



Arizona Project WET's Water Scene Investigation (WSI) Program

College of Agriculture and Life Science's
Water Resources Research Center
and Arizona Cooperative Extension
University of Arizona



COLLEGE OF AGRICULTURE
AND LIFE SCIENCES
COOPERATIVE EXTENSION

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The Water Scene Investigation - WSI



Introduction

The Water Scene Investigation (WSI) was developed by Arizona Project WET for use by local water providers and water educators in middle school classrooms to inspire simple actions that result in real water savings. This guide is the result of several iterations of writing, classroom testing, revision, and re-testing. The WSI is a two-day, in-classroom project; the two days are separated by a week to allow for homework completion. To date, the WSI has reached 13,605 students and saved over 46 million gallons of water. Arizona Project WET is a program of the University of Arizona's College of Agriculture and Life Sciences, Arizona Cooperative Extension, the Water Resources Research Center and the Department of Soil, Water and Environmental Science.

The Water Scene Investigation (WSI) is a valuable tool for raising water use awareness and empowering individuals to make their water use more efficient. This guide was written for presenters from businesses, public agencies, nonformal education and the community to engage 5th through 9th grade students in a project focused on water conservation, efficiency and water auditing. One may adapt it easily for non-classroom use, whether that is in community groups or clubs, with youth or with adults.

The WSI is a participatory method of learning where students learn effective ways of conserving water indoors, while developing specific STEM skills. Students develop skills by measuring water use before and after the installation of new faucet aerators in their own homes and then calculating annual water use in gallons per year using mathematical thinking skills. Aerators reduce the flow of water without reducing the pressure needed to accomplish tasks such as hand washing, so they are a simple, yet effective technology for students to install. By using aerators and tracking water savings, people of all ages can gain a better understanding of how a small investment in a simple technology can save precious water resources over time.

Advance Preparations to Ensure Success

The most important item used in the WSI is the faucet aerator. Collect water efficient aerators ahead of time so that you can provide at least one to each of your participants. These are often available from your water provider at low or no cost, especially for groups involving youth. Otherwise, they can be purchased from any hardware store, plumbing store or through online retailers. We have found that plumbing stores and online retailers have a wider selection and often lower prices, but you must allow for shipping time. Online retailers that offer good service and low prices when you order bulk quantities include AM Conservation Group

(<http://www.amconservationgroup.com>) and New Resources Group (<http://www.nrgideas.com>).

Aerators do come in a variety of thread specifications. Adaptors are available to fit unusual faucets to standard aerator threads. Whenever possible, check the target faucets ahead of time and take an old aerator into the store to compare with new. In our experience, the best aerator to buy to achieve the best retrofit rate (meaning families actually keep the new aerator on after the home water audit) is a dual-threaded, standard size aerator with a 1.0 gpm flow rate. Dual-thread can fit on both male and female threaded faucets. Although many retailers won't list the standard size dimensions, standard is: female - 55/64 inch diameter, 27 threads/inch; male - 15/16 inch diameter, 27 threads/inch. An aerator gauge can be purchased if you are auditing many different models and sizes of faucets (<http://www.threadtoolsupply.com/faucet-aerator-thread-gauge.html>).

Manufacturers do make 0.5 gpm aerators, but the radial flow and low water volume deter many from keeping them on. These aerators work well in public restrooms where the faucet's only purpose is handwashing.

Think ahead to prepare your own Mystery Box. The Mystery Box is used as the hands-on hook to get students interested in the WSI. Suggested items for a Mystery Box are listed on page 11 of this guide. Any water-saving equipment will do, though you may want to ask your favorite plumber, landscaper, water provider or home repair clerk for good, inexpensive ideas and samples. Remember, it's called a "mystery" box, so participants shouldn't be told what the items are before having the chance to examine and guess. If you are unable to obtain a good selection of items, printed pictures of these items would be an acceptable alternative.

If you don't have flow rate measuring bags, use a bowl instead. The measuring bags (for flow rates as low as 0.5 gpm) are often available from your water provider, particularly if you are addressing a community forum or group and if you are involving youth. Bags are also available for purchase online at bulk rates as low as \$0.30 each (<http://www.nrgideas.com/fg-060>). If you don't have access to a measuring bag, don't let it stop you. Capture the water in any container as it flows for five seconds at full-on. Measure the water captured. Multiply the amount measured by 12 and you will have the quantity per minute. This works because there are 12 five-second periods in one minute. For example, if you measured 3 cups in five seconds and multiplied by 12, your flow rate would be 36 cups/minute. Convert to gallons per minute using the appropriate conversion factor from this table.

16 cups	1 gallon
128 ounces	1 gallon
3.79 liter	1 gallon
0.13 cubic feet	1 gallon

For Example:

$$36 \text{ cups/min} \times 1 \text{ gallons}/16 \text{ cups} = 2.25 \text{ gallons/min (gpm)}$$

Adapting the Classroom Presentation for Use by Non-formal Educators

The Water Scene Investigation was developed by Arizona Project WET for use in middle school classrooms. Since this guide was written for classroom use, you will see many references to “students.” We are all life-long learners, so you may **think of all of your participants as “students,”** regardless of their age or occupation. “Cooperative learning groups” are just small groups of 3-5 participants who for a brief time will work together on a small task. As you prepare for your presentation, think about how you will divide your large group into small groups. You can let it happen naturally, have the participants count off, or separate your group by age, t-shirt color or any other criteria that lends itself to the situation. Keep it fun and quick. In multi-age settings, a mix of ages in each group will help to ensure that someone in the group has the requisite math skills to complete the data sheets.

Reporting WSI Data Online

Encourage your participants to share their data by reporting it online. You and all of your participants will be able to calculate and visualize the group’s success through Arizona Project WET’s online water-savings website. The data entry form requires only the water measurement and daily use data. It will calculate the annual water use and water savings for you. The online form can be a fun way to validate the students’ calculations.

1. Before your presentation, select a *Group ID*. This can be any combination of letters and numbers that you choose. Consider the potential ease of mis-typing the Group ID. Every participant will have to enter it exactly the same way or their data will not be grouped for display with the others’.
2. Write your Group ID at the top of the data sheet before distributing copies.
3. You may create an account and enter your students’ household water savings at: <https://arizonawet.arizona.edu/programs/wsi>. Or you may have individual participants report their results via their own login at this same website. Either way, the site will generate water savings graphs that will enable comparisons of water savings across your group.
 - a. You will be required to either create an account or log into your account in order to submit data to the system. Account creation requires a valid email address. Please register yourself as a group leader. Students may also register but should indicate that they are not group leaders.

- b. When logged in, hover over the *Water Scene Investigation* menu and click the *Report Water Savings* link to enter a single student's data.

Group ID – enter the Group ID exactly – it is sensitive to capitalization.

Participant Initials or ID – this value will appear as the data label on the group data graph; enter any combination of letters and/or numbers that would identify each unique participant.

Participant Name – this name will not show up on the graph, but will show up in the listing of all water savings reports submitted under the group leaders login.

Faucets – enter data in the “If you already have your ...” field if a flow bag was used to capture the water. Enter data in the “If you need help ...” field if an alternate container was used to capture the water. The system will not accept data in both fields.

Save – click the save button after this user's data is complete. A summary of the user's annual audit and water savings will display.

- c. Click again on the *Report Water Savings* link in the *Water Scene Investigation* menu to display a new reporting form where the next student's data can be entered. Please note that students who enter data via a group leader's login will not be able to view the group graphs on their own. Their data will be viewable only through the group leader's login.
- d. Click the *Your Group Savings* tab to see a comparison of all of your group members' savings.
- e. Click the *Compare to Top 10* tab to see the latest user's data compared to the top-ten water savers across the entire program, whether they are members of your group or not. This comparison graph can only be done one participant at a time.

Viewing WSI Data Online

Return to the [Water Scene Investigation website to watch your group's water savings grow.](#)

You will also be able to track the group's participation through the water-savings website.

1. Log into the website at <http://arizonawet.arizona.edu/user/login/>.
2. Hover your mouse over the *Water Scene Investigation* menu item and click on the *View List of Water Savings Reports* link.
3. Select one of the water data savings data sets from the group ID that you are interested in viewing.

4. Select the *Compare to Top 10* tab to view the selected data as compared to the top-10 water savers participating in the program. Select the *Your Group Savings* to view the data from all of the participants in the selected Group.
5. To view data from one of your other groups, return to the *View List of Water Savings Reports* link and select a water data savings data set from another Group.

Water Scene Investigation - WSI: **Classroom Presentation for Middle School Students**

WSI Presentation Outline and Timing:

Day 1:

1. Introductions (1 minutes)
2. Warm up: Discussion of Water Uses & Behavioral Changes (10 minutes)
3. Exploration: Technological Ways to Save Water - Water Savers' Mystery Box (15 minutes)
4. Demonstration: Measuring Faucet Flow Rate (10 minutes)
5. Brainstorm: Bathroom faucet water uses & variables (15 minutes)
6. Wrap-up/Homework Discussion: Technological and behavioral ways to save water (4 minutes)

Day 2:

1. Homework Review & Completion (15 minutes)
2. Data Input and Analysis (20 minutes)
3. Discussion (15 minutes)

Summary:

Students will inventory their families' use of home bathroom faucets (number of times used per day, length of time with each use) and determine the flow rate of those faucets with and without aerators to calculate water savings through the use of water efficient devices. The Water Scene Investigation is a two day in-classroom project, separated by a week to allow for homework completion.

Objectives:

Students will:

- Follow a set procedure
- Measure water flow
- Collect scientific data through observations and interviews
- Analyze data and draw conclusions from mathematical calculations
- Make claims and recommendations based on evidence for more efficient water use

Materials/Supplies:

- Flow rate measuring bag* (see picture on page 14)
- Mixing bowl
- Stopwatch or timing device
- Faucet aerator*
- Pair of pliers
- 5 gallon bucket
- Water Savers' Mystery Box*

*See Introduction on page 3 for sources and alternatives for these items.

Per student for Homework:

- Parent/Guardian Letter about Homework (*Sample Parent Letter* is found in Appendix A)
- *Home Faucet Audit Procedure* (Appendix B)
- *Faucet Audit Data Sheet* (Appendix D)
- One aerator per faucet (1 gpm)
- Flow Rate bag

Lesson Guide:

Day 1:

1. Introductions (1 minute)

Presenters should introduce themselves, explain their jobs/interests and briefly mention why they are in the classroom.

2. Warm-up: Discussion of Water Uses (10 minutes)

Focus questions:

How do we use water? How do we conserve it?

Activity:

Ask the question, "How do we use water?" Have students brainstorm all the ways they can think of that water is used in their daily lives, both at home and at school.

Example list:

- Cooking
- Drinking
- Watering plants
- Showering

- Washing dishes
- Washing clothes
- Cleaning
- Filling swimming pool
- Watering grass

After they have a fairly comprehensive list (at least 8-10 ways), pose the question, “How do we conserve water?” This question will most likely be answered with actions people can take to reduce water use, like taking shorter showers, etc. These are called **Behavioral Changes**, because people change their behaviors to reduce water use. Make another column and list behavioral changes directly across from the use they would affect.

To wrap up this warm-up activity, ask students how they would describe the ways they have listed to save water and who is responsible for making these changes. Facilitate the discussion so that the students figure out for themselves that their water conservation list includes mostly behavioral ways to save water. Make sure the discussion ends with: these ways to save water are called **Behavioral Changes** and **you** are responsible for these changes!

3. Exploration: Technological Ways to Save Water - Water Savers' Mystery Box (15 minutes)

Focus question:

How can we reduce water use or use water more efficiently at home?

Activity:

Pass out the inquiry items from the Water Savers' Mystery Box (see photo and description below), one item per cooperative learning group. Ask students to examine the item and try to determine what the item is and how it can be used to save water. Give each group 3-5 minutes to answer these questions:

- 1) What is it?
- 2) What are its parts and how do they work together to save water?

Have each group report out on their findings (they should report out in their own words NOT the words of the descriptions below). As student groups report out, write down the technology device in a third column to the left of the associated use (behavioral changes are to the right).

After all student groups have reported out, ask students: What did we find out? What do these items have in common? They are all **Technological Devices**. They all can be used to save water.

Water Savers' Mystery Box

- **Water meter** – A water meter is a gauge that measures water use. If you want to assess whether there is a leak at your house using your water meter, you can check it once before the whole family leaves one day (record number) and again when you return. If no automatic water use occurred while you were gone, it should be the exact same reading when you return. If not, you have a leak.



- **Faucet aerator** – lowers the amount of water coming out of your faucet each minute by mixing in air. If an aerator is already installed on your faucet, it will have its rated flow imprinted on the side. For most homes the aerator will likely read 2.2 gpm (gallons per minute). Most people are satisfied with 1.0 gpm flow in the bathroom faucets. You can replace the aerator easily. If no aerator is installed, check to see if there are threads just inside the tip of the faucet. Most modern faucets are threaded to accept aerators.



- **Toilet tablets** – are used to check for leaks in toilets that have a tank in back. Put the tablet in the tank and do not flush. Check the toilet again in 10 minutes. If you have a leaky flapper you will see dye in the bowl of your toilet. The toilet flapper needs replacing.



- **Irrigation timer** – is used to control the timing (how many days per week) and duration (run time) of watering on a landscape. These timers can be programmed for different plant needs and seasonal changes in water use.



- **Toilet flapper** – is pulled up when you flush the toilet which allows water in the tank to replace the water flushed from the toilet bowl. The flapper then seals so the tank can fill up with water again.



- **Water efficient shower head** – uses less water at a higher pressure than a traditional shower head. To test shower head flow, set a 2 quart saucepan in the middle of the shower stream. With the shower on full, count how many seconds it takes to fill the pan. If it takes less than 12 seconds, you could use a water efficient shower head. Water efficient shower heads are 2 gpm or less. You can also use a flow rate measurement bag.



- **Catch cans** – are used to measure irrigation uniformity, how evenly you apply water over a turf area.



- **Irrigation tubing & emitters** – are used to apply water to shrubs and plants instead of using a hose. The emitters control how much water is applied to specific plants and when used with an irrigation timer, water will be applied to a landscape automatically for a set amount of time, ensuring that water doesn't accidentally get left on.



- **Dual-flush toilet valve** – is a \$30 valve that replaces the toilet flapper and handle and can be installed in an existing toilet to convert it to a dual-flush toilet. This allows the user to flush with less or more water by choosing “number one or number two,” respectively.



- **Spray nozzles** – are used to stop or restrict the flow of water from a hose, yet have it available for use when needed. This keeps water from running constantly if you are washing a car or watering plants.



4. Demonstration: Measuring Faucet Flow Rate (10 minutes)

Focus question:

How can we determine the flow rate of a classroom faucet?

Activity:

This activity is an example of implementing one of the technological devices from the mystery box, the aerator. Hand out extra data sheets (one per student).

Introduce the *Faucet Audit Data Sheet* (Appendix D), starting with **Table 1** where students will record water audit data at home. Demonstrate the *Bathroom Faucet Flow Rate Procedure* (the procedure is below but do it in your own words) by having student volunteers come up and take the measurements. Measure, the faucet flow rate for all three cases: baseline, without an aerator and with a new aerator, but only take 1 measurement for each case. Let students know that they will be taking 3 measurements for each case at home. Ask: Why do you think you'll take the measurement 3 times? Students should record the data that is measured as a class in the first row of the data sheet.

Measuring Bathroom Faucet Flow Rate Procedure:

1. Examine the faucet for leaks:
 - a. Look and feel around the faucet as well as under the sink along the drain pipe.
 - b. Indicate the presence of leaks on your data sheet.
2. Measure the flow of water from the faucet for 5 seconds (you will need help from a family member):
 - a. With the mixing bowl in the sink, turn on the faucet all the way.
 - b. Put the opening of the flow rate measuring bag (page 14) under the running faucet and start the stopwatch simultaneously. (If you have a stopwatch, use it to time for 5 seconds, otherwise use a watch with a second-hand).
 - c. Collect water for EXACTLY 5 seconds by counting aloud 1, 2, 3, 4, 5 in time with the stopwatch.
 - d. On the count of “5,” immediately remove the bag.
 - e. Turn the water off.
 - f. Read the water level from the flow rate measuring bag and record the measurement in gallons per minute (gpm) on the Faucet Audit Data Sheet.
 - g. Pour the water from the measuring bag and mixing bowl into a bucket.
 - h. Remind them to repeat this water flow measurement two more times for a total of three measurements.
 - i. Average the three measured values. This is your Baseline Flow Rate.
3. Check for an existing faucet aerator.
4. If an aerator is on the faucet, remove it (mention they may have difficulty removing the old aerator and may need a tool). Hold up the pliers and ask “What is this tool called?”
5. Make a note of the aerator’s condition.
6. Repeat directions in Step 2 to measure Flow Rate Without an Aerator and record your data.
7. Install a new aerator (Tell them to hand tighten 1.0 gpm aerator and NOT use the pliers).
8. Repeat directions in Step 2, recording the data. This is your Flow Rate With a New Aerator. Please leave the new aerator on if it’s okay with your family.
9. Pour the water collected in the bucket on plants outside.
10. Complete Table 1 and the questions below it if you have time.
11. Return “old, used” aerators that were replaced and unused aerators to school.

New Resources Group, Inc.
 P.O. Box 320049
 Fairfield, CT 06825
 Phone: 203-366-1000 Fax: 203-366-1004
 www.NRGIDEAS.com





How Much Can You Save?

Save water and energy (energy used to heat your hot water) and money with high efficiency lower flow shower heads and aerators.

Determine the flow at showers and sinks.

Flow is measured as volume per minute. This handy tool will show you the flow in gallons and liters per minute, and help guide you to saving water, energy and money.
Easy instructions on how to test your showers and faucets.

- 1) Turn on the fixture to be tested - shower head, faucet, or hose. Adjust the flow to how you would normally use the fixture.
- 2) Hold the bag open and place under the fixture for exactly FIVE seconds.
- 3) Remove from the flow, hold the bag up and read the flow rate measurement on the bag. Pour water out and repeat. It is important to get the FIVE seconds correct. Practice counting with a watch. Repeat the test to check your results.
- 4) Below we have indicated efficient shower head, kitchen aerator and bathroom aerator guidelines. NOTE: These are maximum recommendations. You can always go lower if you are comfortable with the performance of the lower flow. The lower the flow, the more water, energy and money you will save.



Showerheads

Compare the water level for your shower heads to the efficient one. Look in the **Potential Savings** column to see how much you can save by installing a new shower head.
 The most efficient shower heads are available at www.nrgideas.com.



Faucets

(Bathroom and Kitchen)
 Compare the water level for faucet to the efficient one. Look in the **Potential Savings** column to see how much you can save with a new faucet aerator.
 The most efficient aerators are available at www.nrgideas.com.

Water Level	Flow Rate		Potential Savings on your utility bills
	Gallons (US)	Liters	
— 5 GPM	19 LPM	\$207/year	
— 4 GPM	15.2 LPM	\$124/year	
— 3 GPM	11.4 LPM	\$41/year	
— 2 GPM	7.6 LPM		
— 1.5 GPM	5.7 LPM		
— 1 GPM	3.8 LPM		
— .5 GPM	1.9 LPM		

Water Level	Flow Rate		Potential Savings on your utility bills
	Gallons (US)	Liters	
— 5 GPM	19 LPM	\$16/year	
— 4 GPM	15.2 LPM	\$11/year	
— 3 GPM	11.4 LPM	\$6/year	
— 2 GPM	7.6 LPM		
— 1.5 GPM	5.7 LPM		
— 1 GPM	3.8 LPM		
— .5 GPM	1.9 LPM		

Calculations assume 2 people per household, 2.5 gpm shower head, 8 minutes per shower, 4 showers per person each week. Water, sewer and energy savings are included.

EPA WaterSense Flow • Showers: 2.0 gpm, Bath Faucet: 1.5 gpm

Figure 1 - Flow rate measurement bag.

5. Brainstorm: Bathroom faucet water uses & variables (15 minutes)

Focus Question:

How much water is used by your family at home bathroom faucets each year?

Activity:

Recall the ways water is used at home. Ask the question, “How is water used by your family at the bathroom faucets in your home?” Have students brainstorm a list of specific uses of the bathroom faucets for a family each day.

Example list:

- Men may shave using the faucet
- All members brush their teeth
- All members wash their hands
- Many get washcloth wet to wash face

Discussing Frequency and Duration:

State the focus question, “How **much** water is used by your family at the bathroom faucets in your home each year?” From the measurement that we made, we know how much water comes out of the faucet each minute that it’s left on (Section 4). This is called the **flow rate**.

Ask the students, “What else do we need to know to figure out how much water we use from a bathroom faucet in your home **in a day**?” Allow cooperative learning groups to discuss this for 3 minutes. (This is a real critical thinking question and needs time for thought).

Answers (should be in their own words):

- Duration - How long water is run for each use.
- Frequency - How many times each use happens per day.

Referring to the *Faucet Audit Data Sheet* (Appendix D), orient the students to Table 2. Have students add any brainstormed uses of water not already listed to the first column. Note that the whole table is for one bathroom faucet location and that there is a different section for each water user as you move across the page from left to right. Have student’s role play, in pairs, to practice interviewing family members. One student should act as the water user and one student should act as the interviewer, then switch roles. Have them estimate how long they leave the faucet on for each use and how many times per day they use the faucet for each use. Show them where to record these figures for two water users in Table 2.

If there is more than 5 minutes left, work through an example calculation of the total number of seconds per day for each use, based on the frequency and duration data.

Explain to the students that they will follow a similar process, interviewing each family member to determine the number of times they conduct each of the uses in a day. They will also do one

of two things: estimate the length of time the water is on for each use or time family members as they use the water. Students will use Table 2 on the *Faucet Audit Data Sheet* to collect this water use data and then they will bring the completed data sheet back to class to complete the calculations on Day 2.

Wrap-up/Homework Discussion (4 minutes) – Technological and behavioral ways to save water

Review homework

- Have them tell you the faucet audit assignment, the equipment needed to complete home faucet audit, the procedures, how to use the data sheet and what the name of the technological device that we are using is (aerators).
- Ask students: What is the goal of the home water audit? Is changing aerators a behavioral or a technological change? Emphasize that changing aerators is a technological change that can be supplemented with a commitment to change how water is used (i.e. behavioral change).
- Remind students that they need to bring back old aerators that are replaced as well as any new aerators that do not get installed.

Day 2:

1. Homework Review and Completion (15 minutes)

Have students finalize their calculations on the *Faucet Audit Data Sheet* in Tables 1 and 2. Ask them how they think we could quantify their water savings? Refer them to Table 3 to calculate their water savings.

2. Data Input and Analysis (20 minutes)

After students have calculated annual water savings through the installation of new faucet aerators at their house, tell students that we will use Arizona Project WET's online water-savings website <https://arizonawet.arizona.edu/programs/wsi> to calculate a total water savings for the entire class in gallons per day and gallons per year. The data entry form requires only the water measurement and daily use data. It will calculate the annual water use and water savings for you. The online form is a fun way to validate the students' calculations.

Direct them to:

- a. Go to the right side of webpage under WSI resources and click the *Report Water Savings* link to enter a single student's data. Enter the following fields:

Group ID – enter the Group ID exactly – it is sensitive to capitalization (make this easy to remember, for instance the teachers last name and a number).

Participant Initials or ID – this value will appear as the data label on the group data graph; enter any combination of letters and/or numbers that would identify each unique participant. We don't use the students full name here.

Participant Name – this name will not show up on the graph, but will show up in the listing of all water savings reports submitted under the group leaders login.

Have you figured out your faucet flow rate? - answer the question by clicking the appropriate circle. The system will not accept data in both fields.

How many minutes per day does water flow from this faucet? Enter the number from your data sheet in minutes per day.

What was the average BASELINE flow rate i.e. BEFORE aerator installation/replacement? - Enter the number from your data sheet in gallons per minute.

What was the average flow rate AFTER aerator installation/replacement? - Enter the number from your data sheet in gallons per minute.

Save – click the save button after this user's data is complete. A summary of the user's annual audit and water savings will display.

- b. Your water savings will be calculated automatically in gallons per year. Write down this value at the bottom of your data sheet so that you can report back to your family.
- c. Click the *Your Group Savings* tab to see your groups annual savings and a comparison of all of your group members' savings.
- d. Click the *Compare to Top 10* tab to see the top-ten water savers across the entire program, whether they are members of your group or not. This comparison graph can only be done one participant at a time.

3. Discussion (15 minutes)

Why were your water savings different? Discuss variables that would influence overall usage. Variables include: family size, daily routines, working in/out of the home, travel, etc.

How much water did we save as a class? Look at the total classroom water savings from the Water Scene Investigation project. Ask students what could be done with the saved water? Based on the class savings, work with the class to figure out how that saved water could be put to use.

- **How many native trees with a 30 foot canopy could you grow and maintain?**

1 = ~ 6,000 gallons of water (Lancaster, Brad. *Rainwater Harvesting for Drylands and Beyond - Volume 1*. Tucson: Rainsource Press, 2008. Print). For Velvet Mesquite and Palo Verde Trees.

- **How many typical swimming pools could you fill?** 1 = ~ 15,000 gallons of water ([http://cms3.tucsonaz.gov/water/terms and definitions](http://cms3.tucsonaz.gov/water/terms_and_definitions))
- **How many pairs of cotton jeans could you grow the cotton for and produce?** 1 = ~ 2,650 gallons of water (www.waterfootprint.org)
- **How many hamburgers could you grow and produce?** 1 = ~ 633 gallons of water (Hoekstra, A.Y. and Chapagain, A.K. (2007) Water footprints of nations: water use by people as a function of their consumption pattern, *Water Resources Management*. 21(1): 35-48. Retrieved October 1, 2012 from www.waterfootprint.org)
- **How many new cars could you produce?** 1 = ~ 35,750 gallons of water (www.amwater.com)

October 1, 2017

Dear Parents and Guardians,

Arizona Project WET partners with sponsors all over Arizona to offer relevant, project-based learning to 5th through 9th grade students. Students learn to audit a faucet during the **Water Scene Investigation** in-classroom presentation. People learn and remember more through application of knowledge. After the presentation, students will be asked to audit all the bathroom faucets in their homes as a **homework assignment**. This is an opportunity for students to apply their new knowledge, and in the process, show you what they have learned. They will be measuring each bathroom faucet's flow rate and determining how many times and for how long each faucet is used in a day. They will use this data to calculate your home's bathroom faucet water use in gallons per day.

In addition to determining how much water is used, students have the opportunity to install a simple technology that will save water. Arizona Project WET and its sponsors have provided each student with a new faucet aerator for a bathroom faucet in your home and a flow rate measurement bag with pre-printed gallons per minute markings. They will be measuring the faucet flow rate for three conditions: baseline flow, without an aerator and with the new aerator. Your student also has a procedure sheet, a data sheet and an audit report to guide the audit; please have your student explain these to you. Please allow your student to install the new aerator for this assignment and please leave the new 1-gallon per minute aerator on if you are happy with the result. This will save water and money. **After installing new aerators, please return old aerators to the classroom. Please have your child enter the bathroom faucet water audit data for your home at:**

<https://arizonawet.arizona.edu/programs/wsi>

This project hopefully inspires students to save water through their behavior, but also provides them with an opportunity to discover how simple technology can be used to save a significant amount of water over time. Water efficient devices that really work are readily available to consumers (See: <http://www.epa.gov/WaterSense/>)! *Since 2006, WaterSense has helped save 2.1 trillion gallons of water, which is the amount of water needed for all Arizona homes for at least six years.*

According to the Report to the President entitled: Prepare and Inspire: K-12 Education in Science, Technology, Engineering and Math (STEM) for America's Future (September 2010), "We must prepare students so they have a strong foundation in STEM (Science, Technology, Engineering and Math) subjects and are able to use this knowledge in their personal and professional lives. And we must inspire students so that all are motivated to study STEM subjects in school and many are excited about the prospect of having careers in STEM fields. Furthermore, the report states that STEM education is most successful when students develop personal connections with the ideas." The Water Scene Investigation does all of these things.

We hope that you will be as excited as we are to be partners in this endeavor. Students shine when they are engaged in relevant, project-based learning. In advance, we thank you for the time, dedication and support you give to your child and his/her education. We sincerely appreciate you and your efforts.

Sincerely,

Request Parent Letter for adaptation at arizona.wet@gmail.com.



Water Scene Investigation Home Faucet Audit Procedure

Measure (Table 1): to determine how much water flows from the bathroom faucet in gallons per minute.

1. Examine the faucet for leaks:
 - a. Look and feel around the faucet as well as under the sink along the drain pipe.
 - b. Indicate the presence of leaks on your data sheet.
2. Measure the flow of water from the faucet for 5 seconds (you will need help from a family member):
 - a. With the mixing bowl in the sink, turn on the faucet all the way.
 - b. Put the opening of the flow rate measuring bag (page 14) under the running faucet and start the stopwatch simultaneously. (If you have a stopwatch, use it to time for 5 seconds, otherwise use a watch with a second-hand).
 - c. Collect water for EXACTLY 5 seconds by counting aloud 1, 2, 3, 4, 5 in time with the stopwatch.
 - d. On the count of "5," immediately remove the bag.
 - e. Turn the water off.
 - f. Read the water level from the flow rate measuring bag and record the measurement in gallons per minute (gpm) on the Faucet Audit Data Sheet.
 - g. Pour the water from the measuring bag and mixing bowl into a bucket.
 - h. Remind them to repeat this water flow measurement two more times for a total of three measurements.
 - i. Average the three measured values. This is your Baseline Flow Rate.
3. Check for an existing faucet aerator.
4. If an aerator is on the faucet, remove it (mention they may have difficulty removing the old aerator and may need a tool). Hold up the pliers and ask "What is this tool called?"
5. Make a note of the aerator's condition.
6. Repeat directions in Step 2 to measure Flow Rate Without an Aerator and record your data.
7. Install a new aerator (Tell them to hand tighten 1.0 gpm aerator and NOT use the pliers).
8. Repeat directions in Step 2, recording the data. This is your Flow Rate With a New Aerator. Please leave the new aerator on if it's okay with your family.
9. Pour the water collected in the bucket on plants outside.
10. Complete Table 1 and the questions below it if you have time.
11. Return "old, used" aerators that were replaced and unused aerators to school.

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How Much Can You Save?
Save water and energy (energy used to heat your hot water) and money with high efficiency lower flow shower heads and aerators.

Determine the flow at showers and sinks.
Flow is measured as volume per minute. This handy tool will show you the flow in gallons and liters per minute, and help guide you to saving water, energy and money. Easy instructions on how to test your showers and faucets.

- 1) Turn on the fixture to be tested - shower head, faucet, or hose. Adjust the flow to how you would normally use the fixture.
- 2) Hold the bag open and place under the fixture for exactly FIVE seconds.
- 3) Remove from the flow, hold the bag up and read the flow rate measurement on the bag. Pour water out and repeat. It is important to get the FIVE seconds correct. Practice counting with a watch. Repeat the test to check your results.
- 4) Below we have indicated efficient shower heads, kitchen aerator and bathroom aerator guidelines. NOTE: These are maximum recommendations. You can always go lower if you are comfortable with the performance of the lower flow. The lower the flow, the more water, energy and money you will save.

Showerheads			Faucets (Kitchen and Bathroom)		
Water Level	Flow Rate	Potential Savings	Water Level	Flow Rate	Potential Savings
Gallons (US)	Liters	on your utility bills	Gallons (US)	Liters	on your utility bills
5 GPM	19 LPM	\$207/year	5 GPM	19 LPM	\$16/year
4 GPM	15.2 LPM	\$124/year	4 GPM	15.2 LPM	\$11/year
3 GPM	11.4 LPM	\$41/year	3 GPM	11.4 LPM	\$6/year
2 GPM	7.6 LPM		2 GPM	7.6 LPM	
1.5 GPM	5.7 LPM		1.5 GPM	5.7 LPM	
1 GPM	3.8 LPM		1 GPM	3.8 LPM	
.5 GPM	1.9 LPM		.5 GPM	1.9 LPM	

EPA WaterSense Flow • Showers: 2.0 gpm, Bath Faucet: 1.5 gpm

Interview (Table 2): to determine how many minutes per day water flows from the bathroom faucet.

1. Start with the bathroom faucet that you think gets used the most; write down the faucet location.
2. Enter the names of all the users of this faucet, one in each section as you move horizontally across the data sheet. If you have more than three users, you will need a second data sheet.
3. Ask each user:
 - a. “What do you use this faucet for?” For example, the uses could be to brush teeth, wash hands, wash face etc. Record this information under the column titled Water Use.
 - b. “How many times each day is water used for this reason?” For example, if the user brushes his/her teeth twice a day, record the number 2 into the column titled # of Times per Day.
4. Time each water use, once for each user. You can measure the time using a stopwatch, clock or timer to capture the number of seconds the faucet is running. Record the amount of time the faucet runs in the column titled Duration for Each Time. (If you cannot time the water use, ask the water user to estimate how long the water is on for each use.)
5. Calculate the Total seconds per day that the water runs for each water use by multiplying the # of Times per Day value by the Duration for Each Time value.
6. Calculate the Each User’s Total per Day by adding all the values in the Total Seconds per Day column. Each user will have their own Total per Day.
7. Calculate the total number of minutes per day that water flows from this faucet by adding all user’s Total per Day, then dividing by 60 seconds/minute.

Calculate (Table 3): to determine whether the new aerator results in water savings

1. Copy:
 - a. Total Time in min/day from Table 1 in to appropriate two boxes in Table 3.
 - b. Average Flow Rate for Baseline Water Use from Table 2 into Table 3.
 - c. Average Flow Rate for New Aerator Water Use from Table 2 into Table 3.
2. Calculate:
 - a. Avg. Baseline Flow Rate X Total Time = Baseline water use/day
 - b. Avg. New Aerator Flow Rate X Total Time = New Aerator water use/day
 - c. Baseline water use/day – New Aerator water use/day = Water Savings
3. Mark the form for whether you will keep the new aerator on the faucet or not and enter the water savings in gallons per day.

Repeat: complete a separate data sheet for each bathroom faucet that will receive a new aerator. Each faucet may involve different water users and therefore different water use will be recorded.

Summarize: the overall impact of your Home Water Audit in the Faucet Water Audit Report (Appendix E)

Student Name: _____ Group ID: _____ Class Period: _____ Date: _____

Faucet Location: kid's bathroom

Table 1 Focus Question: How much water flows from the bathroom faucet when you turn it on? (in gallons per minute = gpm)

	Baseline Flow Rate (how you found the faucet, i.e. may or may not have an aerator)				Flow Rate <u>Without</u> Aerator				Flow Rate With <u>New</u> Aerator			
	1	2	3	Avg.	1	2	3	Avg.	1	2	3	Avg.
<input type="checkbox"/>	2.6	2.3	2.4	2.43	4.0	3.8	3.7	3.83	0.9	1.1	1.1	1.03

What is the **Average Baseline** flow rate? (gpm) = **2.43** What is the **Average New Aerator** flow rate? (gpm) = **1.03**

Notes: (leak location, old aerator's condition, observations, etc.)

Table 2 Focus Question: How many minutes per day does water flow from this faucet on an average day?

	Water User #1: Me			Water User #2: Sister			Water User #3:		
	# of Times per Day	Duration for Each Time (seconds)	Total Seconds per Day	# of Times per Day	Duration for Each Time (seconds)	Total Seconds per Day	# of Times per Day	Duration for Each Time (seconds)	Total Seconds per Day
Brushing teeth	2	30	60	2	120	240			
Washing Hands	5	15	75	4	20	80			
Other uses: Washing face	1	60	60	1	45	45			
Each User's Total Seconds Per Day	⇒⇒⇒⇒⇒⇒⇒⇒		195	⇒⇒⇒⇒⇒⇒⇒⇒		365	⇒⇒⇒⇒⇒⇒⇒⇒		

Total seconds this faucet runs per day: **User #1's total + User #2's total + User #3's total = 560** sec/day

For how many minutes per day does water flow from this faucet? **Total seconds/60 = 9.33** min/day

Table 3 Focus Question: Does the New Aerator result in water savings?

Baseline Water Use			New Aerator Water Use		
Average Flow Rate (gpm)	Total Time min/day	Baseline Water Use per Day (Avg. x total time = gal/day)	Average Flow Rate (gpm)	Total Time min/day	New Aerator Water Use per Day (Avg. x total time = gal/day)
2.43	9.33	22.67	1.03	9.33	9.61

Change in daily water use due to aerator installation:

Baseline Water Use/day – New Aerator Water Use/day = 13.06 gal/day

What will you do to use **LESS** water each day? Mark one of the following:

- Re-install OLD aerator = 0 gallons/day savings Keep new aerator = **13.06** gallons/day water savings
- ___ Old aerator has a lower flow rate.
- ___ My family chose not to keep the new aerator.

Student Name: _____ Group ID: _____ Class Period: _____ Date: _____

Faucet Location: _____

Table 1 Focus Question: How much water flows from the bathroom faucet when you turn it on? (in gallons per minute = gpm)												
	<u>Baseline</u> Flow Rate (how you found the faucet, i.e. may or may not have an aerator)				Flow Rate <u>Without</u> Aerator				Flow Rate With <u>New</u> Aerator			
	1	2	3	Avg.	1	2	3	Avg.	1	2	3	Avg.
<input type="checkbox"/>												

What is the **Average Baseline** flow rate? (gpm) = _____ What is the **Average New Aerator** flow rate? (gpm) = _____

Notes: (leak location, old aerator's condition, observations, etc.)

Table 2 Focus Question: How many minutes per day does water flow from this faucet on an average day?									
	Water User #1:			Water User #2:			Water User #3:		
	# of Times per Day	Duration for Each Time (seconds)	Total Seconds per Day	# of Times per Day	Duration for Each Time (seconds)	Total Seconds per Day	# of Times per Day	Duration for Each Time (seconds)	Total Seconds per Day
Brushing teeth	X	=		X	=		X	=	
Washing Hands	X	=		X	=		X	=	
Other uses:	X	=		X	=		X	=	
Each User's Total Seconds Per Day	⇒⇒⇒⇒⇒⇒⇒⇒			⇒⇒⇒⇒⇒⇒⇒⇒			⇒⇒⇒⇒⇒⇒⇒⇒		

Total seconds this faucet runs per day: User #1's total + User #2's total + User #3's total = _____ sec/day

For how many minutes per day does water flow from this faucet? Total seconds/60 = _____ min/day

Table 3 Focus Question: Does the New Aerator result in water savings?					
Baseline Water Use			New Aerator Water Use		
Average Flow Rate (gpm)	Total Time min/day	Baseline Water Use per Day (Avg. x total time = gal/day)	Average Flow Rate (gpm)	Total Time min/day	New Aerator Water Use per Day (Avg. x total time = gal/day)
X		=	X		=

Change in daily water use due to aerator installation:

Baseline Water Use/day – New Aerator Water Use/day = _____ gal/day Water Savings

What will you do to use **LESS** water each day? Mark one of the following:

Re-install OLD aerator = gallons/day savings Keep new aerator = gallons/day water savings

 Old Aerator has a lower flow rate.

 My family chose not to keep the new aerator.

