Chapter 5. Using Water

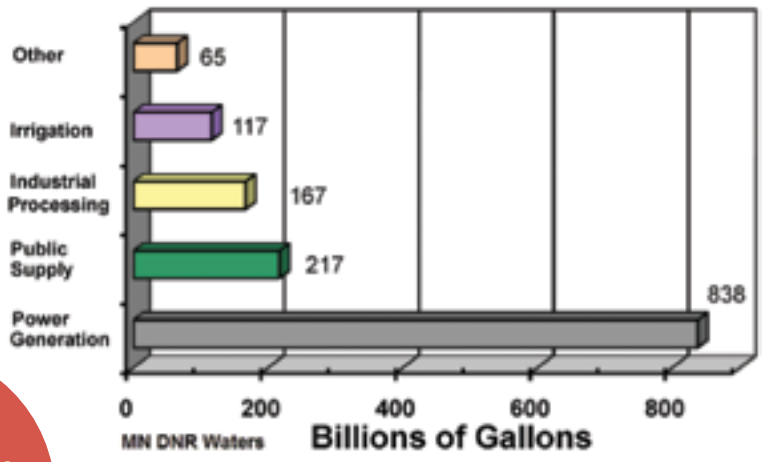
Key Concepts:

- People use water in many ways
- Water influences where people live
- Most household water supplies in Minnesota come from groundwater
- Water is important for generating electricity
- Water is important in manufacturing
- Agriculture depends on the right amount of water at the right time
- Transportation uses can affect water
- Minnesota's tourism industry depends on water

Why do people so universally seek water? It's probably because we use water in many ways. In fact, we literally can't live without it. If you were stranded without food, you could probably survive for weeks. If you were stranded without water, your fate would be dire within days.

Water use can be divided into two broad categories. **Offstream use** is water use that involves removing water from its source. Examples include diverting water for drinking, irrigating farm fields or cooling power plants. In 2008, Minnesotans used 1.4 trillion gallons of water for power generation, public water supply, industrial processing, irrigation, and other offstream uses.

Minnesota Water Use for 2008: 1.4 trillion gallons



Pick 10 Minnesota cities—any cities. Find them on the map. What do they have in common? They're all in Minnesota, for one. And chances are, most (if not all) are associated with a body of water. Winona, Red Wing, St. Paul. St. Cloud, Grand Rapids all grew up along the Mississippi. Duluth, Lutsen, and Grand Marais share Lake Superior. Moorhead, Red River of the North. Bemidji, Lake Bemidji. New Ulm and Mankato, the Minnesota River. Stillwater and Taylors Falls, the St. Croix River.

From the earliest times people have been drawn to water. Some of Minnesota's best records of original inhabitants come from the shores of Mille Lacs Lake, where evidence of inhabitation dates back some 9,000 years. Fort Snelling was built as a wilderness outpost at the confluence of the Minnesota and Mississippi Rivers in 1825—making the place the Dakota had called *makoce cokaya kin*, the center of the universe, a hub for settlers as well as Native Americans. As European immigrants settled the state, cities and towns developed along rivers and on the shores of lakes all around the state.

Confluence: the place where two rivers run together.

How much is 1.4 trillion gallons?

Lake Superior contains 3 quadrillion gallons of water (10% of the worlds fresh water). If Minnesotans used water exclusively from Lake Superior and it was not replenished, how many years until it would run out? Have students figure out how long the water supply would last.

Answer: 2142 years.

Uses in which the water is not removed from the lake, stream, groundwater, or other source are considered **instream uses.** Examples of instream use include fishing, providing habitat for a wide range of living things, hydropower production, and transporting goods.

Offstream and instream uses of water are important to helping people survive and thrive. However, they can have adverse effects on the water cycle, water bodies, and the community of living things that depend on them. Chapter 6 describes some of the negative impacts water use has had in the past and continues to have on waterways, and provides examples of how we can and do work to protect waters from harm as we benefit from them.

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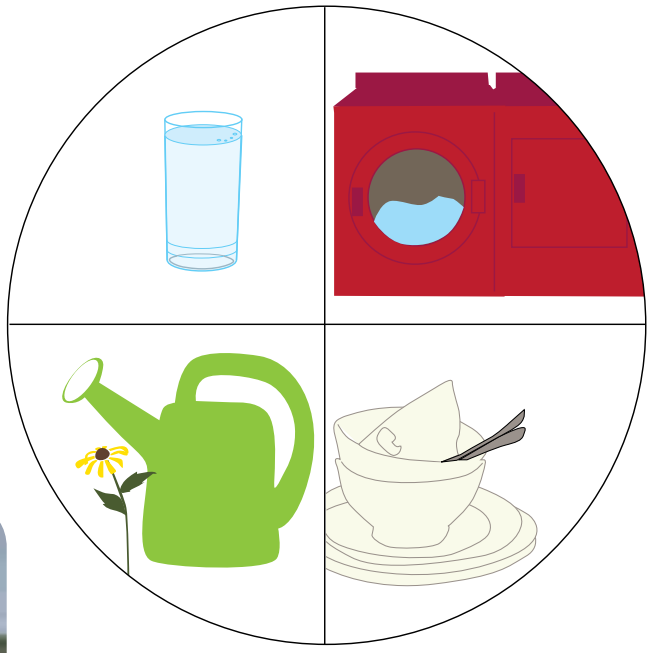
Instream water use.

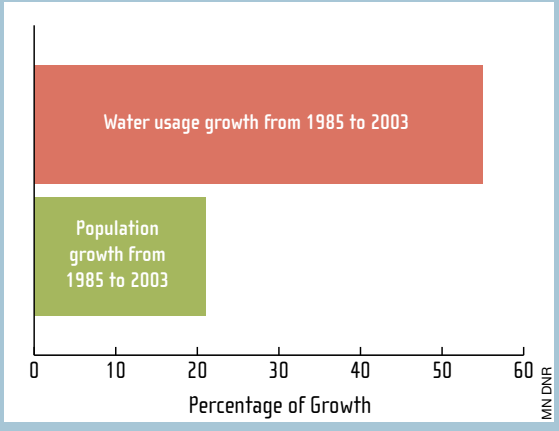
The average American uses 80 to 100 gallons of water each day for drinking, washing dishes and laundry, watering lawns and gardens, and other activities. That's the equivalent of 853 cans of pop.



Adult humans need to take in about 2½ quarts of water per day to stay healthy.

Slicing the Water Pie. All together, Minnesotans used 3.4 billion gallons of water per day in 1995. By volume, the most water use is for cooling power plants, followed by public water supply, mining, irrigation, industrial uses, domestic uses, commercial uses, and livestock.

In recent years in Minnesota, water use has grown faster than population. Between 1985 and 2003, for instance, water use grew 55 percent. During that same time, population grew 21 percent.



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Water at Home

The most universal use of water is domestic use. Every day we tap our local water resources for drinking, food preparation, cleaning, and waste disposal in our homes. Some of us get our household water from a municipal water supply, and some of us get it from private wells. Municipal water supplies may come from groundwater or surface waters such as Lake Superior or the Mississippi River. Wherever your household water supply comes from, it's part of Minnesota's water cycle.

Water In …

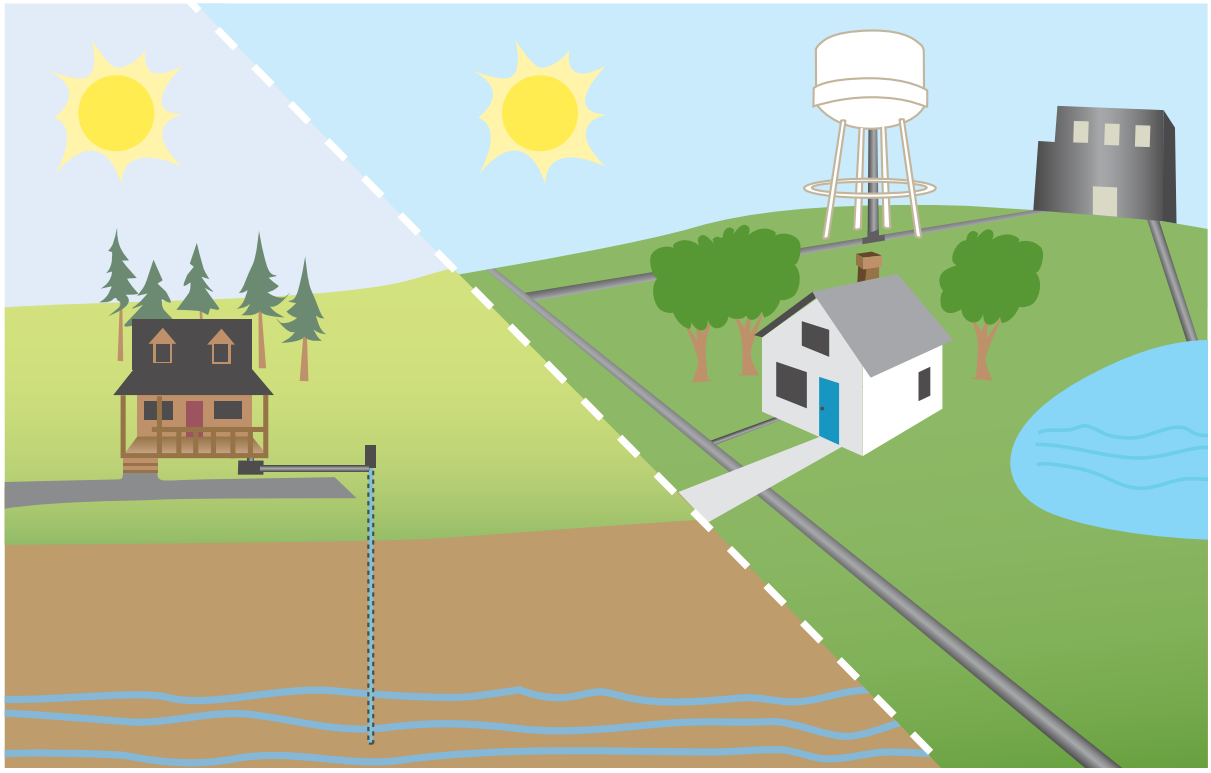
You probably don't think too much about it when you turn a handle in your kitchen or bathroom and water comes out of the faucet. But historically, that's a relatively new notion. For much of history—and in some places, yet today—people have scooped water directly from lakes and streams or drawn it up from beneath the ground to meet the water needs of everyday living. That means using water at its source, or carrying it in containers to where it is needed. When European settlers first began to settle Minnesota, they often settled where they could find water.

Today, most Minnesotans draw their household water from a municipal water supply or have it pumped directly from a well that taps groundwater.

In the case of a private water supply (well), an electric pump pulls water from the aquifer into a pressure tank. The water may be screened for particles and treated to remove minerals that give it an undesirable color or flavor. The pressure tank uses electricity to pressurize the water. When someone turns on a tap or flushes a toilet, the pressurized water flows through pipes to the point of use.

Minnesotans drill an average of 10,000 to 12,000 new wells each year.

In cities and towns, residents share a municipal water supply rather than obtaining their water from individual wells. The local water treatment facility draws water from a river, lake, or large well. A process called flocculation uses chemicals to make the dirt in the water to clump together. Small particles are allowed to settle out, then the water is filtered to remove even smaller particles. The water is treated with chlorine to kill germs, and it may also be fluoridated to reduce dental decay. Other substances may be added to reduce iron staining, hardness, or scaling. Then it is stored in a water tower or other reservoir so enough will be available to meet an average daily demand for emergencies and fire protection. Homes and businesses are hooked up to the water supply via a series of underground pipes known as water mains. Water mains have branches leading to individual houses. When a resident turns on the tap to obtain water for drinking, cooking, cleaning, flushing the toilet, or watering the lawn or garden, water flows from the holding tank or water tower.



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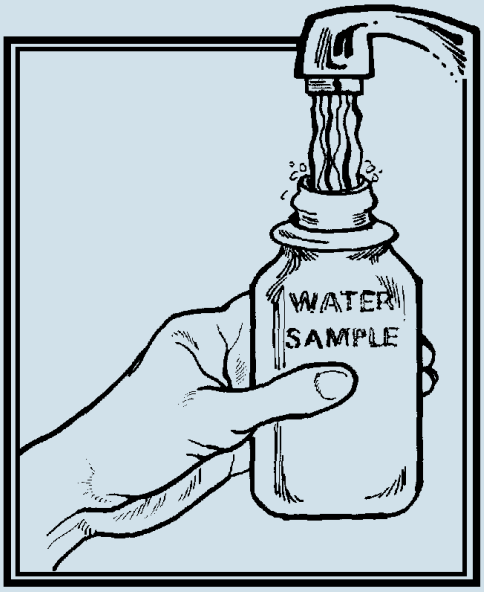
Keeping Drinking Water Safe. The Minnesota Department of Health has a number of requirements to ensure the safety of drinking water throughout the state. Community water suppliers, noncommunity water suppliers (like schools, day cares, and factories that serve the same individuals daily) and noncommunity nontransient water suppliers—those that are independent of the community supply but supply water to a stable population of 25 or more, such as a school or business—must engage a certified water operator and follow a prescribed schedule for testing water to make sure it's safe. Noncommunity transient public suppliers—places like restaurants and churches that supply water to people who come and go—need not engage a certified operator, but they, like nontransient suppliers, are required to undergo a sanitary survey every three years. MDH recommends that people on private wells have their drinking water tested once a year for total coliform, once every two to three years for nitrate (more often if infants or young children are in the home), and at least once for arsenic.



U of WI Extension

More than a million Minnesotans get their water from private wells.

About three-quarters of Minnesota's drinking water is drawn from groundwater. For example, the city of Rochester withdraws about 4 billion gallons per year from the Prairie du Chien–Jordan aquifer. The city of Willmar withdraws 1.6 billion gallons per year from the Quaternary Buried Artesian aquifer. The city of Grand Rapids pumps water from five wells and stores it in a half-million-gallon tank underground. Many Twin Cities suburbs tap groundwater as well.

The other one-quarter of Minnesota's drinking water comes from various sources of surface water. Most of the drinking water in the Twin Cities and St. Cloud comes from the Mississippi River—in fact, about 1.1 million Minnesotans use water from the Mississippi. Duluth and other North Shore communities such as Two Harbors, Silver Bay, and Grand Marais draw their water from Lake Superior. Moorhead and East Grand Forks take water from the Red River. Other communities that use surface water include Thief River Falls, Albert Lea, and Chisholm.

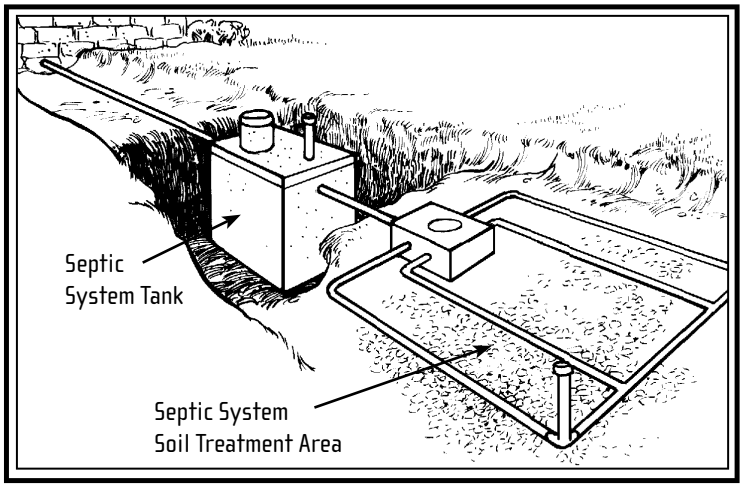
In 2007, domestic water and other "public supply" uses in Minnesota added up to 227 billion gallons.

The city of Minneapolis water distribution system has 1,000 miles of water mains. That's equal to almost half the length of the Mississippi River!

Treatment on Arrival. In addition to the treatment water receives where it is withdrawn from a source, some homes and business places choose to treat water again to remove any remaining undesirable staining substances, chemicals, tastes, and odors. These devices include water softeners, filters, distillation systems, activated carbon, and reverse osmosis.

… And Out Again

What comes in, must go out, and it did not take long for people to realize that water could be used to dispose of waste as well. Today most buildings in Minnesota use water to wash wastewater from sinks, tubs, and toilets through pipes to a place where it is treated and then returned to the environment.



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Nearly one-third of Minnesotans use individual wastewater treatment systems, also known as septic systems or individual sewage treatment systems for disposal of wastewater. Water flows into a tank, where solids settle out and some of the organic matter in the water starts to degrade. From the tank, water flows into a specially designed soil treatment area, where microorganisms finish the job of breaking down the organic matter.

Wastewater from most Minnesotans is treated in a municipal wastewater treatment facility run by their community. Water flows in pipes to a central facility, where first large objects are screened and solids and grease are removed. Microorganisms then begin to break down the organic material in the water. Finally, the water is disinfected to kill any disease-causing organisms it might contain. It also is treated to remove nutrients that would promote the growth of plants and algae wherever it ends up. Eventually the treated water is released through a pipe to a nearby river or lake, or in some cases sprayed onto land.

tMN DNR

Wastewater treatment plant. St. Cloud, Minnesota.

Food From Water

If you're one of Minnesota's 2.3 million avid recreational anglers, you know that our state's great waters also are a source of food. Each year anglers pull millions of fish from state waters. Many of those end up on dinner plates.

Inhabitants of the land we now call Minnesota have been harvesting food from waters here since long before the advent of bait shops and dip nets. Archaeologists believe fish were part of the Paleoindian diet (along with mastodon!) between 10,000 and 6,000 B.C. During the Archaic period, 6,000 to 800 B.C., people often settled along lakes and rivers. We have strong evidence in the tools they left behind that fishing was among the ways they obtained their food.

Biodiversity: Minnesota waterways are home to 158 species of fish.

In addition to supporting sports anglers, Minnesota waters also support commercial fishing. In the early 2000s, more than 50 commercial fishing businesses harvested about 3 million pounds of fish per year from Lake Superior, the Mississippi River, Canadian border waterways, and some scattered lakes in southwestern Minnesota. Commercial fishing also takes place today on Red Lake in northern Minnesota. Many commercial fishing businesses grow fish in aquaculture systems rather than harvesting them from the wild.

MN DNR

Commercial herring fishing, Lake Superior.

Other foods that grow in Minnesota waters include wild rice, cranberries, and snapping turtles.

Manoomin, Wild Rice. For centuries, late summer has meant wild rice harvest in the place we now call Minnesota. A grass with edible, nutritious seeds, wild rice once grew throughout the state in the shallows of lakes and rivers. In fall, people would canoe through the rice stands, bending and brushing the long stalks with special sticks, called flails, so that the seeds fell into their canoe. After processing, the seeds provided a staple food through the long winter.

Minnesota Historical Society.

Today much of the wild rice we find in stores is grown on wild rice farms rather than in the wild. But each year, about 1,600 people buy licenses so they can harvest Minnesota wild rice from the 60,000-some acres of wild waters that still provide habitat for this valued and valuable food source.

Support for Energy

Did you know that Minneapolis was once known as the flour capital of the world? Why do you think that was? The answer is St. Anthony Falls on the Mississippi River. When wheat harvests were ready to be milled into flour, the falls provided the waterpower to turn the mills that ground it into flour.

In the early days of European settlement, waterfalls around Minnesota were used to run sawmills, flour mills, and other equipment and machinery. Use of water for manufacturing forest products in Minnesota, for example, dates back to 1821, when the U.S. Army built a sawmill at St. Anthony Falls on the Mississippi River to produce boards for building Fort Snelling. Today we continue to capture the kinetic energy of water rushing downhill for work that meets human needs by using hydroelectric dams to direct the flow of water through turbines, causing them to turn. The turning turbines are connected to magnets that spin within wire coils, generating electricity. Minnesota has 32 hydropower facilities with a total capacity of 204 megawatts (MW). (For comparison, the Allen S. King coal-fired power plant near Stillwater has a power production capability of 588 MW.)

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By far, the most common use of water in Minnesota is for generating power. In fact, the number one use of water for anything in Minnesota—is in the generation of electricity in both fossil fuel–fired and nuclear-fired power plants. Most electricity in the state is produced by heating water to make steam that is then used to turn turbines and generate electricity. Other water is then used to cool down the heated water. In nuclear power plants, water is also needed to cool equipment.

Water is also used in refining oil to produce transportation fuel, and is an important part of the production equation for renewable fuels such as ethanol and biodiesel from crops and other plant materials. In addition to being used to grow biofuel crops, water is also needed to transform the biomass into a usable fuel. With current technologies, an estimated 4 to 4.8 gallons of water is needed to process each gallon of ethanol produced.

In recent years innovators have been exploring the possibility of generating electricity using small turbines attached to floating barges in flowing water. As with conventional hydropower, such turbines use the energy of flowing water to turn a turbine that in turn turns a generator to produce electricity. The first commercial turbine of this sort in the United States was installed in the Mississippi River near Hastings, Minnesota in 2008. Researchers are studying the turbine's impact on the river and its inhabitants.

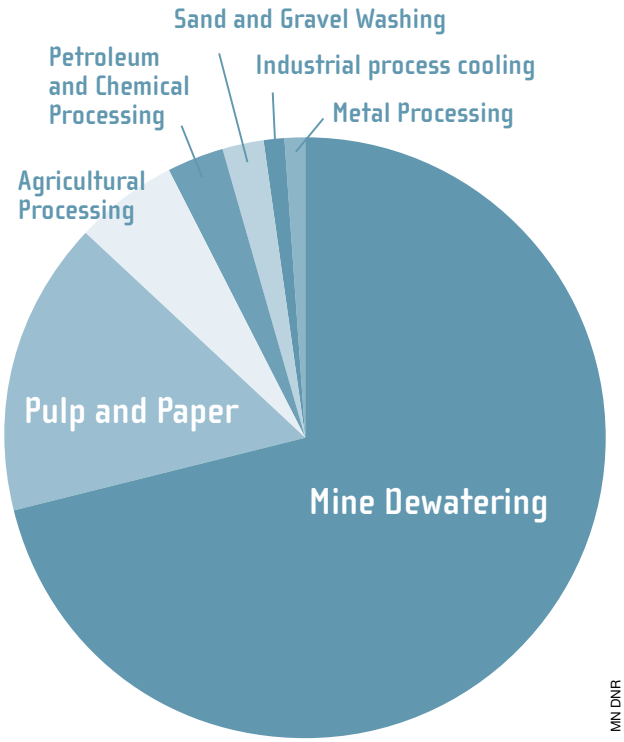
USFWS

Industrial Uses

Water is used in many other industries in addition to electricity generation. In Minnesota, mining processing and pulp and paper manufacturing are the two major industrial uses of water.

Some industrial applications involve adding water to the material being manufactured. When paper is made, for example, tree chips are cooked in water, or recycled paper is soaked in water. Other applications include using water for washing.

Most water used for industrial purposes in Minnesota comes from lakes and rivers. In 2007, some 167 billion gallons of water were withdrawn for industrial purposes in Minnesota. Most of this total—118.3 billion gallons—was for mine dewatering. The second biggest industrial water user was pulp and paper production at 26.2 billion gallons. Other uses included agricultural processing (9.3 billion gallons), petroleum and chemical processing (4.8 billion gallons), sand and gravel washing (3.7 billion gallons), industrial process cooling (2.2 billion gallons), and metal processing (1.4 billion gallons).



MN DNR

MN DNR

Most water used for industrial purposes in Minnesota is for mine dewatering.

In 2007, Minnesotans used some 445 million gallons of water to make artificial snow.

A Lot of Cold Air. In 2007, Minnesota businesses used 338 million gallons of water for air conditioning.

Agriculture and Irrigation

Agriculture is another important use of water in Minnesota and around the world. Both plant agriculture and animal agriculture demand abundant water.

In the early days of modern farming, water for plants came from the sky, and water for animals came from a river or lake, or was drawn up from the ground by a wind-driven pump. Then, in the late 1800s, farmers began to irrigate their crops. Most irrigation water comes from groundwater rather than lakes and streams. In 1995 Minnesota farmers used 62 million gallons of water a day to quench their livestock's thirst and sanitation needs. In 2008, Minnesota agricultural producers and others used 117 billion gallons of water for irrigation.

MN DNR

"The ordinary farmer will pooh, pooh at the desirability of [digging irrigation ditches], and will prefer to do business on the old plan of just looking to Providence for the rain that falls on the just and unjust. You that are engaged in horticultural pursuits, can well afford to look into this matter, remembering that ... each acre upon which you can conduct water means four acres, as its production is increased from two to three fold from irrigation."

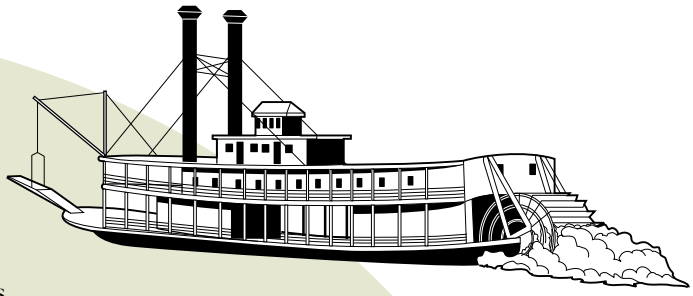
—From *"Irrigation for Minnesota"* by S. M. Emergy, published in the 1894 Annual Report of the Minnesota State Horticultural Society

All Wet. Irrigation is not just for farm crops and front lawns! In 2007, 9.7 billion gallons of water were used to irrigate golf courses in Minnesota, and another 125 million gallons were used to maintain cemetery vegetation.

Water Meal. What's that on the table—a small lake? In a way, yes. From seed to plate, it takes about 1,400 gallons of water to make a hamburger, French fries, and soda. Most items we use daily hide the "virtual water" needed to create them.

Transportation

Before highways and roads, bodies of water served as transportation routes through the land we now know as Minnesota. Native American Indians traveled rivers and lakes in bark canoes and dugouts. They also walked or used sleds to traverse ice: Even when frozen, water bodies offered an easier means of transportation than traveling through forests and over hills. Explorers and voyageurs followed in their wake and their footsteps.



In 1823, a steamboat made the first trip to Fort Snelling from St. Louis. The limiting factor for using the stretch of the Mississippi River above Fort Snelling for transportation was the presence of shallow spots and rough water in the river gorge (now the area south of the Ford Dam). St. Paul grew up at the upper end of feasible steamboat travel on the Mississippi River. In 1824, the federal government assigned the U.S. Army Corps of Engineers the task of creating and maintaining a navigable waterway along the Mississippi River. The corps created the lock and dam system and began dredging the water.

In the mid- to late1800s, Minnesota's northern rivers were used for transportation of a different sort: shipping logs downstream to markets and mills. Over the course of less than a century, huge numbers of logs were transported in this way.

The Mississippi River continues to be an important water highway today, carrying coal, cement, wheat, and other goods.

National Park Service, Voyageurs National Park Collection

Map of main fur trade routes in northern Minnesota and Canada.

Ecosystem Services. As water works its way through the water cycle, it provides a variety of valuable services that would be expensive if not impossible to obtain through technological fixes. The most obvious, of course, is precipitation. Every time it rains, farmers, gardeners, golf course operators, park managers, and lawn caretakers are saved the expense of irrigating or watering their crops and plants. Rain also washes streets and parking lots when it falls. Clouds provide welcome shade in hot weather. Evaporation helps cool everything from our own bodies to entire cities. Water features provide ecosystem services, too. Wetlands cleanse water by filtering nutrients and sediment. Lakes provide food and fun. Rivers carry boats and cargo upstream and downstream, saving fuel.

These functions, known as ecosystem services, are critical to consider when we make decisions that may affect the availability and distribution of water in our lives. Although we may not pay for these services when they are readily available for free, we would likely have to pay some serious money to compensate for their absence if they were not.

Recreation

Water is also a source of fun! Whether swimming, motor boating, fishing, canoeing, kayaking, waterskiing, sailing, ice skating, waterfowl hunting, or any of many other water-related activities, Minnesotans know how to enjoy the world of water. Our state has more boats per capita than any other state in the nation—one boat for every six people! The only outdoor activity that has more participants than recreational boating in Minnesota is walking. Truly this is the place for boaters to be.

Even if we're not motoring or paddling around on it, water can provide us with a source of beauty, comfort, and delight and fill us with a sense of well-being. The sound of running water (as long as it's not a plumbing problem) can be restful and calming. People from all over the United States and beyond flock to Minnesota's North Shore of Lake Superior to take in the striking beauty of foaming waterfalls as rivers tumble over rock to the big lake below.

MN DNR

Grand Portage State Park.

More than 30 of Minnesota's 74 state parks and recreation areas have a water feature as part of their name.

Lake Pepin Prodigy. Getting pulled around a lake by a long rope tied to a motorboat—who ever thought of that?!? With our focus on recreational boating, it's not surprising that the inventor of modern water skiing has a Minnesota connection. The story goes that an 18-year-old Minnesota man, Ralph Samuelson, decided to try skiing on Lake Pepin, a widening of the Mississippi River near Red Wing, on a June day in 1922. After being towed around countless times by his patient brother, he perfected his technique to the point where others wanted to give it a try, too. The rest, as they say, is history.

Minnesota Historical Society.

CAREER PROFILE

Bill Hansen
President,
Sawbill Canoe Outfitters, Inc.
Tofte

Bill Hansen's parents started Sawbill Canoe Outfitters near Tofte, Minnesota, when he was 3 years old. Ever since, he's been helping people enjoy Minnesota's bountiful lakes by providing the equipment they need to travel in the Boundary Waters Canoe Area Wilderness.

"We enable people to visit one of the world's most unique water-based wilderness areas," Hansen says. "I love introducing people to the wilderness and watching them discover the joys of wilderness canoe camping."

Hanson's business depends on clean, healthy waterways that can provide recreational opportunities for people who visit northern Minnesota. A typical summer day might include renting canoes and giving visitors advice on choosing a route, as well as sweeping the floor and maintaining equipment. A typical winter day would include answering email, answering phone questions, shoveling snow, placing orders for equipment, fixing equipment, and enjoying some cross country skiing. Hansen loves living and working right on the edge of a big lake. His only wish is that he could go on more canoe trips himself.

How would a person prepare for a career like his? Hansen recommends spending as much time as you can in the wilderness. Business skills like accounting and human resources management are also important, as is the ability to fix just about anything.

Related careers:
fishing guide,
resort owner

Suggested Project WET Activities and Minnesota Connections

EL = elementary | MS= middle school | HS=high school

Water is essential for all life to exist

Aqua Bodies (water in living things) EL

Poison Pump (waterborne disease/drinking water) EL, MS

Water connects all Earth systems

Wet Vacation (climate, tourism) MS

Water is a natural resource

Common Water (water users) EL, MS

A Drop in the Bucket (global water distribution) EL, MS, HS

Energetic Water (water for energy) EL, MS

Irrigation Interpretation (agriculture) EL, MS

The Long Haul (historical and current water use) EL, MS, HS

Water Works (interdependence of water users) EL, MS

Water resources are managed

Back to the Future (analyzing streamflow data & floodplain planning) EL, MS, HS

The Price is Right (community planning) HS

Sparkling Water (wastewater treatment) EL, MS, HS

Superbowl Surge (wastewater planning) MS, HS

Wet Work Shuffle* (water careers) EL, MS, HS - Career profiles from professionals around MN.

Water resources exist within social constructs

Choices Preferences Water Index (water users) MS, HS

Dilemma Derby* (water issues, problem solving) MS, HS - MN case studies of historical water issues.)

Easy Street (historic and current water use) EL, MS, HS

Hot Water (debate water issues) HS

Water Concentration (historic and current water use) EL, MS

Water Crossings* (rivers & history) EL, MS, HS - MN water crossings stories, maps.

Water resources exist within cultural constructs

Wish Book (recreation) MS, HS

* Some Project WET Activities have Minnesota adaptations posted online for Minnesota Project WET Educators in the trained teacher page at www.mndnr.gov/projectwet. Additional adaptations will be added when possible.

Classroom Connections

Community Roots: Invite students to research the history of water in your community or another community with significance to them. How were local lakes and rivers used in the past? What body or bodies of water sustain people and businesses there today? How do they do so?

What are Ecosystem Services? Have older students identify and explore an ecosystem service provided by water that moves through the water cycle in your community. If water were not available to perform that service, how would the service be provided, and what would it cost? Some ideas: irrigating farm fields, washing streets, filtering sediments and nutrients from runoff before it gets to lakes or rivers, providing cooling water for power plants, cooling the air through evaporation, providing shade (in the form of clouds), transporting cargo up and downstream, providing recreational opportunities.

Calculate Your Water Footprint: Students can get a sense for their own water footprint. Help them identify the source of the water they use at school and at home. Then have them keep track of how much water they use for a week. Do a web search for "personal water use" and "water footprint calculator" for some guidelines on numbers to use for brushing teeth, flushing the toilet, washing dishes, etc.

School Water Use: Talk to your school's facilities management staff to determine how much water is used at school each day—inside and out. What are the biggest users of water: restrooms, swimming pool, sprinkler systems? How much money does you school spend on water each year? How could you help reduce water use?

Sharing Water Stories: Invite very young students to share stories of fun they've had with water—playing in a puddle, swimming in a pool, washing dishes, watering the garden, riding in a boat, walking in the rain, splashing in the tub.

Out and About

Neighborhood Water Use: How is water used in the vicinity of your school? Go for a hike in the neighborhood and look for different ways water is being used. If you encounter a business, ask how water is used there. Take a clipboard and pencil to record your discoveries. If your circumstances allow, split into several groups and head out in different directions, then compare notes when you return.

School Water Use: For very young children, arrange for a tour around the school to see all the different places and ways water is used.

A few excellent resources:

1. Local Drinking Water Information website, US EPA. http://www.epa.gov/safewater/dwinfo/index.html Students can see if their local annual drinking water quality report is posted online.

2. *Water A Natural History* by Alice Outwater (1997). Covering the history of the United States waterways, this book moves from the reservoir to the modern toilet, from the grasslands of the Midwest to the Everglades of Florida, through the guts of a wastewater treatment plant and out to the waterways again. It shows how human-engineered dams, canals and farms replaces nature's beaver dams, prairie dog tunnels, and buffalo wallows.

3. Wastewater Treatment Plant Tours (Twin Cities area), Metropolitan Council. http://www.metrocouncil.org/Environment/Education/mcesTours.htm Find information about scheduling tours for your class.

4. Minnesota Water Use Statistics, MN DNR. http://www.dnr.state.mn.us/waters/watermgmt_section/appropriations/wateruse.html This site shows how and where Minnesota's water is used and permitted.

5. Water Use in the United States, United States Geological Survey. http://ga.water.usgs.gov/edu/wateruse.html This section of the USGS Water Science site is includes information for students about how the USA uses water on an everyday basis.

Want More? See www.mndnr.gov/projectwet for resources and information:

Academic standards correlations to Project WET Activities
Educational materials/classroom resources for Project WET teachers
Out and About—field trip ideas
Citizen science/service learning opportunities
Useful websites
Suggested books