the gaia project
realistic environmentalism

Project Guide: Water Audit

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Water Audit

A guide to delivering a water auditing and water reduction project in your classroom

The Gaia Project is a charitable organization dedicated to providing project based learning opportunities in the areas of energy, environment and sustainable engineering.

We develop projects, provide professional development, technical support and ongoing project support for teachers and students. Our projects aim to incorporate three key principles, which symbolise our focus on realistic environmentalism.

1. **Data Informed Decisions** – We want students to be able to explain why, and quantify the effect of each decision they made along the way to their final solution.
2. **Economic Assessments** – We expect students to be able to assess the cost effectiveness of their solutions, and be able to optimize their projects with limited budgets.
3. **Environmental Impact and Lifecycle Assessments** – We need students to take a holistic view to their projects. This means looking at their projects from cradle to grave, as opposed to just examining the use phase, and acknowledging that greenhouse gas reduction is not the only environmental issue at stake.

For more information, please visit www.thegaiaproject.ca

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Water Audit

Water is something we take for granted in Canada. It's a plentiful resource, and rarely do we experience shortages.

That is not a luxury the rest of the world shares. Millions of people around the world in developing countries do not have access to a secure water supply for their daily lives. This water scarcity issue is only expected to worsen due to the impact of climate change, with water scarcity potentially threatening billions.

The problem isn't just limited to developing countries. Closer to home, many US states suffer annual water shortages that are only increasing in severity.

Our water use is also linked to our energy use. Clean water requires energy to be pumped, cleaned, heated and treated. Reducing our usage not only leads directly to lower energy use (and lower greenhouse gas emissions), but also to cost savings.

Discussing with your class

Ask student to estimate how much water they use every day. Do they feel like they waste water? Ask them to identify areas of intense water use at the school—are there areas where water is wasted due to malfunctioning appliances?

The aim of the water audit is to produce an estimate of the amount of water currently being used at a site, and find ways to reduce that amount while monitoring the level of that reduction.

This guide is best used in conjunction with our Sustainability Plan guide, which provides the overarching framework for conducting this type of inventory and improvement process. It is not necessary to complete the entire sustainability plan.

Essential Resources

Sustainability Plan: The Gaia Project

http://www.thegaiaproject.ca/projects/sustainability-planning

Additional Resources

National Geographic: Water

http://environment.nationalgeographic.com/environment/freshwater

http://environment.nationalgeographic.com/environment/freshwater/embedded-water/

National Geographic put out a fantastic issue on Water. Some of that information and those resources are available on their website. If you have access to National Geographic magazines, the issue in question is April 2010.

Water Science for Schools

http://ga.water.usgs.gov/edu/sq3.html

A quick water use survey for students to get an estimate of per capita water use.

Water Consumption Calculator

http://www.csgnetwork.com/waterusagecalc.html

Creating an Inventory of Users

The first step in a water audit is to identify all the possible users of water within the building. This will most likely focus on bathrooms, kitchens, water fountains, and external watering.

Assembling this information into an inventory of water using equipment by location is important in being able to determine where water is being used in the school. An example of an inventory of users can be seen in Table 1.

Table 1: Inventory of Water Users

Location	User	Number
Men's Bathroom	Toilet	2
	Urinal	3
	Sink	3
Women's Bathroom	Toilet	4
	Sink	3
Hallways	Water Fountain	2

Equipment Required

The great part about a water audit is that is required very little in terms of equipment.

Generally, all you are going to need is:

- Bucket
- Stopwatch
- Measuring cup
- Sound level sensor and datalogger (can be used to detect flushes).

Measuring Water Use

Water can be used by in one of two main ways:

- A fixed amount of water is used every time the device is used (e.g. toilet)
- The amount of water used depends on the amount of time the device is used for (e.g. sink)

The way we estimate the amount of water used depends on which of the above two ways the water is used.

Water per Use / Number of Uses

Where a fixed amount of water is used, the first step is determining the amount of water used during each use. There are several ways of achieving this:

- Letting the water flow into a bucket will enable you to measure the volume later
- Measuring the size of the vessel that the water flows from
- Shutting the water valve off to the equipment, draining it, and then refilling it with a measuring cup (useful for toilets).
- Checking the owner's manual (useful for devices such as dishwashers)

Once we have a measurement of the amount of water used during each use, we need to get an idea of the number of times the device is used. Again, this can be done in a variety of ways:

- **Continuous observation:** Physically counting each and every use over a defined period. This is very labour intensive, but precise.

- **Observing key time periods and assuming that these are representative:** for example, in a school, you may choose to record the number of toilet flushes during one class, during one break between classes, and during one lunch hour, and assume that these are representative of all classes, all breaks between classes, and all lunch hours. This can save a lot of time, but is not as precise. Students will need to ask

themselves when it is appropriate to make an assumption. For example, bathroom use directly after lunch may not be representative of a use at other times of the day.

- **Surveys:** Asking users of the device how often they use the device can be a quick method of obtaining an estimate of the number of uses. Surveys need to be used with caution, as they aren't always the most reliable source of information. Why is this? Firstly, these are things people don't usually keep track of, and so don't have an accurate idea. Secondly, surveys are subject to bias. People like to try and give the answer that the surveyor is looking for. In this case, people are likely to say they use less water than they actually do.

All of these methods can be appropriate, and it is likely that you will use a mix of them. Surveys enable quick data collection, though it may be a good idea to verify by continuous observation or data logging.

After collecting this information, we can update the inventory to look like Table 2 [see end of document].

Rate of Use / Time of Use

For devices where water consumption depends on the amount of time it is used for, the first step needs to be figuring out how fast the water is used.

The most straightforward way to achieve this is to fill a bucket of known volume and record the time taken to fill the bucket. This can then be converted to a flow rate in Litres per second, and entered into a table such as the one shown in Table 3 [see end of document].

Once we know rate of water flow during use, we need to get an idea of the length of time the device is used. Again, this can be done in a variety of ways:

- **Continuous observation:** Physically recording the length of use over a defined period. This is very labour intensive.

- **Observing key time periods and assuming that these are representative:** For example, in a school, you may choose to record the average length of time that someone washes their hands at a sink, and then record the number or people washing their hands during one class, during one break between classes, and during one lunch hour, and assume that these are representative of all classes, all breaks between classes, and all lunch hours

- **Surveys:** Asking users of the device how often they use the device and how long they use it for can be a quick method of obtaining an estimate of the length of time that a device is used for. Surveys need to be used with caution, as they aren't always the most reliable source of information

Implementing Improvements

Now that we have created an inventory of users and water consumption, we can start to identify areas where we can reduce the amount of water being wasted.

There are likely two main areas where students will identify water savings: by changing

behaviour, or by replacing/repairing equipment. Let's start by looking at behaviour.

After monitoring hand washing, we notice that most students leave the water running at high speed while washing their hands.

We could suggest that students turn off taps while soaping their hands; however, here we need to consider something other than water savings —we also need to consider proper hand washing technique.

Proper hand washing avoids touching the taps after washing. Encourage students to use paper towel to turn the taps on and off (though we might need to monitor the amount of paper towel being used so that we are not wasting), which is not only saving water but teaching students about proper hand washing techniques which could prevent transmission of cold viruses at the school.

This could be done through an awareness campaign at the school where the students produce a video, posters or pamphlets for the student body.

It is unlikely that old equipment will be replaced right away, but if students identify equipment that waste significant quantities of water, we can start to look at developing a replacement policy for the school.

For example, if old urinals use a lot of water and flush automatically and continuously, we could calculate the costs, potential water savings and resulting payback period from replacing these in the future with motion activated, or waterless urinals.

Additional Resources

Health Canada: The benefits of hand washing
http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/diseases-maladies/hands-mains-eng.php

Calculating Savings

Once you have implemented changes, you'll want to redo your water audit. Your process should be identical to your first audit to ensure that any savings you identify are due to the changes you implemented.

To be able to calculate reductions, it is important to remember that you need to know what the situation was like before and after a change was made [see Table 4 at the end of this document].

The audit shown in Table 4 [see table at end of document] indicates that water consumption in the areas studied was reduced by 29%.

Per Student

When comparing numbers from two different inventories, it may not be fair to compare the total amount of water used at the site directly. For example, a school could see an increase in enrolment from one year to the next, so more water may be being used even though less water per student is being used.

For this reason, it can be useful to calculate the amount of water used per student for use as a comparison tool.

Table 2: Populating table with information for devices using fixed amounts of water per use

Location	User	Num-ber	Amount per Use (L)	Number of Uses per Day	Water Used per Day (L)
Men's Bathroom	Toilet	2	5	100	1000
	Urinal	3	1.5	200	900
	Sink	3			
Women's Bathroom	Toilet	4	5	200	4000
	Sink	3			
Hallways	Water Fountain	2			

Table 3: Populating table with information for devices whose water use depends on length of time per use

Location	User	Num-ber	Amoun t per Use (L)	Rate of Use (L / s)	Average Time of Use (s)	Number of Uses per Day	Water Used per Day (L)
Men's Bathroom	Toilet	2	5			100	1000
	Urinal	3	1.5			200	900
	Sink	3		0.2	30	200	1200
Women's Bathroom	Toilet	4	5			200	4000
	Sink	3		0.2	30	200	1200
Hallways	Water Fountain	2		0.1	10	700	700

Table 4: Calculating Water Savings

Location	User	Number	Water Used per Day	Water Used per Day	Percentage
Mens Bathroom	Toilet	2	1,000	600	40%
	Urinal	3	900	300	67%
	Sink	3	1,200	1,200	0%
Womens Bathroom	Toilet	4	4,000	2,500	38%
	Sink	3	1,200	1,200	0%
Hallways	Water Fountain	2	700	600	14%
Total			9,000	6,400	29%