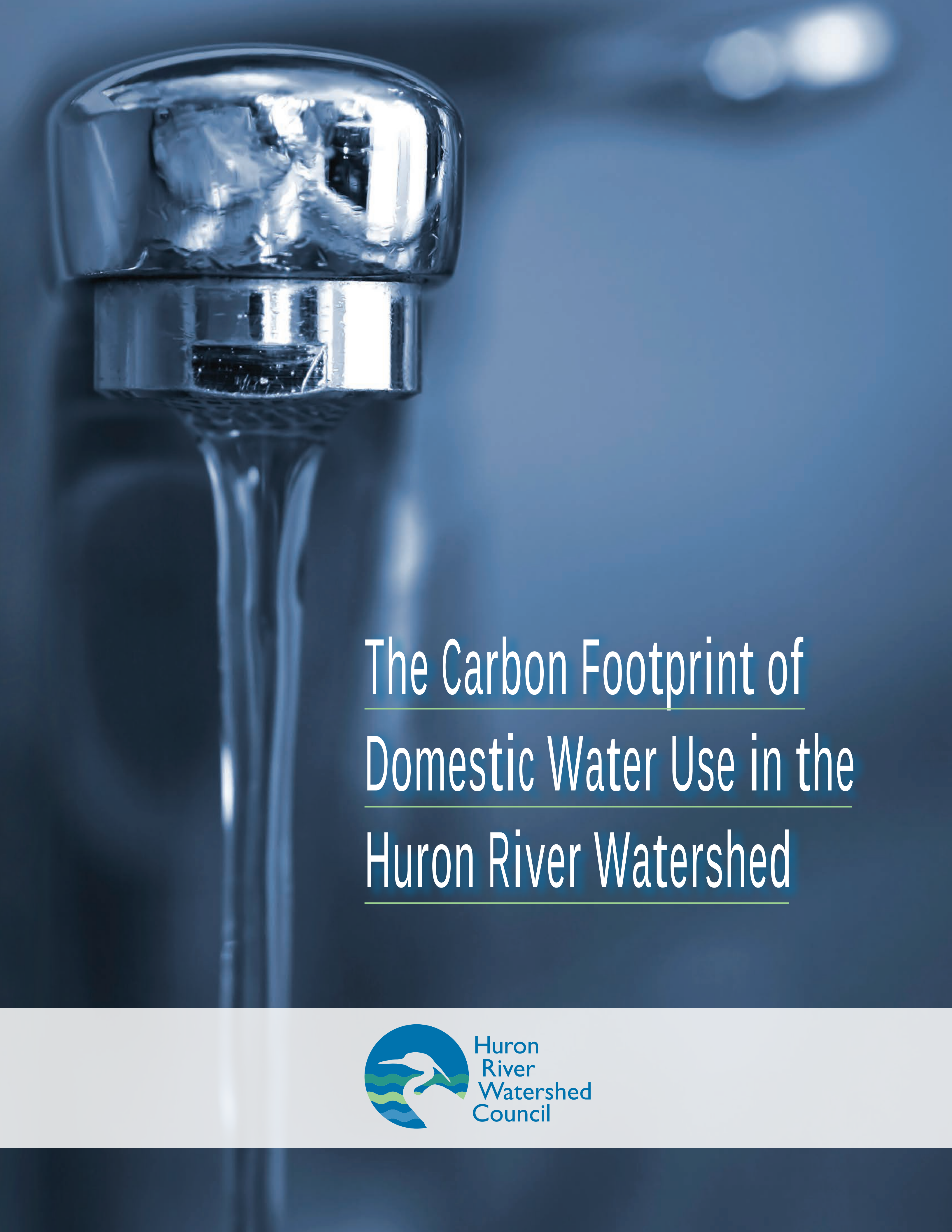


The Carbon Footprint of Domestic Water Use in the Huron River Watershed

Huron River Watershed Council

Introduction

A significant amount of energy enables our daily use of water. Whenever water is moved uphill, treated, heated, cooled, or pressurized, energy is needed. Most energy production emits carbon dioxide (CO_2), which contributes to global warming. Therefore, water use is another, often overlooked, contributor to our individual and collective carbon footprint. Better decisions related to water treatment and use can help reduce the amount of energy used throughout the water use cycle. By focusing on water conservation, efficiency, and reuse, we can minimize energy use, reduce the associated carbon footprint, and protect our freshwater resources.

The Huron River Watershed

The watershed of the Huron River encompasses over 900 square miles of Southeast Michigan. The river itself flows more than 125 miles from its source near Big Lake in Springfield Township, to its outlet at Pointe Mouillee in Lake Erie. The watershed contains all or parts of seven counties: Oakland, Livingston, Ingham, Jackson, Washtenaw, Wayne, and Monroe, and is home to more than a half million residents. The communities of the watershed have access to an abundance of freshwater. That water provides many services, including the provision of clean water for domestic use. While the resource itself may be plentiful, there are other costs associated with the use of water that bear consideration and make a case for the conserving this valuable resource.

The amount of energy required for domestic water use varies widely from place to place. This report provides estimates for energy use and carbon emissions associated with water production, residential use, and treatment in the Huron River watershed.

Carbon Footprint of Water Nationwide

More than 13% of the nation's electricity consumption, nearly 521 billion kilowatt hours (kWh), is associated with water-related energy use.[i] The energy required to provide water to a running faucet for five minutes is equal to that needed to light a 60-watt bulb for 14 hours.[ii] Energy used to move, treat, distribute, and use water produces nearly 290 million metric tons of carbon dioxide annually – the equivalent of 5% of the nation's overall emissions,[iii] or conceptualized as the amount of CO_2 produced annually by 53 million cars.[iv]

Demand for water continues to increase in most areas of this country. As more people move to cities, the demand on municipal water supplies will grow. In some cities the cost of energy to pump, treat, and deliver water to consumers already is around 60% of a city's energy bill.[v] Fifty percent of the total energy consumed by the City of Ann Arbor goes to drinking water and wastewater treatment. Both the costs and energy required to provide clean and reliable water will continue to increase as demand grows. Also, higher regulatory standards are expected for both drinking water and wastewater treatment. Removing contaminants from water requires a great deal of energy; as standards rise, so will the need and total costs for energy.

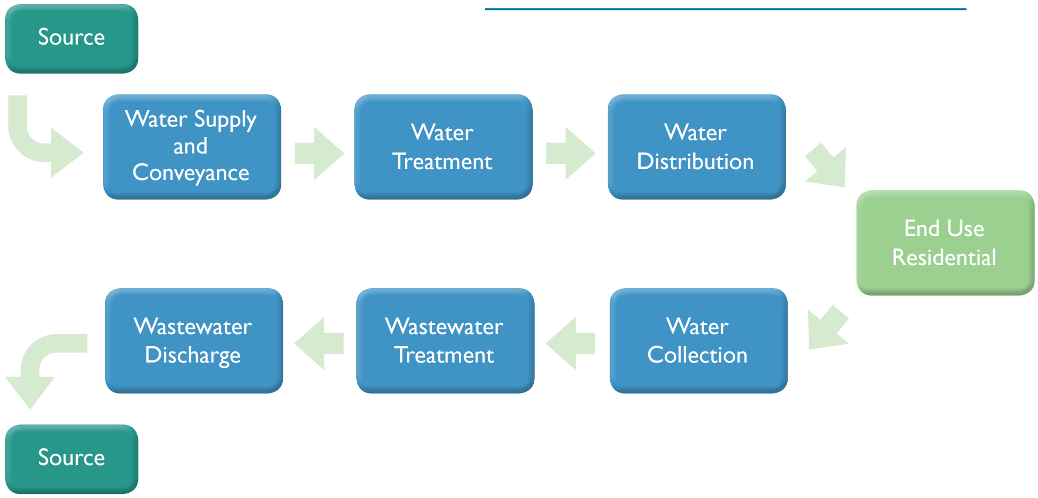
The Domestic Water Use Cycle

Few people pay attention to how water arrives to their homes on a daily basis. There are many stages in the domestic water use cycle, each of which has its own energy requirements (Figure 1). To start, water is transferred from its source to a treatment plant where solids are removed and the water is filtered and disinfected to meet regulatory standards. The water is then distributed throughout the community via pipes to homes, where it is heated for many uses. After water is used, the wastewater is treated before it returns to the environment. **In the Huron River watershed, the most energy-intensive segment of the cycle is residential water use.**

All water providers using water sourced from within the Huron River watershed use groundwater sources with the exception of Ann Arbor, which draws 15% of its drinking water from groundwater and 85% from surface water. Ann Arbor's surface water comes from Barton Pond on the main stem of the Huron River. Wastewater treatment facilities discharge to various surface water bodies throughout the watershed.

The Domestic Water Cycle

FIGURE 1



A simplified water use cycle. Energy is used in most of the steps of the water cycle. Modified from California Energy Commission, 2005 Integrated Energy Policy Report.

Quantifying the Energy and Carbon in our Water Supply

In order to understand energy used and carbon emitted through the water cycle locally, water and energy data were collected from water utilities serving residents of the Huron River watershed. A methodology developed by the River Network[vi] was used to compute the energy intensity and carbon intensity of water production and wastewater treatment. To compute energy associated with residential water use, energy use and water use data were gathered for a subset of the population to serve as a proxy for public water utility customers in the watershed.

Data and Analysis

Water and energy data was requested from 16 drinking water and 18 wastewater treatment utilities identified in the Huron River watershed (Appendix 1). Phone and email inquiries requested the total water produced or treated for a recent year of record and the total energy used that same year both at the plant and associated with off-site infrastructure (such as pumping stations). Data were received from 10 drinking water providers and 17 wastewater treatment facilities. Utility data were self-reported. Errors in reporting are possible. Effort was made to ensure data quality and consistency through follow-up inquiries where necessary. To derive energy embedded in water during residential use, water use for residential water accounts in Ann Arbor was used as a proxy for residents of the watershed. This analysis does not include residents on well and septic systems or those who receive water from sources outside the watershed (e.g., Detroit Water and Sewerage customers). Values should be considered approximate.

Energy Intensity of Water

The energy intensity of water is the amount of energy used per unit of water. Values for energy intensity will be expressed in kilowatt hours per million gallons (kWh/MG) produced, used, or treated.

Drinking Water More than 8.5 billion gallons of drinking water are produced annually by the utilities that submitted data. The total energy used to produce this volume of water is just over 22 million kilowatt hours, or the equivalent of running 502 central air conditioners year-round. The overall energy intensity of drinking water in the Huron River watershed is 2,580 kWh/MG. Individual utilities had energy intensity values that ranged from 1,250 to 3,100 kWh/MG. Larger utilities tended to have higher energy intensity values than facilities serving smaller populations (Table 1).

A similar study of drinking water utilities in Illinois found an average energy intensity value of 1,910 kWh/MG. In Treasure Valley, Idaho, the average energy intensity for water production was 2,288 kWh/MG. A 2002 study that established estimates for energy consumption of public water suppliers nationally found 1,406 kWh/MG is required for treatment from surface water sources and 1,824 kWh/MG for treatment from groundwater sources.[vii] The energy intensity of water production in the Huron River watershed is about 10% higher than national averages but still lower than that seen in the Idaho example – a more arid and mountainous region where water is likely to be pumped from deeper wells and travels further.

TABLE 1

Total kilowatt hours of electricity per million gallons (kWh/MG) drinking water produced annually.

Energy Intensity of Water Production

Retail Population	# of Utilities	Minimum	Maximum	Average
> 10,000	3	1591	2929	2318
5,000 – 10,000	4	1410	3100	2126
Less than 5,000	3	1250	2376	1631

TABLE 2

Example percentages of hot water used for residential uses and energy intensity associated with each.[xii]

Energy Intensity of Hot Water Use

End-use	% of overall water use that is hot water	% of total hot water use	Energy intensity (kWh/MG)
Clothes washer	27.8%	15.5%	56,000
Dishwasher	100.0%	3.6%	203,600
Faucet	72.7%	34.3%	148,017
Shower	73.1%	25.1%	148,832
Toilet	0.0%	0.0%	0

Residential Water Use Water heating in the residential sector comprises the largest share of all water-related carbon emissions.[viii] In Michigan, 17% of all residential energy use goes to heating water[ix] and is the third largest cost behind space heating and cooling.[x] Nationally, 70% of residential water is heated with natural gas and 29% is heated with electricity.[xi] In the Huron River watershed, water is heated with energy derived from both of these sources, consistent with the national average.

Showers, laundry, dishwashing, and other household water uses utilize heated water. The amount of energy consumed for household water use can vary widely by household depending on many factors including the age and efficiency of water heaters, the efficiency of dishwashers and washing machines, the number of individuals in the home, and the habits of residents. Table 2 shows estimates of hot water use associated with common end uses and the energy intensity of those uses.

To establish an estimate of the energy associated with residential water use in the Huron River watershed, an estimate of water use needed to be determined. Water use numbers from Ann Arbor residents for 2013 were used to represent residential water use in the watershed. Based on this sample, individuals use approximately 59 GPD (gallons per day) or 56,328 gallons per household (2.6 occupants) each year. This is considerably lower than the established national average of 172 gallons per person per day; however, the national value was calculated in 1999.[xiii] New construction and retrofits have improved residential water efficiency since then.[xiv]

Residential energy use numbers were derived from a detailed home energy audit of 100 homes in Ann Arbor. The average household within the audit consumes 124 MMbtu (million btu) of energy annually (includes electricity and natural gas). With 17% of home energy use going to heating water, households consume an estimated 21.08 MMbtu/yr for water. This is the equivalent of 6,178 kWh, similar to running a central air conditioner for 51 days. Based on these values the energy intensity of water during residential use is 0.109 kWh/gallon or 109,000 kWh/MG.

Wastewater Treatment Various types of treatment are used to treat wastewater in the watershed. Each level of treatment has different energy consumption requirements. For the purposes of this analysis, each utility was categorized into one of four general treatment types (listed in order of increasing energy required): trickling filter, activated sludge, advanced wastewater treatment, and advanced wastewater treatment with nitrification.[xv]

More than 22 billion gallons[1] of wastewater are treated within the watershed each year by the utilities that submitted data. The total energy used to treat that wastewater is nearly 66 million kilowatt hours (approximately 1,500 central air conditioners running for a year).The overall energy intensity

[1]Volume of wastewater treated is higher than water produced in part because of municipalities that purchase drinking water from sources outside of the watershed but that provide wastewater treatment locally (e.g., Ypsilanti Community Utilities Authority).

TABLE 3

Energy intensity of Wastewater Treatment

Total kilowatt hours of electricity per million gallons (kWh/MG) wastewater treated annually. Water treated is in million gallons per year.

Water treated	# of Utilities	Minimum	Maximum	Average
> 1,000	3	1873	3639	2708
100 – 1,000	10	428	7023	4045
< 100	4	1421	9898	5416

TABLE 4

Energy Intensity of Wastewater by Treatment Type

Total kilowatt hours of electricity per million gallons (kWh/MG) wastewater treated annually.

Type of treatment	# of Utilities	Minimum	Maximum	Average	National Average[xvii]
Advanced treatment with nitrification	7	1873	8395	4422	1911
Advanced treatment	3	2984	4257	3627	1541
Activated sludge	4	2623	6943	4166	1322
Trickling filter	3	428	9898	3916	955

of wastewater treatment in the watershed is 2,975 kWh/MG. Individual utilities had energy intensity values of ranging from 427 to 9,898 kWh/MG. Unlike drinking water production, the larger operations were able to achieve higher efficiencies; however, there are exceptions (Table 3). The average energy intensity of wastewater treatment did not appear to vary by treatment type, and there is high variability among individual utilities independent of treatment type (Table 4). The Environmental Protection Agency Region 9 reports that wastewater treatment in California ranges, on average, from about 1600 to 5000 kWh/MG.[xvi] This is within the range of energy intensity values for wastewater treatment in the Huron River watershed although there is far more variation among facilities here. Estimates established at the national level are significantly lower (57–76%) than values derived for wastewater treatment utilities in the watershed (Table 3).

The Carbon Footprint of Water

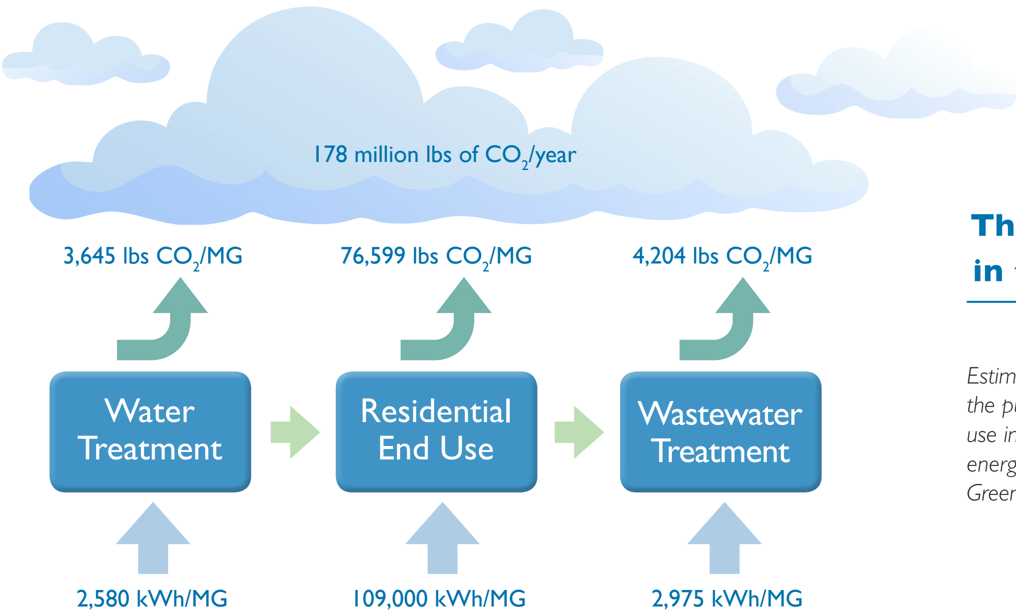
As illustrated, significant amounts of energy are expended to provide clean, dependable water. This energy produces measurable greenhouse gas emissions which, in turn, contributes to the carbon footprint associated with water use. A carbon footprint is defined as a measure of the total amount of greenhouse gas emissions produced from an activity or activities by a defined group of people. In this case, the activity is water use, and the group is residents of the Huron River watershed using water sourced from within the watershed. Ascertaining the carbon footprint of water is possible given that emissions related to water extraction, treatment, distribution, use, and discharge are all measurable.

Determining the carbon footprint of water can offer various benefits. As more people are educated about the energy consumed and carbon emitted by their water use, they will be more likely to adjust their behavior to conserve water than when they were unaware. Reducing water use and conserving water can lead to lower energy consumption, lower carbon emissions, lower monthly water and energy costs, and less demand for water from the Huron River.

Electricity is produced from multiple sources. Each state has a different mix of sources that supply its electricity. Emissions vary based on that mix. According to the U.S. Department of Energy[xviii] Michigan has an electric supply mix of coal (60.5%), nuclear (25.7%), natural gas (10.3%), oil (0.4%), hydro and nonhydro renewable (0.1%), and other (3.0%). The emission factor associated with this mix is 1.413 lbs CO_2/kWh.[xix] Coal, the main source of electricity in Michigan, also is the source that emits the most carbon into the atmosphere. Although natural gas burns more cleanly than coal or petroleum fuels, it still is a nonrenewable fuel that produces carbon dioxide.

Knowing Michigan's supply mix and the energy intensity of the stages of the water cycle, the carbon intensity (or amount of carbon emitted per unit water) can be estimated for the use of publicly supplied and treated water in the Huron River watershed. The total energy used for water treatment, residential use, and wastewater treatment contributes more than 83,219 lbs CO_2/MG of water. Associated with the more than 8.5 billion gallons of water treated and used, plus 22 billion gallons of wastewater treated in the watershed each year, 178 million lbs or nearly 89,000 tons of carbon dioxide are emitted (Figure 2). This amount is equivalent to the annual emissions from nearly 17,000 passenger vehicles. It would take more than 66,000 acres of forest one year to sequester this much carbon; more than double the combined areas of Southeast Michigan's Pinckney and Waterloo Recreation Areas.

FIGURE 2



The Carbon Footprint of Water in the Huron River Watershed

Estimate of total annual carbon dioxide released from the pumping, treating and heating of water for residential use in the Huron River watershed. Blue arrows represent energy inputs during each phase of the water cycle. Green arrows show carbon outputs.

The Role of Water Conservation

In order to reduce the carbon footprint of water use in the Huron River watershed, residents and utilities must make water conservation a priority. Water conservation strategies and practices can be easy to implement, and cost-effective ways to reduce carbon emissions should be applied. Often overlooked when identifying ways to reduce carbon emissions, water conservation holds the potential for significant reductions in a community's contribution to global climate change.

Changing water use behaviors, increasing water efficiency, reusing water, and reducing water loss are all means of achieving water conservation goals. Water conservation requires changes in water-use behavior combined with more efficient technology, improved design, and better water management practices. Although it is important to conserve water in all sectors, the residential sector is vital for significant reductions to be realized. **In the Huron River watershed, the carbon intensity of residential water use is nearly ten times that of drinking water and wastewater treatment combined.** Nationally, residential demand for water from public supply systems is greater than that of the industrial and commercial sectors combined.[xx]

Water use behaviors have a significant influence over the amount of water used in a home. Because the majority of water-related energy use is linked to water heating, the most effective method for reducing energy use is indoor hot water conservation. For example, reducing shower times from 10 to 5 minutes can save 12.5 gallons of water, plus the energy required to heat that water. Washing laundry in cold water reduces the energy needed for clothes washing by 90%, eliminating 1,600 pounds of CO_2 emissions per household per year.[xxi] The Huron River Watershed Council provides residents with a list of water conservation measures that they can implement at home at www.h2oheroes.org.

Water efficiency generally refers to practices and technologies that aim to use the minimum amount of water necessary to accomplish a particular task. A typical single family home uses 70% of its water for indoor uses such as flushing toilets, washing dishes, using showers and faucets, and doing laundry. Indoor water use can be significantly reduced by replacing water-using fixtures with high efficiency models. For example, a standard washing machine manufactured before 1994 uses 30–35 gallons of water per load. High efficiency models use 10–20 gallons. Replacing an old washer with an Energy Star washer saves about 5,100 gallons of water and $135 annually. With the savings in energy and water use, the replacement will pay for itself in 6 years. Switching to more efficient water-using fixtures can reduce household water consumption by nearly 35%. The Environmental Protection Agency's (EPA) WaterSense program offers labeling to help consumers identify water-efficient products www.usepa.gov/watersense.

Water and wastewater reuse are other water conservation methods that, while not widely used, hold significant potential for water and energy use reductions. Water reuse is simply reusing wastewater either before or after treatment for another application. In urban areas, wastewater can be reused for landscape irrigation, vehicle washing, toilet flushing, commercial air conditioners, and fire protection. According to the River Network "a typical household using 22,000 gallons of gray water per year to offset their potable water demand would save about 73 kWh of electricity annually."[xxii] However, there are obstacles to making residential water reuse practically and economically feasible in this region.[xxiii] For communities in the Huron River watershed, efforts need to be made to improve codes and regulations to facilitate easier adoption of water reuse practices. The WateReuse Association (www.watereuse.org) provides information of water and wastewater reuse.

Water loss can be the source of the greatest waste in a system and therefore a place where the largest savings can be realized. In homes, it is estimated that 10,000 gallons of water are lost to leaks yearly.[xxiv] This is one-fifth of the total amount of water used by watershed residents in the average home. For utilities, leaks in the distribution system can be on the order of 10% of total supply. If water systems leaks could be reduced by just 5% (0.5% of total water supply) enough electricity would be saved to power 31,000 homes. Approximately 225,000 metric tons of CO_2 emissions would be avoided.[xxv] There are a number of ways to identify and fix leaks in the home (www.usepa.gov/watersense). The American Water Works Association provides assistance to water utilities looking to reduce system water loss (www.awwa.org).

Summary

Energy is consumed during every step of the domestic water use cycle. It is used to extract water from its source, treat, and distribute that water to consumers. Consumers then use energy to heat water. Water used in homes becomes wastewater that is then treated before being released back into the environment. Of all these processes, heating is the largest water-related energy use in the residential sector.

If consumers used less water, it would minimize the energy consumption associated with water. Water conservation strategies can provide significant energy savings, while simultaneously reducing costs for consumers and reducing carbon emissions. Retrofitting homes and businesses with high-efficiency fixtures and appliances can help reduce emissions and lead to long-term environmental benefits and financial savings.

For utilities, reducing the demand for water will lead to reductions in the need to pump, treat, and distribute water to consumers, as well as reduce wear and tear on equipment. Improving energy efficiency at the facility and reducing water loss in the distribution system also contribute to savings in cost and carbon emissions.

The carbon pollution that results from energy use contributes to one of the largest threats to communities of the Huron River watershed – climate change. Michigan already is experiencing a range of negative impacts associated with climate change, such as increased average temperatures, increased precipitation, and more extreme and varied storm events.[xxvi] These changes will lead to significant impacts on the watershed, such as increased stormwater pollution, changes in fish and wildlife habitats, increases in invasive species, increased evaporation, and potential negative impacts to human health. Communities within the Huron River watershed can help to reduce these impacts and reduce greenhouse gas emissions by reducing their water-related energy use.

Often overlooked when identifying ways to reduce carbon emissions, water conservation holds the potential for significant gains in reducing a community's contribution to global climate change and something individuals and families can take on to reduce their carbon footprint.

Endnotes

[i] Griffiths-Sattenspiel, B and W Wilson. The Carbon Footprint of Water. Publication. May 2009. River Network. www.rivernetwork.org/resource-library/carbon-footprint-water. (Pg. 23)

[ii] US EPA WaterSense- Why Water Efficiency. www.epa.gov/watersense/our_water/why_water_efficiency.html

[iii] Griffiths-Sattenspiel, B. Water-Energy Toolkit: Understanding the Carbon Footprint of Your Water Use. July 2010. (iv)

[iv] The River Network. The Water-Energy Connection. www.eeweek.org/assets/files/water_and_energy/Water_Energy_Student_Facts.pdf [another cannot be found message]

[v] The River Network. The Water-Energy Connection. www.rivernetwork.org/sites/default/files/Water-EnergyFactsheetEEWeek.pdf

[vi] A River Network Report. July 2010. Water-Energy Toolkit: Understanding the Carbon Footprint of your Water Use.

[vii] Water and Sustainability: U.S. Electricity Consumption for Water Supply & Treatment—The Next Half Century, EPRI, Palo Alto, CA: 2000. 1006787

[viii] Griffiths-Sattenspiel, B and W Wilson. The Carbon Footprint of Water. Publication. May 2009. River Network. www.rivernetwork.org/resource-library/carbon-footprint-water.

[ix] EIA, 2009. Household Energy Use in Michigan. www.eia.gov/consumption/residential/reports/2009/state_briefs/pdf/mi.pdf

[x] Washington State University Energy Program. Energy Efficient Water Heating Fact Sheet. 2003. www.energy.wsu.edu/documents/AHT_Efficient%20Water%20Heating.pdf

[xi] Paul, L, I Swanson and K Conley. 2012. Treasure Valley Energy Outlook: Why Domestic Water Use Matters. Idaho Rivers United.

[xii] DeOreo, W and P Mayer. 2001. The End Uses of Hot Water in Single Family Homes from Flow Trace Analysis. Aquacraft, Inc. www.aquacraft.com/sites/default/files/pub/DeOreo-%282001%29-Disaggregated-Hot-Water-Use-in-Single-Family-Homes-Using-Flow-Trace-Analysis.pdf

[xiii] AWWA Research Foundation, 1999. Residential End Uses of Water. AWWA Research Foundation and American Water Works Association. www.waterrf.org/PublicReportLibrary/RFR90781_1999_241A.pdf

[xiv] DeOreo, W and P Mayer. 2012. Insights into Declining Single Family Residential Water Demands. Journal American Water Works Association, vol 104/6.

[xv] Water and Sustainability: U.S. Electricity Consumption for Water Supply & Treatment—The Next Half Century, EPRI, Palo Alto, CA: 2000. 1006787

[xvi] www.epa.gov/region9/waterinfrastructure/waterenergy.html

[xvii] Water and Sustainability: U.S. Electricity Consumption for Water Supply & Treatment—The Next Half Century, EPRI, Palo Alto, CA: 2000. 1006787

[xviii] U.S. Department of Energy, Energy Information Administration, Power Plant Report (EIA-920), Combined Heat and Power Plant Reprot (EIA-920) and Electric Power Monthly (2006 Preliminary).

[xix] EPA's eGRID2006v2.1 released in April 2007 www.epa.gov/cleanenergy/energy-resources/egrid/index.html

[xx] Griffiths-Sattenspiel, B and W Wilson. The Carbon Footprint of Water. Publication. May 2009. River Network. www.rivernetwork.org/resource-library/carbon-footprint-water.

[xxi] Borris, C. 2002. The Hidden Life of Laundry. Sierra Magazine. Sierra Club.

[xxii] A River Network Report. July 2010. Water-Energy Toolkit: Understanding the Carbon Footprint of your Water Use.

[xxiii] The Corporation of the City of Guelph. 2012. Guelph Residential Greywater Field Test Final Report. www.guelph.ca/wp-content/uploads/GreywaterFieldTestReport.pdf

[xxiv] EPA WaterSense Fix a Leak Week website www.epa.gov/watersense/pubs/fixleak.html

[xxv] Griffiths-Sattenspiel, B and W Wilson. The Carbon Footprint of Water. Publication. May 2009. River Network. www.rivernetwork.org/resource-library/carbon-footprint-water.

[xxvi] Andresen, J, S Hilberg, K Kunkel. 2012. Historical Climate and Climate Trends in the Midwestern USA. In: U.S. National Climate Assessment Midwest Technical Input Report. J Winkler, J Andresen, J Hatfield, D Bidwell, and D Brown, coordinators. Available from the Great Lakes Integrated Sciences and Assessments (GLISA) Center, glisa.msu.edu/docs/NCA/MTIT_Historical.pdf.

Appendix 1

Municipal Water Utilities in the Huron River Watershed

Drinking Water Utilities	Data Provided for Analysis
Ann Arbor Water Treatment Services	Yes
Barton Hills Village Water	No
Brighton Municipal Wells	Yes
Chelsea Utilities	Yes
Dexter Municipal Wells	Yes
Fonda Island and Brigs Lake Water Authority	No
Hartland Water Supply	No
Livingston Community Water Authority	No
Loch Alpine Sanitary Authority	Yes
Lyon Municipal Wells (Woodwind)	Yes
Marion, Howell, Oceola and Genoa Water Authority	Yes
Milford Municipal Wells	Yes
Pinckney Municipal Wells	Yes
South Lyon Municipal Wells	Yes
Stockbridge Municipal Wells	No
Waterford Municipal Wells	No

Wastewater Treatment Utilities	Data Provided for Analysis
Ann Arbor Waste Water Treatment Services	Yes
Brighton Township WWTP	Yes
Brighton WWTP	Yes
Chelsea Utilities	Yes
Commerce Township	Yes
Dexter WWTP	Yes
Genoa-Oceola Sewer Authority	Yes
Green Oak Township WWTP (Hidden Lake Sewer)	Yes
Loch Alpine SA-Scio-Web WWTP	Yes
Milford Department of Public Services	Yes
Northfield Township WWTP	Yes
Oakland Co Walled Lake/Novi WWTP	Yes
Pinckney Sewer Services	Yes
Salem Township Sewer Department	Yes
South Huron Valley Wastewater Treatment	Yes
South Lyon Water Department	Yes
Woodwind Water Treatment Plant	No
Ypsilanti Community Utilities Authority	Yes

Acknowledgements

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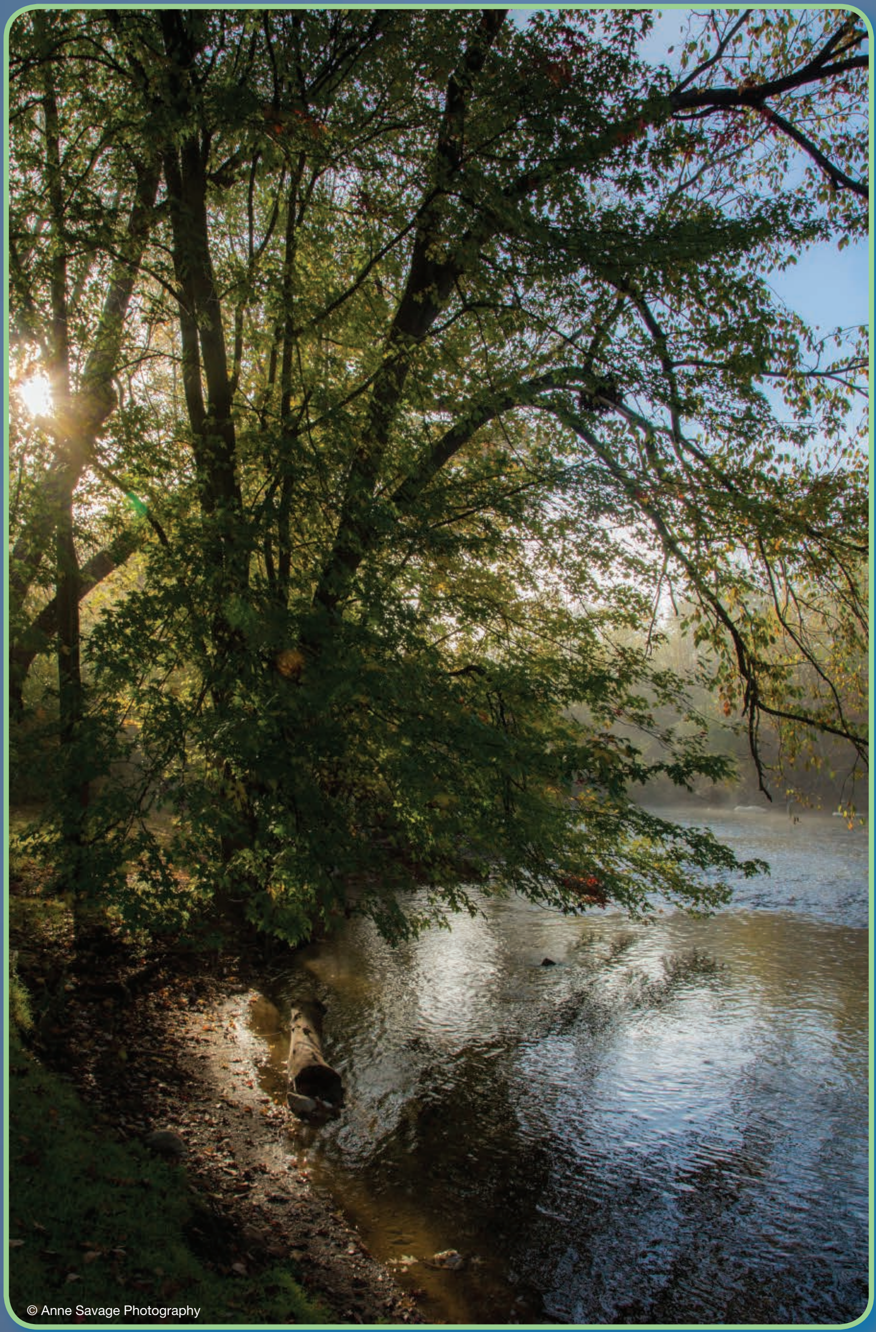
HRWC is a nonprofit coalition of local communities, businesses, and residents established in 1965 to protect the Huron River and its tributary streams, lakes, wetlands, and groundwater. HRWC works to inspire attitudes, behaviors, and economies that protect, rehabilitate, and sustain the Huron River system. Services include hands-on citizen education, technical assistance in policy development, and river protection and monitoring projects. See www.hrwc.org for information.

Huron River Watershed Council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