of the water consumed in the Western States (fig. 6, p. 9). The consumptive-use coefficients from the USGS circulars are summarized in appendix tables 1–1 to 1–16 of this report.

Solley, W.B., Chase, E.B., and Mann, W.B., 1983, Estimated use of water in the United States in 1980: U.S. Geological Survey Circular 1001, 56 p.

USGS circular 1001 includes water-withdrawal and consumptive-use data for states and water-resources regions in the United States for 1980. Categories include public supply, rural use (domestic use and livestock), irrigation, self-supplied industrial, thermoelectric power and hydroelectric power. Water-use data (withdrawals and consumptive use) were compiled by USGS offices in each state and water-use project chiefs. For public supply, 21 percent of the withdrawals was consumed (p. 8 and table 2, p. 11), approximately the same as in 1965, 1970, and 1975. In 1980, the total consumptive use was 69 percent for rural withdrawals (p. 12); 57 percent for domestic withdrawals, with state values ranging from 0 to 100 percent (p. 12); and 86 percent for livestock withdrawals, with state values ranging from 50 to 100 percent (p. 12). Irrigation consumptive use, which accounted for 81 percent of the consumptive use for the nation, was 55 percent of the irrigation water withdrawals, with state values ranging from 24 to 100 percent (p. 18). An additional 16 percent of the 1980 irrigation withdrawals was lost through conveyance (p. 16). Self-supplied industrial consumptive use was 13 percent of the 1980 self-supplied industrial withdrawals, with state values ranging from 2 to 82 percent (p. 22); and thermoelectric consumptive use was 2 percent of the thermoelectric withdrawals with state values ranging from 0 to 85 percent (p. 26). “These [industrial and thermoelectric] consumptive use figures are higher than in previous years and indicated an increased reuse of water” (p. 20). Included in this report is a section on trends in water use during 1950–1980, which discusses the changes in water use and consumption during the period.

The water withdrawal data, water consumed data, and the consumptive-use coefficients are summarized in appendix tables 1–1 to 1–16 of this report.

Solley, W.B., Merk, C.F., and Pierce, R.R., 1988, Estimated use of water in the United States in 1985: U.S. Geological Survey Circular 1004, 82 p.

USGS Circular 1004 includes 1985 water-withdrawal and consumptive-use data for states and water-resource regions for public supply, domestic, commercial, irrigation, livestock, industrial, mining, thermoelectric power water-use categories. Water-use data (withdrawals and consumptive use) were compiled by USGS offices in each state and water-use project chiefs. This compilation of water-use data included new categories of mining and commercial, as well as some reorganization of historic categories. Rural use, which formerly comprised both livestock and domestic uses, was replaced with a livestock section and a revised domestic category that included data from self-supplied and publicly supplied households. Public-supply consumptive use was no longer reported, but each of the categories that public-supply delivers to had a consumptive-use coefficient. For the new domestic-use category, the consumptive use was 23 percent of the water withdrawn, with state values ranging from 2 to 70 percent (table 3, p. 15). Commercial water use, which included “motels, hotels, restaurants, office buildings, other commercial facilities, and civilian and military institutions,” had a consumptive-use rate of 17 percent of the total commercial withdrawals, with state values ranging from 1 to 38 percent (self-supplied and publicly supplied; table 6, p. 21). For irrigation water use, 54 percent of the withdrawals were consumed, with state values ranging from 21 to 100 percent, and 17 percent was lost through conveyance (table 8, p. 25). The livestock consumption rate was 53 percent, with state values ranging from 0 to 100 percent (table 9, p. 27)—a substantial reduction from that reported in previous USGS circulars. The change was due, in part, to certain states that had included fish farming in the industrial category for previous water-use compilations but included it in with the livestock category for the 1985 compilation. Self-supplied industrial consumptive use was 16 percent of the 1985 self-supplied industrial withdrawals, with state values ranging from 3 to 84 percent. The consumptive-use coefficients from the USGS circulars are summarized in appendix tables 1–1 to 1–16 of this bibliography.

Solley, W.B., Pierce, R.R., and Perlman, H.A., 1993, Estimated use of water in the United States in 1990: U.S. Geological Survey Circular 1081, 76 p.

USGS Circular 1081 for 1990 includes water-use and consumptive-use data for public-supply, domestic, commercial, irrigation, livestock, industrial, mining, and thermoelectric-power water-use categories. Water-use data (withdrawals and consumptive use) were compiled by USGS offices in each state and water-use project chiefs. Consumption in the domestic water-use category, which includes the self-supplied and public-supplied users, ranged from 2 percent (Idaho) to 56 percent (New Mexico) of withdrawals and deliveries (table 11, p. 27), and was 23 percent for the United States as a whole (p. 26). For the commercial water-use category, 11 percent of the withdrawals and deliveries was consumed, with state values ranging from 1 to 59 percent (table 14, p. 33). “In most States, consumptive use was based on coefficients ranging from 40 to 100 percent of withdrawals, or on theoretical crop requirements. In a few States, consumptive use was calculated as the difference between reported withdrawals and reported return flows” (p. 34). Overall, 56 percent of the total water withdrawn for irrigation was consumed, with state values ranging from 22 to 100 percent (table 16, p. 37); 20 percent was lost through conveyance (p. 34). For 1990, the livestock

category was further divided into two categories: livestock and animal specialties. Although the consumptive-use estimates were based on coefficients that ranged from 2 to 100 percent for livestock and from 0 to 100 percent for animal specialties, overall averages for consumption were 88 percent of water withdrawals for livestock, 47 percent for animal specialties, and 68 percent for livestock and animal specialties combined (table 18, p. 41). The industrial consumptive use for 1990 was 14 percent for freshwater withdrawals, with state ranges from 3 to 92 percent. For industrial saline-water withdrawals, overall consumptive use was 28 percent, with state ranges from 0 to 55 percent (table 20, p. 45). Mining consumptive use was 31 percent of the total withdrawals, with state ranges from 0 to 100 percent (p. 46). Thermoelectric power consumed 2 percent (p. 50) of the water withdrawn, with state values ranging from 0 to 99 percent. The consumptive-use coefficients from the USGS circulars are summarized in appendix tables 1–1 to 1–16 of this bibliography.

Solley, W.B., Pierce, R.R., and Perlman, H.A., 1998, Estimated use of water in the United States in 1995: U.S. Geological Survey Circular 1200, 71 p.

This publication, like the previous USGS circular for 1990, reports withdrawal and consumptive-use data for public supply, domestic, commercial, irrigation, livestock, industrial, mining, and thermoelectric water-use categories. Water-use data (withdrawals and consumptive use) were compiled by USGS offices in each state and water-use project chiefs. For self-supplied and public-supplied domestic water use, about 26 percent was consumed, with state values ranging from 5 to 55 percent (table 12, p. 27); for commercial water use, about 14 percent was consumed, with state values ranging from 0 to 58 percent (table 14, p. 31). About 61 percent of water used for irrigation was consumed, with state values ranging from 21 to 100 percent (table 16, p. 35), and another 19 percent was lost through conveyance (p. 32). Under the livestock category, around 96 percent of livestock withdrawal was consumed, with state values ranging from 20 to 100 percent, and about 32 percent of animal-specialties withdrawal was consumed, with state values ranging from 0 to 100 percent; for livestock and animal specialties combined, about 58 percent was consumed (p. 36). For industrial water use, 15 percent of combined fresh and saline withdrawals was consumed, with state values ranging from 2 to 92 percent (table 20, p. 43); and for mining withdrawals, 27 percent was consumed, with state values ranging from 0 to 100 percent (table 22, p. 47). For thermoelectric power, freshwater plants consumed about 2.5 percent of withdrawals, with state values ranging from 0 to 100 percent; whereas saline-water plants consumed less than 1 percent, with state values ranging from 0 to 3 percent (table 24, p. 51). The consumptive-use coefficients from the USGS circulars are summarized in appendix tables 1–1 to 1–16 of this bibliography.

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U.S. Geological Survey, 1984, National water summary 1983—Hydrologic events and issues: U.S. Geological Survey Water-Supply Paper 2250, 243 p.

This report describes and analyzes the condition of the Nation's water and summarizes the water issues of concern for each state, the District of Columbia, Puerto Rico, the U.S. Virgin Islands, and western Pacific Islands under the United States jurisdiction. It includes a summary of withdrawal and consumptive use for each state from USGS Circular 1001 (Solley and others, 1980).

U.S. Geological Survey, 2000, Consumptive use and renewable water supply, by water-resources region: Accessed August 2, 2005, at *http:// water.usgs.gov/watuse/misc/consuse-renewable.html*

This Web page lists the 1995 water consumed (in billion gallons per day based on data from Solley and others, 1998) over the renewable water supply by U.S. water-resources region. Renewable water supply is a simplified sum of precipitation and imports of water, minus water not available for use because of natural evapotranspiration and exports. It is used as an upper limit for water consumption in a region on a sustained basis. The ratios of consumed water over renewable water supply for water-resources regions in the Great Lakes and climatically similar areas are Upper Mississippi, 2.3/77.2; Great Lakes, 1.9/74.3; Ohio, 2.8/139.6; Mid-Atlantic, 1.3/80.7; New England, 0.6/78.4; and Tennessee, 0.3/41.2.

U.S. Geological Survey and Tennessee Department of Environment and Conservation, 2003, Water use in Tennessee: Accessed June 20, 2005, at *http://tn.water.usgs.gov/wustates/tn/octodiagram.html*

The Web page shows the source, use, and disposition of water in Tennessee in 1995. Overall, only 3 percent of freshwater was consumed in Tennessee in 1995. This percentage is largely skewed by the large amount of thermoelectric withdrawals and the low percentage of consumption of these withdrawals. For individual water-use categories, consumptive-use coefficients are more representative. For domestic and public losses, 24 percent of the withdrawals was consumed. For industry (which includes commercial and mining), 11 percent of the withdrawals was consumed. Of the thermoelectric withdrawals, only 0.5 percent was consumed. Agriculture, which includes irrigation and livestock, is listed at 100 percent consumption.

van der Leeden, Frits, 1975, Water resources of the world — Selected statistics: Port Washington, N.Y., Water Information Center, 568 p.

Water-availability and water-use information from references around the world are summarized in this publication. For the United States, this book summarizes the 1970 USGS water-use circular information, includes a profile of the Great Lakes drainage system, and includes per capita figures from municipal water-supply systems (fig. 5–8, p. 365). Many countries included in the tables report domestic consumption as part of their municipal water-supply system. It is unclear whether these figures represent actual consumption or just what was delivered because the numbers seem fairly high. For example, U.S. Geological Survey "consumption" refers to water removed from the immediate hydrologic environment, whereas "consumption gallons per capita per day" as reported by the American Water Works Association reflects withdrawal in gallons per capita per day and not actual consumption. Although this document summarizes a wealth of information, it is probably best used as a means of finding original sources of information than as a data source itself. One data table in this document (reconstructed below) lists ground-water withdrawal and consumption amounts for industrial categories in Belgium. The consumptive use coefficient is calculated.

[Withdrawal and consumption are in thousands of cubic meters, Consumptive-use coefficient is computed by dividing the water consumption by the water withdrawal and multiplying by 100. Modified from table 1–12, p. 11, of van der Leeden (1975)]

Category	Withdrawal	Consumption	Consumptive-use coefficient
Coal mines	139,311	10,427	7
Quarries	41,209	1,972	5
Food (margarine, oils, etc.)	120,528	14,140	12
Textiles	57,796	4,713	8
Wood	2,988	551	18
Paper	96,832	10,138	10
Leather	5,368	332	6
Chemical	650,292	39,711	6
Rubber	7,987	754	9
Petroleum refineries	335,426	160	0
Coke plant (gas)	81,029	9,458	12
Terra cotta	1,476	752	51
Glass	20,842	1,968	9
Ceramic	1,051	301	29
Cement	17,190	5,093	30
Iron & steel	1,099,867	66,626	6
Non-ferrous	202,913	39,137	19
Metallic construction	66,604	4,980	7
Hydroelectric power	13,257,900	-	-
Thermoelectric power	3,703,580	11,866	0

Van Til, Ronald, and Scott, G. M., 1986, Water use for thermoelectric power generation in Michigan: Michigan Department of Natural Resources, 42 p.

A compilation of withdrawal data and consumptive use data for thermoelectric plants in Michigan, this report recognizes that there are "substantial differences in the rate of water consumed by different cooling systems." The report was a cooperative effort by the USGS and the Michigan Department of Natural Resources. Once-through cooling requires a larger volume of water, but it is estimated that only 1–2 percent of the water is consumed in the cooling process." The report notes that, because most of the Michigan thermoelectric plants do not have reservoir storage, 1 percent is the more representative end of the range. Wet cooling towers require smaller water withdrawals than once-through cooling, but the evaporation and drift losses are estimated to be 66 percent. A third type of cooling system, cooling ponds, has a varied consumptive use because "heat dissipation is highly dependent on local meteorological conditions (p. 21)." In Michigan, cooling-pond systems are rarely used.

[Water withdrawn and water consumed are in million gallons per day (Mgal/d). Consumptive-use coefficient is computed by dividing the water consumed by the water withdrawn and multiplying by 100. Modified from Van Til and Scott (1986; table 7, p. 22), all for Michigan.]

Type of cooling	Water withdrawn	Water consumed	Average consumptive-use rate
Once-through	8,178.64	81.79	1
Wet tower	2.31	1.52	66
Wet tower/discharge	202.04	26.27	13[1]
Radiator/dry	0.00	0.00	0
Cooling ponds	4.30	2.84	66
Combination	<0.01	-	-
Total	8,387.29	112.42	1.3

[1] There were four plants in this category, and the individual consumptive rates varied widely.

Veeger, A.I., Vinhateiro, N.D., Nakao, M., and Craft, P.A., 2003, Water use and availability, Block Island, Rhode Island, 2000: Rhode Island Geological Survey Report 03–01, 22 p.

As part of estimating the water use and availability on Block Island, R.I., for 2000, consumptive use was estimated by use of the following coefficients: domestic, 15 percent; public use and commercial, 10 percent; and livestock 100 percent (p. 12), referenced from Horn (2000).

Vickers, Amy, 2001, Handbook of water use and conservation: Amherst, Mass., Water Plow Press, 446 p.

Geared largely at promoting water efficiency through designing and retrofitting of water-using devices and facilities, this reference work nevertheless contains interesting facts and figures related to consumptive use, particularly with regard to new technologies. Each chapter is liberally referenced to other literature. Among the types of water use data given are per capita rates of indoor and outdoor residential use, per capita use rates (visitors and employees) for a variety of industrial, commercial, and institutional facility types (p. 234), and detailed data on water consumption by cooling towers.

Water Resources Council (U.S.), 1978, The Nation's water resources, 1975–2000: Washington, D.C., four volumes and 6 appendixes.

Water Resources Council (U.S.), 1978, The Nation's water resources, 1975–2000: Volume 3: Analytical data summary, 89 p.

Annual water withdrawals and consumption are provided by water-use categories by regions for base conditions in table 11–4, p. 42–53, "Annual water requirements for offstream uses." This table includes 1975 data and estimates data for 1985 and 2000. The consumptive-use coefficients from the report "The Nation's water resources, 1975–2000" are summarized in appendix 5 of this report (tables 5–1 to 5–4). Withdrawal and consumptive data are from multiple Federal agencies, including the U.S. Departments of Agriculture, Energy, and Commerce; the Water Resources Council; and U.S. Department of the Interior (USGS, National Park Service, Bureau of Mines, Bureau of Land Management, and Fish and Wildlife Service.)

Water Resources Council (U.S.), 1978, The Nation's water resources, 1975–2000—Volume 3— Analytical data, Appendix II, Annual water supply and use analysis, 174 p.

Annual water withdrawals and consumption are provided by water-use categories by subregions for base conditions in table 11–4, p. 40–105, "Annual water requirements for offstream uses." This table includes 1975 data and estimates data for 1985 and 2000.

Water Resources Council (U.S.), 1978, The Nation's water resources, 1975–2000—Volume 3— Analytical data, Appendix III, Monthly water supply and use analysis, 302 p.

Monthly water withdrawals and consumption are provided by water-use categories and by subregions for base conditions in table III–4, p. 82–187, "Monthly water requirements for offstream uses." This table includes 1975 data and estimates data for 1985 and 2000. Also of interest in this publication are monthly streamflow frequency analyses for surface-water resources for subregions (or HUCs), and monthly imports, exports, and net evaporation by subregions.

Water Resources Council (U.S), 1978, The Nation's water resources, 1975–2000—Volume 3— Analytical data, Appendix IV, dry conditions water supply and use analysis, 337 p.

Annual water withdrawals and consumption are provided by water-use categories by regions for dry conditions in table IV–1, p. 22–86, "Annual water requirements for offstream uses." This table includes 1975 data and estimates for 1985 and 2000. Monthly water withdrawals and consumption are provided by water-use categories and by subregions for dry conditions in table IV–3, p. 104–209, "Monthly water requirements for offstream uses." This table includes 1975 data and estimates for 1985 and 2000. Also of interest is a table for monthly water-adequacy analyses for subregions in dry conditions.

Wild, E.C., and Nimiroski, M.T., 2004, Estimated water use and availability in the Pawcatuck Basin, southern Rhode Island and southeastern Connecticut, 1995–99: U.S. Geological Survey Scientific Investigations Report 2004–5020, 72 p.

Withdrawal, use, and return-flow data were collected for the Pawcatuck Basin in southern Rhode Island and southeastern Connecticut. This study used consumptive-use coefficients of 10 percent for commercial and industrial categories (p. 32) (Solley and others, 1998) and 100 percent for agricultural use (livestock, crop irrigation and golf course irrigation) (p. 37). The authors referenced Horn and others (1994) for livestock consumptive use, but did not use these coefficients because of negligible livestock water use in the study area. For the basin, the domestic publicly supplied consumptive use was 9.4 percent (tables 11 and 12, p. 30–31, 33–34) and domestic self-supplied consumptive use was 20.6 percent (tables 11 and 12, p. 30–31, 33–34).

Wild, E.C., and Nimiroski, M.T., 2005, Estimated water use and availability in the South Coastal Drainage Basin, southern Rhode Island, 1995–99: U.S. Geological Survey Scientific Investigations Report 2004–5288, 46 p.

Withdrawal, use, and return flow data were collected for the South Coastal Drainage Basin in southern Rhode Island. This study used consumptive-use coefficients of 10 percent for commercial and industrial categories (p. 26) (Solley and others, 1998) and 100 percent for agricultural use (livestock, crop irrigation and golf course irrigation) (Horn and others, 1994). The authors referenced Horn and others (1994) for livestock consumptive use but did not use these coefficients because of negligible livestock water use in the study area. For the basin, the domestic publicly-supplied consumptive use was 6.3 percent (tables 11 and 12, p. 26, 28) and the domestic self-supplied consumptive use was 46 percent (tables 11 and 12, p. 26, 28).

Woldorf, A.F., 1959, Irrigation and rural water use in Ohio: Ohio Department of Natural Resources, Division of Water, Ohio Water Plan Inventory Report 7, 57 p.

As part of this report, water use and water consumption for Ohio were summarized. The rate of consumption for irrigation was at least 90 percent, and the rate of consumption was less than 10 percent for manufacturing (p. 2). By using the figure 1 on page 7, the rate of consumption is 3 percent for rural home, 97 percent for irrigation, 1 percent for power, 11 percent for municipal, and 5 percent for manufacturing (see below). Of particular interest was that fewer than 1,000 property managers (farmers and golf course operators) controlled 13 percent of the total water consumption of Ohio at the time Woldorf's report was written (p. 6). The bulk of the water consumption for rural water use is by golf-course irrigation; farm irrigation is the next largest rural consumer.

[Modified from figure 1, p. 7 of Woldorf (1959). Coefficient is expressed as percent. Water consumption and water withdrawals are in million of gallons per day (Mgal/d). Ggal/d; billion gallons per day.]

Water –use category	Percent of statewide total withdrawal (Total withdrawal is 12 Ggal/d)	Water withdrawal (Mgal/d)	Percent of statewide total consumption (Total consumption is 410 Mgal/d)	Water consumption (Mgal/d)	Coefficient
Rural home	1	120	1	4.1	3
Irrigation	0.6	72	17	69.7	97
Power	62	7,440	18	73.8	1
Municipal	6	720	19	77.9	11
Manufacturing	31	3,720	45	184	5

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Appendixes 1–5

Table 1-1. Domestic water-use category: total withdrawals, water consumed, and consumptive-use coefficients, by USGS compilation year, for the Great Lakes Basin and Great Lakes States.

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data. The 1960–95 coefficient was calculated by dividing the sum of the consumptive use by the sum of the total withdrawn for each geographic area. Data from 1960 to 1980 were reported in two significant figures and data from 1985 to 1995 were reported in three significant figures.]

Statistic	1960[1]	1965[2]	1970[3]	1975[4]	1980[5]	1985[6]	1990[7]	1995[8]	1960–95
Great Lakes Basin									
Total withdrawn	290	280	280	290	270	1,730	1,690	1,760	6,590
Consumptive use	96	103	78	61	74	213	235	248	1,108
Coefficient	33	37	28	21	27	12	14	14	17
Illinois									
Total withdrawn	73	92	17	17	82	981	1,020	1,060	3,342
Consumptive use	51	64	12	12	58	97	102	107	503
Coefficient	70	70	71	71	70	10	10	10	15
Indiana									
Total withdrawn	96	94	87	100	120	562	421	441	1,921
Consumptive use	67	66	61	31	120	56	63	66	530
Coefficient	70	70	70	31	100	10	15	15	28
Michigan									
Total withdrawn	100	100	160	160	160	752	707	817	2,956
Consumptive use	21	21	26	26	27	98	103	119	441
Coefficient	21	21	16	16	17	13	15	15	15
Minnesota									
Total withdrawn	52	49	110	89	120	532	601	326	1,879
Consumptive use	7.7	49	110	8.7	120	172	204	110	781.4
Coefficient	15	100	100	10	100	32	34	34	42
New York									
Total withdrawn	110	130	120	120	130	1,660	2,010	1,960	6,240
Consumptive use	12	13	12	12	13	166	201	107	536
Coefficient	11	10	10	10	10	10	10	5	9
Ohio									
Total withdrawn	110	100	110	110	89	606	589	637	2,351
Consumptive use	97	94	100	77	62	91	88	96	705
Coefficient	88	94	91	70	70	15	15	15	30
Pennsylvania									
Total withdrawn	97	100	110	120	150	723	711	740	2,751
Consumptive use	9.7	10	11	12	15	72	71	74	274.7
Coefficient	10	10	10	10	10	10	10	10	10
Wisconsin									
Total withdrawn	70	82	74	70	72	253	269	281	1,171
Consumptive use	7.0	8.2	7.3	6.9	7	25	54	56	171.4
Coefficient	10	10	10	10	10	10	20	20	15

Table 1-1. Domestic water-use category: total withdrawals, water consumed, and consumptive-use coefficients, by USGS compilation year, for the Great Lakes Basin and Great Lakes States. —Continued

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data. The 1960–95 coefficient was calculated by dividing the sum of the consumptive use by the sum of the total withdrawn for each geographic area. Data from 1960 to 1980 were reported in two significant figures and data from 1985 to 1995 were reported in three significant figures.]

Statistic	1960[1]	1965[2]	1970[3]	1975[4]	1980[5]	1985[6]	1990[7]	1995[8]	1960–95
				Great Lakes States					
Total withdrawn	708	747	788	786	923	6,069	6,328	6,262	22,611
Consumptive use	272.4	325.2	339.3	185.6	422	777	886	735	3,942.7
Coefficient	38	44	43	24	46	13	14	12	17

[1] MacKichan and Kammerer (1961, tables 3 and 4). Total withdrawn is from the column “Domestic use—Withdrawn—All water.” Consumptive use is from the column “Domestic use—Consumed.”

[2] Murray (1968, tables 8 and 9). Total withdrawn is from the column “Domestic use—Withdrawn—All water.” Consumptive use is from the column “Domestic use—Consumed.”

[3] Murray and Reeves (1972, tables 6 and 13). Total withdrawn is from the column “Domestic use—Withdrawn—All water.” Consumptive use is from the column “Domestic use—Water consumed.”

[4] Murray and Reeves (1977, tables 6 and 13). Total withdrawn is from the column “Domestic use—Withdrawn—All water.” Consumptive use is from the column “Domestic use—Fresh-water consumed.”

[5] Solley and others (1983, tables 3 and 4). Total withdrawn is from the column “Domestic use—Withdrawals and deliveries.” Consumptive use is from the column “Domestic use—Consumptive use.” For this and previous 5-year compilations, only self-supplied domestic was accounted for.

[6] Solley and others (1988, tables 3 and 4). Total withdrawn is from the column “Total—Withdrawals and deliveries.” Consumptive use is from the column “Total—Consumptive use.” For this and following 5-year compilations, domestic included self-supplied and publicly supplied deliveries to domestic.

[7] Solley and others (1993, tables 11 and 12). Total withdrawn is from the column “Total use—Withdrawals and deliveries.” Consumptive use is from the column “Total use—Consumptive use.”

[8] Solley and others (1998, tables 11 and 12). Total withdrawn is from the column “Total use—Withdrawals and deliveries.” Consumptive use is from the column “Total use—Consumptive use.”

Table 1-2. Domestic water-use category: total withdrawals, water consumed, and consumptive-use coefficients, by USGS compilation year, for water-resources regions and states climatically similar to the Great Lakes Basin.

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data. The 1960–95 coefficient was calculated by dividing the sum of the consumptive use by the sum of the total withdrawn for each geographic area. Data from 1960 to 1980 were reported in two significant figures and data from 1985 to 1995 were reported in three significant figures.]

Statistic	1960[1]	1965[2]	1970[3]	1975[4]	1980[5]	1985[6]	1990[7]	1995[8]	1960–95
Mid-Atlantic Region									
Total withdrawn	260	270	340	380	430	3,350	3,660	3,830	
Consumptive use	86	88	130	100	110	420	415	355	
Coefficient	33	33	38	29	26	13	11	9	14
New England Region									
Total withdrawn	39	100	96	110	130	943	882	886	
Consumptive use	31	84	47	36	63	249	124	139	
Coefficient	79	84	49	33	48	26	14	16	24
Ohio Region									
Total withdrawn	230	260	270	300	310	1,470	1,410	1,470	
Consumptive use	140	180	180	140	200	220	191	189	
Coefficient	61	69	67	47	65	15	14	13	25
Tennessee Region									
Total withdrawn	58	90	52	42	61	311	308	338	
Consumptive use	54	84	31	25	39	48	43	51	
Coefficient	93	93	60	60	64	15	14	15	30
Upper Mississippi Region									
Total withdrawn	180	200	210	200	300	1,940	1,900	1,760	
Consumptive use	73	100	130	48	190	409	401	329	
Coefficient	41	50	62	24	63	21	21	19	25
Connecticut									
Total withdrawn	22	46	39	50	53	217	234	246	
Consumptive use	22	46	39	26	32	59	47	49	
Coefficient	100	100	100	52	60	27	20	20	35
Delaware									
Total withdrawn	6.1	5.2	11	10	25	46	52	55	
Consumptive use	.6	.5	1.2	1.1	0	4.6	5.2	5.5	
Coefficient	10	10	11	11	0	10	10	10	9
Iowa									
Total withdrawn	56	41	47	51	55	354	183	184	
Consumptive use	14	7.0	19	20	22	144	73	73	
Coefficient	25	17	40	39	40	41	40	40	38
Kentucky									
Total withdrawn	24	65	55	38	61	226	235	260	
Consumptive use	14	39	44	30	48	60	41	34	
Coefficient	58	60	80	79	79	27	17	13	32
Maine									
Total withdrawn	7.4	10	12	16	26	114	88	81	
Consumptive use	2.2	3.1	3.3	5.3	26	80	13	12	
Coefficient	30	31	28	33	100	70	15	15	41

Table 1-2. Domestic water-use category: total withdrawals, water consumed, and consumptive-use coefficients, by USGS compilation year, for water-resources regions and states climatically similar to the Great Lakes Basin. —Continued

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data. The 1960–95 coefficient was calculated by dividing the sum of the consumptive use by the sum of the total withdrawn for each geographic area. Data from 1960 to 1980 were reported in two significant figures and data from 1985 to 1995 were reported in three significant figures.]

Statistic	1960[1]	1965[2]	1970[3]	1975[4]	1980[5]	1985[6]	1990[7]	1995[8]	1960–95
				Maryland					
Total withdrawn	30	33	46	49	49	428	484	506	
Consumptive use	30	33	46	32	32	43	48	51	
Coefficient	100	100	100	65	65	10	10	10	19
				Massachusetts					
Total withdrawn	4.7	38	28	25	32	450	402	396	
Consumptive use	4.2	34	2.7	3.0	3.9	77	40	54	
Coefficient	89	89	10	12	12	17	10	14	16
				Missouri					
Total withdrawn	55	46	39	58	92	408	410	433	
Consumptive use	55	21	18	26	39	114	114	108	
Coefficient	100	46	46	45	42	28	28	25	32
				New Hampshire					
Total withdrawn	4.3	6.3	11	8.5	9.3	85	76	89	
Consumptive use	3.9	4.5	1.1	.4	.5	17	11	13	
Coefficient	91	71	10	5	5	20	14	15	18
				New Jersey					
Total withdrawn	83	36	80	110	75	567	580	624	
Consumptive use	25	11	40	53	15	103	106	122	
Coefficient	30	31	50	48	20	18	18	20	22
				Rhode Island					
Total withdrawn	1.2	4.8	4.6	4.4	4.9	64	67	64	
Consumptive use	0	1.4	.7	.7	.8	14	10	9.6	
Coefficient	0	29	15	16	16	22	15	15	17
				Tennessee					
Total withdrawn	28	48	39	41	43	373	397	409	
Consumptive use	28	48	9.9	11	12	37	40	41	
Coefficient	100	100	25	27	28	10	10	10	16
				Vermont					
Total withdrawn	7.5	7.4	11	19	20	46	43	45	
Consumptive use	6.8	6.6	1.1	.9	1.0	9.1	6.5	6.7	
Coefficient	91	89	10	5	5	20	15	15	19
				Virginia					
Total withdrawn	66	84	74	84	150	448	464	548	
Consumptive use	39	50	45	4.3	74	90	47	55	
Coefficient	59	60	61	5	49	20	10	10	21
				West Virginia					
Total withdrawn	19	28	18	22	19	102	136	136	
Consumptive use	.2	28	.2	.1	.2	29	14	14	
Coefficient	1	100	1	0	1	28	10	10	18

Table 1-2. Domestic water-use category: total withdrawals, water consumed, and consumptive-use coefficients, by USGS compilation year, for water-resources regions and states climatically similar to the Great Lakes Basin. —Continued

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data. The 1960–95 coefficient was calculated by dividing the sum of the consumptive use by the sum of the total withdrawn for each geographic area. Data from 1960 to 1980 were reported in two significant figures and data from 1985 to 1995 were reported in three significant figures.]

Statistic	1960[1]	1965[2]	1970[3]	1975[4]	1980[5]	1985[6]	1990[7]	1995[8]	1960–95
District of Columbia									
Total withdrawn	0	0	0	0	0	174	109	95	
Consumptive use	0	0	0	0	0	17	11	9.5	
Coefficient	-	-	-	-	-	10	10	10	10
Climatically similar states									
Total withdrawn	414.2	498.7	514.6	585.9	714.2	4,102	3,960	4,171	14,961
Consumptive use	244.9	333.1	271.2	213.8	306.4	897.7	626.7	6,573	3,551
Coefficient	59	67	53	36	43	22	16	16	24

[1] MacKichan and Kammerer (1961, tables 3 and 4). Total withdrawn is from the column “Domestic use—Withdrawn—All water.” Consumptive use is from the column “Domestic use—Consumed.”

[2] Murray (1968, tables 8 and 9). Total withdrawn is from the column “Domestic use—Withdrawn—All water.” Consumptive use is from the column “Domestic use—Consumed.”

[3] Murray and Reeves (1972, tables 6 and 13). Total withdrawn is from the column “Domestic use—Withdrawn—All water.” Consumptive use is from the column “Domestic use—Water consumed.”

[4] Murray and Reeves (1977, tables 6 and 13). Total withdrawn is from the column “Domestic use—Withdrawn—All water.” Consumptive use is from the column “Domestic use—Fresh-water consumed.”

[5] Solley and others (1983, tables 3 and 4). Total withdrawn is from the column “Domestic use—Withdrawals and deliveries.” Consumptive use is from the column “Domestic use—Consumptive use.” For this and previous 5-year compilations, only self-supplied domestic was accounted for.

[6] Solley and others (1988, tables 3 and 4). Total withdrawn is from the column “Total—Withdrawals and deliveries.” Consumptive use is from the column “Total—Consumptive use.” For this and following 5-year compilations, domestic included self-supplied and publicly supplied deliveries to domestic.

[7] Solley and others (1993, tables 11 and 12). Total withdrawn is from the column “Total use—Withdrawals and deliveries.” Consumptive use is from the column “Total use—Consumptive use.”

[8] Solley and others (1998, tables 11 and 12). Total withdrawn is from the column “Total use—Withdrawals and deliveries.” Consumptive use is from the column “Total use—Consumptive use.”

Table 1-3. Industrial water-use category: total withdrawals, water consumed, and consumptive-use coefficients, by USGS compilation year, for the Great Lakes Basin and Great Lakes States.

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data.]

Statistic	1960[1]	1965[2]	1970[3]	1975[4]	1980[5]	1985[6]	1990[7]	1995[8]	1960–95
Great Lakes Basin									
Total withdrawn	7,700	9,000	9,000	7,600	6,120	5,120	5,040	4,950	
Consumptive use	280	360	570	490	490	380	458	436	
Coefficient	4	4	6	6	8	7	9	9	6
Illinois									
Total withdrawn	2,100	1,800	1,940	1,631	1,838	790	728	570	
Consumptive use	44	41	76	80	88	273	80	63	
Coefficient	2	2	4	5	5	35	11	11	7
Indiana									
Total withdrawn	2,000	2,600	3,200	3,300	3,100	2,730	2,590	2,400	
Consumptive use	78	100	130	130	160	228	155	144	
Coefficient	4	4	4	4	5	8	6	6	5
Michigan									
Total withdrawn	1,800	1,900	2,100	1,900	2,120	1,570	2,100	2,120	
Consumptive use	51	54	240	216	219	124	152	160	
Coefficient	3	3	11	11	10	8	7	8	8
Minnesota									
Total withdrawn	840	1,400	1,200	600	590	231	198	181	
Consumptive use	59	110	85	42	58	70	35	26	
Coefficient	7	8	7	7	10	30	18	14	9
New York									
Total withdrawn	3,000	3,200	1,466	1,638	1,230	2,050	588	615	
Consumptive use	120	130	130	142	107	205	60	62	
Coefficient	4	4	9	9	9	10	10	10	7
Ohio									
Total withdrawn	2,600	4,600	3,700	2,400	2,000	802	679	912	
Consumptive use	87	140	110	72	180	156	204	190	
Coefficient	3	3	3	3	9	19	30	21	6
Pennsylvania									
Total withdrawn	4,860	4,950	5,450	4,743	3,600	2,300	2,120	1,870	
Consumptive use	190	200	220	344	260	186	189	158	
Coefficient	4	4	4	7	7	8	9	8	6
Wisconsin									
Total withdrawn	700	350	330	310	450	614	619	592	
Consumptive use	17	8.6	10	31	45	58	125	95	
Coefficient	2	2	3	10	10	9	20	16	10

Table 1-3. Industrial water-use category: total withdrawals, water consumed, and consumptive-use coefficients, by USGS compilation year, for the Great Lakes Basin and Great Lakes States. —Continued

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data.]

Statistic	1960[1]	1965[2]	1970[3]	1975[4]	1980[5]	1985[6]	1990[7]	1995[8]	1960–95
					Great Lakes States				
Total withdrawn	17,900	20,800	19,386	16,522	14,928	11,087	9,622	9,260	119,505
Consumptive use	646	784	1,001	1,057	1,117	1,300	1,000	898	7,803
Coefficient	4	4	5	6	7	12	10	10	7

[1] MacKichan and Kammerer (1961, tables 7 and 8). Total withdrawn is from the columns “Other uses—water withdrawn—All water—Fresh and Saline.” Consumptive use is from the column “Other uses—Water consumed.”

[2] Murray (1968, tables 14 and 15). Total withdrawn is from the columns “Other uses—water withdrawn—All water—Fresh and Saline.” Consumptive use is from the column “Other uses—Water consumed.”

[3] Murray and Reeves (1972, tables 8 and 15). Total withdrawn is from the columns “Other uses—water withdrawn—All water—Fresh and Saline.” Consumptive use is from the columns “Other uses—Water consumed—fresh and saline.”

[4] Murray and Reeves (1977, tables 8 and 15). Total withdrawn is from the columns “Other industrial uses—water withdrawn—All water—Fresh and Saline.” Consumptive use is from the columns “Other industrial uses—Water consumed—fresh and saline.”

[5] Solley and others (1983, tables 7 and 8). Total withdrawn is from the columns “Other industries—Total, excluding reclaimed sewage—Fresh and Saline.” Consumptive use is from the columns “Other industries—Consumptive use—fresh and saline.”

[6] Solley and others (1988, tables 11 and 12). Total withdrawn is from the columns “Total—Withdrawals and deliveries—Fresh” and “Self-supplied withdrawals—Total—Saline.” Consumptive use is from the column “Total—Consumptive use—Total.”

[7] Solley and others (1993, tables 19 and 20). Total withdrawn is from the columns “Total—Withdrawals and deliveries—Fresh” and “Self-supplied withdrawals—Total—Saline.” Consumptive use is from the columns “Total use—Consumptive use—Fresh and Saline.”

[8] Solley and others (1998, tables 19 and 20). Total withdrawn is from the columns “Total use—Withdrawals and deliveries—Fresh” and “Self-supplied withdrawals—Total—Saline.” Consumptive use is from the columns “Total use—Consumptive use—Fresh and Saline.”

Table 1-4. Industrial water-use category: total withdrawals, water consumed, and consumptive-use coefficients by USGS compilation year, for water-resources regions and states climatically similar to the Great Lakes Basin.

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data.]

Statistic	1960[1]	1965[2]	1970[3]	1975[4]	1980[5]	1985[6]	1990[7]	1995[8]	1960–95
Mid-Atlantic Region									
Total withdrawn	7,080	7,490	8,000	6,200	5,500	5,400	3,870	2,476	
Consumptive use	460	470	340	365	410	495	341	247	
Coefficient	6	6	4	6	7	9	9	10	7
New England Region									
Total withdrawn	1,410	1,560	1,520	1,670	1,578	988	766	321	
Consumptive use	84	79	114	91	71.1	199	85	24	
Coefficient	6	5	8	5	5	20	11	7	8
Ohio Region									
Total withdrawn	7,234	8,526	5,858	6,020	5,024	3,720	2,990	4,280	
Consumptive use	310	400	260	360	420	550	297	480	
Coefficient	4	5	4	6	8	15	10	11	7
Tennessee Region									
Total withdrawn	1,500	1,100	1,400	1,600	2,000	1,850	1,290	1,170	
Consumptive use	240	180	72	120	220	229	163	115	
Coefficient	16	16	5	8	11	12	13	10	11
Upper Mississippi Region									
Total withdrawn	1,720	1,618	1,720	1,815	3,315	1,350	1,430	1,350	
Consumptive use	36	58	75	98	170	325	214	176	
Coefficient	2	4	4	5	5	24	15	13	8
Connecticut									
Total withdrawn	316	268	215	322	272	207	212	51	
Consumptive use	20	6.1	6	23	19	14	30	1.1	
Coefficient	6	2	3	7	7	7	14	2	6
Delaware									
Total withdrawn	435	521	387	500	412	428	86	79	
Consumptive use	54	1.2	1.4	5.4	41.1	7.5	12	11	
Coefficient	12	0	0	1	10	2	14	14	5
Iowa									
Total withdrawn	110	180	280	310	550	239	253	335	
Consumptive use	11	19	5.3	6	11	31	33	44	
Coefficient	10	11	2	2	2	13	13	13	7
Kentucky									
Total withdrawn	251	261	385	280	320	408	512	543	
Consumptive use	24	44	40	29	33	17	19	22	
Coefficient	10	17	10	10	10	4	4	4	8
Maine									
Total withdrawn	353	497	424	439	661	256	270	25	
Consumptive use	25	29	25.4	6	8.9	88	27	2.5	
Coefficient	7	6	6	1	1	34	10	10	7
Maryland									
Total withdrawn	880	1,440	1,440	1,210	650	405	502	370	
Consumptive use	74	130	52	41	20	101	75	42	
Coefficient	8	9	4	3	3	25	15	11	8

Table 1-4. Industrial water-use category: total withdrawals, water consumed, and consumptive-use coefficients by USGS compilation year, for water-resources regions and states climatically similar to the Great Lakes Basin. —Continued

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data.]

Statistic	1960[1]	1965[2]	1970[3]	1975[4]	1980[5]	1985[6]	1990[7]	1995[8]	1960–95
Massachusetts									
Total withdrawn	580	600	690	680	374	220	195	171	
Consumptive use	30	30	69	50	30.1	44	20	13	
Coefficient	5	5	10	7	8	20	10	8	8
Missouri									
Total withdrawn	163	316	310	240	300	221	218	179	
Consumptive use	9	30	29	5.0	24	30	29	27	
Coefficient	6	9	9	2	8	14	13	15	9
New Hampshire									
Total withdrawn	150	170	190	210	210	254	53	56	
Consumptive use	8	9	9.6	11	10	51	5.3	6.6	
Coefficient	5	5	5	5	5	20	10	12	9
New Jersey									
Total withdrawn	1,320	1,530	1,000	1,100	1,750	1,300	1,587	487	
Consumptive use	150	170	70	90	115	53	65	37	
Coefficient	11	11	7	8	7	4	4	8	7
Rhode Island									
Total withdrawn	47.3	45.4	38.4	30.3	35.6	37.2	24	13	
Consumptive use	2.2	4.4	3.8	3.0	2.9	2.6	1.7	1.3	
Coefficient	5	10	10	10	8	7	7	10	8
Tennessee									
Total withdrawn	1,400	890	1,000	1,300	1,700	1,700	988	993	
Consumptive use	310	180	47	120	150	187	109	109	
Coefficient	22	20	5	9	9	11	11	11	12
Vermont									
Total withdrawn	34	34	46	15	15	67	47	17	
Consumptive use	2	1.6	2.3	1.8	2.3	13	4.7	1.7	
Coefficient	6	5	5	12	15	19	10	10	11
Virginia									
Total withdrawn	1,285	802	1,080	950	551	714	713	671	
Consumptive use	0	1.4	7.4	8.4	55.1	80	85.9	80	
Coefficient	0	0	1	1	10	11	12	12	5
West Virginia									
Total withdrawn	2,300	2,100	660	660	830	909	145	1,330	
Consumptive use	120	140	57	57	82	133	22	200	
Coefficient	5	7	9	9	10	15	15	15	9
District of Columbia									
Total withdrawn	1.8	1.4	1.4	1.4	1.4	0	.5	1.2	
Consumptive use	.7	.3	.3	.3	.3	0	0	.1	
Coefficient	39	21	21	21	21	-	0	8	22

Table 1-4. Industrial water-use category: total withdrawals, water consumed, and consumptive-use coefficients by USGS compilation year, for water-resources regions and states climatically similar to the Great Lakes Basin. —Continued

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data.]

Statistic	1960[1]	1965[2]	1970[3]	1975[4]	1980[5]	1985[6]	1990[7]	1995[8]	1960–95
Climatically similar states									
Total withdrawn	9,626	9,656	8,147	8,248	8,632	7,365	5,806	5,321	62,799
Consumptive use	840	796	426	457	604.7	852.1	539	598	5,111
Coefficient	9	8	5	6	7	12	9	11	8

[1] MacKichan and Kammerer (1961, tables 7 and 8). Total withdrawn is from the columns “Other uses—water withdrawn—All water—Fresh and Saline.” Consumptive use is from the column “Other uses—Water consumed.”

[2] Murray (1968, tables 14 and 15). Total withdrawn is from the columns “Other uses—water withdrawn—All water—Fresh and Saline.” Consumptive use is from the column “Other uses—Water consumed.”

[3] Murray and Reeves (1972, tables 8 and 15). Total withdrawn is from the columns “Other uses—water withdrawn—All water—Fresh and Saline.” Consumptive use is from the columns “Other uses—Water consumed—fresh and saline.”

[4] Murray and Reeves (1977, tables 8 and 15). Total withdrawn is from the columns “Other industrial uses—water withdrawn—All water—Fresh and Saline.” Consumptive use is from the columns “Other industrial uses—Water consumed—fresh and saline.”

[5] Solley and others (1983, tables 7 and 8). Total withdrawn is from the columns “Other industries—Total, excluding reclaimed sewage—Fresh and Saline.” Consumptive use is from the columns “Other industries—Consumptive use—fresh and saline.”

[6] Solley and others (1988, tables 11 and 12). Total withdrawn is from the columns “Total—Withdrawals and deliveries—Fresh” and “Self-supplied withdrawals—Total—Saline.” Consumptive use is from the column “Total—Consumptive use—Total.”

[7] Solley and others (1993, tables 19 and 20). Total withdrawn is from the columns “Total—Withdrawals and deliveries—Fresh” and “Self-supplied withdrawals—Total—Saline.” Consumptive use is from the columns “Total use—Consumptive use—Fresh and Saline.”

[8] Solley and others (1998, tables 19 and 20). Total withdrawn is from the columns “Total use—Withdrawals and deliveries—Fresh” and “Self-supplied withdrawals—Total—Saline.” Consumptive use is from the columns “Total use—Consumptive use—Fresh and Saline.”

Table 1-5. Thermoelectric power water-use category: total withdrawals, water consumed, and consumptive-use coefficients, by USGS compilation year, for the Great Lakes Basin and Great Lakes States.

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data. The 1960–95 coefficient was calculated by dividing the sum of the consumptive use by the sum of the total withdrawn for each geographic area. Data from 1960 to 1980 were reported in two significant figures and data from 1985 to 1995 were reported in three significant figures.]

Statistic	1960[1]	1965[2]	1970[3]	1975[4]	1980[5]	1985[6]	1990[7]	1995[8]	1960–95
Great Lakes Basin									
Total withdrawn	18,000	21,000	26,000	25,000	27,000	22,400	22,800	22,800	
Consumptive use	12	11	14	52	93	1,100	476	429	
Coefficient	0	0	0	0	0	5	2	2	1
Illinois									
Total withdrawn	9,700	13,000	11,000	9,100	14,000	11,700	15,200	17,100	
Consumptive use	2	4	5	5	260	121	370	407	
Coefficient	0	0	0	0	2	1	2	2	1
Indiana									
Total withdrawn	3,200	6,400	4,800	7,300	9,700	4,480	5,960	5,690	
Consumptive use	7	6	5	65	65	77	119	114	
Coefficient	0	0	0	1	1	2	2	2	1
Michigan									
Total withdrawn	3,900	5,800	9,800	12,000	12,000	8,390	8,060	8,370	
Consumptive use	1	4	0	0	0	108	204	126	
Coefficient	0	0	0	0	0	1	3	2	1
Minnesota									
Total withdrawn	1,200	1,300	1,700	2,900	1,700	1,480	1,880	2,090	
Consumptive use	0	2	.2	58	7.2	140	323	48	
Coefficient	0	0	0	2	0	9	17	2	4
New York									
Total withdrawn	8,300	10,500	13,000	20,000	12,000	10,900	15,500	13,100	
Consumptive use	8	10	27	39	38.6	2,310	340	300	
Coefficient	0	0	0	0	0	21	2	2	3
Ohio									
Total withdrawn	8,200	9,100	14,000	12,000	10,000	10,500	9,550	8,190	
Consumptive use	22	7	14	78	93	64	393	336	
Coefficient	0	0	0	1	1	1	4	4	1
Pennsylvania									
Total withdrawn	6,600	8,800	12,000	11,000	10,000	10,200	5,750	5,930	
Consumptive use	4	6	8.9	230	290	193	218	239	
Coefficient	0	0	0	2	3	2	4	4	2
Wisconsin									
Total withdrawn	2,900	3,900	5,300	2,200	4,500	5,440	5,100	5,830	
Consumptive use	0	1	0	30	46	54	51	58	
Coefficient	0	0	0	1	1	1	1	1	1

Table 1-5. Thermoelectric power water-use category: total withdrawals, water consumed, and consumptive-use coefficients, by USGS compilation year, for the Great Lakes Basin and Great Lakes States. —Continued

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data. The 1960–95 coefficient was calculated by dividing the sum of the consumptive use by the sum of the total withdrawn for each geographic area. Data from 1960 to 1980 were reported in two significant figures and data from 1985 to 1995 were reported in three significant figures.]

Statistic	1960[1]	1965[2]	1970[3]	1975[4]	1980[5]	1985[6]	1990[7]	1995[8]	1960–95
				Great Lakes States					
Total withdrawn	44,000	58,800	71,600	76,500	73,900	63,090	67,000	66,300	521,190
Consumptive use	44	40	60.1	506	800	3,067	2,018	1,628	8,163.1
Coefficient	0	0	0	1	1	5	3	2	2

[1] MacKichan and Kammerer (1961, tables 9 and 10). Total withdrawn is from the columns “Condenser cooling and Other uses—Self-supplied and Public supplies.” Consumptive use is from the column “Consumed.” Because data was reported to two significant figures, totals were rounded to two significant figures as well. In some cases, tables 7 and 8, as well as partial columns were used to help determine rounding.

[2] Murray (1968, tables 17 and 18). Total withdrawn is from the columns “Condenser cooling and Other uses—Self-supplied and Public supplies.” Consumptive use is from the column “Water consumed.” Because data were reported to two significant figures, totals were rounded to two significant figures as well. In some cases, tables 14 and 15, as well as partial columns, were used to help determine rounding.

[3] Murray and Reeves (1972, tables 9 and 16). Total withdrawn is from the columns “Condenser cooling and Other uses—Self-supplied and Public supplies.” Consumptive use is from the columns “Water consumed—Fresh and Saline.” Because data were reported to two significant figures, totals were rounded to two significant figures as well. In some cases, tables 8 and 15, as well as partial columns, were used to help determine rounding.

[4] Murray and Reeves (1977, tables 9 and 16). Total withdrawn is from the columns “Condenser and reactor cooling and Other thermoelectric uses—self-supplied and public supplies.” Consumptive use is from the columns “Water consumed—Fresh and Saline.” Because data were reported to two significant figures, totals were rounded to two significant figures as well. In some cases, tables 8 and 15, as well as partial columns, were used to help determine rounding.

[5] Solley and others (1983, tables 9 and 10). Total withdrawn is from the columns “Cooling of condensers and reactors—Total and Other thermoelectric uses—total. Consumptive use is from the columns “Consumptive use—Fresh and Saline.” Because data were reported to two significant figures, totals were rounded to two significant figures as well.

[6] Solley and others (1988, tables 15 and 16). Total withdrawn is from the columns “Self-supplied withdrawals, by source and type” for both “Ground water—Fresh” and “Surface water—Total,” plus “Public-supply deliveries”. As a check—because independent rounding is noted as a reason figures might not add to totals, the “Total use—Withdrawals and deliveries—Fresh” was added to the “Surface water—saline.” Consumptive use is from the column “Total—Consumptive use—total.”

[7] Solley and others (1993, tables 23 and 24.) Total withdrawn is from the columns “Self-supplied withdrawals, by source and type” for both “Ground water—Fresh” and “Surface water—Total” plus “Public-supply deliveries.” As a check—because independent rounding is noted as a reason figures might not add to totals—the column “Total— Withdrawals and deliveries—Fresh” was added to the column “Surface water—saline.” Consumptive use is from the column “Total Use—Consumptive use—total.”

[8] Solley and others (1998, tables 23 and 24). Total withdrawn is from the columns “Self-supplied withdrawals, by source and type” for both “Ground water—Fresh” and “Surface water—Total” plus “Public-supply deliveries.” As a check—because independent rounding is noted as a reason figures might not add to totals—the column “Total use—Withdrawals and deliveries—Fresh” was added to the column “Surface water—saline.” Consumptive use is from the column “Total Use—Consumptive use—Total.”

Table 1-6. Thermoelectric power water-use category: total withdrawals, water consumed, and consumptive-use coefficients, by USGS compilation year, for the water-resources regions and states climatically similar to the Great Lakes Basin.

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive use data. The 1960–95 coefficient was calculated by dividing the sum of the consumptive use by the sum of the total withdrawn for each geographic area. Data from 1960 to 1980 were reported in two significant figures and data from 1985 to 1995 were reported in three significant figures.]

Statistic	1960[1]	1965[2]	1970[3]	1975[4]	1980[5]	1985[6]	1990[7]	1995[8]	1960–95
Mid-Atlantic Region									
Total withdrawn	15,300	21,000	32,000	39,000	40000	32400	37,200	32,400	
Consumptive use	15	27	52	186	920	2,040	413	401	
Coefficient	0	0	0	0	2	6	1	1	2
New England Region									
Total withdrawn	3,900	4,200	6,500	11,000	9,900	13,200	11,510	10,400	
Consumptive use	1	3	4	96	21	254	230	105	
Coefficient	0	0	0	1	0	2	2	1	1
Ohio Region									
Total withdrawn	16,000	20,000	27,000	27,000	30,000	24,400	23,900	22,600	
Consumptive use	33	17	50	280	520	1,020	881	838	
Coefficient	0	0	0	1	2	4	4	4	2
Tennessee Region									
Total withdrawn	5,600	6,500	6,100	8,700	9,200	6,810	7,070	6,990	
Consumptive use	0	8	64	59	20	11	15	13	
Coefficient	0	0	1	1	0	0	0	0	0
Upper Mississippi Region									
Total withdrawn	8,200	13,000	12,000	13,000	16,000	12,800	16,500	19,100	
Consumptive use	4	27	23	96	290	276	635	388	
Coefficient	0	0	0	1	2	2	4	2	2
Connecticut									
Total withdrawn	1,500	1,600	2,900	1,900	3,200	3,210	4,240	3,940	
Consumptive use	0	1	2	4.7	1.9	65	85	80	
Coefficient	0	0	0	0	0	2	2	2	1
Delaware									
Total withdrawn	440	600	730	1,500	680	1,120	1,160	1,270	
Consumptive use	0	4	0	0	68	.7	6.6	3.1	
Coefficient	0	1	0	0	10	0	1	0	1
Iowa									
Total withdrawn	1,500	1,500	1,400	2,800	3,200	1,810	2,080	2,130	
Consumptive use	2	21	20	15	20	54	10	10	
Coefficient	0	1	1	1	1	3	0	0	1
Kentucky									
Total withdrawn	2,000	2,700	3,800	2,300	4,100	3,410	3,440	3,440	
Consumptive use	1	5	21	45	140	124	203	203	
Coefficient	0	0	1	2	3	4	6	6	3
Maine									
Total withdrawn	120	180	200	620	750	746	691	137	
Consumptive use	0	0	0	0	0	0	14	5.2	
Coefficient	0	0	0	0	0	0	2	4	1

Table 1-6. Thermoelectric power water-use category: total withdrawals, water consumed, and consumptive-use coefficients, by USGS compilation year, for the water-resources regions and states climatically similar to the Great Lakes Basin. —Continued

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive use data. The 1960–95 coefficient was calculated by dividing the sum of the consumptive use by the sum of the total withdrawn for each geographic area. Data from 1960 to 1980 were reported in two significant figures and data from 1985 to 1995 were reported in three significant figures.]

Statistic	1960[1]	1965[2]	1970[3]	1975[4]	1980[5]	1985[6]	1990[7]	1995[8]	1960–95
Maryland									
Total withdrawn	1,100	2,200	3,200	5,600	6,500	5,420	4,970	6,360	
Consumptive use	0	0	0	20	19	465	59	52	
Coefficient	0	0	0	0	0	9	1	1	2
Massachusetts									
Total withdrawn	1,800	2,000	2,700	7,200	4,700	8,450	4,500	4,520	
Consumptive use	1	2	2	0	0	182	90	6	
Coefficient	0	0	0	0	0	2	2	0	1
Missouri									
Total withdrawn	1,300	1,600	2,500	3,000	5,500	4,930	5,600	5,550	
Consumptive use	1	9	13	29	300	89	97	51	
Coefficient	0	1	1	1	5	2	2	1	2
New Hampshire									
Total withdrawn	260	240	410	700	700	542	1,150	1,110	
Consumptive use	0	0	0	0	0	5.3	23	4.3	
Coefficient	0	0	0	0	0	1	2	0	1
New Jersey									
Total withdrawn	2,700	4,000	4,200	4,300	7,400	4,540	10,100	4,390	
Consumptive use	4	9	26	2.5	570	14	.2	36	
Coefficient	0	0	1	0	8	0	0	1	2
Rhode Island									
Total withdrawn	310	300	310	330	330	261	393	275	
Consumptive use	0	0	0	0	0	2.6	7.9	5.5	
Coefficient	0	0	0	0	0	1	2	2	1
Tennessee									
Total withdrawn	3,900	3,300	4,900	5,800	7,800	6,060	7,320	8,300	
Consumptive use	1	1	62	50	1.0	.8	0	.5	
Coefficient	0	0	1	1	0	0	0	0	0
Vermont									
Total withdrawn	29	53	5.0	250	240	.8	519	453	
Consumptive use	0	0	0	94	22	.6	11	4	
Coefficient	0	0	0	38	9	75	2	1	8
Virginia									
Total withdrawn	3,400	4,200	3,900	5,900	8,400	5,760	5,290	6,620	
Consumptive use	2	8	.8	0	83	89	12	8.8	
Coefficient	0	0	0	0	1	2	0	0	0
West Virginia									
Total withdrawn	3,700	2,700	5,000	5,400	4,600	4,210	3,710	3,010	
Consumptive use	0	1	1.1	1.2	110	658	99	122	
Coefficient	0	0	0	0	2	16	3	4	3
District of Columbia									
Total withdrawn	270	200	1,100	130	130	130	8.0	9.7	
Consumptive use	0	0	0	2	2	2	.6	.8	
Coefficient	0	0	0	2	2	2	8	8	0

Table 1-6. Thermoelectric power water-use category: total withdrawals, water consumed, and consumptive-use coefficients, by USGS compilation year, for the water-resources regions and states climatically similar to the Great Lakes Basin. —Continued

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive use data. The 1960–95 coefficient was calculated by dividing the sum of the consumptive use by the sum of the total withdrawn for each geographic area. Data from 1960 to 1980 were reported in two significant figures and data from 1985 to 1995 were reported in three significant figures.]

Statistic	1960[1]	1965[2]	1970[3]	1975[4]	1980[5]	1985[6]	1990[7]	1995[8]	1960–95
					Climatically similar states				
Total withdrawn	24,329	27,373	37,255	47,730	58,230	50,600	55,171	51,515	352,203
Consumptive use	12	61	147.9	263.4	1,336.9	1,752	718.3	592.2	4,883.7
Coefficient	0	0	0	1	2	3	1	1	1

[1] MacKichan and Kammerer (1961, tables 9 and 10). Total withdrawn is from the columns “Condenser cooling and Other uses—Self-supplied and Public supplies.” Consumptive use is from the column “Consumed.” Because data was reported to two significant figures, totals were rounded to two significant figures as well. In some cases, tables 7 and 8, as well as partial columns were used to help determine rounding.

[2] Murray (1968, tables 17 and 18). Total withdrawn is from the columns “Condenser cooling and Other uses—Self-supplied and Public supplies.” Consumptive use is from the column “Water consumed.” Because data were reported to two significant figures, totals were rounded to two significant figures as well. In some cases, tables 14 and 15, as well as partial columns, were used to help determine rounding.

[3] Murray and Reeves (1972, tables 9 and 16). Total withdrawn is from the columns “Condenser cooling and Other uses—Self-supplied and Public supplies.” Consumptive use is from the columns “Water consumed—Fresh and Saline.” Because data were reported to two significant figures, totals were rounded to two significant figures as well. In some cases, tables 8 and 15, as well as partial columns, were used to help determine rounding.

[4] Murray and Reeves (1977, tables 9 and 16). Total withdrawn is from the columns “Condenser and reactor cooling and Other thermoelectric uses—self-supplied and public supplies.” Consumptive use is from the columns “Water consumed—Fresh and Saline.” Because data were reported to two significant figures, totals were rounded to two significant figures as well. In some cases, tables 8 and 15, as well as partial columns, were used to help determine rounding.

[5] Solley and others (1983, tables 9 and 10). Total withdrawn is from the columns “Cooling of condensers and reactors—Total and Other thermoelectric uses—total. Consumptive use is from the columns “Consumptive use—Fresh and Saline.” Because data were reported to two significant figures, totals were rounded to two significant figures as well.

[6] Solley and others (1988, tables 15 and 16). Total withdrawn is from the columns “Self-supplied withdrawals, by source and type” for both “Ground water—Fresh” and “Surface water—Total,” plus “Public-supply deliveries.” As a check—because independent rounding is noted as a reason figures might not add to totals, the “Total use—Withdrawals and deliveries—Fresh” was added to the “Surface water—saline.” Consumptive use is from the column “Total—Consumptive use—total.”

[7] Solley and others (1993, tables 23 and 24.) Total withdrawn is from the columns “Self-supplied withdrawals, by source and type” for both “Ground water—Fresh” and “Surface water—Total” plus “Public-supply deliveries.” As a check—because independent rounding is noted as a reason figures might not add to totals—the “Total— Withdrawals and deliveries—Fresh” was added to the “Surface water—saline.” Consumptive use is from the column “Total Use—Consumptive use—total.”

[8] Solley and others (1998, tables 23 and 24). Total withdrawn is from the columns “Self-supplied withdrawals, by source and type” for both “Ground water—Fresh” and “Surface water—Total” plus “Public-supply deliveries.” As a check—because independent rounding is noted as a reason figures might not add to totals—the “Total use—Withdrawals and deliveries—Fresh” was added to the “Surface water—saline.” Consumptive use is from the column “Total Use—Consumptive use—total.”

Table 1-7. Irrigation water-use category: total withdrawals, water consumed, and consumptive-use coefficients, by USGS compilation year, for the Great Lakes Basin and Great Lakes States.

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data. The 1960–95 coefficient was calculated by dividing the sum of the consumptive use by the sum of the total withdrawn for each geographic area. Data from 1960 to 1980 were reported in two significant figures and data from 1985 to 1995 were reported in three significant figures.]

Statistic	1960[1]	1965[2]	1970[3]	1975[4]	1980[5]	1985[6]	1990[7]	1995[8]	1960–95
Great Lakes Basin									
Total withdrawn	46	67	90	99	340	275[1]	290	315	
Consumptive use	45	65	87	94	330	274	274	295	
Coefficient	98	97	97	95	97	100	94	94	96
Illinois									
Total withdrawn	2.4	15	21	41	110	71	78	180	
Consumptive use	2.4	15	21	41	110	71	70	180	
Coefficient	100	100	100	100	100	100	90	100	98
Indiana									
Total withdrawn	7.2	9	25	34	230	47	51	116	
Consumptive use	7.2	9	25	33	230	47	46	104	
Coefficient	100	100	100	100	100	100	90	90	97
Michigan									
Total withdrawn	22	37	58	64	210	231[1]	240	227	
Consumptive use	22	36	58	64	210	231	227	216	
Coefficient	100	97	100	100	100	100	95	95	98
Minnesota									
Total withdrawn	7.1	5.8	20	47	160	209	195	157	
Consumptive use	7.1	5.8	20	47	160	190	175	140	
Coefficient	100	100	100	100	100	91	90	89	93
New York									
Total withdrawn	28	53	27	32	46	38	54	30	
Consumptive use	28	53	27	32	46	38	49	26	
Coefficient	100	100	100	100	100	100	91	87	97
Ohio									
Total withdrawn	8.5	11	31	18	5.3	17	15	27	
Consumptive use	7.7	11	28	16	4.8	15	14	26	
Coefficient	91	100	90	89	91	88	93	96	92
Pennsylvania									
Total withdrawn	3	6.7	10	34	160	11	14	16	
Consumptive use	3	6.7	10	34	160	11	14	16	
Coefficient	100	100	100	100	100	100	100	100	100
Wisconsin									
Total withdrawn	16	39	52	71	85	84	151	169	
Consumptive use	16	29	40	56	77	84	151	151	
Coefficient	100	74	77	79	91	100	100	89	91

Table 1-7. Irrigation water-use category: total withdrawals, water consumed, and consumptive-use coefficients, by USGS compilation year, for the Great Lakes Basin and Great Lakes States. —Continued

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data. The 1960–95 coefficient was calculated by dividing the sum of the consumptive use by the sum of the total withdrawn for each geographic area. Data from 1960 to 1980 were reported in two significant figures and data from 1985 to 1995 were reported in three significant figures.]

Statistic	1960[1]	1965[2]	1970[3]	1975[4]	1980[5]	1985[6]	1990[7]	1995[8]	1960–95
					Great Lakes States				
Total withdrawn	94.2	176.5	244	341	1,006.3	708	798	922	4,290
Consumptive use	93.4	165.5	229	323	997.8	687	744	859	4,099
Coefficient	99	94	94	95	99	97	93	93	96

[1] MacKichan and Kammerer (1961, tables 5 and 6). Total withdrawn is from the column “Water delivered to farms (million gallons per day)—All water.” Consumptive use is from the column “Consumptive use (mgd).”

[2] Murray (1968, tables 11 and 12). Total withdrawn is from the column “Total water withdrawn (million gallons per day)—All water.” Consumptive use is from the column “Consumptive use (mgd).”

[3] Murray and Reeves (1972, tables 7 and 14). Total withdrawn is from the column “Total water withdrawn (million gallons per day)—All water.” Consumptive use is from the column “water consumed.”

[4] Murray and Reeves (1977, tables 7 and 14). Total withdrawn is from the column “Total water withdrawn (million gallons per day)—All water.” Consumptive use is from the column “freshwater consumed (mgd).”

[5] Solley and others (1983, tables 5 and 6). Total withdrawn is from the column “Million gallons per day—Withdrawals—Total.” Consumptive use is from the column “Million gallons per day—Consumptive use, fresh water.”

[6] Solley and others (1988, tables 7 and 8). Total withdrawn is from the column “Million gallons per day—Withdrawals, by source—Total.” Consumptive use is from the column “Million gallons per day—Consumptive use, fresh water.”

[7] Solley and others (1993, tables 15 and 16). Total withdrawn is from the column “Million gallons per day—Withdrawals, by source—Total.” Consumptive use is from the column “Million gallons per day—Consumptive use, fresh water.”

[8] Solley and others (1998, tables 15 and 16). Total withdrawn is from the column “Million gallons per day—Withdrawals, by source—Total.” Consumptive use is from the column “Million gallons per day—Consumptive use, fresh water.”

Table 1-8. Irrigation water-use category: total withdrawals, water consumed, and consumptive-use coefficients, by USGS compilation year, for water-resources regions and states climatically similar to the Great Lakes Basin.

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data. The 1960–95 coefficient was calculated by dividing the sum of the consumptive use by the sum of the total withdrawn for each geographic area. Data from 1960 to 1980 were reported in two significant figures and data from 1985 to 1995 were reported in three significant figures.]

Statistic	1960[1]	1965[2]	1970[3]	1975[4]	1980[5]	1985[6]	1990[7]	1995[8]	1960–95
Mid-Atlantic Region									
Total withdrawn	82	122	130	230	250	248	197	293	
Consumptive use	82	122	120	200	240	229	168	200	
Coefficient	100	100	92	87	96	92	85	68	88
New England Region									
Total withdrawn	11	26	80	57	53	25	120	146	
Consumptive use	6.9	26	64	57	52	25	120	142	
Coefficient	63	100	80	100	98	100	100	97	95
Ohio Region									
Total withdrawn	13	23	35	34	150	40	68	104	
Consumptive use	12	23	35	32	150	38	59	97	
Coefficient	92	100	100	94	100	95	87	93	96
Tennessee Region									
Total withdrawn	14	9.2	6.6	7.2	6.8	10	27	48	
Consumptive use	14	9.2	6.6	6.9	6.6	7.7	19	48	
Coefficient	100	100	100	96	97	77	70	100	92
Upper Mississippi Region									
Total withdrawn	44	85	100	150	380	358	392	484	
Consumptive use	44	77	95	140	370	345	364	449	
Coefficient	100	91	95	93	97	96	93	93	95
Connecticut									
Total withdrawn	1.0	10	5.9	4.3	21	2.7	15	28	
Consumptive use	1.0	10	5.9	4.3	21	2.7	15	28	
Coefficient	100	100	100	100	100	100	100	100	100
Delaware									
Total withdrawn	2.4	3.6	2.7	14	6.5	27	32	48	
Consumptive use	2.4	3.6	2.7	14	6.5	27	32	48	
Coefficient	100	100	100	100	100	100	100	100	100
Iowa									
Total withdrawn	61	73	26	21	56	67	23	39	
Consumptive use	61	73	26	21	56	67	23	39	
Coefficient	100	100	100	100	100	100	100	100	100
Kentucky									
Total withdrawn	2.5	8.9	7.1	2.7	4.9	7.7	12	12	
Consumptive use	2.5	8.9	6.8	2.6	4.9	7.3	11	11	
Coefficient	100	100	96	96	100	95	92	92	95
Maine									
Total withdrawn	.88	2.5	8.9	8.5	6.1	1.9	1.8	27	
Consumptive use	.88	2.5	8.8	8.5	5.8	1.9	1.8	24	
Coefficient	100	100	99	100	95	100	100	89	94
Maryland									
Total withdrawn	5.3	6.1	6.6	9.5	20	34	29	62	
Consumptive use	5.3	6.1	6.6	9.4	19	34	29	57	
Coefficient	100	100	100	99	95	100	100	92	96

Table 1-8. Irrigation water-use category: total withdrawals, water consumed, and consumptive-use coefficients, by USGS compilation year, for water-resources regions and states climatically similar to the Great Lakes Basin. —Continued

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data. The 1960–95 coefficient was calculated by dividing the sum of the consumptive use by the sum of the total withdrawn for each geographic area. Data from 1960 to 1980 were reported in two significant figures and data from 1985 to 1995 were reported in three significant figures.]

Statistic	1960[1]	1965[2]	1970[3]	1975[4]	1980[5]	1985[6]	1990[7]	1995[8]	1960–95
Massachusetts									
Total withdrawn	7.5	11	58	33	19	16	100	82	
Consumptive use	3.3	11	43	33	19	16	100	81	
Coefficient	44	100	74	100	100	100	100	99	94
Missouri									
Total withdrawn	28	82	77	96	130	306	371	567	
Consumptive use	28	66	55	76	100	221	269	421	
Coefficient	100	80	71	79	77	72	73	74	75
New Hampshire									
Total withdrawn	1.4	2.1	2.8	5.4	1.6	.6	.9	6.3	
Consumptive use	1.3	2.1	2.0	5.3	1.3	.6	.8	5.7	
Coefficient	93	100	71	98	81	100	89	90	91
New Jersey									
Total withdrawn	35	54	76	140	55	132	58	125	
Consumptive use	35	53	70	110	45	119	42	46	
Coefficient	100	98	92	79	82	90	72	37	77
Rhode Island									
Total withdrawn	.22	.6	4.5	4.6	5.0	3.4	2.1	2.3	
Consumptive use	.22	.5	3.4	4.6	4.5	3.4	2.1	2.3	
Coefficient	100	83	76	100	90	100	100	100	93
Tennessee									
Total withdrawn	11	3.1	4.2	8.6	12	8.9	38	24	
Consumptive use	11	3.1	3.8	8.1	9.2	5.3	23	24	
Coefficient	100	100	90	94	77	60	60	100	80
Vermont									
Total withdrawn	.75	.7	.1	2.2	1.4	.5	.5	3.9	
Consumptive use	.71	.7	.1	2.2	1.0	.5	.5	3.5	
Coefficient	95	100	100	100	71	100	100	90	92
Virginia									
Total withdrawn	36	27	35	20	28	52	36	30	
Consumptive use	35	26	34	12	17	34	23	18	
Coefficient	97	96	97	60	61	65	64	60	75
West Virginia									
Total withdrawn	1.2	1.4	1.3	1.2	1.3	3.7	0	0	
Consumptive use	1.2	1.4	1.3	1.2	1.3	3.7	0	0	
Coefficient	100	100	100	100	100	100	-	-	100
District of Columbia									
Total withdrawn	0	0	0	0	0	0	0	0	
Consumptive use	0	0	0	0	0	0	0	0	
Coefficient									

Table 1-8. Irrigation water-use category: total withdrawals, water consumed, and consumptive-use coefficients, by USGS compilation year, for water-resources regions and states climatically similar to the Great Lakes Basin. —Continued

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data. The 1960–95 coefficient was calculated by dividing the sum of the consumptive use by the sum of the total withdrawn for each geographic area. Data from 1960 to 1980 were reported in two significant figures and data from 1985 to 1995 were reported in three significant figures.]

Statistic	1960[1]	1965[2]	1970[3]	1975[4]	1980[5]	1985[6]	1990[7]	1995[8]	1960–95
					Climatically similar states				
Total withdrawn	194.15	286	316.1	371	367.8	663.4	719.3	1,056.5	3,974
Consumptive use	188.81	267.9	269.4	312.2	311.5	543.4	572.2	808.5	3,274
Coefficient	97	94	85	84	85	82	80	77	82

[1] MacKichan and Kammerer (1961, tables 5 and 6). Total withdrawn is from the column “Water delivered to farms (million gallons per day)—All water.” Consumptive use is from the column “Consumptive use (mgd).”

[2] Murray (1968, tables 11 and 12). Total withdrawn is from the column “Total water withdrawn (million gallons per day)—All water.” Consumptive use is from the column “Consumptive use (mgd).”

[3] Murray and Reeves (1972, tables 7 and 14). Total withdrawn is from the column “Total water withdrawn (million gallons per day)—All water.” Consumptive use is from the column “water consumed.”

[4] Murray and Reeves (1977, tables 7 and 14). Total withdrawn is from the column “Total water withdrawn (million gallons per day)—All water.” Consumptive use is from the column “freshwater consumed (mgd).”

[5] Solley and others (1983, tables 5 and 6). Total withdrawn is from the column “Million gallons per day—Withdrawals—Total.” Consumptive use is from the column “Million gallons per day—Consumptive use, fresh water.”

[6] Solley and others (1988, tables 7 and 8). Total withdrawn is from the column “Million gallons per day—Withdrawals, by source—Total.” Consumptive use is from the column “Million gallons per day—Consumptive use, fresh water.”

[7] Solley and others (1993, tables 15 and 16). Total withdrawn is from the column “Million gallons per day—Withdrawals, by source—Total.” Consumptive use is from the column “Million gallons per day—Consumptive use, fresh water.”

[8] Solley and others (1998, tables 15 and 16). Total withdrawn is from the column “Million gallons per day—Withdrawals, by source—Total.” Consumptive use is from the column “Million gallons per day—Consumptive use, fresh water.”

Table 1-9. Livestock water-use category: total withdrawals, water consumed, and consumptive-use coefficients, by USGS compilation year, for the Great Lakes Basin and Great Lakes States.

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use numbers. The 1960–95 coefficient was calculated by dividing the sum of the consumptive use by the sum of the total withdrawn for each geographic area. Data from 1960 to 1980 were reported in two significant figures and data from 1985 to 1995 were reported in three significant figures.]

Statistic	1960[1]	1965[2]	1970[3]	1975[4]	1980[5]	1985[6]	1990[7]	1995[8]	1960–95
Great Lakes Basin									
Total withdrawn	92	84	86	84	84	78	72	61	
Consumptive use	85	77	82	78	77	69	62	53	
Coefficient	92	92	95	93	92	88	86	87	91
Illinois									
Total withdrawn	78	62	42	42	65	57	52	45	
Consumptive use	78	62	42	42	65	49	41	36	
Coefficient	100	100	100	100	100	86	79	80	94
Indiana									
Total withdrawn	44	41	46	65	42	48	46	46	
Consumptive use	44	40	46	59	42	41	36	37	
Coefficient	100	98	100	91	100	86	78	80	91
Michigan									
Total withdrawn	29	27	31	25	22	25	23	13	
Consumptive use	23	21	28	22	19	22	19	12	
Coefficient	79	78	90	88	86	88	83	92	85
Minnesota									
Total withdrawn	71	69	68	77	68	63	65	62	
Consumptive use	71	62	68	76	68	63	65	62	
Coefficient	100	90	100	99	100	100	100	100	99
New York									
Total withdrawn	35	33	38	38	58	20	25	33	
Consumptive use	32	30	34	34	52	18	23	30	
Coefficient	91	91	89	89	90	90	92	91	90
Ohio									
Total withdrawn	45	38	40	58	40	41	33	26	
Consumptive use	45	37	39	54	36	41	32	25	
Coefficient	100	97	98	93	90	100	97	96	96
Pennsylvania									
Total withdrawn	32	28	28	51	61	70	53	55	
Consumptive use	32	23	18	38	41	61	40	41	
Coefficient	100	82	64	75	67	87	75	75	78
Wisconsin									
Total withdrawn	73	72	71	70	75	90	68	64	
Consumptive use	73	72	71	70	75	73	55	51	
Coefficient	100	100	100	100	100	81	81	80	93

Table 1-9. Livestock water-use category: total withdrawals, water consumed, and consumptive-use coefficients, by USGS compilation year, for the Great Lakes Basin and Great Lakes States. —Continued

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use numbers. The 1960–95 coefficient was calculated by dividing the sum of the consumptive use by the sum of the total withdrawn for each geographic area. Data from 1960 to 1980 were reported in two significant figures and data from 1985 to 1995 were reported in three significant figures.]

Statistic	1960[1]	1965[2]	1970[3]	1975[4]	1980[5]	1985[6]	1990[7]	1995[8]	1960–95
				Great Lakes States					
Total withdrawn	407	370	364	426	431	414	365	344	3121
Consumptive use	398	347	346	395	398	368	311	294	2,857
Coefficient	98	94	95	93	92	89	85	85	92

[1] MacKichan and Kammerer (1961, tables 3 and 4). Total withdrawn is from the column “Livestock use—Withdrawn—All water.” Consumptive use is from the column “Livestock use—Consumed.”

[2] Murray, 1968 (tables 8 and 9). Total withdrawn is from the column “Livestock use—Withdrawals—All water.” Consumptive use is from the column “Livestock use—Consumed.”

[3] Murray and Reeves (1972, tables 6 and 13). Total withdrawn is from the column “Livestock use—Withdrawals—All water.” Consumptive use is from the column “Livestock use—Water consumed.”

[4] Murray and Reeves (1977, tables 6 and 13). Total withdrawn is from the column “Livestock use—Withdrawals—All water.” Consumptive use is from the column “Livestock use—Fresh-water consumed.”

[5] Solley and others (1983, tables 3 and 4). Total withdrawn is from the column “Livestock use—Withdrawals—Total.” Consumptive use is from the column “Livestock use—Consumptive use.”

[6] Solley and others (1988, tables 9 and 10). Total withdrawn is from the column “Withdrawals—Total.” Consumptive use is from the column “Consumptive use.”

[7] Solley and others (1993, tables 17 and 18). Total withdrawn is from the column “Livestock—Withdrawals—Total.” Consumptive use is from the column “Livestock—Consumptive use.”

[8] Solley and others (1998, tables 17 and 18). Total withdrawn is from the column “Livestock—Withdrawals—Total.” Consumptive use is from the column “Livestock—Consumptive use.”

Table 1-10. Livestock water-use category: total withdrawals, water consumed, and consumptive-use coefficients, by USGS compilation year, for water-resources regions and states climatically similar to the Great Lakes Basin.

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data. The 1960–95 coefficient was calculated by dividing the sum of the consumptive use by the sum of the total withdrawn for each geographic area. Data from 1960 to 1980 were reported in two significant figures and data from 1985 to 1995 were reported in three significant figures.]

Statistic	1960[1]	1965[2]	1970[3]	1975[4]	1980[5]	1985[6]	1990[7]	1995[8]	1960–95
Mid-Atlantic Region									
Total withdrawn	64	60	79	95	110	142	90	107	
Consumptive use	58	51	65	76	86	85	78	92	
Coefficient	91	85	82	80	78	60	87	86	79
New England Region									
Total withdrawn	13	11	12	8.6	9.2	44	7.5	7.2	
Consumptive use	13	11	12	8.5	9.2	30	6.8	6.0	
Coefficient	100	100	100	99	100	68	91	83	86
Ohio Region									
Total withdrawn	130	120	140	180	150	184	125	123	
Consumptive use	130	120	140	170	140	155	111	111	
Coefficient	100	100	100	94	93	84	89	90	93
Tennessee Region									
Total withdrawn	38	51	31	38	41	59	33	18	
Consumptive use	38	50	30	32	40	28	33	18	
Coefficient	100	98	97	84	98	47	100	100	87
Upper Mississippi Region									
Total withdrawn	290	310	260	260	270	300	236	223	
Consumptive use	290	300	250	250	270	279	217	205	
Coefficient	100	97	96	96	100	93	92	92	96
Connecticut									
Total withdrawn	3.0	2.3	2.5	3.0	2.2	8.4	1.2	1.2	
Consumptive use	3.0	2.3	2.5	3.0	2.2	1.8	1.0	1.0	
Coefficient	100	100	100	100	100	21	83	83	71
Delaware									
Total withdrawn	1.8	2.2	1.7	2.9	2.0	1.9	2.4	4.1	
Consumptive use	.9	1.0	1.4	2.3	2.0	1.9	2.4	3.7	
Coefficient	50	45	82	79	100	100	100	90	82
Iowa									
Total withdrawn	140	150	130	120	130	172	118	109	
Consumptive use	130	150	130	120	130	172	118	109	
Coefficient	93	100	100	100	100	100	100	100	99
Kentucky									
Total withdrawn	31	38	40	46	39	50	32	45	
Consumptive use	31	37	40	46	39	50	32	45	
Coefficient	100	97	100	100	100	100	100	100	100
Maine									
Total withdrawn	3.4	3.5	2.8	0	1.7	29	1.7	1.8	
Consumptive use	3.4	3.5	2.6	0	1.7	25	1.5	1.6	
Coefficient	100	100	93	-	100	86	88	89	90

Table 1-10. Livestock water-use category: total withdrawals, water consumed, and consumptive-use coefficients, by USGS compilation year, for water-resources regions and states climatically similar to the Great Lakes Basin. —Continued

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data. The 1960–95 coefficient was calculated by dividing the sum of the consumptive use by the sum of the total withdrawn for each geographic area. Data from 1960 to 1980 were reported in two significant figures and data from 1985 to 1995 were reported in three significant figures.]

Statistic	1960[1]	1965[2]	1970[3]	1975[4]	1980[5]	1985[6]	1990[7]	1995[8]	1960–95
Maryland									
Total withdrawn	8.8	11	11	11	11	23	10	11	
Consumptive use	8.8	11	11	11	11	11	10	10	
Coefficient	100	100	100	100	100	48	100	91	87
Massachusetts									
Total withdrawn	3.0	2.7	2.1	1.4	1.2	1.3	1.6	1.8	
Consumptive use	2.7	2.4	2.3	1.4	1.2	1.3	1.6	1.4	
Coefficient	90	89	---	100	100	100	100	78	95
Missouri									
Total withdrawn	71	110	110	150	65	41	52	76	
Consumptive use	71	100	100	140	58	41	52	76	
Coefficient	100	91	91	93	89	100	100	100	95
New Hampshire									
Total withdrawn	1.8	1.4	1.3	.9	.8	1.2	1.0	.8	
Consumptive use	1.6	1.4	1.3	.8	.7	.2	.8	.5	
Coefficient	89	100	100	89	88	17	80	63	79
New Jersey									
Total withdrawn	4.7	3.0	2.4	2.3	3.0	3.1	1.5	1.2	
Consumptive use	3.3	2.1	2.1	2.1	2.5	3.1	1.5	1.2	
Coefficient	70	70	88	91	83	100	100	100	84
Rhode Island									
Total withdrawn	.4	.4	.2	.2	.2	2.3	.2	.4	
Consumptive use	.3	.3	.3	.2	.2	2.0	.1	.3	
Coefficient	75	75	---	100	100	87	50	75	86
Tennessee									
Total withdrawn	30	30	34	38	42	65	21	8.4	
Consumptive use	30	30	34	34	42	28	21	8.4	
Coefficient	100	100	100	89	100	43	100	100	85
Vermont									
Total withdrawn	6.6	5.4	8.3	8.7	9.2	5.6	6.0	5.1	
Consumptive use	6.0	4.9	8.4	8.7	9.2	1.1	5.4	4.6	
Coefficient	91	91	---	100	100	20	90	90	88
Virginia									
Total withdrawn	22	19	29	25	28	53	28	36	
Consumptive use	17	15	23	15	17	5.4	28	36	
Coefficient	77	79	79	60	61	10	100	100	65
West Virginia									
Total withdrawn	8.9	7.2	6.9	7.4	7.6	26	4.7	5.1	
Consumptive use	8.9	7.1	6.0	6.4	6.7	22	4.0	4.4	
Coefficient	100	99	87	86	88	85	85	86	89

Table 1-10. Livestock water-use category: total withdrawals, water consumed, and consumptive-use coefficients, by USGS compilation year, for water-resources regions and states climatically similar to the Great Lakes Basin. —Continued

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data. The 1960–95 coefficient was calculated by dividing the sum of the consumptive use by the sum of the total withdrawn for each geographic area. Data from 1960 to 1980 were reported in two significant figures and data from 1985 to 1995 were reported in three significant figures.]

Statistic	1960[1]	1965[2]	1970[3]	1975[4]	1980[5]	1985[6]	1990[7]	1995[8]	1960–95
Climatically similar states									
Total withdrawn	336.4	386.1	382.2	416.8	342.9	482.8	281.3	306.9	2,935
Consumptive use	317.9	368	364.9	390.9	323.4	365.8	279.3	303.1	2,713
Coefficient	95	95	95	94	94	76	99	99	92

[1] MacKichan and Kemmerer (1961, tables 3 and 4). Total withdrawn is from the column “Livestock use—Withdrawn—All water.” Consumptive use is from the column “Livestock use—Consumed.”

[2] Murray, 1968 (tables 8 and 9). Total withdrawn is from the column “Livestock use—Withdrawals—All water.” Consumptive use is from the column “Livestock use—Consumed.”

[3] Murray and Reeves (1972, tables 6 and 13). Total withdrawn is from the column “Livestock use—Withdrawals—All water.” Consumptive use is from the column “Livestock use—Water consumed.”

[4] Murray and Reeves (1977, tables 6 and 13). Total withdrawn is from the column “Livestock use—Withdrawals—All water.” Consumptive use is from the column “Livestock use—Fresh-water consumed.”

[5] Solley and others (1983, tables 3 and 4). Total withdrawn is from the column “Livestock use—Withdrawals—Total.” Consumptive use is from the column “Livestock use—Consumptive use.”

[6] Solley and others (1988, tables 9 and 10). Total withdrawn is from the column “Withdrawals—Total.” Consumptive use is from the column “Consumptive use.”

[7] Solley and others (1993, tables 17 and 18). Total withdrawn is from the column “Livestock—Withdrawals—Total.” Consumptive use is from the column “Livestock—Consumptive use.”

[8] Solley and others (1998, tables 17 and 18). Total withdrawn is from the column “Livestock —Withdrawals—Total.” Consumptive use is from the column “Livestock—Consumptive use.”

Table 1-11. Animal specialties water-use category: total withdrawals, water consumed, and consumptive-use coefficients, by USGS compilation year, for the Great Lakes Basin and Great Lakes States.

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data. The 1990–95 coefficient was calculated by dividing the sum of the consumptive use by the sum of the total withdrawn for each geographic area.]

Statistic	1990[1]	1995[2]	1990–95
Great Lakes Basin			
Total withdrawn	20	8.6	28.6
Consumptive use	2.4	1.8	4.2
Coefficient	12	21	15
Illinois			
Total withdrawn	11	11	22
Consumptive use	11	11	22
Coefficient	100	100	100
Indiana			
Total withdrawn	.5	.6	1.1
Consumptive use	.5	.5	1.0
Coefficient	100	83	91
Michigan			
Total withdrawn	6.3	.6	6.9
Consumptive use	.8	.6	1.4
Coefficient	13	100	20
Minnesota			
Total withdrawn	2.2	.4	2.6
Consumptive use	2.2	.4	2.6
Coefficient	100	100	100
New York			
Total withdrawn	.5	.5	1.0
Consumptive use	.5	.5	1.0
Coefficient	100	100	100
Ohio			
Total withdrawn	.5	.7	1.2
Consumptive use	0	0	0
Coefficient	0	0	0
Pennsylvania			
Total withdrawn	0	.6	.6
Consumptive use	0	.6	.6
Coefficient	-	100	100
Wisconsin			
Total withdrawn	31	29	60
Consumptive use	3.1	2.8	5.9
Coefficient	10	10	10
Great Lakes States			
Total withdrawn	52	43.4	95.4
Consumptive use	18.1	16.4	34.5
Coefficient	35	38	36

[1] Solley, and others (1993, tables 17 and 18). Total withdrawn is from the column “Animal specialties—Withdrawals—Total.” Consumptive use is from the column “Animal specialties—Consumptive use.”

[2] Solley and others (1998, tables 17 and 18). Total withdrawn is from the column “Animal specialties—Withdrawals—Total.” Consumptive use is from the column “Animal Specialties—Consumptive use.”

Table 1-12. Animal specialties water-use category: total withdrawals, water consumed, and consumptive-use coefficients, by USGS compilation year, for water-resources regions and states climatically similar to the Great Lakes Basin.

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data. The 1990–95 coefficient was calculated by dividing the sum of the consumptive use by the sum of the total withdrawn for each geographic area.]

Statistic	1990[1]	1995[2]	1990–95
Mid-Atlantic Region			
Total withdrawn	9.4	26	
Consumptive use	1.5	1.3	
Coefficient	16	5	8
New England Region			
Total withdrawn	.6	12	
Consumptive use	.6	9.5	
Coefficient	100	79	80
Ohio Region			
Total withdrawn	7.4	18	
Consumptive use	4.6	4.6	
Coefficient	62	26	36
Tennessee Region			
Total withdrawn	168	188	
Consumptive use	23	26	
Coefficient	14	14	14
Upper Mississippi Region			
Total withdrawn	32	32	
Consumptive use	17	13	
Coefficient	53	41	47
Connecticut			
Total withdrawn	.3	.3	
Consumptive use	.3	.3	
Coefficient	100	100	100
Delaware			
Total withdrawn	0	0	
Consumptive use	0	0	
Coefficient	-	-	-
Iowa			
Total withdrawn	2.4	.5	
Consumptive use	2.4	.5	
Coefficient	100	100	100
Kentucky			
Total withdrawn	.9	.9	
Consumptive use	.9	.9	
Coefficient	100	100	100
Maine			
Total withdrawn	0	0	
Consumptive use	0	0	
Coefficient	-	-	-
Maryland			
Total withdrawn	9.4	24	
Consumptive use	0	0	
Coefficient	0	0	0
Massachusetts			
Total withdrawn	.2	8.2	
Consumptive use	.2	6.5	
Coefficient	100	79	80
Missouri			
Total withdrawn	2.5	1.0	
Consumptive use	2.5	1.0	
Coefficient	100	100	100
New Hampshire			
Total withdrawn	0	.1	
Consumptive use	0	.1	
Coefficient	-	100	100
New Jersey			
Total withdrawn	.6	.3	
Consumptive use	.6	.3	
Coefficient	100	100	100
Rhode Island			
Total withdrawn	.2	3.2	
Consumptive use	.1	2.6	
Coefficient	50	81	79
Tennessee			
Total withdrawn	28	28	
Consumptive use	28	28	
Coefficient	100	100	100
Vermont			
Total withdrawn	0	.2	
Consumptive use	0	.2	
Coefficient	-	100	100
Virginia			
Total withdrawn	.9	.1	
Consumptive use	.9	.1	
Coefficient	100	100	100
West Virginia			
Total withdrawn	.1	13	
Consumptive use	.1	.1	
Coefficient	100	1	2
Climatically similar states			
Total withdrawn	45.5	79.8	125.3
Consumptive use	36.0	40.6	76.6
Coefficient	79	51	61

[1] Solley, and others (1993, tables 17 and 18). Total withdrawn is from the column "Animal specialties—Withdrawals—Total." Consumptive use is from the column "Animal specialties—Consumptive use."

[2] Solley and others (1998, tables 17 and 18). Total withdrawn is from the column "Animal specialties—Withdrawals—Total." Consumptive use is from the column "Animal Specialties—Consumptive use."

Table 1-13. Commercial water-use category: total withdrawals, water consumed, and consumptive-use coefficients, by USGS compilation year, for the Great Lakes Basin and Great Lakes States.

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data. The 1985–95 coefficient was calculated by dividing the sum of the consumptive use by the sum of the total withdrawn for each geographic area. The 1985–95 compilations rounded data to three significant figures.]

Statistic	1985[1]	1990[2]	1995[3]	1985–95
Great Lakes Basin				
Total withdrawn	776	746	752	
Consumptive use	73	69	82	
Coefficient	9	9	11	10
Illinois				
Total withdrawn	577	672	544	
Consumptive use	64	54	44	
Coefficient	11	8	8	9
Indiana				
Total withdrawn	79	165	212	
Consumptive use	5.5	25	32	
Coefficient	7	15	15	14
Michigan				
Total withdrawn	374	375	294	
Consumptive use	27	30	31	
Coefficient	7	8	11	8
Minnesota				
Total withdrawn	49	93	169	
Consumptive use	11	12	18	
Coefficient	22	13	11	13
New York				
Total withdrawn	413	452	609	
Consumptive use	40	45	61	
Coefficient	10	10	10	10
Ohio				
Total withdrawn	377	361	424	
Consumptive use	19	30	66	
Coefficient	5	8	16	10
Pennsylvania				
Total withdrawn	214	229	247	
Consumptive use	46	23	11	
Coefficient	21	10	4	12
Wisconsin				
Total withdrawn	102	110	128	
Consumptive use	27	22	26	
Coefficient	26	20	20	22
Great Lakes States				
Total withdrawn	2,185	2,454	2,627	7,269
Consumptive use	239.5	241	289	703.5
Coefficient	11	10	11	10

[1] Solley and others (1988, tables 5 and 6). Total withdrawn is from the column "Total—Withdrawals and deliveries." Consumptive use is from the column "Total—Consumptive Use."

[2] Solley and others (1993, tables 13 and 14). Total withdrawn is from the column "Total Use—Withdrawals and deliveries." Consumptive use is from the column "Total use—Consumptive use."

[3] Solley and others (1998, tables 13 and 14). Total withdrawn is from the column "Total Use—Withdrawals and deliveries." Consumptive use is from the column "Total use—Consumptive use."

Table 1-14. Commercial water-use category: total withdrawals, water consumed, and consumptive-use coefficients, by USGS compilation year, for water-resources regions and states climatically similar to the Great Lakes States.

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data. The 1985–95 coefficient was calculated by dividing the sum of the consumptive use by the sum of the total withdrawn for each geographic area.]

Statistic	1985[1]	1990[2]	1995[3]	1985–95
Mid-Atlantic Region				
Total withdrawn	854	1,070	1,230	
Consumptive use	102	101	102	
Coefficient	12	9	8	10
New England Region				
Total withdrawn	635	305	433	
Consumptive use	143	36	46	
Coefficient	23	12	11	16
Ohio Region				
Total withdrawn	439	500	631	
Consumptive use	33	52	93	
Coefficient	8	10	15	11
Tennessee Region				
Total withdrawn	108	167	156	
Consumptive use	10	16	18	
Coefficient	9	10	12	10
Upper Mississippi Region				
Total withdrawn	628	867	861	
Consumptive use	76	83	86	
Coefficient	12	10	10	10
Connecticut				
Total withdrawn	58	69	116	
Consumptive use	15	13	12	
Coefficient	26	19	10	16
Delaware				
Total withdrawn	14	20	22	
Consumptive use	1.4	2.0	2.2	
Coefficient	10	10	10	10
Iowa				
Total withdrawn	42	86	108	
Consumptive use	5.5	11	14	
Coefficient	13	13	13	13
Kentucky				
Total withdrawn	35	37	45	
Consumptive use	1.3	1.3	1.6	
Coefficient	4	4	4	4
Maine				
Total withdrawn	40	58	37	
Consumptive use	13	5.5	3.7	
Coefficient	33	9	10	16
Maryland				
Total withdrawn	82	113	118	
Consumptive use	8.1	11	11	
Coefficient	10	10	9	10
Massachusetts				
Total withdrawn	514	132	200	
Consumptive use	112	13	25	
Coefficient	22	10	13	18
Missouri				
Total withdrawn	78	81	73	
Consumptive use	5.4	5.5	5.3	
Coefficient	7	7	7	7
New Hampshire				
Total withdrawn	9.1	17	51	
Consumptive use	1.8	1.9	3.5	
Coefficient	20	11	7	9
New Jersey				
Total withdrawn	151	157	197	
Consumptive use	7.5	6.3	7.5	
Coefficient	5	4	4	4
Rhode Island				
Total withdrawn	15	28	21	
Consumptive use	.6	2.7	2.1	
Coefficient	4	10	10	8
Tennessee				
Total withdrawn	168	236	234	
Consumptive use	15	21	21	
Coefficient	9	9	9	9
Vermont				
Total withdrawn	5.2	6.9	33	
Consumptive use	1.0	.9	2.4	
Coefficient	19	13	7	10
Virginia				
Total withdrawn	92	208	193	
Consumptive use	12	25	23	
Coefficient	13	12	12	12
West Virginia				
Total withdrawn	22	23	68	
Consumptive use	2.4	2.3	10	
Coefficient	11	10	15	13
Climatically similar states				
Total withdrawn	1,325.3	1,271.9	1,516	4,113.2
Consumptive use	202	122.4	144.3	468.7
Coefficient	15	10	10	11

[1] Solley and others (1988, tables 5 and 6). Total withdrawn is from the column "Total—Withdrawals and deliveries." Consumptive use is from the column "Total—Consumptive Use."

[2] Solley and others (1993, tables 13 and 14). Total withdrawn is from the column "Total Use—Withdrawals and deliveries." Consumptive use is from the column "Total use—Consumptive use."

[3] Solley and others (1998, tables 13 and 14). Total withdrawn is from the column "Total Use—Withdrawals and deliveries." Consumptive use is from the column "Total use—Consumptive use."

Table 1-15. Mining water-use category: total withdrawals, water consumed, and consumptive-use coefficients, by USGS compilation year, for the Great Lakes Basin and Great Lakes States.

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data. The 1985–95 coefficient was calculated by dividing the sum of the consumptive use by the sum of the total withdrawn for each geographic area. The 1985–95 compilations rounded data to three significant figures.]

Statistic	1985	1990	1995	1985–95
Great Lakes Basin				
Total withdrawn	253	257	398	
Consumptive use	61	66	37	
Coefficient	24	26	9	18
Illinois				
Total withdrawn	104	94	75	
Consumptive use	48	46	35	
Coefficient	46	49	47	47
Indiana				
Total withdrawn	91	97	137	
Consumptive use	.3	5.8	8.2	
Coefficient	0	6	6	4
Michigan				
Total withdrawn	61	56	58	
Consumptive use	2.3	2.2	3.0	
Coefficient	4	4	5	4
Minnesota				
Total withdrawn	273	220	298	
Consumptive use	122	57	12	
Coefficient	45	26	4	24
New York				
Total withdrawn	50	62	62	
Consumptive use	5.0	17	17	
Coefficient	10	27	27	22
Ohio				
Total withdrawn	78	243	93	
Consumptive use	11	140	52	
Coefficient	14	58	56	49
Pennsylvania				
Total withdrawn	148	252	252	
Consumptive use	20	25	25	
Coefficient	14	10	10	11
Wisconsin				
Total withdrawn	0	.2	12	
Consumptive use	0	0	2.5	
Coefficient	-	0	21	20
Great Lakes States				
Total withdrawn	805	1,024.2	987	2,816.2
Consumptive use	208.6	293	154.7	656.3
Coefficient	26	29	16	23

[1] Solley and others (1988, tables 13 and 14). Total withdrawn is from the column “Withdrawals—Total—Total.” Consumptive use is from the column “Consumptive use—Total.”

[2] Solley and others (1993, tables 21 and 22). Total withdrawn is from the column “Withdrawals—Total—Total.” Consumptive use is from the column “Consumptive use—Total.”

[3] Solley and others (1998, tables 21 and 22). Total withdrawn is from the column “Withdrawals—Total—Total.” Consumptive use is from the column “Consumptive use—Total.”

Table 1-16. Mining water-use category: total withdrawals, water consumed, and consumptive-use coefficients, by USGS compilation year, for water-resources regions and states climatically similar to the Great Lakes States.

[Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total withdrawn and consumptive-use data. The 1985–95 coefficient was calculated by dividing the sum of the consumptive use by the sum of the total withdrawn for each geographic area. The 1985–95 compilations rounded data to three significant figures.]

Statistic	1985	1990	1995	1985–95
Mid-Atlantic Region				
Total withdrawn	227	416	330	
Consumptive use	27	81	36	
Coefficient	12	19	11	15
New England Region				
Total withdrawn	13	20	24	
Consumptive use	1.5	2.2	3.8	
Coefficient	12	11	16	13
Ohio Region				
Total withdrawn	440	1,020	349	
Consumptive use	72	530	76	
Coefficient	16	52	22	37
Tennessee Region				
Total withdrawn	16	92	11	
Consumptive use	1.9	9.6	1.4	
Coefficient	12	10	13	11
Upper Mississippi Region				
Total withdrawn	213	158	138	
Consumptive use	76	33	24	
Coefficient	36	21	17	26
Connecticut				
Total withdrawn	1.7	2.2	1.7	
Consumptive use	0	.4	.3	
Coefficient	0	18	18	13
Delaware				
Total withdrawn	0	0	0	
Consumptive use	0	0	0	
Coefficient	-	-	-	-
Iowa				
Total withdrawn	63	34	43	
Consumptive use	0	0	0	
Coefficient	0	0	0	0
Kentucky				
Total withdrawn	25	18	28	
Consumptive use	.7	.5	.8	
Coefficient	3	3	3	3
Maine				
Total withdrawn	4.0	3.7	5.0	
Consumptive use	.6	.5	.9	
Coefficient	15	14	18	16
Maryland				
Total withdrawn	21	49	5.2	
Consumptive use	4.2	26	1.0	
Coefficient	20	53	19	41
Massachusetts				
Total withdrawn	2.0	5.0	3.2	
Consumptive use	.5	0	.3	
Coefficient	25	0	9	8
Missouri				
Total withdrawn	28	25	24	
Consumptive use	2.8	2.5	2.4	
Coefficient	10	10	10	10
New Hampshire				
Total withdrawn	1.2	2.8	7.0	
Consumptive use	0	.6	1.4	
Coefficient	0	21	20	18
New Jersey				
Total withdrawn	80	110	90	
Consumptive use	8.0	8.8	7.2	
Coefficient	10	8	8	9
Rhode Island				
Total withdrawn	2.7	6.8	6.2	
Consumptive use	.3	.7	.8	
Coefficient	11	10	13	11
Tennessee				
Total withdrawn	13	90	5.5	
Consumptive use	1.1	9.9	.6	
Coefficient	8	11	11	11
Vermont				
Total withdrawn	1.1	3.7	3.0	
Consumptive use	0	.7	.6	
Coefficient	0	19	20	17
Virginia				
Total withdrawn	16	91	39	
Consumptive use	1.9	11	4.7	
Coefficient	12	12	12	12
West Virginia				
Total withdrawn	142	527	12	
Consumptive use	29	369	2.7	
Coefficient	20	70	23	59
Climatically similar states				
Total withdrawn	400.7	968.2	272.8	1,641.7
Consumptive use	49.1	430.6	23.7	503.4
Coefficient	12	44	9	31

[1] Solley and others (1988, tables 13 and 14). Total withdrawn is from the column "Withdrawals—Total—Total." Consumptive use is from the column "Consumptive use—Total."

[2] Solley and others (1993, tables 21 and 22). Total withdrawn is from the column "Withdrawals—Total—Total." Consumptive use is from the column "Consumptive use—Total."

[3] Solley and others (1998, tables 21 and 22). Total withdrawn is from the column "Withdrawals—Total—Total." Consumptive use is from the column "Consumptive use—Total."

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Table 2-1. Census of Manufacturing: summary of 1983 water-use statistics for Great Lakes States.

[Adapted from table 2b of the U.S. Bureau of Census (1986). Total withdrawn and water discharged are in billion gallons; coefficient is the percentage of water withdrawn that was consumed (computed from the total withdrawn and water discharged data).]

State	Total withdrawn	Water discharged	Coefficient
Illinois	296.2	257.8	13
Indiana	754.1	678.0	10
Michigan	521.7	495.3	5
Minnesota	59.2	54.7	8
New York	357.5	299.1	16
Ohio	466.9	417.2	11
Pennsylvania	714.4	632.1	12
Wisconsin	236.3	218.3	8
Great Lakes States, mean	3,406.3	3,052.5	10

Table 2-2. Census of Manufacturing: summary of 1983 water-use statistics for states climatically similar to the Great Lakes Basin.

[Adapted from table 2b of the U.S. Bureau of Census (1986). Total withdrawn and water discharged are in billion gallons; coefficient is the percentage of water withdrawn that was consumed (computed from the total withdrawn and water discharged data). D, withheld to avoid disclosing data for individual companies; data are included in higher level totals.]

State	Total withdrawn	Water discharged	Coefficient
Connecticut	65.8	63.3	4
Delaware	165.9	D	-
Iowa	100.5	94.0	6
Kentucky	115.1	100.4	13
Maine	138.9	134.1	3
Maryland	185.1	174.1	6
Massachusetts	130.4	124.7	4
Missouri	38.3	33.1	14
New Hampshire	23.7	D	-
New Jersey	230.7	222.5	4
North Carolina	188.6	152.2	19
Rhode Island	5.2	5.2	0
Tennessee	437.1	344.9	21
Vermont	4.7	4.4	6
Virginia	262.0	240.0	8
West Virginia	288.3	275.3	5
All states, mean[1]	2,190.7	1,968.2	10

[1] "All states, mean" refers to only the states in the table. The total withdrawn, water discharged and coefficient do not include New Hampshire and Delaware data since the water-discharged data were withheld for this report.

Table 2-3. Census of Manufacturing: water use in manufacturing by water-resources regions and major standard industrial classification groups; total withdrawals, water discharged, and calculated consumptive-use coefficients for the Great Lakes Basin and climatically similar areas in 1983.

[Adapted from table 7c of the U.S. Bureau of Census (1986). Total withdrawn and water discharged are in billion gallons; coefficient is the percentage of water withdrawn that was consumed (computed from the middle and top numbers). D, withheld to avoid disclosing data for individual companies; data are included in higher level totals.]

Statistic	Great Lakes	New England	Middle Atlantic	Ohio	Tennessee	Upper Mississippi	Mean
SIC code 20: Food and kindred products							
Total withdrawn	70.8	12.1	76.7	29	4.9	106.4	
Water discharged	62.4	6.7	62.7	22.4	3.8	98.3	
Coefficient	12	45	18	23	22	8	15
SIC code 21: Tobacco products							
Total withdrawn	-	-	-	.4	-	-	
Water discharged	-	-	-	.3	-	-	
Coefficient	-	-	-	25	-	-	25
SIC code 22: Textile mill products							
Total withdrawn	D	5.7[1]	7.5	1.3	5.5	.3	
Water discharged	D	5.8[1]	6.4	1.2	4.7	.3	
Coefficient	-	-	15	8	15	0	14
SIC code 24: Lumber and wood products							
Total withdrawn	1.3	-	D	-	-	-	
Water discharged	1.2	-	D	-	-	-	
Coefficient	8	-	-	-	-	-	8
SIC code 25: Furniture and fixtures							
Total withdrawn	.6	-	.1[2]	.3	-	.4	
Water discharged	.6	-	D	.3	-	.4	
Coefficient	0	-	-	0	-	0	0
SIC code 26: Paper and allied products							
Total withdrawn	228.5	208.3	138.8	129.4	82.4	87.4	
Water discharged	181.1	200.2	118.5	127.4	78.8	78.4	
Coefficient	21	4	15	2	4	10	10
SIC code 28: Chemicals and allied products							
Total withdrawn	183.6	50.7	293.1	402.5	417.7	51.6	
Water discharged	174.3	50.7	282.6	389.9	324.7	43.8	
Coefficient	5	0	4	3	22	15	10
SIC code 29: Petroleum and coal products							
Total withdrawn	D	-	297.8	21.8	-	12.2	
Water discharged	D	-	285.6	15.4	-	7.9	
Coefficient	-	-	4	29	-	35	7
SIC code 30: Rubber and miscellaneous plastic products							
Total withdrawn	11.5	3.0	7.1	9.0	2	9.3	
Water discharged	9.5	2.6	6.6	8.6	1.6	8.2	
Coefficient	17	13	7	4	20	12	11
SIC code 31: Leather and leather products							
Total withdrawn	1.2	.9	1.6	-	-	-	
Water discharged	1.2	.9	1.6	-	-	-	
Coefficient	0	0	0	-	-	-	0
SIC code 32: Stone, clay, and glass products							
Total withdrawn	49.2	2.0	21.8	17.5	1.5[1]	13.8	
Water discharged	46.7	1.7	20.3	15.4	1.7[1]	11.8	
Coefficient	5	15	7	12	-	14	8

Table 2-3. Census of Manufacturing: water use in manufacturing by water-resources regions and major standard industrial classification groups; total withdrawals, water discharged, and calculated consumptive-use coefficients for the Great Lakes Basin and climatically similar areas in 1983. —Continued

[Adapted from table 7c of the U.S. Bureau of Census (1986). Total withdrawn and water discharged are in billion gallons; coefficient is the percentage of water withdrawn that was consumed (computed from the middle and top numbers). D, withheld to avoid disclosing data for individual companies; data are included in higher level totals.]

Statistic	Great Lakes	New England	Middle Atlantic	Ohio	Tennessee	Upper Mississippi	Mean
SIC code 33: Primary metal industries							
Total withdrawn	1,218.2	6.1	335.4	480.5	4.5[1]	48.7	
Water discharged	1,119.6	5.6	294.7	426.1	5.2[1]	30.9	
Coefficient	8	8	12	11	-	37	10
SIC code 34: Fabricated metal products							
Total withdrawn	14.3	14.1	4.9	7.6	.4	5.2	
Water discharged	14.0	14.0	4.8	7.3	.3	5.1	
Coefficient	2	1	2	4	25	2	2
SIC code 35: Machinery, except electrical							
Total withdrawn	13.2	13.8	21.5	9.5	.7	41.8	
Water discharged	10.3	13.6	21.1	8.3	.7	41.4	
Coefficient	22	1	2	13	0	1	5
SIC code 36: Electric and electronic equipment							
Total withdrawn	12.6	4.7[1]	18.6	10.7	1.8	4.1	
Water discharged	11.4	6.1[1]	17.1	10.6	1.7	3.9	
Coefficient (%)	10	-	8	1	6	5	6
SIC code 37: Transportation Equipment							
Total withdrawn	48.8	D	18.5	14.4	1.4	6.0	
Water discharged	44.6	D	17.6	12.2	1.3	5.2	
Coefficient	9	-	5	15	7	13	9
SIC code 38: Instruments and related products							
Total withdrawn	D	6.3	1.6	.8	D	1.4	
Water discharged	D	6.1	1.5	.8	.8[2]	1.4	
Coefficient	-	3	6	0	-	0	3
SIC code 39: Miscellaneous							
Total withdrawn	.7	1.3	.7	.2	-	.5	
Water discharged	.6	1.2	.6	.2	-	.5	
Coefficient	14	8	14	0	-	0	9
All SIC Codes							
Total withdrawn	1,942.7	365.5	1,247.8	1,136.0	524.0	389.9	
Water discharged	1,759.5	351.4	1,145.1	1,047.2	425.5	338.1	
Coefficient	9	4	8	8	19	13	10

[1] Denotes that the total withdrawn is less than water discharged. These data were not used in calculation of the mean.

[2] Denotes that, although a number was disclosed, other data were not and a coefficient cannot be determined. These data are not included in the totals or means.

Table 2-4. Census of Manufacturing: summary of 1983 water-use statistics for major groups.

[Adapted from table 1c of the U.S. Bureau of Census (1986). Total withdrawn and water discharged are in billion gallons; coefficient is the percentage of water withdrawn that was consumed (computed from the middle and top numbers). D, withheld to avoid disclosing data for individual companies; data are included in higher level totals.]

Statistic	1983	1978	1973	1968	1964	1959	1954	Mean
SIC code 20: Food and kindred products								
Total withdrawn	648	740	804	811	760	624	616	
Water discharged	552	649	745	753	688	571	550	
Coefficient	15	12	7	7	9	8	11	10
SIC code 21: Tobacco products								
Total withdrawn	5	5	5	6	3	3	3	
Water discharged	4	3	4	5	2	2	2	
Coefficient	20	40	20	17	33	33	33	27
SIC code 22: Textile mill products								
Total withdrawn	133	163	178	154	148	135	184	
Water discharged	116	147	160	136	135	120	147	
Coefficient	13	10	10	12	9	11	20	12
SIC code 24: Lumber and wood products								
Total withdrawn	86	157	160	101	151	140	133	
Water discharged	71	112	123	93	123	126	109	
Coefficient	17	29	23	8	19	10	18	18
SIC code 25: Furniture and fixtures								
Total withdrawn	3	24	6	4	3	3	7	
Water discharged	3	24	6	4	3	2	4	
Coefficient	0	0	0	0	0	33	43	8
SIC code 26: Paper and allied products								
Total withdrawn	1,899	1,963	2,415	2,252	2,064	1,937	1,786	
Water discharged	1,768	1,765	2,301	2,078	1,942	1,824	1,620	
Coefficient	7	10	5	8	6	6	9	7
SIC code 28: Chemicals and allied products								
Total withdrawn	3,401	4,326	4,176	4,476	3,899	3,240	2,685	
Water discharged	2,980	3,910	3,911	4,175	3,688	3,061	2,550	
Coefficient	12	10	6	7	5	6	5	7
SIC code 29: Petroleum and coal products								
Total withdrawn	818	1,173	1,283	1,435	1,398	1,319	1,245	
Water discharged	699	964	1,159	1,217	1,317	1,204	1,134	
Coefficient	15	18	9	15	6	9	9	11
SIC code 30: Rubber and miscellaneous plastic products								
Total withdrawn	76	187	154					
Water discharged	63	168	143					
Coefficient	17	10	7					10
SIC code 31: Leather and leather products								
Total withdrawn	6	9	8	16	14	12	20	
Water discharged	6	8	8	15	12	12	18	
Coefficient	0	11	0	6	14	0	20	7
SIC code 32: Stone, clay, and glass products								
Total withdrawn	155	207	219	251	249	251[1]	279	
Water discharged	133	182	192	218	218	264	254	
Coefficient	14	12	12	13	12		9	12
SIC code 33: Primary metal industries								
Total withdrawn	2,363	3,392	4,941	5,005	4,600	3,702	3,842	
Water discharged	2,112	3,132	4,757	4,696	4,312	3,551	3,682	
Coefficient	11	8	4	6	6	4	4	6

Table 2-4. Census of Manufacturing: summary of 1983 water-use statistics for major groups. —Continued

[Adapted from table 1c of the U.S. Bureau of Census (1986). Total withdrawn and water discharged are in billion gallons; coefficient is the percentage of water withdrawn that was consumed (computed from the middle and top numbers). D, withheld to avoid disclosing data for individual companies; data are included in higher level totals.]

Statistic	1983	1978	1973	1968	1964	1959	1954	Mean
SIC code 34: Fabricated Metal products								
Total withdrawn	65	90	107					
Water discharged	61	86	101					
Coefficient	6	4	6					5
SIC code 35: Machinery, except electrical								
Total withdrawn	120	165	171	189	158	171	114[1]	
Water discharged	105	159	165	181	150	165	116	
Coefficient	13	4	4	4	5	4		5
SIC code 36: Electric and electronic equipment								
Total withdrawn	74	116	104	127	102	93	114	
Water discharged	70	112	97	118	88	88	90	
Coefficient	5	3	7	7	14	5	21	9
SIC code 37: Transportation Equipment								
Total withdrawn	153	235	242	313	242	260	231	
Water discharged	139	220	227	293	233	229	215	
Coefficient	9	6	6	6	4	1	7	7
SIC code 38: Instruments and related products								
Total withdrawn	30	36	37	38	29	23	19	
Water discharged	28	33	35	36	26	22	18	
Coefficient	7	8	5	5	10	4	5	7
SIC code 39: Miscellaneous								
Total withdrawn	4	8	12	14	13	14	21	
Water discharged	4	7	12	13	12	13	21	
Coefficient	0	13	0	7	8	7	0	5
All SIC Codes								
Total withdrawn	10,039	12,992	15,024	15,467	14,007	12,131	11,570	
Water discharged	8,914	11,682	14,144	14,276	13,111	11,445	10,789	
Coefficient	11	10	6	8	6	6	7	8

[1] Denotes that the total withdrawn is less than water discharged. These data were not used in the calculation of the mean.

Table 2-5. Census of Manufacturing: summary of 1983 water-use statistics for industry groups and individual industries.

[Adapted from table 2a of U.S. Bureau of Census (1986). Water intake and water discharged are in billion gallons; coefficient is the percentage of water withdrawn that was consumed (computed from the water intake and water discharged data). SIC code (Standardized Industrial Classification code) and NAICS (North American Industrial Classification System) are two classification systems. * denotes a NAICS code that relates to more than one SIC code, n.e.c., not elsewhere classified. D, withheld to avoid disclosing data for individual companies; data are included in higher level totals. Z, less than half the unit shown. A double dash (--) means water discharged was greater than water intake (no coefficient).]

Sic code	NAICS code	Industry group and industry	Water intake	Water discharged	Coefficient
		All manufacturing industries			
		All manufacturing industries	10,038.9	8,913.7	11
		Food and kindred products			
		Food and kindred products	647.7	552.0	15
201		Meat products	92.7	85.5	8
2011	311611	Meat packaging plants	44.7	41.9	6
2013	311612 311613	Sausages and other prepared meats	11.3	9.8	13
2016	311615	Poultry dressing plants	35.2	32.4	8
2017	311999	Poultry and egg processing	1.5	1.4	7
202		Dairy products	38.8	35.9	7
2021	311512	Creamery butter	1.0	.9	10
2022	311513	Cheese, natural and processed	10.2	9.3	9
2023	311511 311514*	Condensed and evaporated milk	9.5	8.6	9
2024	311520	Ice cream and frozen desserts	1.4	1.1	21
2025	311514*	Fluid milk	16.7	16.0	4
203		Preserved fruits and vegetables	100.1	88.6	11
2032	311422 311999	Canned specialties	17.4	13.4	23
2033	311421	Canned fruits and vegetables	30.6	26.3	14
2034	311211 311423 311999	Dehydrated fruits, vegetables, and soups	5.6	4.9	13
2035	311941	Pickles, sauces, and salad dressings	2.4	1.9	21
2037	311411	Frozen fruits and vegetables	40.0	38.8	3
2038	311412	Frozen specialties	4.1	3.4	17
204		Grain mill products	79.3	74.3	6
2041	311211	Flour and other grain mill products	.8	.5	38
2043	311230 311920	Cereal breakfast foods	5.9	3.8	36
2044	311212	Rice milling	.6	.4	33
2045	311822	Blended and prepared foods	.1	.1	0
2046	311221 311225	Wet corn milling	68.3	66.6	2
2047	311111	Dog, cat, and other pet food	2.9	2.1	28
2048	311119 311611	Prepared feeds, n.e.c.	.8	.7	13

Table 2-5. Census of Manufacturing: summary of 1983 water-use statistics for industry groups and individual industries. —Continued

[Adapted from table 2a of U.S. Bureau of Census (1986). Water intake and water discharged are in billion gallons; coefficient is the percentage of water withdrawn that was consumed (computed from the water intake and water discharged data). SIC code (Standardized Industrial Classification code) and NAICS (North American Industrial Classification System) are two classification systems. * denotes a NAICS code that relates to more than one SIC code, n.e.c., not elsewhere classified. D, withheld to avoid disclosing data for individual companies; data are included in higher level totals. Z, less than half the unit shown. A double dash (--) means water discharged was greater than water intake (no coefficient).]

Sic code	NAICS code	Industry group and industry	Water intake	Water discharged	Coefficient
		Food and kindred products—Continued			
205		Bakery products	3.0	2.0	33
2051	311812	Bread, cake, and related products	1.9	1.1	42
2052	311812 311821 311919	Cookies and crackers	1.1	.9	18
206		Sugar and confectionery products	178.7	142	21
2061	311311	Raw cane sugar	83.1	63	24
2062	311312	Cane sugar refining	62.8	54.9	13
2063	311313	Beet sugar	14.6	9.6	34
2065	311330 311340	Confectionary products	(D)	(D)	
2066	311320 311330	Chocolate and cocoa products	(D)	(D)	
207		Fats and oils	34.1	28.9	15
2074	311223 311225	Cottonseed oil mills	1.2	(D)	
2075	311222 311225	Soybean oil mills	20.1	18.2	9
2076	311223 311225	Vegetable oil mills, n.e.c.	.5	(D)	
2077	311613 311711 311712	Animal and marine fats and oils	2.8	1.5	46
2079	311222 311223 311225	Shortening and cooking oils	9.5	7.8	18
208		Beverages	88.5	68.2	23
2082	311942 312120	Malt beverages	53.3	41.4	22
2083	311213	Malt	7.3	6.5	11
2084	312130	Wines, brandy, and brandy spirits	2.6	2.3	12
2085	312130* 312140	Distilled liquor, except brandy	10.3	9.0	13
2086	312111 312112	Bottled and canned soft drinks	12.3	6.8	45
2087	311920 311930 311942 311999	Flavoring extracts and syrups, n. e. c.	2.7	2.3	15

Table 2-5. Census of Manufacturing: summary of 1983 water-use statistics for industry groups and individual industries. —Continued

[Adapted from table 2a of U.S. Bureau of Census (1986). Water intake and water discharged are in billion gallons; coefficient is the percentage of water withdrawn that was consumed (computed from the water intake and water discharged data). SIC code (Standardized Industrial Classification code) and NAICS (North American Industrial Classification System) are two classification systems. * denotes a NAICS code that relates to more than one SIC code, n.e.c., not elsewhere classified. D, withheld to avoid disclosing data for individual companies; data are included in higher level totals. Z, less than half the unit shown. A double dash (--) means water discharged was greater than water intake (no coefficient).]

Sic code	NAICS code	Industry group and industry	Water intake	Water discharged	Coefficient
		Food and kindred products—Continued			
209		Miscellaneous foods and kindred products	32.6	26.5	19
2091	311711	Canned and cured seafoods	3.0	(D)	
2092	311712	Fresh and frozen packaged fish	4.4	4.3	2
2095	311920	Roasted coffee	(D)	(D)	
2097	312113	Manufactured ice	1.2	.9	25
2098	311823	Macaroni and spaghetti	.1	(D)	
2099	111998 311212 311340 311423 311823 311830 311911 311920 311941 311942 311991 311999	Food preparations, n. e. c.	(D)	11.3	
		Tobacco products			
21		Tobacco products	5.3	4.0	25
2111	312221	Cigarettes	(D)	3.1	
		Textile products			
22		Textile mill products	132.6	115.6	13
2211	313210*	Weaving mills, cotton	20.7	17.9	14
2221	313210*	Weaving mills, manmade fiber and silk	18.1	14.5	20
2231	313210* 313311 313312*	Weaving and finishing mills, wool	2.7	2.6	4
2241	313221	Narrow fabric mills	.5	.4	20
225		Knitting mills	27.2	25.3	7
2251	313312* 315111	Women’s hosiery, except socks	.7	.7	0
2252	313312 315111 315119	Hosiery, n. e. c.	.9	.8	11

Table 2-5. Census of Manufacturing: summary of 1983 water-use statistics for industry groups and individual industries. —Continued

[Adapted from table 2a of U.S. Bureau of Census (1986). Water intake and water discharged are in billion gallons; coefficient is the percentage of water withdrawn that was consumed (computed from the water intake and water discharged data). SIC code (Standardized Industrial Classification code) and NAICS (North American Industrial Classification System) are two classification systems. * denotes a NAICS code that relates to more than one SIC code, n.e.c., not elsewhere classified. D, withheld to avoid disclosing data for individual companies; data are included in higher level totals. Z, less than half the unit shown. A double dash (--) means water discharged was greater than water intake (no coefficient).]

Sic code	NAICS code	Industry group and industry	Water intake	Water discharged	Coefficient
		Textile products—Continued			
2253	313312 315191 315192	Knit outerwear mills	2.2	2.1	5
2254	313312 315192	Knit underwear mills	.6	.5	17
2257	313241 313312	Circular knit fabric mills	17.2	16.2	6
2258	313249 313312*	Warp knit fabric mills	5.6	4.9	13
226		Textile finishing, except wool	39.0	33.6	14
2261	313311*	Finishing plants, cotton	6.8	6.2	9
2262	313311*	Finishing plants, manmade	26.9	22.5	16
2269	313312 313311*	Finishing plants, n. e. c.	5.4	4.8	11
227		Floor covering mills	11.3	9.8	13
2272		Tufted carpets and rugs	10.4	(D)	
2279		Carpets and rugs, n. e. c.	1.0	(D)	
228		Yarn and thread mills	8.1	7.4	9
2281	313111	Yarn mills, except wool	4.6	4.2	9
2282	313112	Throwing and winding mills	1.8	1.6	11
2284	313113 313312	Thread mills	(D)	1.5	
229		Miscellaneous textile goods	5.0	4.3	14
2291		Felt goods, except woven felts and hats	1.4	1.4	0
2294		Processed textile waste	.2	(D)	
2295	313320	Coated fabrics, not rubberized	.6	.6	0
2296	314992	Tire cord and fabric	.3	.2	33
2297	313230	Nonwoven fabrics	1.5	1.0	33
2298	314991 313111	Textile goods, n. e. c.	(D)	(D)	
		Lumber and wood products			
24		Lumber and wood products	86.0	71.0	17
2411	113310	Logging camps and logging contractors	.2	.3	
242		Sawmills and planing mills	68.4	58.9	14

Table 2-5. Census of Manufacturing: summary of 1983 water-use statistics for industry groups and individual industries. —Continued

[Adapted from table 2a of U.S. Bureau of Census (1986). Water intake and water discharged are in billion gallons; coefficient is the percentage of water withdrawn that was consumed (computed from the water intake and water discharged data). SIC code (Standardized Industrial Classification code) and NAICS (North American Industrial Classification System) are two classification systems. * denotes a NAICS code that relates to more than one SIC code, n.e.c., not elsewhere classified. D, withheld to avoid disclosing data for individual companies; data are included in higher level totals. Z, less than half the unit shown. A double dash (--) means water discharged was greater than water intake (no coefficient).]

Sic code	NAICS code	Industry group and industry	Water intake	Water discharged	Coefficient
		Lumber and wood products—Continued			
2421	321113 321912 321918 321920 321999	Sawmills and planing mills	68.4	58.9	14
243		Millwork, plywood, and structural members	7.6	4.4	42
2431	321911 321918	Millwork	.4	.4	0
2435	321211	Hardwood veneer and plywood	.3	.1	67
2436	321212	Softwood veneer and plywood	6.9	3.9	43
249	321214	Miscellaneous wood products	9.6	7.3	24
2491	321114	Wood preserving	(D)	(D)	
2492		Particleboard	(D)	(D)	
2499	321920 321999 333415 337125 339113 339999	Wood products, n. e. c.	8.5	6.6	22
		Furniture and fixtures			
25		Furniture and fixtures	3.4	3.3	3
251		Household furniture	1.9	1.8	5
2511	337122 337215	Wood household furniture	1.5	1.5	0
2514	337121 337124 337215	Metal household furniture	.2	.2	0
252		Office furniture	.6	.6	0
2522	337214	Metal office furniture	.6	.6	0
254		Partitions and fixtures	.5	.5	0
2542	337215	Metal partitions and fixtures	(D)	(D)	
259		Miscellaneous furniture and fixtures	(D)	(D)	
2591	337920	Drapery hardware and blinds and shades	(D)	(D)	
26		Paper and allied products	1,899.3	1,768.1	7

Table 2-5. Census of Manufacturing: summary of 1983 water-use statistics for industry groups and individual industries. —Continued

[Adapted from table 2a of U.S. Bureau of Census (1986). Water intake and water discharged are in billion gallons; coefficient is the percentage of water withdrawn that was consumed (computed from the water intake and water discharged data). SIC code (Standardized Industrial Classification code) and NAICS (North American Industrial Classification System) are two classification systems. * denotes a NAICS code that relates to more than one SIC code, n.e.c., not elsewhere classified. D, withheld to avoid disclosing data for individual companies; data are included in higher level totals. Z, less than half the unit shown. A double dash (--) means water discharged was greater than water intake (no coefficient).]

Sic code	NAICS code	Industry group and industry	Water intake	Water discharged	Coefficient
		Furniture and fixtures—Continued			
2611	322110 322121 322122 322130	Pulp mills	283.2	282.7	0
2621	322121 322122	Paper mills, except building paper	1,009.5	958.2	5
2631	322130	Paperboard mills	538.7	462.3	14
264		Miscellaneous converted paper products	56.5	55.0	3
2641		Paper coating and glazing	6.5	6.2	5
2643		Bags, except textile bags	5.6	5.5	2
2646		Pressed and molded pulp goods	32.1	(D)	
2647		Sanitary paper products	8.9	9.4	--
2649		Converted paper products	3.3	3.2	3
265		Paperboard containers and boxes	6.6	5.9	11
2651		Folding paperboard boxes	4.1	(D)	
2653	322211	Corrugated and solid fiber boxes	.4	.4	0
2654		Sanitary food containers	.9	.9	0
2655	322214	Fiber cans, drums, and similar products	3.3	3.2	3
2661		Building paper and board mills	4.8	3.9	19
		Chemicals and allied products			
28		Chemical and allied products	3,400.7	2,979.8	12
281		Industrial inorganic chemicals	885.0	758.4	14
2812	325181	Alkalies and chlorine	157.4	142.9	9
2813	325120	Industrial gases	18.6	11.9	36
2816	325131 325182	Inorganic pigments	48.9	49.5	--
2819	325131 325188 325998 331311	Industrial inorganic chemicals n. e. c.	660.1	554.0	16
282		Plastics materials and synthetics	427.1	391.7	8
2821	325211	Plastics materials and resins	132.7	108.0	19
2822	325212	Synthetic rubber	62.9	58.5	7
2823	325221	Cellulosic manmade fiber	71.7	67.6	6
2824	325412	Organic fibers, noncellulosic	159.9	157.5	2

Table 2-5. Census of Manufacturing: summary of 1983 water-use statistics for industry groups and individual industries. —Continued

[Adapted from table 2a of U.S. Bureau of Census (1986). Water intake and water discharged are in billion gallons; coefficient is the percentage of water withdrawn that was consumed (computed from the water intake and water discharged data). SIC code (Standardized Industrial Classification code) and NAICS (North American Industrial Classification System) are two classification systems. * denotes a NAICS code that relates to more than one SIC code, n.e.c., not elsewhere classified. D, withheld to avoid disclosing data for individual companies; data are included in higher level totals. Z, less than half the unit shown. A double dash (--) means water discharged was greater than water intake (no coefficient).]

Sic code	NAICS code	Industry group and industry	Water intake	Water discharged	Coefficient
		Chemicals and allied products—Continued			
283		Drugs	90.5	87.1	4
2831		Biological products	.8	.5	38
2833	325411	Medicinals and botanicals	55.3	54.9	1
2834	325412	Pharmaceutical preparations	34.4	31.6	8
284		Soaps, cleaners, and toilet goods	64.8	38.8	40
2841	325611*	Soap and other detergents	16.6	14.3	14
2842	325612	Polishes and sanitation goods	(D)	3.8	
2843	325613	Surface active agents	(D)	(D)	
2844	325611* 325620	Toilet preparations	2.3	(D)	
2851	325510	Paints and allied products	2.1	2.1	0
286		Industrial organic chemicals	1515.9	1381.0	9
2861	325191	Gum and wood chemicals	(D)	6.5	
2865	325110* 325132 325192	Cyclic crudes and intermediates	(D)	30.9	
2869	325110* 325120 325188 325192 325193 325199 325998	Industrial organic chemicals n.e.c.	1,467.6	1,343.5	8
287		Agriculture chemicals	305	202.7	34
2873	325311	Nitrogenous fertilizers	70.5	45.2	36
2874	325312	Phosphatic fertilizers	216.1	142.2	34
2879	325320	Agricultural chemicals n.e.c.	18.4	15.3	17
289		Miscellaneous chemical products	110.3	95.7	13
2891	325520	Adhesives and sealants	(D)	(D)	
2892	325920	Explosives	(D)	(D)	
2895	325182	Carbon pack	1.6	.3	81
2899	311942 325199 325510 325998	Chemical preparations, n.e.c.	63.3	52.4	17

Table 2-5. Census of Manufacturing: summary of 1983 water-use statistics for industry groups and individual industries. —Continued

[Adapted from table 2a of U.S. Bureau of Census (1986). Water intake and water discharged are in billion gallons; coefficient is the percentage of water withdrawn that was consumed (computed from the water intake and water discharged data). SIC code (Standardized Industrial Classification code) and NAICS (North American Industrial Classification System) are two classification systems. * denotes a NAICS code that relates to more than one SIC code, n.e.c., not elsewhere classified. D, withheld to avoid disclosing data for individual companies; data are included in higher level totals. Z, less than half the unit shown. A double dash (--) means water discharged was greater than water intake (no coefficient).]

Sic code	NAICS code	Industry group and industry	Water intake	Water discharged	Coefficient
		Petroleum and coal products			
29		Petroleum and coal products	818.4	699.3	15
2911	324110	Petroleum refining	814.4	695.1	15
295		Paving and roofing materials	2.6	3.3	--
2951	324121	Paving and mixtures and blocks	.8	1.9	--
2952	324122	Asphalt felts and coatings	1.8	1.4	22
299		Miscellaneous petroleum and coal products	1.4	.9	36
2992	324191	Lubricating oils and greases	.2	.1	50
2999	324199	Petroleum and coal products	1.3	.7	46
		Rubber and miscellaneous plastics products			
30		Rubber and miscellaneous plastics products	76.0	62.6	18
3011	326211	Tires and inner tubes	(D)	16.5	
3021	316211	Rubber and plastics footwear	.1	.1	0
3041		Rubber and plastics hose and belting	(D)	7.4	
3069	313320 314911 315299 315999 326192 326299 339113 339920 339932	Fabricated rubber products, n.e.c.	8.3	7.4	11
3079		Miscellaneous plastics products	41.9	33.6	20
		Leather and leather products			
31		Leather and leather products	6.1	5.7	7
3111	316110	Leather tanning and finishing	(D)	(D)	
		Stone, clay, and glass products			
32		Stone, clay, and glass products	154.7	132.8	14
3211	327211	Flat glass	4.8	4.7	2
322		Glass and glassware, pressed or blown	13.3	11.4	14

Table 2-5. Census of Manufacturing: summary of 1983 water-use statistics for industry groups and individual industries. —Continued

[Adapted from table 2a of U.S. Bureau of Census (1986). Water intake and water discharged are in billion gallons; coefficient is the percentage of water withdrawn that was consumed (computed from the water intake and water discharged data). SIC code (Standardized Industrial Classification code) and NAICS (North American Industrial Classification System) are two classification systems. * denotes a NAICS code that relates to more than one SIC code, n.e.c., not elsewhere classified. D, withheld to avoid disclosing data for individual companies; data are included in higher level totals. Z, less than half the unit shown. A double dash (--) means water discharged was greater than water intake (no coefficient).]

Sic code	NAICS code	Industry group and industry	Water intake	Water discharged	Coefficient
		Stone, clay, and glass products—Continued			
3221	327213	Glass containers	7.1	5.9	17
3229	327212	Pressed and blown glass, n.e.c.	6.2	5.5	11
3231	327215	Products of purchased glass	7.2	7.1	1
3241	327310	Cement, hydraulic	80.0	68.7	14
325		Structural clay products	1.4	.7	50
3253	327122	Ceramic wall and floor tile	(D)	(D)	
3255	327124	Clay refractories	(D)	(D)	
326		Pottery and related products	1.5	1.1	27
3261	327111	Vitreous plumbing fixtures	.5	.4	20
3262	327112	Vitreous china food utensils	.3	.3	0
3264	327113	Porcelain electrical supplies	.6	.4	33
327		Concrete, gypsum, and plaster products	10.8	6.5	40
3272	327999 327332 327390	Concrete products	(D)	3	
3273	327320	Ready-mixed concrete	2.1	1.5	29
3274	327410	Lime	4.3	3.2	26
3275	327420	Gypsum products	3.7	1.5	59
3281	327991	Cut stone and stone products	1.1	1.1	0
329		Miscellaneous nonmetallic mineral products	34.5	31.5	9
3291	327910 327999	Abrasive products	3.5	3.5	0
3292	327999 336340 336350	Asbestos products	1.8	1.4	22
3293		Gaskets, packing, and sealing devices	1.8	.9	50
3295	212324 212325 212393 212399 327992	Minerals, ground or treated	18.7	18.8	--
3296	327993	Mineral wool	6.2	4.4	29
3297	327125	Nonclay refractories	2.0	2.0	0
3299	327112 327420 327999	Nonmetallic mineral products, n.e.c.	.5	.5	0

Table 2-5. Census of Manufacturing: summary of 1983 water-use statistics for industry groups and individual industries. —Continued

[Adapted from table 2a of U.S. Bureau of Census (1986). Water intake and water discharged are in billion gallons; coefficient is the percentage of water withdrawn that was consumed (computed from the water intake and water discharged data). SIC code (Standardized Industrial Classification code) and NAICS (North American Industrial Classification System) are two classification systems. * denotes a NAICS code that relates to more than one SIC code, n.e.c., not elsewhere classified. D, withheld to avoid disclosing data for individual companies; data are included in higher level totals. Z, less than half the unit shown. A double dash (--) means water discharged was greater than water intake (no coefficient).]

Sic code	NAICS code	Industry group and industry	Water intake	Water discharged	Coefficient
		Primary metal industries			
33		Primary metal industries	2,362.5	2,112.0	11
331		Blast furnace and basic steel products	2,077.6	1,829.8	12
3312	324199 331111 331221	Blast furnaces and steel mills	2,038.9	1,829.8	10
3313	331112	Electrometallurgical products	1.2	1.5	--
3315	331222	Cold finishing of steel shapes	2.1	2.1	0
3316	331221	Cold finishing of steel shapes	11.3	11.0	3
3317	331210	Steel pipe and tubes	24.1	23.7	2
332		Iron and steel foundries	69.1	51.5	25
3321	331511*	Gray iron foundries	63.0	45.7	27
3322	331511*	Malleable iron foundries	(D)	1.4	
3324	331512	Steel investment foundries	(D)	.5	
3325	331513	Steel foundries, n.e.c.	4.2	3.9	7
333		Primary nonferrous metals	125.6	111.6	11
3331	331511*	Primary copper	(D)	10.6	
3332		Primary lead	.7	.3	57
3333		Primary zinc	7.2	(D)	
3334	331312	Primary aluminum	67.8	62.9	7
3339	331419	Primary nonferrous metals, n.e.c.	(D)	(D)	
3341	331314 331423 331492	Secondary nonferrous metals, n.e.c.	3.7	3.1	16
335		Nonferrous rolling and drawing	79.9	71.4	11
3351	331421	Copper rolling and drawing	18.6	14.8	20
3353	331315	Aluminum sheet, plate, and foil	37.0	34.6	6
3354	331316	Aluminum extruded products	3.9	3.7	5
3355	331319	Aluminum rolling and drawing, n.e.c.	7.1	6.9	3
3356	331491	Nonferrous rolling and drawing, n.e.c.	6.6	4.9	26
3357	331319 331422 331491 335921 335929	Nonferrous wire drawing and insulating	6.8	6.5	4
336		Nonferrous foundries	2.4	2.2	8
3361		Aluminum foundries	1.7	(D)	
3362		Brass, bronze, and copper foundries	.2	(D)	

Table 2-5. Census of Manufacturing: summary of 1983 water-use statistics for industry groups and individual industries. —Continued

[Adapted from table 2a of U.S. Bureau of Census (1986). Water intake and water discharged are in billion gallons; coefficient is the percentage of water withdrawn that was consumed (computed from the water intake and water discharged data). SIC code (Standardized Industrial Classification code) and NAICS (North American Industrial Classification System) are two classification systems. * denotes a NAICS code that relates to more than one SIC code, n.e.c., not elsewhere classified. D, withheld to avoid disclosing data for individual companies; data are included in higher level totals. Z, less than half the unit shown. A double dash (--) means water discharged was greater than water intake (no coefficient).]

Sic code	NAICS code	Industry group and industry	Water intake	Water discharged	Coefficient
		Primary metal industries—Continued			
3369	331528	Non ferrous foundries, n.e.c.	0.5	0.5	0
339		Miscellaneous primary metal products	4.1	4.0	2
3398	332811	Metal heat treating	1.5	1.5	0
3399	331111 331221 331314 331423 331492 332618 332813	Primary metal products n.e.c.	2.6	2.6	0
		Fabricated metal products			
34		Fabricated metal products	65.4	61.4	6
341		Metal cans and shipping containers	6.6	6.0	9
3411	332431	Metal cans	6.2	5.6	10
3412	332211	Metal barrels, drums, and pails	.4	.4	--
342		Cutlery, hand tools, and hardware	14.9	14.4	3
3421	332211 332212*	Cutlery	(D)	(D)	
3423	332212*	Hand and edge tools	1.0	.9	10
3425	332213	Hand saws and saw blades	.4	(D)	
3429	332510 332722 332919 332999 333923 334518 336399 337215	Hardware, n.e.c.	(D)	2.9	
343		Plumbing and heating, except electric	3.0	3.0	0
3431	332998	Metal sanitary ware	.6	.7	--
3432	332913 332919 332999	Plumbing fittings and brass goods	2.1	2.1	0
3433	333414	Heating equipment, except electric	.3	.2	33
344		Fabricated structural metal products	7.0	6.0	14
3441	332312	Fabricated structural metal	1.2	1.1	8
3442	332321	Metal doors, sash, and trim	.6	.6	0
3443	332313	Fabricated structural metal	1.2	1.1	8

Table 2-5. Census of Manufacturing: summary of 1983 water-use statistics for industry groups and individual industries. —Continued

[Adapted from table 2a of U.S. Bureau of Census (1986). Water intake and water discharged are in billion gallons; coefficient is the percentage of water withdrawn that was consumed (computed from the water intake and water discharged data). SIC code (Standardized Industrial Classification code) and NAICS (North American Industrial Classification System) are two classification systems. * denotes a NAICS code that relates to more than one SIC code, n.e.c., not elsewhere classified. D, withheld to avoid disclosing data for individual companies; data are included in higher level totals. Z, less than half the unit shown. A double dash (--) means water discharged was greater than water intake (no coefficient).]

Sic code	NAICS code	Industry group and industry	Water intake	Water discharged	Coefficient
		Fabricated metal products—Continued			
3444	332321 323322 332439 333415	Sheet metal work	0.3	0.3	0
3448	332311	Prefabricated metal buildings	(D)	(D)	
3449	332114 332312 332323	Miscellaneous metal work	.6	.6	0
345		Screw machine products, bolts, etc	2.8	2.7	4
3451	332721	Screw machine products	.1	.1	0
3452	332722	Bolts, nuts, rivets, and washers	2.7	2.6	4
346		Metal forgings and stampings	10.1	9.7	4
3462	332111	Iron and steel forgings	2.8	2.8	0
3463	332112	Nonferrous forgings	1.4	1.4	0
3465	336370	Automotive stampings	3.3	3.0	9
3466	332115	Crowns and closures	.3	.3	0
3469	332116 332214 332439	Metal stampings, n.e.c.	2.3	2.2	4
347		Metal services, n.e.c.	6.9	6.7	3
3471	332813	Plating and polishing	6.0	5.8	3
3479	332812	Metal coating and allied services	.9	.9	0
348		Ordnance and accessories, n.e.c.	6.7	6.0	10
3482	332992	Small arms ammunition	1.4	1.2	14
3483	332993	Ammunition, except for small arms, n.e.c.	2.2	2.0	9
3484	332994	Small arms	.8	.8	0
3489	332995	Ordnance and accessories	2.3	2.0	13
349		Miscellaneous fabricated metal products	7.5	6.8	9
3493	332611	Steel springs, except wire	.2	(D)	
3494	332919 332999	Valves and pipe fittings	2.9	2.8	3
3495	332612 334518	Wire springs	.1	.1	0
3496	332214 332618 333924	Miscellaneous fabricated wire products	.2	.2	0
3497	322225 332999	Metal foil and leaf	1.7	1.4	18
3498	332996	Fabricated pipe and fittings	.2	(D)	

Table 2-5. Census of Manufacturing: summary of 1983 water-use statistics for industry groups and individual industries. —Continued

[Adapted from table 2a of U.S. Bureau of Census (1986). Water intake and water discharged are in billion gallons; coefficient is the percentage of water withdrawn that was consumed (computed from the water intake and water discharged data). SIC code (Standardized Industrial Classification code) and NAICS (North American Industrial Classification System) are two classification systems. * denotes a NAICS code that relates to more than one SIC code, n.e.c., not elsewhere classified. D, withheld to avoid disclosing data for individual companies; data are included in higher level totals. Z, less than half the unit shown. A double dash (--) means water discharged was greater than water intake (no coefficient).]

Sic code	NAICS code	Industry group and industry	Water intake	Water discharged	Coefficient
		Fabricated metal products—Continued			
3499	332117 332439 332510 332919 332999 336360 337215	Fabricated metal products, n.e.c.	2.2	2.1	5
		Machinery, except electrical			
35		Machinery, except electrical	120.0	104.9	13
351		Engines and turbines	32.0	20.7	35
3519	333618	Internal combustion engines, n.e.c.	(D)	(D)	
352		Farm and garden machinery	32.8	32.0	2
3523	332212 332323 333111 333922	Farm machinery and equipment	32.1	31.3	2
3524	332212 333112	Lawn and garden equipment	.7	.7	0
353		Construction and related machinery	11.4	11.8	--
3531	333120 333923 336510	Construction machinery	10.3	10.8	--
3532	333131	Mining machinery	(D)	(D)	
3533	333132	Oil field machinery	.8	(D)	
354		Metalworking machinery	4.0	3.7	8
3541	333512	Machine tools, metal cutting types	3.0	2.7	10
3542	333513	Machine tools, metal forming types	(D)	(D)	
3544	333511 333514	Special dies, tools, jigs, and fixtures	.2	(D)	
3545	332212	Machine tool accessories	(D)	.4	
3546	333991	Power driven hand tools	.3	.3	0
355		Special industry machinery	6.4	6.2	3
3551		Food products machinery	(D)	.3	
3554	333291	Paper industries machinery	(D)	.1	
3555	333293	Printing trades machinery	(D)	.1	

Table 2-5. Census of Manufacturing: summary of 1983 water-use statistics for industry groups and individual industries. —Continued

[Adapted from table 2a of U.S. Bureau of Census (1986). Water intake and water discharged are in billion gallons; coefficient is the percentage of water withdrawn that was consumed (computed from the water intake and water discharged data). SIC code (Standardized Industrial Classification code) and NAICS (North American Industrial Classification System) are two classification systems. * denotes a NAICS code that relates to more than one SIC code, n.e.c., not elsewhere classified. D, withheld to avoid disclosing data for individual companies; data are included in higher level totals. Z, less than half the unit shown. A double dash (--) means water discharged was greater than water intake (no coefficient).]

Sic code	NAICS code	Industry group and industry	Water intake	Water discharged	Coefficient
		Machinery, except electrical—Continued			
3559	332410 333111 333220 333295 333298 333319	Special industry machinery, n.e.c.	(D)	(D)	
356		General industrial machinery	7.1	6.1	14
3561	333911	Pumps and pumping machinery	1.6	1.5	6
3562	332991	Ball and roller bearings	2.6	2.4	8
3563	333912	Air and gas compressors	1.4	.7	50
3564	333411 333412	Blowers and fans	(D)	(D)	
3566	333612	Speed changers, drives, and gears	.4	.4	0
3568	333613	Power transmission equipment, n.e.c.	.7	.7	0
3569	314999 333414 333999	General industrial machinery, n.e.c.	.2	.2	0
357		Office and computing machines	15.0	13.3	11
3573		Electronic computing equipment	(D)	12.3	
3579	333313 334518 339942	Office machines, n.e.c. and typewriters	(D)	(D)	
358		Refrigeration and service machinery	9.6	9.6	0
3585	333415 336391	Refrigeration and heating equipment	9.2	9.3	--
3586	333913	Measuring and dispensing pumps	.2	.2	0
3589	333319	Service industry machinery, n.e.c.	(D)	.1	
359		Miscellaneous machinery, except electrical	1.7	1.5	12
3592	336311	Carburetors, pistons, rings, valves	1.5	1.3	13
3599	332710 332813 332999 333319 333999 334519 336399	Machinery, except electrical, n.e.c.	.2	.2	0

Table 2-5. Census of Manufacturing: summary of 1983 water-use statistics for industry groups and individual industries. —Continued

[Adapted from table 2a of U.S. Bureau of Census (1986). Water intake and water discharged are in billion gallons; coefficient is the percentage of water withdrawn that was consumed (computed from the water intake and water discharged data). SIC code (Standardized Industrial Classification code) and NAICS (North American Industrial Classification System) are two classification systems. * denotes a NAICS code that relates to more than one SIC code, n.e.c., not elsewhere classified. D, withheld to avoid disclosing data for individual companies; data are included in higher level totals. Z, less than half the unit shown. A double dash (--) means water discharged was greater than water intake (no coefficient).]

Sic code	NAICS code	Industry group and industry	Water intake	Water discharged	Coefficient
		Electric and electronic equipment			
36		Electric and electronic equipment	74.1	70.3	5
361		Electric distributing equipment	3.4	4.7	--
3612	335311	Transformers	1.6	2.9	--
3613	335313	Switchgear and switchboard apparatus	1.9	1.8	5
362		Electrical industrial apparatus	9.5	9.4	1
3621	335312	Motors and generators	4.8	5.0	--
3622		Industrial controls	(D)	.6	
3623		Welding apparatus, electric	.2	.2	0
3624	335991	Carbon and graphite products	3.8	3.5	8
3629	335999	Electrical industrial apparatus, n.e.c.	(D)	.1	
363		Household appliances	9.4	9.1	3
3631	335221	Household cooking equipment	1.8	1.7	6
3632	335222	Household refrigerators and freezers	2.6	2.5	4
3633	335224	Household laundry equipment	2.1	2.2	--
3634	333414 335211 339999	Electric housewares and fans	1.0	.9	10
3635	335212	Household vacuum cleaners	(D)	.2	
3639	333298 335212 335228	Household appliances, n.e.c.	1.5	1.5	0
364		Electric lighting and wiring equipment	6.9	6.0	13
3641	335110	Electric lamps	(D)	.8	
3643	335931	Current-carrying wiring devices	2.1	2.1	0
3644	332212 335932	Non-current-carrying wiring devices	1.7	1.6	6
3645	335121	Residential lighting fixtures	.3	.3	0
3646	335122	Commercial lighting fixtures	.1	.1	0
3648	335129	Lighting equipment, n.e.c.	.2	(D)	
365		Radio and TV receiving equipment	2.3	2.4	--
3651	334310	Radio and TV receiving sets	1.7	1.8	--
3652	334612 512220	Phonograph records and prerecorded tape	.6	.5	17
366		Communication equipment	13.3	11.7	12
3661	334210 334418	Telephone and telegraph apparatus	3.5	3.2	9

Table 2-5. Census of Manufacturing: summary of 1983 water-use statistics for industry groups and individual industries. —Continued

[Adapted from table 2a of U.S. Bureau of Census (1986). Water intake and water discharged are in billion gallons; coefficient is the percentage of water withdrawn that was consumed (computed from the water intake and water discharged data). SIC code (Standardized Industrial Classification code) and NAICS (North American Industrial Classification System) are two classification systems. * denotes a NAICS code that relates to more than one SIC code, n.e.c., not elsewhere classified. D, withheld to avoid disclosing data for individual companies; data are included in higher level totals. Z, less than half the unit shown. A double dash (--) means water discharged was greater than water intake (no coefficient).]

Sic code	NAICS code	Industry group and industry	Water intake	Water discharged	Coefficient
		Electric and electronic equipment—Continued			
3662		Radio and TV communication equipment	9.8	8.5	13
367		Electronic components and accessories	23.6	21.9	7
3671	334411	Electron tubes, all types	2.8	2.6	7
3674	334413	Semiconductors and related devices	11.6	10.7	8
3675	334414	Electronic capacitors	3.0	2.9	3
3676	334415	Electronic resistors	.4	.4	0
3678	334417	Electronic connectors	1.4	1.2	14
3679	334220 334310 334418 334419	Electronic components, n.e.c.	4.6	4.2	9
369		Miscellaneous electrical equipment and supplies	5.6	5.1	9
3691	335911	Storage, batteries	1.9	1.5	21
3693		X-ray electromedical, and electrotherapeutic apparatus	.4	(D)	
3694	336322	Engine electrical equipment	2.7	2.7	0
3699	333319 333618 333992 335129 335999	Electrical equipment and supplies, n.e.c.	(D)	.2	
		Transportation equipment			
37		Transportation equipment	152.8	139.2	9
371		Motor vehicles and equipment	66.4	59.6	10
3711	336112 336120 336211 336992	Motor vehicles and car bodies	22.6	21.0	7
3713	336211	Truck and bus bodies	(D)	.2	
3714	336211 336312 336322 336330 336340 336350 336399	Motor vehicle parts and accessories	43.5	38.4	12
372		Aircraft and parts	58.4	54.1	7
3721	336411 541710	Aircraft	18.0	(D)	

Table 2-5. Census of Manufacturing: summary of 1983 water-use statistics for industry groups and individual industries. —Continued

[Adapted from table 2a of U.S. Bureau of Census (1986). Water intake and water discharged are in billion gallons; coefficient is the percentage of water withdrawn that was consumed (computed from the water intake and water discharged data). SIC code (Standardized Industrial Classification code) and NAICS (North American Industrial Classification System) are two classification systems. * denotes a NAICS code that relates to more than one SIC code, n.e.c., not elsewhere classified. D, withheld to avoid disclosing data for individual companies; data are included in higher level totals. Z, less than half the unit shown. A double dash (--) means water discharged was greater than water intake (no coefficient).]

Sic code	NAICS code	Industry group and industry	Water intake	Water discharged	Coefficient
		Transportation equipment—Continued			
3724	336412 541710	Aircraft engines and engine parts	(D)	(D)	
3728	332912 336411 336413 541710	Aircraft equipment, n.e.c.	(D)	4.5	
373		Ship and boat building and repairing	16.3	15.8	3
3731	336611 488390	Ship building and repairing	16.3	15.8	3
3743	333911 336510	Railroad equipment	3.1	2.8	10
3751	336991	Motorcycles, bicycles, and parts	1.0	.9	10
376		Guided missiles, space vehicles, parts	6.5	4.9	25
3761	336414 541710	Guided missiles and space vehicles	2.8	2.2	21
3764	336415 541710	Space propulsion units and parts	3.3	2.3	30
3769	336419 541710	Space vehicle equipment, n.e.c.	.4	.4	0
379		Miscellaneous transportation equipment	1.2	1.1	8
3795	336992	Tanks and tank components	1.1	1.0	9
3799	333924 336214 336399 336999	Transportation equipment, n.e.c.	(D)	(Z)	
		Instruments and related products			
38		Instruments and related products	29.8	27.6	7
3811		Engineering and scientific instruments	.2	.2	0
382		Measuring and controlling devices	4.2	3.8	10
3822	334512	Environmental controls	1.0	1.0	0
3823	334513	Process control instruments	.8	.7	13
3824	334514*	Fluid meters and counting devices	.4	.3	25
3825	334514* 334515	Instruments to measure electricity	1.7	1.5	12

Table 2-5. Census of Manufacturing: summary of 1983 water-use statistics for industry groups and individual industries. —Continued

[Adapted from table 2a of U.S. Bureau of Census (1986). Water intake and water discharged are in billion gallons; coefficient is the percentage of water withdrawn that was consumed (computed from the water intake and water discharged data). SIC code (Standardized Industrial Classification code) and NAICS (North American Industrial Classification System) are two classification systems. * denotes a NAICS code that relates to more than one SIC code, n.e.c., not elsewhere classified. D, withheld to avoid disclosing data for individual companies; data are included in higher level totals. Z, less than half the unit shown. A double dash (--) means water discharged was greater than water intake (no coefficient).]

Sic code	NAICS code	Industry group and industry	Water intake	Water discharged	Coefficient
		Instruments and related products—Continued			
3829	334514 334518 334519 339112	Measuring and controlling devices, n.e.c.	0.3	0.3	0
3832		Optical instruments and lenses	(D)	.4	0
384		Medical instruments and supplies	2.2	2.1	5
3841	332994 339111 339112	Surgical and medical instruments	(D)	.8	
3842	322291 334510 339113 339999	Surgical appliances and supplies	1.4	1.3	7
3861	325992 333315	Photographic equipment and supplies	17.3	15.7	9
3873	334518	Watches, clocks, and watchcases	(D)	(D)	
		Miscellaneous manufacturing industries			
39		Miscellaneous manufacturing industries	4.3	4.0	7
394		Toys and sporting goods	1.5	1.4	7
3944	336991 339932	Games, toys, and children’s vehicles	(D)	.4	
3949	339920	Sporting and athletic goods, n.e.c.	1.0	.9	10
395		Pens, pencils, and office and art supplies	.6	.6	0
3951	339941	Pens and mechanical pencils	(D)	(D)	
396		Costume jewelry and notions	.8	.8	0
3961	339914 339993	Costume jewelry	(D)	(D)	
3964		Needles, pins, and fasteners	.6	(D)	
399		Miscellaneous manufacturers	1.2	1.1	8

Table 2-5. Census of Manufacturing: summary of 1983 water-use statistics for industry groups and individual industries. —Continued

[Adapted from table 2a of U.S. Bureau of Census (1986). Water intake and water discharged are in billion gallons; coefficient is the percentage of water withdrawn that was consumed (computed from the water intake and water discharged data). SIC code (Standardized Industrial Classification code) and NAICS (North American Industrial Classification System) are two classification systems. * denotes a NAICS code that relates to more than one SIC code, n.e.c., not elsewhere classified. D, withheld to avoid disclosing data for individual companies; data are included in higher level totals. Z, less than half the unit shown. A double dash (--) means water discharged was greater than water intake (no coefficient).]

Sic code	NAICS code	Industry group and industry	Water intake	Water discharged	Coefficient
		Miscellaneous manufacturing industries—Continued			
3999	316110 321999 325998 326199 332211 332212 332812 332999 333319 335121 335211 337127 339932 339999	Manufacturing industries, n.e.c.	0.6	(D)	

Table 3–1. Consumptive-use coefficients used by Great Lakes jurisdictions, by water-use category.

[Facsimile of table from Great Lakes Commission (2005a).]

Water Use Category	ILLINOIS	INDIANA	MICHIGAN	MINNESOTA	NEW YORK	OHIO	ONTARIO	PENNSYLVANIA	QUÉBEC	WISCONSIN
Public Supply	10-15%	15%	10-15%	10-15%	10%	10-15%	15%	10%	10-15%	10-15%
Self-Supply Domestic	10-15%	15%	10-15%	10-15%	10%	10-15%	15%	10%	10-15%	10-15%
Self-Supply Irrigation	90%	90%	90%	90%	90%	90%	78%	90%	90%	70%
Self-Supply Livestock	80%	80%	80%	80%	90%	80%	80%	80%	80%	90%
Self-Supply Industrial	Varies by plant & SIC code	6%	10-15%	Varies by plant & SIC code	25%	10%; salt mining is 90%	Varies by plant & SIC code	Varies by plant & SIC code	10% for pulp & paper industry	10.2% for manufac-turing & mining
Self-Supply Thermoelectric (Fossil Fuel)	Individually estimated based on the quantity of make-up water	2%	1-2% for plants using once-through cooling; individual analysis for wet cooling towers	2%	2%	Individually estimated based on the quantity of make-up water	.9% based on reports of increased local lake evaporation due to discharge of heated water to lakes	NA (Pennsyl-vania has no facilities in the basin)	10%; estimates obtained from USGS report	.5-1%
Self-Supply Thermoelectric (Nuclear)	Individually estimated based on the quantity of make-up water	NA (Indiana has no facilities in the basin)	1-2% for plants using once-through cooling; individual analysis for wet cooling towers	NA (Minnesota has no facilities in the basin)	5%	14% based on reports of increased local lake evaporation due to discharge of heated water to lakes	.9% based on reports of increased local lake evaporation due to discharge of heated water to lakes	NA (Pennsyl-vania has no facilities in the basin)	NA (Québec has no facilities in the basin)	.5-1%
Hydroelectric	Coefficient for all states and provinces is 0%									
Self-Supply Other	Varies based on use	12%	Varies based on use	Varies based on use	Varies based on use	Varies based on use	Varies based on use	Varies based on use	Varies based on use	Varies based on use

Table 3–2. Total water use by category for the Great Lakes Basin, by year, from the Great Lakes Commission annual reports, 1998–2002.

[Adapted from annual reports 1998–2002 from the Great Lakes Commission (2005a). Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total-withdrawn and consumptive-use data. For 2001 and 2002, the annual report used units of billion gallons per day. For consistency's sake, these numbers are listed in million gallons per day.]

Statistic	1998[1]	1999[2]	2000[3]	2001[4]	2002[5]	1998–2002[6]
			Public supply			
Total withdrawn	6,711.70	6,311.48	6,060.85	6,030	5,990	31,104.03
Consumptive use	719.26	664.19	630.85	610	600	3224.3
Coefficient	11	11	10	10	10	10
			Self-supply domestic			
Total withdrawn	453.18	459.60	463.72	470	460	2,306.5
Consumptive use	57.46	58.34	58.99	60	60	294.79
Coefficient	13	13	13	13	13	13
			Self-supply irrigation			
Total withdrawn	434.10	434.48	376.65	420	510	2,175.23
Consumptive use	374.57	373.81	264.15	300	380	1,692.53
Coefficient	86	86	70	71	75	78
			Self-supply livestock			
Total withdrawn	131.43	125.92	126.73	140	140	664.08
Consumptive use	103.02	100.00	69.88	90	90	452.9
Coefficient	78	79	55	64	64	68
			Self-supply industrial			
Total withdrawn	4,934.15	4,860.68	4,792.90	4,410	4,380	23,377.73
Consumptive use	492.18	446.63	442.57	390	370	2,141.38
Coefficient	10	9	9	9	8	10
			Self-supply thermoelectric (fossil fuel)			
Total withdrawn	19,791.20	20,082.56	18,052.49	15,750	15,680	89,356.25
Consumptive use	215.40	242.66	223.34	180	170	1,031.4
Coefficient	1	1	1	1	1	1
			Self-supply thermoelectric (nuclear)			
Total withdrawn	14,133.04	14,190.55	14,908.09	15,070	15,140	73,441.68
Consumptive use	206.22	208.45	223.42	220	220	1,078.09
Coefficient	1	1	1	1	1	1
			Self-supply other			
Total withdrawn	639.50	1,341.32	1,264.79	1,190	1,190	5,625.61
Consumptive use	.03	32.55	32.97	30	30	125.55
Coefficient	0	2	3	3	3	2

[1] 1998 report, water use data in gallons, page 20, Water-Use by Category—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive use."

[2] 1999 report, water use data in gallons, page 15, Water-Use by Category—All Facilities. Total withdrawn is from the column "Withdrawals—Total. " Consumptive use is from the column "Consumptive use."

[3] 2000 report, water use data in gallons, page 16, Water-Use by Category—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive use."

[4] 2001 report, water use data in gallons, page 17, Water-Use by Category—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive use."

[5] 2002 report, water use data in gallons, page 17, Water-Use by Category – All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive use."

[6] Includes the total of the 1998 to 2002 data for total withdrawn and total consumed. The consumptive-use coefficient was calculated by dividing the total consumed over the total withdrawn and multiplying it by 100.

Table 3–3. Self-supplied industrial water use and consumptive use for the Great Lakes Basin, by jurisdiction and year, 1998–2002.

[Adapted from annual reports 1998–2002 from the Great Lakes Commission (2005a). Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total-withdrawn and consumptive-use data.]

Statistic	1998[1]	1999[2]	2000[3]	2001[4]	2002[5]	1998–2002[6]
			Illinois			
Total withdrawn	20.33	12.09	19.67	17.41	12.84	82.34
Consumptive use	.00	.00	1.96	.00	.00	1.96
Coefficient	0	0	10	0	0	2
			Indiana			
Total withdrawn	1,911.82	1,895.88	1,799.75	1,746.05	1,663.39	9,016.89
Consumptive use	114.71	113.75	107.99	104.77	99.80	541.02
Coefficient	6	6	6	6	6	6
			Michigan			
Total withdrawn	681.96	668.18	698.22	632.95	694.17	3,375.48
Consumptive use	68.19	66.82	69.84	63.29	69.42	337.56
Coefficient	10	10	10	10	10	10
			Minnesota			
Total withdrawn	357.09	357.15	365.22	206.86	341.75	1,628.07
Consumptive use	74.99	35.72	36.52	20.69	34.18	202.1
Coefficient	21	10	10	10	10	12
			New York			
Total withdrawn	360.24	357.66	342.07	337.01	241.16	1,638.14
Consumptive use	90.07	89.42	85.52	84.26	60.30	409.57
Coefficient	25	25	25	25	25	25
			Ohio			
Total withdrawn	244.82	211.82	210.07	198.97	156.62	1,022.3
Consumptive use	24.48	21.18	21.00	19.90	15.66	102.22
Coefficient	10	10	10	10	10	10
			Ontario			
Total withdrawn	923.22	923.22	923.22	923.22	923.22	4,616.10
Consumptive use	58.16	58.16	58.16	58.16	58.16	290.80
Coefficient	6	6	6	6	6	6
			Pennsylvania			
Total withdrawn	41.94	41.94	41.94	30.65	30.65	187.12
Consumptive use	8.95	8.95	8.95	5.31	5.31	37.47
Coefficient	21	21	21	17	17	20
			Quebec			
Total withdrawn	125.48	125.48	125.48	125.48	125.48	627.40
Consumptive use	12.55	12.55	12.55	12.55	12.55	62.75
Coefficient	10	10	10	10	10	10
			Wisconsin			
Total withdrawn	267.26	267.26	267.26	187.00	187.00	1,175.78
Consumptive use	40.08	40.08	40.08	19.07	19.07	158.38
Coefficient	15	15	15	10	10	13
			Total			
Total withdrawn	4,934.16	4,860.68	4,792.90	4,405.6	4,376.28	23,369.62
Consumptive use	492.18	446.63	442.57	388	374.45	2,143.83
Coefficient	10	9	9	9	9	9

[1] 1998 category tables, water use data in gallons, page 10, Industrial, water-use by jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[2] 1999 category tables, water use data in gallons, page 11, Industrial water-use by jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[3] 2000 category tables, water use data in gallons, page 10, Industrial water-use by jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[4] 2001 category tables, water use data in gallons, page 10, Industrial water-use by jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[5] 2002 category tables, water use data in gallons, page 10, Industrial water-use by jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[6] Includes the total of the 1998 to 2002 data for total withdrawn and total consumed. The consumptive-use coefficient was calculated by dividing the total consumed over the total withdrawn and multiplying it by 100.

Table 3–4. Fossil fuel power water use and consumptive use for the Great Lakes Basin, by jurisdiction and years, 1998–2002.

[Adapted from annual reports 1998–2002 from the Great Lakes Commission (2005a). Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total-withdrawn and consumptive-use data.]

Statistic	1998[1]	1999[2]	2000[3]	2001[4]	2002[5]	1998–2002[6]
			Illinois			
Total withdrawn	727.05	601.31	709.69	736.03	698.57	3,472.65
Consumptive use	.00	.00	14.19	.00	.00	14.19
Coefficient	0	0	2	0	0	0
			Indiana			
Total withdrawn	828.67	1,138.68	1,157.16	1,021.98	750.90	4,897.39
Consumptive use	16.58	22.78	23.15	20.44	15.02	97.97
Coefficient	2	2	2	2	2	2
			Michigan			
Total withdrawn	6,446.63	6,420.17	6,394.79	6,368.75	6,454.90	32,085.24
Consumptive use	77.37	77.03	76.73	76.42	77.46	385.01
Coefficient	1	1	1	1	1	1
			Minnesota			
Total withdrawn	153.66	158.93	173.90	188.19	158.78	833.46
Consumptive use	3.07	3.18	3.47	3.76	3.18	16.66
Coefficient	2	2	2	2	2	2
			New York			
Total withdrawn	2,181.29	2,155.75	2,021.59	1,976.92	1,933.26	10,268.81
Consumptive use	43.62	43.12	40.44	39.53	38.67	205.38
Coefficient	2	2	2	2	2	2
			Ohio			
Total withdrawn	2,045.14	2,034.94	2,160.05	2,183.92	2,407.88	10,831.93
Consumptive use	.03	20.35	21.60	21.84	24.08	87.9
Coefficient	0	1	1	1	1	1
			Ontario			
Total withdrawn	3,441.13	3,605.14	1,467.67	1,467.67	1,467.67	11,449.28
Consumptive use	30.97	32.45	.00	.00	.00	63.42
Coefficient	1	1	0	0	0	1
			Pennsylvania			
Total withdrawn	0.00	0.00	0.00	0.00	0.00	-
Consumptive use	.00	.00	.00	.00	.00	-
Coefficient	-	-	-	-	-	-
			Quebec			
Total withdrawn	47.02	47.02	47.02	47.02	47.02	235.1
Consumptive use	4.70	4.70	4.70	4.70	4.70	23.5
Coefficient	10	10	10	10	10	10
			Wisconsin			
Total withdrawn	3,920.61	3,920.61	3,920.61	1,763.00	1,763.00	15,287.83
Consumptive use	39.05	39.05	39.05	8.81	8.81	134.77
Coefficient	1	1	1	0	0	1
			Total			
Total withdrawn	19,791.20	20,082.55	18,052.48	15,753.48	15,681.98	89,361.69
Consumptive use	215.39	242.66	223.33	175.50	171.92	1,028.80
Coefficient	1	1	1	1	1	1

[1] 1998 category tables, water use data in gallons, page 12, Fossil Fuel Power, Water-Use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive use."

[2] 1999 category tables, water use data in gallons, page 13, Fossil Fuel Power Water-use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column Consumptive use.

[3] 2000 category tables, water use data in gallons, page 12, Fossil Fuel Power Water-use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column Consumptive use.

[4] 2001category tables, water use data in gallons, page 12, Fossil Fuel Power Water-use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column Consumptive use.

[5] 2002 category tables, water use data in gallons, page 12, Fossil Fuel Power Water-use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column Consumptive use.

[6] Includes the total of the 1998 to 2002 data for total withdrawn and total consumed. The consumptive-use coefficient was calculated by dividing the total consumed over the total withdrawn and multiplying it by 100.

Table 3–5. Nuclear power water use and consumptive use for the Great Lakes Basin, by jurisdiction and year, 1998–2002.

[Adapted from annual reports 1998–2002 from the Great Lakes Commission (2005a). Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total-withdrawn and consumptive-use data.]

Statistic	1998[1]	1999[2]	2000[3]	2001[4]	2002[5]	1998–2002[6]
			Illinois			
Total withdrawn	19.84	21.60	21.60	31.70	31.70	126.44
Consumptive use	.00	.00	.43	.00	.00	.43
Coefficient	0	0	2	0	0	0
			Indiana			
Total withdrawn	.00	.00	.00	.00	.00	.00
Consumptive use	.00	.00	.00	.00	.00	.00
Coefficient	-	-	-	-	-	-
			Michigan			
Total withdrawn	182.00	621.94	1,313.34	2,196.19	2,305.68	6,619.15
Consumptive use	3.46	11.81	24.95	41.73	43.80	125.75
Coefficient	2	2	2	2	2	2
			Minnesota			
Total withdrawn	.00	.00	.00	.00	.00	.00
Consumptive use	.00	.00	.00	.00	.00	.00
Coefficient	-	-	-	-	-	-
			New York			
Total withdrawn	1,354.57	1,324.99	1,350.21	1,395.53	1,374.53	6,799.83
Consumptive use	67.73	66.25	67.51	69.78	68.73	340
Coefficient	5	5	5	5	5	5
			Ohio			
Total withdrawn	123.43	130.70	131.62	128.50	102.82	617.07
Consumptive use	20.98	19.60	19.74	12.85	10.28	83.45
Coefficient	17	15	15	10	10	14
			Ontario			
Total withdrawn	10,487.27	10,125.39	10,125.39	10,125.39	10,125.39	50,988.83
Consumptive use	94.39	91.13	91.13	91.13	91.13	458.91
Coefficient	1	1	1	1	1	1
			Pennsylvania			
Total withdrawn	.00	.00	.00	.00	.00	.00
Consumptive use	.00	.00	.00	.00	.00	.00
Coefficient	-	-	-	-	-	-
			Quebec			
Total withdrawn	.00	.00	.00	.00	.00	.00
Consumptive use	.00	.00	.00	.00	.00	.00
Coefficient	-	-	-	-	-	-
			Wisconsin			
Total withdrawn	1,965.93	1,965.93	1,965.80	1,195.00	1,195.00	8,287.66
Consumptive use	19.66	19.66	19.66	5.97	5.97	70.92
Coefficient	1	1	1	0	0	1
			Total			
Total withdrawn	14,133.04	14,190.55	14,908.09	15,072.31	15,135.12	73,439.11
Consumptive use	206.22	208.45	223.42	221.46	219.91	1,079.46
Coefficient	1	1	1	1	1	1

[1] 1998 category tables, water use data in gallons, page 14, Nuclear Power, Water-Use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[2] 1999 category tables, water use data in gallons, page 14, Nuclear Power, Water-Use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[3] 2000 category tables, water use data in gallons, page 14, Nuclear Power, Water-Use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[4] 2001 category tables, water use data in gallons, page 14, Nuclear Power, Water-Use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[5] 2002 category tables, water use data in gallons, page 14, Nuclear Power, Water-Use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[6] Includes the total of the 1998 to 2002 data for total withdrawn and total consumed. The consumptive-use coefficient was calculated by dividing the total consumed over the total withdrawn and multiplying it by 100.

Table 3–6. Public-supply water use and consumptive use for the Great Lakes Basin, by jurisdiction and year, 1998–2002.

[Adapted from annual reports 1998–2002 from the Great Lakes Commission (2005a). Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total-withdrawn and consumptive-use data.]

Statistic	1998[1]	1999[2]	2000[3]	2001[4]	2002[5]	1998–2002[6]
			Illinois			
Total withdrawn	1,119.47	1,112.60	1,095.80	1,088.08	1,071.40	
Consumptive use	.00	.00	.00	.00	.00	
Coefficient	0	0	0	0	0	0
			Indiana			
Total withdrawn	193.22	197.38	188.15	186.75	196.55	
Consumptive use	28.98	29.60	28.28	28.02	29.48	
Coefficient	15	15	15	15	15	15
			Michigan			
Total withdrawn	1,228.10	1,234.40	1,143.30	1,191.38	1,189.25	
Consumptive use	153.52	154.31	142.92	148.93	149.65	
Coefficient	13	13	13	13	13	13
			Minnesota			
Total withdrawn	44.78	41.30	40.55	40.12	40.44	
Consumptive use	9.40	4.13	4.06	4.01	4.05	
Coefficient	21	10	10	10	10	12
			New York			
Total withdrawn	710.63	719.48	719.93	724.11	694.17	
Consumptive use	71.06	81.22	80.64	80.97	77.78	
Coefficient	10	11	11	11	11	11
			Ohio			
Total withdrawn	588.63	605.40	596.62	597.28	590.60	
Consumptive use	88.29	90.81	89.49	89.59	88.59	
Coefficient	15	15	15	15	15	15
			Ontario			
Total withdrawn	1,313.36	887.43	763.00	763.00	763.00	
Consumptive use	197.00	133.12	114.45	114.45	114.45	
Coefficient	15	15	15	15	15	15
			Pennsylvania			
Total withdrawn	44.70	44.70	44.70	44.99	36.87	
Consumptive use	4.47	4.47	4.47	4.5	3.68	
Coefficient	10	10	10	10	10	10
			Quebec			
Total withdrawn	1,100.01	1,100.01	1,100.01	1,100.01	1,100.01	
Consumptive use	109.90	109.90	109.90	109.90	109.90	
Coefficient	10	10	10	10	10	10
			Wisconsin			
Total withdrawn	368.79	368.79	368.79	299.16	307.91	
Consumptive use	56.64	56.64	56.64	24.70	26.70	
Coefficient	15	15	15	8	9	13
			Total			
Total withdrawn	6,711.69	6,311.49	6,060.85	6,034.88	5,990.20	31,109.11
Consumptive use	719.26	664.20	630.85	605.07	604.28	3,223.66
Coefficient	11	11	10	10	10	10

[1] 1998 category tables, water use data in gallons, page 2, Public Supply, Water-Use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[2] 1999 category tables, water use data in gallons, page 3, Public Supply, Water-Use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[3] 2000 category tables, water use data in gallons, page 2, Public Supply, Water-Use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[4] 2001 category tables, water use data in gallons, page 2, Public Supply, Water-Use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[5] 2002 category tables, water use data in gallons, page 2, Public Supply, Water-Use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[6] Includes the total of the 1998 to 2002 data for total withdrawn and total consumed. The consumptive-use coefficient was calculated by dividing the total consumed over the total withdrawn and multiplying it by 100.

Table 3–7. Domestic-supply water use and consumptive use for the Great Lakes Basin, by jurisdiction and year, 1998–2002.

[Adapted from annual reports 1998–2002 from the Great Lakes Commission (2005a). Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total-withdrawn and consumptive-use data.]

Statistic	1998[1]	1999[2]	2000[3]	2001[4]	2002[5]	1998–2002[6]
			Illinois			
Total withdrawn	3.88	4.31	4.38	4.39	4.10	
Consumptive use	0	0	.44	.00	.00	
Coefficient	0	0	10	0	0	2
			Indiana			
Total withdrawn	54.23	55.34	49.98	66.58	50.62	
Consumptive use	8.14	8.30	7.49	9.98	7.60	
Coefficient	15	15	15	15	15	15
			Michigan			
Total withdrawn	-	-	-	-	-	
Consumptive use	-	-	-	-	-	
Coefficient						-
			Minnesota			
Total withdrawn	2.40	1.46	.79	1.33	1.38	
Consumptive use	.19	.15	.08	.14	.14	
Coefficient	8	10	10	11	10	10
			New York			
Total withdrawn	121.40	123.17	131.59	127.34	129.32	
Consumptive use	12.14	12.32	13.16	12.73	12.93	
Coefficient	10	10	10	10	10	10
			Ohio			
Total withdrawn	57.85	60.63	60.89	56.99	56.70	
Consumptive use	8.68	9.08	9.12	8.55	8.51	
Coefficient	15	15	15	15	15	15
			Ontario			
Total withdrawn	105.24	106.51	107.91	107.91	107.91	
Consumptive use	15.79	15.97	16.19	16.19	16.19	
Coefficient	15	15	15	15	15	15
			Pennsylvania			
Total withdrawn	2.05	2.05	2.05	2.60	2.60	
Consumptive use	.20	.20	.20	.26	.26	
Coefficient	10	10	10	10	10	10
			Quebec			
Total withdrawn	71.59	71.59	71.59	71.59	71.59	
Consumptive use	7.13	7.13	7.13	7.13	7.13	
Coefficient	10	10	10	10	10	10
			Wisconsin			
Total withdrawn	34.54	34.54	34.54	34.00	34.00	
Consumptive use	5.18	5.18	5.18	3.40	3.40	
Coefficient	15	15	15	10	10	13
			Total			
Total withdrawn	453.18	459.6	463.72	472.73	458.22	2,307.45
Consumptive use	57.45	58.33	58.99	58.38	56.16	289.31
Coefficient	13	13	13	12	12	13

[1] 1998 category tables, water use data in gallons, page 4, Domestic Supply, Water-Use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[2] 1999 category tables, water use data in gallons, page 5, Domestic Supply, Water-Use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[3] 2000 category tables, water use data in gallons, page 4, Domestic Supply, Water-Use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[4] 2001 category tables, water use data in gallons, page 4, Domestic Supply, Water-Use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[5] 2002 category tables, water use data in gallons, page 4, Domestic Supply, Water-Use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[6] Includes the total of the 1998 to 2002 data for total withdrawn and total consumed. The consumptive-use coefficient was calculated by dividing the total consumed over the total withdrawn and multiplying it by 100.

Table 3–8. Irrigation water use and consumptive use for the Great Lakes Basin, by jurisdiction and year, 1998–2002.

[Adapted from annual reports 1998–2002 from the Great Lakes Commission (2005a). Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total-withdrawn and consumptive-use data.]

Statistic	1998[1]	1999[2]	2000[3]	2001[4]	2002[5]	1998–2002[6]
			Illinois			
Total withdrawn	0.00	0.00	0.00	-	-	
Consumptive use	.00	.00	.00	-	-	
Coefficient	-	-	-	-		-
			Indiana			
Total withdrawn	25.64	35.59	27.06	27.07	37.79	
Consumptive use	23.06	32.05	24.36	24.35	34.02	
Coefficient	90	90	90	90	90	90
			Michigan			
Total withdrawn	273.12	250.26	201.42	243.23	314.71	
Consumptive use	245.82	225.24	181.29	218.92	283.23	
Coefficient	90	90	90	90	90	90
			Minnesota			
Total withdrawn	.38	.24	.31	.37	.37	
Consumptive use	.34	.22	.28	.33	.33	
Coefficient	89	92	90	89	89	90
			New York			
Total withdrawn	3.60	3.66	2.05	5.65	8.59	
Consumptive use	3.21	3.22	1.84	5.08	7.72	
Coefficient	89	88	90	90	90	90
			Ohio			
Total withdrawn	14.79	19.15	15.47	18.52	20.49	
Consumptive use	13.31	17.23	13.92	16.75	18.45	
Coefficient	90	90	90	90	90	90
			Ontario			
Total withdrawn	59.45	68.46	73.22	73.22	73.22	
Consumptive use	46.38	53.40	-	-	-	
Coefficient	78	78	-	-	-	-
			Pennsylvania			
Total withdrawn	.35	.35	.35	.31	.31	
Consumptive use	.32	.32	.32	.31	.31	
Coefficient	91	91	91	100	100	95
			Quebec			
Total withdrawn	9.22	9.22	9.22	9.22	9.22	
Consumptive use	8.30	8.30	8.30	8.30	8.30	
Coefficient	90	90	90	90	90	90
			Wisconsin			
Total withdrawn	47.55	47.55	47.55	42.70	42.70	
Consumptive use	33.84	33.84	33.84	29.89	29.89	
Coefficient	71	71	71	70	70	71
			Total			
Total withdrawn	424.88	425.26	294.21[6]	294.21[6]	424.96[6]	1,179.25[6]
Consumptive use	366.28	365.52	255.85[6]	255.85[6]	373.95[6]	1,557.45[6]
Coefficient	86	86	87[6]	88[6]	88[6]	88[6]

[1] 1998 category tables, water use data in gallons, page 6, Irrigation, Water-Use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[2] 1999 category tables, water use data in gallons, page7, Irrigation, Water-Use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[3] 2000 category tables, water use data in gallons, page 6, Irrigation, Water-Use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[4] 2001 category tables, water use data in gallons, page 6, Irrigation, Water-Use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[5] 2002 category tables, water use data in gallons, page 6, Irrigation, Water-Use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[6] Includes the total of the 1998 to 2002 data for total withdrawn and total consumed. The consumptive-use coefficient was calculated by dividing the total consumed over the total withdrawn and multiplying it by 100.

Table 3–9. Livestock water use and consumptive use for the Great Lakes Basin, by jurisdiction and year, 1998–2002.

[Adapted from annual reports 1998–2002 from the Great Lakes Commission (2005a). Total withdrawn and consumptive use are in million gallons per day; coefficient is the percentage of water withdrawn that was consumed, computed from the total-withdrawn and consumptive-use data.]

Statistic	1998[1]	1999[2]	2000[3]	2001[4]	2002[5]	1998–2002[6]
			Illinois			
Total withdrawn	0.00	0.00	0.00	-	-	
Consumptive use	.00	.00	.00	-	-	
Coefficient	-	-	-	-	-	-
			Indiana			
Total withdrawn	6.11	6.01	6.07	5.86	5.44	
Consumptive use	4.89	4.81	4.86	4.70	4.35	
Coefficient	80	80	80	80	80	80
			Michigan			
Total withdrawn	-	-	-	-	-	
Consumptive use	-	-	-	-	-	
Coefficient	-	-	-	-	-	-
			Minnesota			
Total withdrawn	.25	.64	.71	.76	.65	
Consumptive use	.00	.58	.64	.68	.58	
Coefficient	0	91	90	89	89	82
			New York			
Total withdrawn	20.57	20.57	20.57	20.57	20.57	
Consumptive use	18.51	18.51	18.51	18.51	18.51	
Coefficient	90	90	90	90	90	90
			Ohio			
Total withdrawn	13.02	14.17	14.51	12.46	12.38	
Consumptive use	10.41	12.45	11.61	9.97	9.90	
Coefficient	80	88	80	80	80	82
			Ontario			
Total withdrawn	43.69	36.74	37.09	37.09	37.09	
Consumptive use	34.95	29.39	-	-	-	
Coefficient	80	80	-	-	-	-
			Pennsylvania			
Total withdrawn	.00	.00	.00	-	-	
Consumptive use	.00	.00	.00	-	-	
Coefficient	-	-	-	-	-	-
			Quebec			
Total withdrawn	19.10	19.10	19.10	19.10	19.10	
Consumptive use	15.28	15.28	15.28	15.28	15.28	
Coefficient	80	80	80	80	80	80
			Wisconsin			
Total withdrawn	28.69	28.69	28.69	40.60	40.60	
Consumptive use	18.98	18.98	18.98	36.54	36.54	
Coefficient	66	66	66	90	90	78
			Total			
Total withdrawn	131.43	125.92	89.65[6]	99.35[6]	98.74[6]	545.09[6]
Consumptive use	103.02	100.00	69.88[6]	85.68[6]	85.16[6]	443.74[6]
Coefficient	78	79	78[6]	86[6]	86[6]	81[6]

[1] 1998 category tables, water use data in gallons, page 8, Livestock, Water-Use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[2] 1999 category tables, water use data in gallons, page 9, Livestock, Water-Use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[3] 2000 category tables, water use data in gallons, page 8, Livestock, Water-Use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[4] 2001 category tables, water use data in gallons, page 8, Livestock, Water-Use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[5] 2002 category tables, water use data in gallons, page 8, Livestock, Water-Use by Jurisdiction—All Facilities. Total withdrawn is from the column "Withdrawals—Total." Consumptive use is from the column "Consumptive Use."

[6] Includes the total of the 1998 to 2002 data for total withdrawn and total consumed. The consumptive-use coefficient was calculated by dividing the total consumed over the total withdrawn and multiplying it by 100.

Table 4–1. Manufacturing water intake, consumption, and derived consumptive-use coefficients for the Canadian part of the Great Lakes Basin, 1972–91.

[From Tate and Harris (1999, p. 50–55). Categories correspond to Canadian Standard Industrial Classifications. Intake and consumption data are in million cubic meters; coefficient is in percent. No withdrawals reported during the survey years for the categories tobacco products, furniture and fixtures, leather products, machinery, or miscellaneous manufacturing]

Statistic	1972	1976	1981	1986	1991	1996	Mean
Food and beverages							
Intake	130	100	120	120	110	220	
Consumption	10	10	10	10	10	40	
Coefficient	8	10	8	8	9	18	11
Textiles, knitting mills, and clothing							
Intake	70	90	80	70	200	60	
Consumption	0	0	0	0	30	0	
Coefficient	0	0	0	0	15	0	5
Wood products							
Intake	10	40	0	0	0	10	
Consumption	0	0	0	0	0	0	
Coefficient	0	0	0	0	0	0	0
Paper and allied products							
Intake	710	670	650	580	540	900	
Consumption	30	30	10	40	40	50	
Coefficient	4	4	2	7	7	6	5
Chemicals and chemical products							
Intake	1,090	1,030	1,940	1,280	1,070	1,020	
Consumption	50[1]	60	140	20	30	30	
Coefficient	5	6	7	2	3	3	4
Petroleum and coal products							
Intake	310	320	350	310	250	220	
Consumption	10	0	20	10	10	10	
Coefficient	3	0	6	3	4	5	3
Rubber and plastics							
Intake	340	40	20	20	40	20	
Consumption	0	0	0	0	0	0	
Coefficient	0	0	0	0	0	0	0
Non-metallic mineral products							
Intake	40	60	50	60	60	60	
Consumption	0	10	10	0	10	10	
Coefficient	0	17	20	0	17	17	12
Primary metals							
Intake	1,120	1,430	1,120	1,170	1,100	1,040	
Consumption	50	40	20	20	40	30	
Coefficient	4	3	2	2	4	3	3
Metal fabricating							
Intake	20	10	0	20	10	10	
Consumption	0	0	0	0	0	0	
Coefficient	0	0	0	0	0	0	0
Electrical products							
Intake	20	0	0	0	0	0	
Consumption	0	0	0	0	0	0	
Coefficient	0	0	0	0	0	0	0
Transportation equipment							
Intake	130	110	80	100	50	50	
Consumption	0	0	0	0	10	10	
Coefficient	0	0	0	0	20	20	7
Total of the preceding							
Intake	3,990	3,900	4,410	3,730	3,430	3,610	
Consumption	150	150	210	100	180	180	
Coefficient	4	4	5	3	5	5	4

[1] Value missing; derived by subtraction.

Table 4–2. Water intake, consumption, and derived consumptive-use coefficients for agriculture, electric power, water and other utilities, and wholesale and retail trade in the Canadian part of the Great Lakes Basin, 1972–91.

[From Tate and Harris (1999, p. 50–55). Intake and consumption data are in million cubic meters; coefficient is in percent.]

Statistic	1972	1976	1981	1986	1991	1996	Mean
Agriculture							
Intake	240	300	280	320	340	370	
Consumption	190	230	220	260	280	320	
Coefficient	79	77	79	81	82	86	81
Electric power							
Intake	5,630	6,690	14,930	19,970	23,100	24,000	
Consumption	100	120	150	200	210	210	
Coefficient	2	2	1	1	1	1	1
Water and other utilities							
Intake	950	990	1,020	1,120	1,090	970	
Consumption	190	200	200	230	220	170	
Coefficient	20	20	20	21	20	18	20
Wholesale and retail trade							
Intake	360	450	460	390	460	390	
Consumption	70	90	90	80	90	110	
Coefficient	19	20	20	21	20	28	21

Table 5–1. Annual water requirements for offstream uses for agriculture, irrigation, and livestock during base conditions.

[From Water Resources Council (U.S.) (1978), v. 3, Analytical data summary. Withdrawal and consumption are in million gallons per day. The consumptive-use coefficient (in percent) is computed by dividing the water consumption by the water withdrawal and multiplying by 100. Agriculture includes both irrigation and livestock. The withdrawals and consumption for agriculture are from the U.S. Department of Agriculture (Soil Conservation Service)]

Region	Withdrawal	Consumption	Consumptive-use coefficient
	Agriculture		
New England Region	53	43	81
Mid-Atlantic Region	333	264	79
Great Lakes Region	230	199	87
Ohio Region	160	150	94
Tennessee Region	41	38	93
Upper Mississippi Region	422	383	91
	Irrigation		
New England Region	35	25	71
Mid-Atlantic Region	265	196	74
Great Lakes Region	145	114	79
Ohio Region	47	37	79
Tennessee Region	14	11	79
Upper Mississippi Region	192	153	80
	Livestock		
New England Region	18	18	100
Mid-Atlantic Region	68	68	100
Great Lakes Region	85	85	100
Ohio Region	113	113	100
Tennessee Region	27	27	100
Upper Mississippi Region	230	230	100

Table 5–2. Annual water requirements for offstream uses for steam electrical and manufacturing withdrawals during base conditions.

[From Water Resources Council (U.S.) (1978), v. 3, Analytical data summary. Withdrawal and consumption are in million gallons per day. The consumptive use coefficient (in percent) is computed by dividing the water consumption by the water withdrawal and multiplying by 100. Steam electric withdrawals and consumption are from the Department of Energy (Federal Energy Regulatory Commission), and the manufacturing withdrawals and consumption are from the Department of Commerce (Industry and Trade Administration, Office of Business Policy Analysis)]

Region	Withdrawal	Consumption	Consumptive-use coefficient
Steam electrical			
New England Region	1,263	21	2
Mid-Atlantic Region	7,463	103	1
Great Lakes Region	24,362	175	1
Ohio Region	21,022	324	2
Tennessee Region	4,799	42	1
Upper Mississippi Region	7,644	129	2
Manufacturing			
New England Region	2,170	192	9
Mid-Atlantic Region	5,416	607	11
Great Lakes Region	13,220	1,474	11
Ohio Region	10,881	817	8
Tennessee Region	2,093	147	7
Upper Mississippi Region	2,030	240	12
Primary metals			
New England Region	132	4	3
Mid-Atlantic Region	1,124	173	15
Great Lakes Region	7,545	1,030	14
Ohio Region	6,346	467	7
Tennessee Region	77	12	16
Upper Mississippi Region	315	41	13
Chemicals			
New England Region	109	15	14
Mid-Atlantic Region	1,850	179	10
Great Lakes Region	1,939	71	4
Ohio Region	3,261	168	5
Tennessee Region	1,520	81	5
Upper Mississippi Region	384	54	14
Paper			
New England Region	962	86	9
Mid-Atlantic Region	745	76	10
Great Lakes Region	982	143	15
Ohio Region	224	23	10
Tennessee Region	381	41	11
Upper Mississippi Region	348	20	6
Food			
New England Region	56	9	16
Mid-Atlantic Region	271	45	17
Great Lakes Region	354	38	11
Ohio Region	124	17	14
Tennessee Region	19	1	5
Upper Mississippi Region	506	62	12

Table 5–2. Annual water requirements for offstream uses for steam electrical and manufacturing withdrawals during base conditions. —Continued

[From Water Resources Council (U.S.) (1978), v. 3, Analytical data summary. Withdrawal and consumption are in million gallons per day. The consumptive use coefficient (in percent) is computed by dividing the water consumption by the water withdrawal and multiplying by 100. Steam electric withdrawals and consumption are from the Department of Energy (Federal Energy Regulatory Commission), and the manufacturing withdrawals and consumption are from the Department of Commerce (Industry and Trade Administration, Office of Business Policy Analysis)]

Region	Withdrawal	Consumption	Consumptive-use coefficient
	Petroleum		
New England Region	16	3	19
Mid-Atlantic Region	562	71	13
Great Lakes Region	687	51	7
Ohio Region	114	23	20
Tennessee Region	0	0	-
Upper Mississippi Region	50	18	36
	Transportation		
New England Region	341	26	8
Mid-Atlantic Region	67	6	9
Great Lakes Region	657	80	12
Ohio Region	89	21	24
Tennessee Region	0	0	-
Upper Mississippi Region	26	5	19
	Textiles		
New England Region	45	2	4
Mid-Atlantic Region	37	3	8
Great Lakes Region	0	0	-
Ohio Region	7	1	14
Tennessee Region	31	8	26
Upper Mississippi Region	0	0	-
	All other		
New England Region	509	47	9
Mid-Atlantic Region	760	54	7
Great Lakes Region	1,056	61	6
Ohio Region	716	97	14
Tennessee Region	65	4	6
Upper Mississippi Region	401	40	10

Table 5–3. Annual water requirements for offstream uses for commercial and domestic water-use categories during base conditions.

[From Water Resources Council (U.S.) (1978), v. 3, Analytical data summary. Withdrawal and consumption are in million gallons per day. The consumptive use coefficient (in percent) is computed by dividing the water consumption by the water withdrawal and multiplying by 100. Domestic-central is from U.S. Department of Interior (U.S. Geological Survey) and Water Resource Council. Domestic-noncentral is from the U.S. Department of Agriculture (Soil Conservation Service)]

Region	Withdrawal	Consumption	Consumptive-use coefficient
	Commercial		
New England Region	361	48	13
Mid-Atlantic Region	650	91	14
Great Lakes Region	1,010	113	11
Ohio Region	495	62	13
Tennessee Region	90	11	12
Upper Mississippi Region	515	63	12
	Domestic		
New England Region	1,122	164	15
Mid-Atlantic Region	3,954	705	18
Great Lakes Region	3,267	476	15
Ohio Region	1,842	349	19
Tennessee Region	263	59	22
Upper Mississippi Region	1,450	282	19
	Domestic–central		
New England Region	1,011	96	9
Mid-Atlantic Region	3,627	505	14
Great Lakes Region	2,946	280	10
Ohio Region	1,561	175	11
Tennessee Region	210	26	12
Upper Mississippi Region	1,280	178	14
	Domestic–noncentral		
New England Region	111	68	61
Mid-Atlantic Region	327	200	61
Great Lakes Region	321	196	61
Ohio Region	281	174	62
Tennessee Region	53	33	62
Upper Mississippi Region	170	104	61

Table 5–4. Annual water requirements for offstream uses for mining water-use categories during base conditions.

[From Water Resources Council (U.S.) (1978), v. 3, Analytical data summary. Withdrawal and consumption are in million gallons per day. The consumptive-use coefficient (in percent) is computed by dividing the water consumption by the water withdrawal and multiplying by 100. Mineral withdrawals and consumption data are from the U.S. Department of the Interior (Bureau of Mines)]

Region	Withdrawal	Consumption	Consumptive-use coefficient
Minerals			
New England Region	90	11	12
Mid-Atlantic Region	459	70	15
Great Lakes Region	696	155	22
Ohio Region	493	91	18
Tennessee Region	110	15	14
Upper Mississippi Region	333	46	14
Nonmetals			
New England Region	87	11	13
Mid-Atlantic Region	424	56	13
Great Lakes Region	451	62	14
Ohio Region	308	34	11
Tennessee Region	86	12	14
Upper Mississippi Region	268	35	13
Fuels			
New England Region	0	0	-
Mid-Atlantic Region	21	11	57
Great Lakes Region	14	8	57
Ohio Region	183	57	31
Tennessee Region	8	1	12
Upper Mississippi Region	20	4	20
Metals			
New England Region	3	<1	-
Mid-Atlantic Region	14	2	14
Great Lakes Region	231	85	37
Ohio Region	2	<1	-
Tennessee Region	16	2	12
Upper Mississippi Region	45	7	16