



Australian Government
Quality Teacher Programme

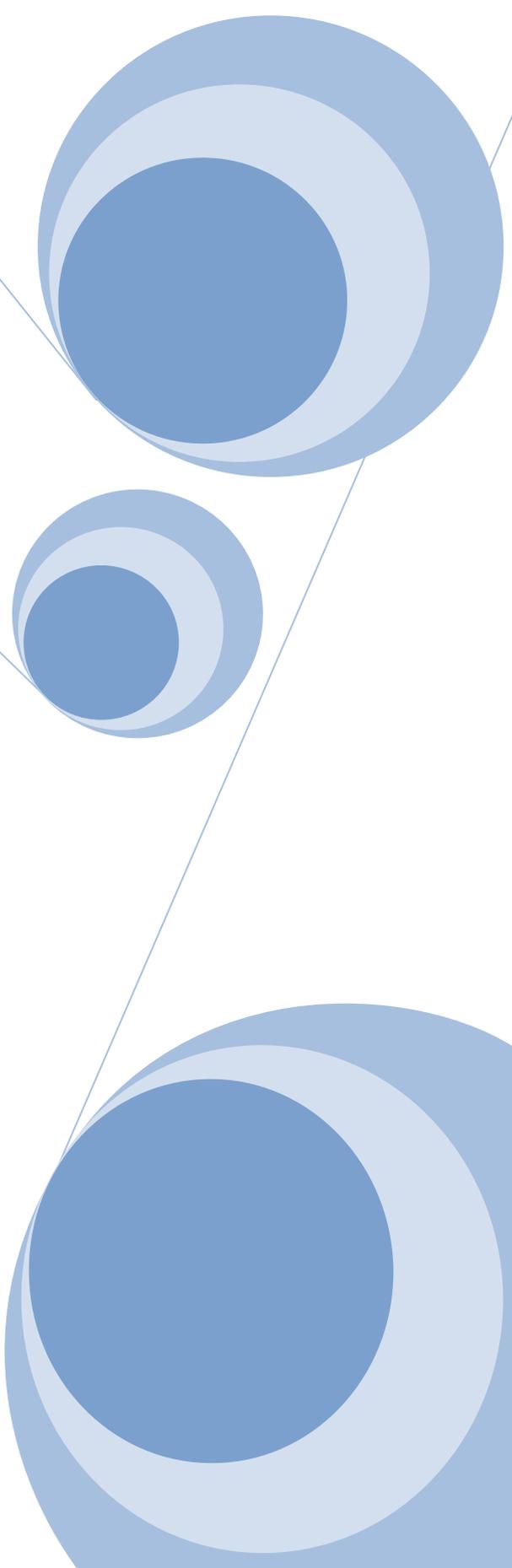


Bottled Water or Tap Water - Your Choice!

Science and Financial Literacy by SEA*ACT

This document provides stimulus materials to assist secondary science teachers to integrate science investigations, with activities to develop financial literacy, and an understanding of the need for sustainable development.

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2008**



Bottled Water or Tap Water – Your Choice!

Essential Learning Areas from the ACT Curriculum Framework: [Every Chance to Learn](#)

Early Adolescence Band of Development

The student:

- ELA 24 makes informed choices about money and finance
- ELA 20 acts for an environmentally sustainable future
- ELA 2 understands and applies the inquiry process
- ELA 3 makes considered decisions
- ELA 4 acts with integrity and regard for others
- ELA 6 uses Information and Communication technologies effectively
- ELA 8 listens and speaks with purpose and effect
- ELA 9 reads effectively
- ELA 10 writes effectively
- ELA 11 critically interprets and creates texts
- ELA 16 understands and applies number
- ELA 17 chooses and uses measures
- ELA 18 recognises and represents patterns and relationships

Through the delivery of this unit of work, teachers may also include content from:

- ELA 1 The student uses a range of strategies to think and learn
- ELA 5 The student contributes to group effectiveness

The following table provides further information about outcomes in ELA 24 and ELA 20:

Outcomes (skills & processes)	Concepts	Suggested Strategies	Stimulus questions	Resources
Evaluate a range of consumer information and justify purchasing choices	<p>ELA 24 : EA.2 ELA 24 : EA.9</p>	<p>Science Investigation. Research. Using web based calculators to determine CarbonZero emissions calculator</p>	<p>What is the financial cost of using bottled water? What is the environmental cost of using bottled water?</p>	Activities 1-5
Develop & consider personal perspectives on the use of bottled water and sustainability.	<p>Personal responsibility. Environmental stewardship</p> <p>ELA20 : EA.8 ELA 20 : EA.10</p>	<p>Socratic discussion. Debate, group presentation</p>	<p><i>The Case for and Against Bottled Water</i></p>	Activities 1-5

Description

Students apply their inquiry skills to investigate a consumer product. They investigate the properties of the product, its price, and waste produced as a consequence of using this product. The environmental consequences of the product packaging and transport are considered and related to the impact on the environment.

Purpose

To enable students to:

- become more critical consumers and to consider the consequences of their actions
- make evidence based decisions at the supermarket

Duration:

5 x 50 minutes lessons

Possible Outcomes in Financial Literacy

By completing this activity students could demonstrate:

- Knowledge and understanding
- Competence
- Enterprise
- Responsibility

They will be involved in making informed decisions, evaluating consumer information, considering their rights and responsibilities as consumers and justifying their purchase choices.

Materials required

Drinking Glasses or transparent disposable cups

A variety of different brands of bottled water

Dropper pipettes

Detergent, soap or shampoo

Test tubes with stopper and test tube racks

Information on the prices of the bottled water

Brand	Neverfail Spring Water	Evian Spring Water	Noble Water Ultra Pure	Fiji Water Natural Spring
Volume	5L	1.5L	5L	1L
Price *	\$4.72	\$3.34	\$4.52	\$2.89
Origin	Australia	France	Australia	Fiji

(* These prices are correct at 21 November 2008)

Introduction



Crushed water bottles at a recycling plant in Chullora, NSW. Despite recycling efforts, 65 per cent of plastic drink bottles still ended up in landfills.

ENVIRONMENTALISTS have pleaded with authorities to help cut waste caused by Australia's increasing thirst for bottled water.

Demand for the product is growing by 10per cent annually, adding to the 118,000 tonnes of plastic drink containers manufactured each year.

Latest research by Clean Up Australia shows that just 35per cent of all plastic bottles are recycled. The rest end up in landfill sites.

Figures compiled by the Australian Conservation Foundation (ACF) show the manufacture and transportation of bottled water is leaving a massive "carbon footprint".

For every tonne of one-litre bottles of Evian water shipped to Australia each year, for example, at least 84 kilograms of harmful emissions are created.

About 150 million litres of bottled water is consumed in Australia each year.

(The Sydney Morning Herald, Hannah Edwards, July 29, 2007Full text available at: <http://www.smh.com.au/news/environment/dont-buy-bottled-water-activists-urge/2007/07/28/1185339322381.html>)

In the following sequence of activities students are involved in science investigations to determine the properties of water, in consideration of the financial and environmental costs associated with using bottled water and in developing evidence based arguments for and against using bottled water.

Lesson Sequence

Lesson Title	Description
Water Tasting	In this activity students are required to conduct a taste test to see whether they can detect any differences between tap water and four different brands of bottled water.
Measuring the Froth	Students conduct an investigation to determine whether any of the water samples are more successful at creating froth than others.
The cost of Water – Tap or Bottled	Students consider the cost of tap water compared with the cost of bottled water. Each water sample is considered in terms of where the source of the water is located, the number of kilometres the water travels to be bottled and then transported to the supermarket and the home.
The real cost of bottled water	Students consider the impact on the environment of bottling water, transporting it and then disposing of the packaging.
Evaluation – The Case for and Against bottled water	Students reflect on all the work that they have done and develop an argument for either buying or not buying bottled water. The argument can be presented as part of a class debate, as a written report or as an oral presentation.

Activity 1 **Water Tasting**

Introduction

The bottled water craze is so big that Coca Cola and Pepsi predict that within a short time, water will create more revenue for them than their less healthy products. By 2007 the market will be twice the size.

Australians love bottled water. We spend \$525 million per annum on something supposed to be "pure" or drawn from "springs", and we fall for the images of sparkling streams and idyllic waterfalls as we rush for the checkout.

Source: <https://secure15.ozhosting.com/ionlife/water-filter-lessons-101-bottled-water.asp>

But does bottled taste better than tap water?

If you were given a glass of tap water and a glass of bottled water would you be able to tell the difference?



Before the students arrive for class:

Prepare for each group of students bottles of water with labels Brand A, B, C, D and E. If possible refrigerate the water before the lesson.

One bottle should contain tap water. Collect the tap water at least 8 hours before it is needed. The other bottles should contain samples of bottled water that has been purchased at the local supermarket.

To make this a fair test it is suggested that you restrict your purchases to **Spring water**. **Spring water** must come from underground. Unless the label specifies that the water has been 'bottled at source', it's probably been **transported to a bottling plant in a bulk tanker**. Many spring waters are filtered and some may be chemically disinfected (usually with ozone).

Artesian water is similar, except that the water probably comes from deeper underground. (Artesian water is confined underground between layers of impervious rock and is under pressure, so it comes to the surface without pumping.) As the water has come from underground it may contain some dissolved minerals and these could affect the taste of the water.

Welcome your students to the Water Tasting and issue each student with a Water Tasting Report Card.

Demonstrate the process to be used for pouring and tasting the water samples.

Explain the rules of water tasting:

There are essentially three steps in water tasting, **look**, **smell** and **taste**. These three steps will influence your entire decision making process.

1. You can tell a lot about water just by **observing**. Simply look at the water first as you can determine many things about it. Hold each glass of water up to the light, preferably against a white background, so that you can carefully examine the colour of the water.
2. The **smell** of the water is also important. Begin by swirling the water in your glass which will assist you in visually observing the body of the water and also help in releasing the smell to the air. You can get a first impression by taking a quick whiff of the water as it swirls. If you like what you smell, take a second deeper whiff of the water.
3. Finally you need to **taste** the water. Take a mouthful of the water and let it rest in your mouth for a few seconds before swallowing. Does the water taste sweet and fresh or can you detect other tastes?

Record your opinions on the **Water Tasting Record Sheet**.

Once the water tasting is complete, conduct a quick survey to determine which water sample was allocated a grade of 5, by the largest number of students.

Show the students the bottles of water that were purchased. Invite them to discuss with their group members the results of the water tasting and see whether they can identify which of the bottles have been used as Brand A, B, C, D and E.



Once the students have recorded their decisions about the origin of each water sample, gather the responses from each group and use them to create a table of data for the class. An example is shown on the following page.

Sample Table of Data obtained from a class

	Bottle A	Bottle B	Bottle C	Bottle D	Bottle E
Group 1	Brand A	Brand B	Brand C	Brand D	Brand E
Group 2	Brand B	Brand A	Brand D	Brand C	Brand E
Group 3	Brand C	Brand E	Brand A	Brand D	Brand B
Group 4	Brand C	Brand E	Brand B	Brand A	Brand D
Group 5	Brand B	Brand E	Brand C	Brand D	Brand A
Group 6	Brand C	Brand A	Brand D	Brand B	Brand E
Group 7	Brand E	Brand C	Brand A	Brand D	Brand B

Discuss with the students the level of difficulty they experienced with identifying the different water samples.

Provide the students with the identity of each of the water samples.

Identify which groups were able to correctly identify the water samples and invite them to share their strategy and reasoning with the class.

Q. Does this activity convince you that bottled water tastes better than tap water?

Q. Is this information enough to convince you that you should buy bottled water?

References

Choice

<http://www.choiceextra.com.au/images/pdfs/0507Bottled%20Water.pdf>

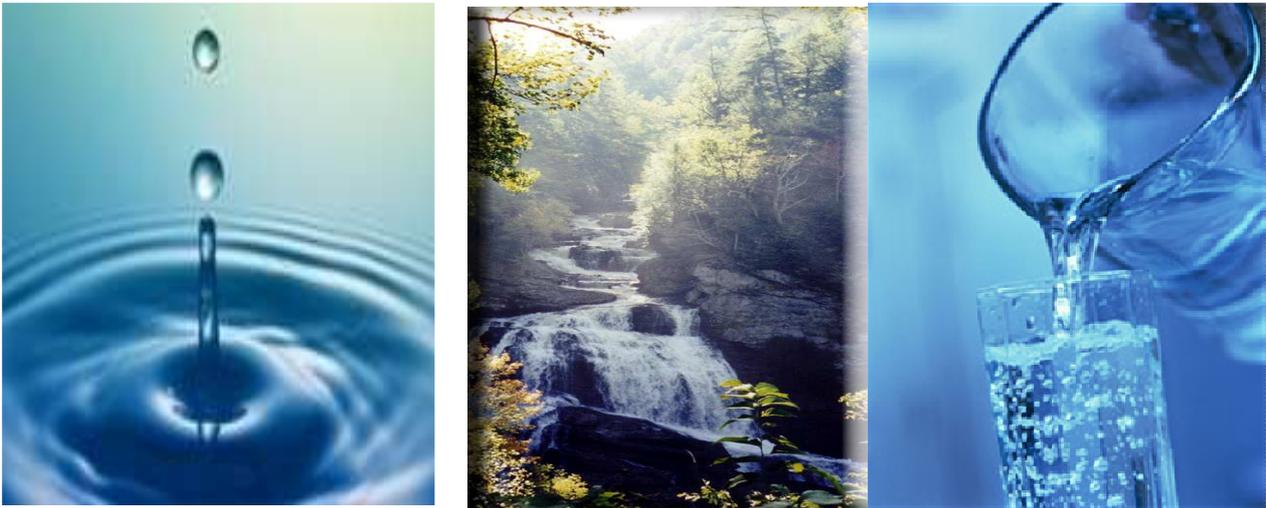
Information on conducting water tasting

http://www.finewaters.com/Bottled_Water_News/Events/2002_Australian_Water_Tasting.asp

Water Tasting, Portland Water Bureau

<http://www.portlandonline.com/shared/cfm/image.cfm?id=31573>

Water Tasting Report Card



You have five water samples to taste.

Grade each sample with a mark from 1 – 5, where 5 is the water sample that tasted the best and 1 is the water sample that you liked the least.

Water Sample	Your Mark	Notes about Odour	Notes about Taste
A			
B			
C			
D			
E			

Which sample do you think is tap water? _____

Do you ever buy bottled water? Yes No

If you buy bottled water, how often do you buy it? Daily, weekly, monthly, occasionally

If you buy bottled water, what brand do you buy? _____

Activity 2 Measuring the Froth

Introduction

You can use the method below to test samples of water to see how hard they are. **Hard water** is the type of water that has high mineral content. Hard water minerals primarily consist of calcium (Ca^{2+}), and magnesium (Mg^{2+}) ions, and sometimes other dissolved compounds such as bicarbonates and sulfates. The simplest way to determine the hardness of water is the lather/froth test: soap, shampoo or detergent, when agitated, lathers easily in soft water but not in hard water.

Plan an investigation using this test to compare the hardness of different samples of water. Read the description of the hardness test first, and then make your plan. Get your teacher to check your plan before you start the practical activity. Bear in mind the following questions:

- how will you make sure that your tests are fair?
- how will you make the investigation safe?
- what information will you record about each sample you test?
- what precautions will you need to take to make sure your results are as accurate as possible?

One possible method is described below.

Use the five water samples that were used for activity 1 for this test.

1. Place 2 ml of each water sample into a labelled test tube.
2. Using a dropper pipette carefully add one drop of dishwashing detergent or shampoo to each water sample.
3. Using the same method for each test tube, shake vigorously for one minute.
4. Measure the depth of froth produced and record the results in a table.

What's going on?

This investigation is used as a test for water hardness. The presence of dissolved minerals in the water limits the ability of the detergent to form bubbles and froth. The water sample producing the greatest level of froth will be the water sample with the greatest purity.

More tests

There are many other tests that you can do on water to detect whether it is just pure H_2O or whether there are other substances present.

You could test the water to determine its pH. You could use some test papers to detect whether the water has dissolved nitrate, phosphate or chloride compounds present.

Have a look at Tap Water Testing at

<http://www.chemistryland.com/CHM107Lab/Lab5/WaterTest/Lab5Exp1water.html>

Testing Water Quality

http://www.westone.wa.gov.au/toolboxes/aquaculture/units/monitorstock/a4_testingwaterquality/00_testingwater.htm



Activity 3 **The Cost of Water – tap or bottled?**

Part 1

Introduction

In 2008 water from the tap in Canberra costs 55 cents for 1000 litres, while the samples of bottled water costs tested in activity 1 and 2 range in price from \$627 per 1000 litres to \$2890 per 1000 litres.

If you drank two litres of tap water per day instead of two litres of bottled water how much money would you save in a year?

Cost per day for 2 litres of tap water		Cost per day for 2 litres of your favourite bottled water	
Multiply by 365 = number of days in a year		Multiply by 365 = number of days in a year	
Cost per year to drink tap water		Cost per year to drink bottled water	

Q. How much money would you save if you only drank water from the tap for a year?

Q. Is this information enough to convince you that you should not buy bottled water?

Part 2

The amount of money that you pay at the supermarket for a bottle of water is only part of the cost. Transporting bottle from its source to the bottling plant and then to Australia and then to a supermarket near you involves costs as well.

Packaging the water in bottles or casks also involves a cost. This is considered in the next activity.

In the twenty first century we need to carefully considering the impact that we are having on our environment. We want to change the way that we live so that we have a lifestyle which is more sustainable. One of the issues that is of great concern is the use of fossil fuels for transport as the combustion of the fuel produces carbon dioxide and other gases which are thought to contribute to global warming.

In the next activity you need to consider the distance that the water has travelled so that it is available for you to drink.

	Canberra tap water	Neverfail Spring Water	Evian Spring Water	Noble Water Ultra Pure	Fiji Water Natural Spring
Source	Cotter Dam, ACT	Thomastown, Victoria Australia	France	St Mary's NSW Australia	Fiji
Distance* travelled	35.6km *	642 km	16 950km	274 km	3480 km
Means of transport	pipeline	Truck	Plane	Truck	Plane
Carbon Dioxide emissions for the journey #	0	0.24 tonnes	5.02 tonnes	0.1 tonnes	1.01 tonnes

* Use Google Maps to find out the distance from the source to your local supermarket. In the example above the final destination is a supermarket in Gungahlin, ACT.

The carbon dioxide emissions were calculated at the CarbonZero Emissions Calculator at <http://carbonzero.ca/calculator/flights-carbon-calculator.php>

The two water samples that come from other countries are more likely to be transported by ship rather than plane. "Ships pump out twice as much carbon dioxide as planes, according to new figures from the maritime industry body Intertanko." (Source: *Ships pollute more than planes*, at http://www.theregister.co.uk/2007/10/19/co2_ships/.)

Q. Would the information about the amount of carbon dioxide produced by transporting the water make any difference to your choice at the supermarket?

Data has been provided for four water samples. However, it is useful exercise for students to visit their local supermarkets to see the range of bottle water products that are available and to use the calculator themselves to calculate the carbon dioxide emissions associated with the transport of their favourite brand of water.

Guidelines for the visit are listed below:

1. Visit your local suppliers of bottled water (as many of them as possible). Make a record of the brands, sizes and costs of all types available at each outlet.
 2. Organise your data into a table format.
 3. Compare the price of bulk buying with that of purchasing several smaller bottles of equivalent capacity.
 4. Now consider your needs for a weekly supply.
- Take into account the following points.

Your bottled water supply must provide for all drinking and food preparation needs. The water has a long shelf life, so bulk purchases may be more economical (if you have storage room and funds available).

Reducing your carbon footprint – Carbon offsets

Travel, whether by car, bus, ship or aeroplane involves the combustion of fossil fuels and this generates carbon dioxide emissions. The increasing level of carbon dioxide in the atmosphere is of great concern because it seems to be linked to global warming. One of the issues associated with the use of bottled water is that water is being transported by trucks and tankers, ships and aeroplanes.

Use the calculator at this website to determine how much carbon dioxide would be generated transporting the brand of bottled water that you prefer:

Carbonzero Emissions Calculator:

<http://carbonzero.ca/calculator/ground-carbon-calculator.php>

Read more about reducing your carbon footprint at these sites:

Go Carbon Neutral:

http://www.davidsuzuki.org/Climate_Change/What_You_Can_Do/carbon_neutral.asp

Choice article about Going Carbon Neutral:

<http://www.choice.com.au/viewArticle.aspx?id=105933&catId=100285&tid=100008&p=1&title=Going+carbon+neutral>

The World Wildlife Fund also provides some good advice at Reduce, Renew, Offset:

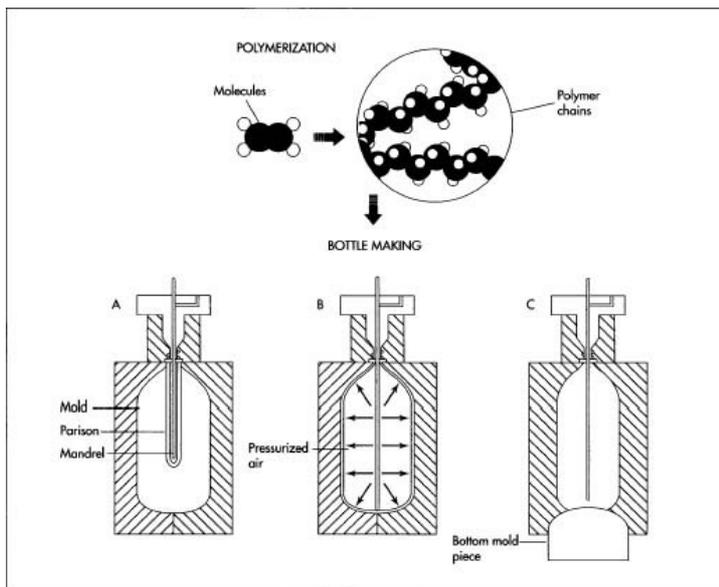
<http://www.wwf.org.au/act/takeaction/carbon-offsets/>

Activity 4 The real cost of bottled water

Packaging

Bottled water is packaged in plastic bottles!

Watch the [animation](#) to learn about how plastics are made from crude oil.



You can learn about how PET bottles are made at <http://www.madehow.com/Volume-1/Soda-Bottle.html>

Water bottles can be made from [PET](#) (Polyethylene terephthalate), [Polycarbonate](#) or [HDPE](#) (High Density Polyethylene). All of these materials can be recycled.

Watch the [video](#) at to learn about the processes used to recycle PET bottles.

However, most water bottles are not being recycled!

According to [Janet Larsen, Director of Research](#) at the [Earth Policy Institute](#) in Washington, 2.7 million tonnes of plastic are used to bottle water each year. Though PET is made for recycling, nine out of 10 such bottles in the United States end up in landfill - roughly 30 million a day - where they can take up to 1000 years to biodegrade. In Australia, just 35 per cent of PET bottles are recycled.

Source: [Disaster in a Bottle](#), April 24, 2007



Recycling PET water bottles is attractive when there are incentives associated with it.

What incentives could be used at your school to encourage students to recycle bottled water containers?



For larger volumes of water, such as 5 or 10 litres, larger plastic containers or casks made from layers of cardboard, plastic and metal can be used. You can find out more about Pureau's Water in a Cask [here](#).

Companies that market bottled water are keen to identify that the processes involved in the production of their product are environmentally friendly. Read about [Neverfail's Commitment to the Environment](#) and about the [Green Goals](#) that Fiji Water is striving to achieve. Then read these [Plastic Bottle Facts to make you think before your drink](#).

Is the production of bottled water friendly to the environment?
What concerns do you have about the process?

Bottled water – contaminated water?

Have you ever picked up a plastic bottle containing water after it has been sitting in the sun? When you taste the water it tastes different. Why is this? Perhaps the heat has caused some of the plastic to start breaking down and it has contaminated the water?

This should not be a problem if the water bottle is made of PET but there has been concern that bottles made from Polycarbonate and PVC bottles can leach chemicals into the water.

Polycarbonate plastic is a lightweight, high-performance plastic that possesses a unique balance of toughness, optical clarity, high heat resistance and excellent electrical resistance. Bisphenol A (BPA) is a chemical building block that is used to make polycarbonate plastic. Concerns have been raised about Bisphenol A from the polycarbonate bottle leaching into the water but recent studies have shown that there is no cause for concern. Read [Bottled Water Products in Polycarbonate Plastic Containers are Safe for Consumer Use](#) by the Australasian Bottled Water Institute to find out more.

Perhaps there are bacteria in the water and their numbers are increasing because the water is warm. ***Tests carried out by Health Which? in the UK found that once it's opened, bacteria levels can increase if it's kept at room temperature. Air can carry bacteria and the spores of moulds, so once you've opened a bottle of water it's safest to keep it in the fridge.*** (Source: Choice – Bottled Water, <http://www.choice.com.au/viewArticle.aspx?id=104793&catId=100286&tid=100008&p=1&title=Bottled+water>)

What regulations govern bottled water?

The [Food Standards Australia New Zealand](#) (FSANZ) sets the minimum standards for all types of bottled water. Bottled water is but one of thousands of food products packaged in plastic containers. Australian Standards are in place and adhered to, ensuring the safety of all packaging used for food and beverages. The primary goal of the [Australian Bottled Water Institute](#) ABWI's primary goal is to ensure consumers enjoy safe, high quality, good tasting bottled water.

For Reference:

BottledWaterStore.com: <http://bottledwaterstore.com/waterfacts.htm>

Disaster in a Bottle: <http://www.smh.com.au/news/environment/disaster-in-a-bottle/2007/04/23/1177180569554.html>

Bottled Water Issues Summary:

http://www.a2gov.org/SiteCollectionDocuments/public_services_water_a2h2o_FAQs_2007_12_12.pdf

Activity 5 The Case For and Against Bottled Water



Chris likes the convenience of bottled water - he can drink it anywhere, anytime.



Samantha drinks bottled water all the time! She doesn't like the taste of Canberra's tap water.



I can get out of class to go and get a drink. Who needs bottled water?

All my friends drink bottled water so I do too!

Q. What do you think?

Q. Is there a need for bottled water?

Q. Can we afford the financial and environmental cost of bottled water?

Q. Would you be able to argue your case? What evidence would you use?

Some Other Alternatives

The five activities listed in this document provide opportunities for students to:

- Improve their scientific literacy,
- Further develop their inquiry and research skills,
- Develop improved financial literacy
- Develop improved understanding of the need for sustainable development

The activities described in this document all relate to the purchase of bottled water.

However, similar outcomes could be achieved by investigating:

- **Should disposable baby nappies be used instead of cloth nappies: i.e. which is most absorbent, creates the least amount of carbon dioxide and minimises the amount of waste contribution to landfill?**
- **Which brand of tinned tomatoes is best value for money – the no-name brand produced in Australia or the brands imported from Italy, South America or China?**
- **Do batteries made in China last longer and cost less than batteries made in Australia – when all the costs, financial and environmental are considered?**
- **Is it worth buying imported Orange Juice or can you obtain just as much Vitamin C from a local product without having to pay for carbon offsets?**
- **Does paying more for any product ensure that the product is of a superior quality?**

CREST AWARDS

Science investigations, such as the ones outlined in this document would enable students to achieve CREST Awards.

CSIRO's CREativity in Science and Technology (CREST) Awards program encourages and supports students to choose, organise and undertake their own open-ended science or technology project.

CREST is not a competition but a program which focuses on the individual and encourages success and the development of skills as students pursue a topic of interest to them. It is for all students and so can be offered to the whole class as part of the curriculum.

CREST students are encouraged to:

- **be creative**
- **apply** their knowledge and skills
- **persevere** with their project until they have completed it.

A range of support material is available to help introduce and support open-ended work into your classroom. Further information about CREST can be obtained at the [CREST website](#) or by contacting the **CREST Coordinator on 1800 626 646**.