3.2 The School Water Audit - Indoor

Classroom Faucets, Guided Inquiry

**Summary:**

Students will audit classroom faucet use by surveying teachers and direct measurement of faucet flow. They will also examine data, convert units, draw conclusions, and draft recommendations for ways to use water more efficiently.

**Objectives:**

Students will:

- Collect data by surveying teachers
- Utilize collected data in their audit calculations
- Devise a measurement procedure
- Measure water flow
- Convert data units
- Analyze data and draw conclusions
- Make recommendations for ways to use water more efficiently

**Materials/Supplies:**

Per student group

- 1000, 100 and 10 ml graduated cylinders
- Bowl with a spout
- Stopwatch
- Faucet aerators
- Pair of pliers
- Flagging
- Drip Gauge
- 5 gallon bucket

Per student

- *Survey Tool Development Guide* (Appendix 3.2.A)
- *Survey Data Sheet* (Appendix 3.2.B)
- *Measure Classroom Faucet Flow Rate Procedure and Data Sheet* (Appendix 3.2.C)
- *Classroom Faucets Worksheets* (Appendix 3.2.D)
- Clipboard
- Pencil
Background for Teachers:
Although faucets come in many types, colors, and styles, each one makes use of one of four different mechanisms to make them work: cartridge, compression, ball or disc. The cartridge-, ball-, and disc-type faucets are referred to as mixing faucets and have a single handle or control. These faucets do not use washers to close the valve. The compression-type faucet usually has two controls. They are built with washers or seals that close against a valve seat to restrict water flow. Leaks from any of these faucets will be due to worn internal parts that are neither expensive nor difficult to replace. While easy to fix, if left unattended, a small leak can add up quickly. A leak of about one drip per 10 seconds results in 13 gallons of water lost per day and 4,927 gallons of water lost per year.

Leaky fixtures are an obvious source of water waste. Excessive water flow can be a source of not-so-obvious water waste. Adequate water flow has to do with water quantity and water pressure. According to current plumbing codes, new faucet flow rates cannot exceed 2.5 gallons per minute (gpm) at 80 pounds per square inch (psi) or 2.2 gpm at 60 psi.

A faucet aerator is a great device for maintaining the effect of adequate water flow while reducing the actual quantity of water used. They do this by breaking up the solid flow of water, effectively adding air to the water flow; hence, less water is passed out of the tap each second. Faucet aerators usually restrict flow rates down to 1.5 or 0.5 gpm. Aerators are inexpensive to replace and can be one of the most cost-effective water conservation measures. For maximum water efficiency, aerators that have flow rates of no more than 1.5 gpm should be used.

Preparation before the activity:

- Brief fellow teachers at a staff meeting on the School Water Audit Program and let them know about the SWAP Classroom Faucet Audit Survey.
- It’s always a good idea to send reminders via email to teachers and notices in their mailbox to look for the SWAP Classroom Faucet Audit Survey.
- Secure permission ahead of time, if possible, to have small groups of students enter each teacher’s classroom to measure water flow during class. This is a good use of adult volunteers.
- Study the procedures, data sheet and worksheets for Measure Classroom Faucet Flow Rate (Appendices 3.2.C. and 3.2.D).
Lesson Procedure:

Warm up:
1. Have the students write their answer to this question: What does it take to figure out how much water the school uses in a year’s worth of hand-washing? (Assume that all hand-washing takes place at a bathroom sink.)

2. Draw a 3-column chart on the board or overhead similar to the Example Bathroom Faucet Audit Chart.

3. Discuss the previous Bathroom Faucet Audit and write the students’ answers into the chart.

Activity:
Remember the focus question: How can we reduce water use or use water more efficiently at School?

1. Discuss how water is used at the classroom faucets and whether they are all used for the same things. For instance, are the classroom faucets in the science room used for the same purposes as in regular classrooms? What about the art room? What kinds of things affect when, how, how long, and why the water is used? How many times is the faucet used in a day? Will the use of a fixture be consistent through multiple uses in a day? Are uses consistent from person to person or from day to day?

2. Make a list of all variables that could affect classroom faucet water use. Via this discussion, create a chart similar to the Example Classroom Faucet Use Chart above, filling in the chart as much as possible before moving on.

Pose the Inquiry Questions:

- How much water is used at the classroom faucets in one year?
- How much water can be saved each year by using aerators on all classroom faucets?

3. Reflecting back on the warm-up, discuss what it will take to figure out how much water the school consumes in a year’s worth of classroom faucet use. Guide the students to generate a list of data-related questions for classroom faucet use.

   - How many days per week is the classroom faucet used?
   - How many times per day or hours per day is the classroom faucet used?
   - What is the flow rate at each fixture?
4. How will each of these questions be answered? The classroom faucets are even more difficult to audit by direct observation than the bathroom faucets because they have such a variety of different uses – not just hand-washing. Therefore, you will have to rely more on survey results than you did with the bathroom faucet audit to answer these sub-questions. Review the pros and cons of using a survey: greater ease in gathering data but less accurate data.

5. Turn this list of sub-questions into a survey to collect data that will answer the frequency and duration questions regarding classroom faucet use. Use the Survey Tool Development Guide to develop the survey (Appendix 3.2.A). Refer also to the Classroom Faucet Flow Rate Worksheets (Appendix 3.2.D) as the data compiled from the surveys will be transferred to the worksheet for flow rate calculations.

6. Send the survey to classroom teachers with a deadline for response. The survey should be completed by all teachers; it will help students to verify the existence of faucets in all classrooms.

Remember to make arrangements with the classroom teachers ahead of time for student audit teams to enter their classrooms.

7. Divide the class into cooperative learning groups and assign each to the classrooms they will audit. Assign roles: container holder, timer, faucet controller, recorder, and aerator installer. Be clear about each team member’s assignment prior to going in to the classroom.

8. Remind the students that the teacher will be in the middle of conducting class. Set clear expectations for behavior in another teacher’s classroom: respect them and their class by measuring quickly and efficiently and working quietly and without discussion.

Audit Classroom Faucets

1. Direct each cooperative learning group to review the procedures for measuring the classroom faucets. See the Measure Classroom Faucet Flow Rate Procedure and Data Sheet in Appendix 3.2.C. This review is essentially a rehearsal and is important to making their actual work in the other classrooms quick,
efficient, quiet, and organized. A strategy for making this an effective review is to have the students talk through the procedure aloud, each one telling their group members what they are going to do when it’s their turn, while another team member pantomimes. They should always make sure that the pantomimer is “performing” the procedure correctly.

2. Send the students out to conduct the audit, following the procedures for measuring the classroom faucets’ flow rates. Record the data on the Measure Classroom Faucet Flow Rate Procedure and Data Sheet (Appendix 3.2.C.).

Compile the Data

1. Gather the survey results. Depending on the sequence of questions, students may need to calculate the average daily faucet use in min. for each faucet. Review the survey questions and model the calculation if necessary.

2. Direct the students to copy the sample calculation onto the Survey Data Sheet (Appendix 3.2.B) for reference as they transfer their data from the surveys into the summary table on the data sheet.

3. Using the Classroom Faucet Water Use and Water Savings Worksheets (Appendix 3.2.D), each cooperative group will calculate the annual water use and annual water savings for each faucet that they evaluated. Instruct the cooperative groups to copy the survey data into both worksheets and calculate the gallons consumed per year (baseline), the gallons that would flow per year without aerators, and the water savings per year with aerators. Note: for assistance using the appropriate conversion factors see Appendix 3.1.E.

4. Graph the baseline water use per classroom faucet and water savings per classroom faucet on one school-wide graph. (What is the best style of graph for this data – a line-graph? – a bar-graph?)

5. Examine the data. Is there a lot of variability? If so why? How can this data be rolled up into a single value that represents the total amount of water used throughout the school at the classroom sinks? How can a school-wide total water savings due to aerator installation be calculated?

6. Ask students which type of graph would show the conclusions the best and what data should be shown on each graph. Graph the overall baseline water use, the potential water use without
aerators, and the water use with aerators. How much water will actually be saved from aerator installation? How much water will actually be saved from aerator installation? How can you calculate the maximum amount of water that could/will be saved with aerator installation? Could the total water saved also be a bar on the graph? Is the water savings significant in a year’s time?

Wrap-up

1. Brainstorm as a class how to reduce or make the water use in the classroom faucets more efficient. Are there any behavioral changes that you’d recommend?

2. Allow students time to research faucet aerators. How do they work? How much flow can they restrict? How much do they cost? How long are aerators able to reduce the flow to the rate they say they will?

3. Examine your Bathroom Faucet Data Sheet (Appendix 3.1.D) and Measure Classroom Faucet Data Sheet (Appendix 3.2.C). Were aerators present on the classroom faucets when flow was measured initially? If so, how did the flow compare to the flow with no aerator? What about the flow with a new aerator? What conclusions can you draw about the three measurements that you recorded?

4. Find out through school administrators or your local water provider how much water costs at your school. How much money is saved per year due to aerator installation?

Assessment via Notebooking/journaling:

An aerator is a simple device that has a significant impact on water use. What other water fixtures could have similar adaptations installed? Write a paragraph about how you might recommend making other fixtures at home or at school more efficient. Brainstorm, think outside the box.

Have each student share these ideas with a partner.

Extension:

Consider the variables that may contribute to differences between classroom faucet use values. Regroup the data by these uncontrolled variables and examine it to determine whether they have a significant effect or not. For example, you may wish to group the data by grade level and ask, “Do different grade levels use water differently?” Then examine the data for trends. Or you may examine water use per subject area and ask, “Which subjects appear to use more/less water
than others?“ These extra analyses could lead to new investigations!

**Relevant Web sites**

http://www.epa.gov/watersense/
Appendix 3.2.A
Survey Tool Development Guide

Check to be sure that your survey includes each of the following:

1. Logistical Information:
   - Space for recording the teacher’s name and classroom number is included.

2. Introductory Statements/Instructions:
   - Surveys purpose is stated.
   - Information about how the data will be used is included.
   - When, how and by when survey is to be completed is included.
   - Amount of time need to complete the survey is stated.
   - Respondent is thanked up front for completing the survey.

3. Questions:
   - Language that respondents understand is used (no jargon).
   - Questions are clear, complete and specific (not two questions in one).
   - Questions do not contain double negatives.
   - Response format is appropriate to questions asked. If you want to have the teacher list the daily uses of the classroom faucet, then leave room for it.
   - Questions collectively provide the information you intended to collect and the information that you need.

4. Format/Sequencing:
   - The font is legible and large enough to be read easily.
   - The instrument is attractive but not too busy.
   - There is enough space between the questions.
   - Questions are grouped into coherent categories by themes or types of questions or responses.
   - There is space for additional comments or suggestions.

Include a final thank you to the respondent for his/her time and input.
## Appendix 3.2.B

**Survey Data Sheet**

Copy an example of an average daily classroom faucet use (min/day) calculation here:

<table>
<thead>
<tr>
<th>Room #</th>
<th>Calculation</th>
<th>Avg. Daily Faucet Use (min/day)</th>
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</thead>
<tbody>
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Appendix 3.2.C

Measure Classroom Faucet Flow Rate
Procedure and Data Sheet

Objectives: To determine the average flow rate in ml/5 sec for a selected group of classroom faucets.

Materials: 1000 ml graduated cylinder; bowl with a spout; stopwatch, faucet aerators; pair of pliers; flagging; 5 gallon bucket; drip gauge.

Procedure:

1. Enter the identifying information at the top of the data sheet: student name, teacher name, class period, group #, and date.

For each faucet, complete the following steps.

2. Examine the type of faucet. Draw a check-mark on the data sheet if it is a metered (push-button) faucet.

3. Examine the faucet for leaks:
   a. Look and feel around the faucet as well as under the sink along the drain pipe.
   b. Check the Leak? box on the data sheet if a leak is found.
   c. Mark any leaks with flagging.
   d. If possible, capture the leaking water in a drip gauge for 5 seconds.
   e. Record the leakage level and the associated gallons per year (gpy).

4. Measure the flow of water from the faucet for 5 seconds:
   a. Place the bowl with spout in the sink under the faucet.
   b. Faucet controller: turn the water flow to full-on AND Timer: start the stopwatch simultaneously.
   c. Timer: count aloud (softly) 1, 2, 3, 4, 5 in time with the stopwatch.
   d. Bowl holder: when the timer reaches “5,” immediately remove the bowl from the flow of water without spilling any of the water.
   e. Turn the water off.
   f. Pour the water from the bowl into the graduated cylinder.
   g. Read the water level from the cylinder and record the measurement in milliliters (ml) per 5 seconds on the datasheet in Column C, Baseline Flow.
   h. Pour the water from the graduated cylinder into the 5-gallon bucket. This water will be poured over plants rather than down the drain at the end of class.
   i. Repeat steps a-h two more times for a total of 3 measurements if replicate measurements are being made.

5. Check for an existing faucet aerator and make note of its condition.

6. If an old aerator is on the faucet, remove it (pliers may be needed).

7. Repeat steps 4.a-i, recording the data in Column D, Flow Without Aerator.

8. Install a new aerator

9. Repeat Steps 4.a-i again, recording the data in Column E, Flow With New Aerator.

10. Repeat steps 2-9 to audit each faucet assigned to your team.

11. Pour the collected water over plants outside.
# Appendix 3.2.D: Classroom Faucets Water Use Data Sheet

### Inquiry Question
How much water is used at classroom faucets each year?

### Location

<table>
<thead>
<tr>
<th>Location</th>
<th># of Faucets: ______________</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
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<tr>
<td>C</td>
<td>D</td>
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<tr>
<td>E</td>
<td>F</td>
</tr>
</tbody>
</table>

### Faucet/room #

<table>
<thead>
<tr>
<th>Faucet/room #</th>
<th>Metered</th>
<th>Leak-ing</th>
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### Baseline Flow

<table>
<thead>
<tr>
<th>Baseline flow (existing condition with old aerator or no aerator)? (How many ml in 5 seconds?)</th>
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<td>1</td>
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### Flow without Aerator

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<thead>
<tr>
<th>Flow without aerator? (How many ml in 5 seconds?)</th>
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### Flow with New Aerator

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<th>Flow with new aerator? (How many ml in 5 seconds?)</th>
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### Notes and Comments

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<tr>
<th>Notes and Comments (Leak level / GPY)</th>
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</table>
Appendix 3.2.E: Classroom Faucet Water Use Calculations Worksheet 1: *Baseline Flow*

<table>
<thead>
<tr>
<th>Inquiry Questions:</th>
<th>How much water is used each YEAR at each classroom faucet?</th>
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<tbody>
<tr>
<td>Data needed from class survey:</td>
<td>The average number of minutes that each classroom sink is on each DAY; and number of school DAYS per YEAR.</td>
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<table>
<thead>
<tr>
<th>Faucet in Rm #</th>
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<tr>
<td>Baseline Flow (ml/5 sec)</td>
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<td>Convert to gpm*</td>
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<td>From Survey: Avg. flow time each day (min/day)</td>
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<td>Water use per day (gal/day)</td>
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<td>Class days per year</td>
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<td>Baseline water use per year (gal/yr)</td>
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*See Appendix 3.1.E for help.*
### Appendix 3.2.E: Classroom Faucet Water Use Calculations Worksheet 2: *Without Aerator*

**Inquiry Questions:** How much water is used each YEAR at each classroom faucet?

**Data needed from class survey:** The average number of minutes that each classroom sink is on each DAY; and number of school DAYs per YEAR.

<table>
<thead>
<tr>
<th>Faucet in Rm #</th>
<th>Flow without aerator (ml/5 sec)</th>
<th>Convert to gpm*</th>
<th>From Survey: Avg. flow time each day (min/day)</th>
<th>Water use per day (gal/day)</th>
<th>Class days per year</th>
<th>Max water use per year w/o aerator (gal/yr)</th>
<th>TOTAL</th>
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*See Appendix 3.1.E for help with converting from ml/5sec to gal/min.*
### Inquiry Questions:
How much water is used each YEAR at each classroom faucet?

### Data needed from class survey:
The average number of minutes that each classroom sink is on each DAY; and number of school DAYS per YEAR.

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<thead>
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<th>Faucet in Rm #</th>
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<td>Water Flow with new Aerator (ml/5 sec)</td>
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<td>From Survey: Avg. flow time each day (min/day)</td>
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<td>Water use per day (gal/day)</td>
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<td>Water use per year w/ new Aerator (gal/yr)</td>
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<td>Water Savings (baseline – w/ Aerator)</td>
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*See Appendix 3.1.E for help.
Indoor – Classroom Faucets, Guided Inquiry

THE UNIVERSITY OF ARIZONA
COLLEGE OF AGRICULTURE AND LIFE SCIENCES
TUCSON, ARIZONA 85721

Kerry Schwartz
Director, Arizona Project WET
Associate Specialist, Dept. of Agriculture Education, Water Resources Research Center

Mary Ann Stoll
Program Coordinator, Water Sustainability Program, Maricopa County

Candice Rupprecht
Senior Program Coordinator, School of Natural Resources and the Environment, Water Resources Research Center

Nancy Crocker
Senior Program Coordinator, Water Sustainability Program, Maricopa County

CONTACT:
Kerry Schwartz
kschwartz@ag.arizona.edu

This information has been reviewed by University faculty. cals.arizona.edu/pubs/water/az1505.pdf

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