# Water Use and Flow Rate Calculation

**AUTHOR:**
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**GRADE:** 7

**SUBJECTS:** Science

**DURATION:** Several class periods

**GLCEs:** S.IP.07.13, S.IP.07.14, S.IP.07.15, S.IP.07.16, S.IA.07.12, S.IA.07.15, S.RS.07.17, E.ES.07.41, E.ES.07.42, E.ES.07.81, E.ES.07.82

**MATERIALS:**
- Stop watch
- Different measuring devices including: Measuring cups
- Graduated cylinders
- Beakers
- Gallon Jug
- Graph Paper
- Access to multiple faucets

**LESSON OVERVIEW:**
In this lesson, students will become familiar with the water cycle, distribution of water on earth, and various water uses. They will also be able to calculate flow rates for various faucets, and develop various water conservation strategies for their homes, schools, and communities.

**Michigan Grade Level Content Expectations (GLCEs):**
- Use tools and equipment (spring scales, stop watches, hand lens, thermometer, models, sieves, microscopes, hot plates, pH meters) appropriate to scientific study (S.IP.07.13).
- Use metric measurement devices in an investigation (S.IP.07.14).
- Construct charts and graphs from data and observations (S.IP.07.15).
- Identify patterns in data (S.IP.07.16).
- Evaluate data, claims, and personal knowledge through collaborative science discourse (S.IA.07.12).
- Use multiple sources of information to evaluate strengths and weaknesses of claims, arguments, or data (S.IA.07.15).
- Describe the effect humans and other organisms have on the balance of the natural world (S.RS.07.17).
- Explain how human activities (surface mining, deforestation, overpopulation, construction and urban development, farming, dams, landfills, and restoring natural areas) change the surface of the Earth and affect the survival of organisms (E.ES.07.41).
- Describe the origins of pollution in the atmosphere, geosphere, and hydrosphere, (car exhaust, industrial emissions, acid rain, and natural sources), and how pollution impacts habitats, climatic change, threatens or endangers species (E.ES.07.42)
- Explain the water cycle and describe how evaporation, transpiration, condensation, cloud formation precipitation, infiltration, surface runoff, groundwater, and absorption occur within the cycle (E.ES.07.81).
- Analyze the flow of water between the components of a watershed, including surface features (lakes, streams, rivers, wetlands) and groundwater (E.ES.07.82).

**OBJECTIVES:**
Students will be able to:

1. Compare and contrast competing water use rates in the United States (e.g. agricultural vs. residential water use).
2. Compare water use rates in the United State to that of other countries.
3. Calculate flow rates of different faucets at school and/or at home.
4. Calculate the amount of water used to complete daily activities.
5. Calculate the amount of water each student uses in a day.
6. Discuss ways to conserve water resources at school and around the home.

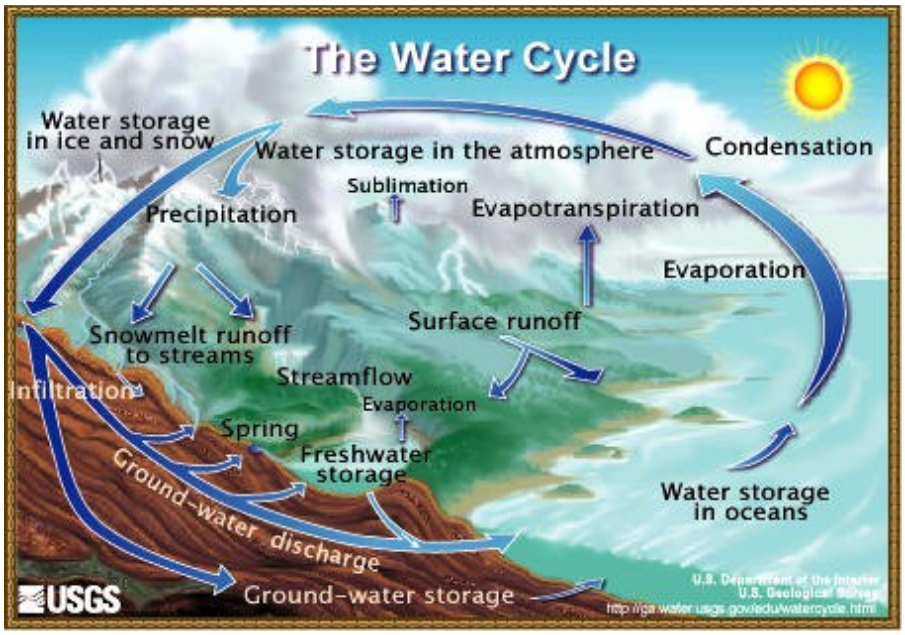
**BACKGROUND INFORMATION:**
Water is essential to life on Earth. Humans can survive for about a month without food but only about seven days without water. Water is a limited resource and its quality and availability are of getting more and more attention in the media. We never acquire any new water on Earth. The same water that is here is the same water that has always been here and keeps getting reused and recycled through the water cycle. For example, an apple may contain rain water from yesterday. That water may also be the same water that was drunk by a dinosaur millions of years ago.

Water is also distributed differently in different parts of the world. Ninety Seven percent of all of the water in the world is salt water. Of the remaining 3% that is freshwater, 2% is stored in the glaciers and ice caps. That leaves 1% of all of the water on earth that can be used as **potable** drinking water.

Michigan is lucky because it is located in the Great Lakes Watershed which contains 20% of all of the potable drinking water in the World! Living in a state with such high availability of freshwater resources can make it easy for people to take water resources for granted. Since Michigan has so much of the world's freshwater, we have a huge responsibility to protect and conserve this important resource.

## The water cycle

Water moves from land to **groundwater** to **surface water** to air (Figure 1). **Precipitation**—rain, snow, sleet and hail—brings water to the earth. This is absorbed into the ground through **infiltration**. Plants may take up the moisture and release it back to the air through the process of **transpiration**. Some of the precipitation runs off the surface of the ground and into surface waters such as lakes and streams. These bodies of water may lose water to groundwater if the water table is low or gain water from groundwater if the water table is high. These bodies may also lose moisture through evaporation, which occurs even in cold weather if the water is not ice-covered. In Michigan, the water moves to the Great Lakes and then on to the Atlantic Ocean.




## Do we have enough water?

Most of the water on earth (about 97 percent) is salt water, which is costly to convert to usable water for consumption by plants, animals and humans. Fresh water makes up only about 3 percent of the earth's water, and most (two-thirds) of this is frozen polar ice caps and glaciers. Fresh groundwater and surface water make up 31 percent of total freshwater. With global warming and melting of the ice, we are losing more fresh water to the saltwater oceans.

Demand for water is increasing globally. Drought, overpopulation, increased usage and pollution are all contributing to the water crisis. Global consumption is doubling every 20 years. This is more than twice the rate of human population growth. Pollution and over-extraction further limit water resources in many areas of the world. Scarcity of water may lead to water conflicts in the future. Today, over a billion people in the world lack access to drinkable water. The world's 6 billion people are already using about 54 percent of all the accessible fresh water contained in rivers, lakes and underground aquifers. According to data collected from NASA and the World Health Organization, 4 billion people will face water shortages by 2050.

Michigan, the Water Wonderland, is blessed with the surrounding Great Lakes (20 percent of the world's fresh surface water). However, this does not mean that overuse or mismanagement of our water resources cannot affect our lakes, streams, wetlands, wildlife, plant life, agriculture, industry or economy, or our future water use supply. As populations grow, controversies grow over who controls the water. Our precious water resources need to be protected and conserved for current and future use.

Even in Michigan, water usage is a significant expense. There are pumping, heating, water treatment and wastewater treatment costs. If you have municipal water and sewage, the more you use, the more you pay. Water conservation can mean homeowner as well as community savings! Water use estimates vary, but the U.S. Geological Survey

states that the average American uses 80 to 100 gallons of water in the home daily. That's a lot of water! Reductions can be made through repairing leaks, using new technologies and changing water use behaviors. See what you can do to make a difference.

Who governs water withdraw and use in Michigan? Who decides how much water can leave the great lakes? Is it controlled at a local, statewide or national level? Do watersheds follow political boundaries and how does this impact laws or ordinances meant to protect them? The Great Lakes Compact is a legally binding agreement between the 8 Great Lakes States (Minnesota, Wisconsin, Indiana, Illinois, Michigan, Ohio, Pennsylvania, and New York) that prevents most diversions of Great Lakes water out of the region and establishes new water conservation and environmental protection standards for water use within the region. The Canadian Great Lakes Provinces are also part of this agreement. This agreement was passed in 2008 and was an extremely important turning point in water use regulation legislature. It is one of the first times that water regulations crossed state and international political boundaries to encompass an entire watershed.

## Water use:

Three-fourths of the water used in the home is used in the bathroom; the toilet accounts for over a fourth of this. Conventional (old-style) toilets using 5.5 gallons per flush use an estimated 13,000 gallons per year to get rid of 165 gallons of body waste. Installation of low-flow or ultra low-flow toilets can save 1.5 gallons to 4.7 gallons per flush (Figure 4). The new ultra low-flow toilets use a pressurized tank to provide high pressure flow of a smaller amount of water, giving water efficiency with high user satisfaction.

**Figure 1: Estimated Water Used To Complete Daily Activities, Listed by Equipment Type**

| Equipment | Gallons per Use | Equipment | Gallons per Use |
|---|---|---|---|
| **Toilet** | | **Washing machine** | |
| Conventional | 5-5.5 | Conventional top load | 37 |
| Low-flow | 3.5 | Wash recycle | 26 |
| Ultra low flow | .8-1.6 | Front load | 21 |
| | | X-axis | 17.5 |
| **Showerheads** (per min) | | **Shaving** | |
| | | Open tap | 5-10 |
| Conventional | 5 | 1 full basin | 1 |
| Low-flow | 2.5 | | |

| | | | |
|---|---|---|---|
| **Bath**<br><br>Full tub<br><br>1/4 to 1/3 full | <br><br>30-45<br><br>9-12 | **Dishwashing**<br><br>By hand-open tap<br><br>Dishwasher full load | <br><br>30<br><br>10-15 |
| **Faucets** (per min)<br><br>Conventional<br><br>Low-flow | <br><br>3<br><br>2.5 | By hand- full basin, wash and rinse | 5 |

**Ways to Conserve Water in Your Home**

- **Check for hidden water leaks.** Read your water meter before and after a two hour period when no water is being used. If the meter reading is not the same then you have a leak.
- **Check the toilet for leaks.** Put food coloring in the tank on your toilet. If you have any dye in the toilet bowl after 30 minutes without flushing then you have a leak.
- **Don't use the toilet as a garbage can.** Every time you flush, you use 5 – 7 gallons of water. Throw things in the waste basket rather than flushing them.
- **Place a weighted plastic bottle in the toilet tank.** This will decrease the amount of water that is used when you flush
- **Insulate your pipes.** You can use pre-slit foam insulation on hot water pipes. This will decrease the time you have to run water from your tap or shower before it becomes hot.
- **Install low flow shower heads and faucet aerators.**
- **Turn off the water after you wet your toothbrush!**
- **Only run the dish washer or laundry machine when you have a full load.**
- **Minimize the use of the garbage disposal in the kitchen sink.**
- **Use rain water for your yard and garden.** Set up rain barrels and use special landscape designs such as rain gardens to capture rainwater and reduce the need for supplemental watering. This is also a great way to help reduce stormwater runoff and non-point source pollution!
- **Use native plants in your landscape.** Using native plants or plants that are adapted to survival at the planting site reduces the need for supplemental watering.
- **Choose to landscape with drought resistant plants.**
- **Mulch bare soil areas around trees and plants.** This helps increase rainwater infiltration and moisture retention.
- **Use a broom to sweep that driveway rather than the hose.**

**VOCABULARY:**
Water cycle, atmosphere, evaporation, water vapor, condensation, clouds, convection, ocean currents, wind, weather, transpiration, oxygen, hold water, potable, non-potable.

**PROCEDURE:**
**Warm-Up (Anticipatory Set):**
Review the water cycle and the location of freshwater in the world. Imagine what life would be like if we there was not enough fresh drinking water for every person in Michigan? What things would we no longer be able to do?

**ACTIVITIES:**

- Make a bar graph or a pie chart that shows the amount of water used for different activities in the US (household water use, lawn and garden watering, water used to irrigate agricultural lands and water livestock, etc.)

- Use graphs and charts to compare and contrast water usage in different parts of the world.

- Using different measuring devices and a stopwatch, calculate the flow for several different faucets in the school or at home. Measurements can be calculated in gallons per minute or liters per minute. Also have students convert between different measurements

- Chart or create a graph the compares different flow rates based on location, activity or type of faucet.

- Keep a log tracking your water use. Calculate the amount of water each student uses in a 24 hour period.

- Discuss ways to conserve water resources at school and around the home.

- Discussion: Who governs water withdraw and use in Michigan? Who decides how much water can leave the great lakes? Is it controlled at a local, statewide or national level? Do watersheds follow political boundaries and how does this impact laws or ordinances designed to protect them? What are the implications of the Great Lakes Compact?

**Wrap-Up (Closure):**
Summarize all of the ways students used water in a 24-hour period. Were all of those uses necessary? How can changing behavior result in a reduction in water use? Are these practices practical for your community? Why or why not?

**ASSESSMENT OPTION:**
Based on the amount of water each student used in a 24-hour period, what are ways to reduce the amount of water used on an individual basis? What can be done to reduce water use at school and in the community? What devices and practices could be

implemented to reduce the amount of water used? Calculate the estimated costs for implementing these water-saving practices. How much water could be saved each year?

**EXTENSIONS:**
Research water conservation practices that are used in other countries. Which of these behaviors could be practically implemented on an individual level in your home, school, or community? Based on the practices that you could implement in your home, calculate how much water you could save in one year.

Assemble a mock Water User Committee for your community that decides who gets access to water in your community, and how much they are allowed to use. First identify all the types of water users, and assign several students to represent that water user group. Then, discuss how you will decide how much water each group gets to use. Does each group get to use as much water as they want? Why or why not? Are the rules used to govern how much water each group gets to use fair? Why or why not?

**RESOURCES:**
Home Assessment System (Home*A*Syst) Water Conservation, Chapter 8 (also available at the Michigan Water Stewardship Program web site):
http://web2.msue.msu.edu/bulletins/Bulletin/PDF/WQ51.pdf

U.S. Environmental Protection Agency:
http://www.epa.gov/ebtpages/watedrinkingwater.html

U.S. Geological Survey:
http://ga.water.usgs.gov/edu/earthwherewater.html

Water Conservation:
www.nrcs.usda.gov/feature/backyard/watercon.html

Water Conservation Tutorial:
http://www.epa.gov/seahome/watcon.html

World Statistics updated in real time:
http://www.worldometers.info/

World Water Statistics:
http://www.wateraid.org/international/what_we_do/statistics/default.asp

UN Water Statistics:
http://www.unwater.org/statistics.html

American Water Works Association (competing water use statistics):
http://www.drinktap.org/consumerdnn/Default.aspx?tabid=85