water

learn it. live it.

an education resource
for primary and
secondary schools

Volume Two: Water in the Urban Environment

A joint initiative of Yarra Valley Water, City West Water, South East Water

Acknowledgements

Water – learn it. live it.
Fourth Edition (2013)

Developed by Melbourne's government-owned water retailers:
City West Water
South East Water
Yarra Valley Water

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Subject Key Science English Environment Geography

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Introduction

Schools play an important role in delivering sustainable messages to our future generations.

Melbourne's government-owned metropolitan water businesses, City West Water, South East Water and Yarra Valley Water, have joined forces to bring you the new Water – learn it. live it. (Water-lili) Curriculum Resource, a collaboration between educators and water industry professionals.

This resource for primary and secondary teachers provides fun, interesting and interactive projects to assist students to learn about all aspects of the water story. From properties of water and catchments, to sewage treatment, recycling, health and hydration and responsible gardening, water is explored at a local, national and global level.

Bloom's Taxonomy underpins this collection of activities and asks more of the students than simple recall, instead requiring knowledge, comprehension, application, analysis, synthesis and evaluation. Great care has also been taken to cater for the varying interests and strengths of students, and offer activities based around Science, Mathematics, English and Communications, Art, Music and Geography, all with a focus on water.

The resource has been designed to be flexible in its use and allows educators the opportunity to pick and choose which activities will suit the needs of their students. There are three volumes in the series.

- *Volume One: Water in the Natural Environment*
- *Volume Two: Water in the Urban Environment*
- *Volume Three: Water in the Community*

Using the Resource

Volume Two: Water in the Urban Environment investigates the journey of water through the urban water cycle. This volume is broken into four sections: Collecting Water, The Water Journey, Water Coming and Going, and Water Industry - Innovation and Careers. Each section provides a collection of relevant activities for students from Years Prep to 10 and includes a main activity supported by three scaffolded options to explore the subject further.

The scaffolds are aimed at different levels of student ability, and are categorised as Engage (Prep-2), Connect (3-6) and Explore (7-10). These categories are a guide only, and you may find an activity that suits your students in any of the sections.

A selection of specific worksheets, thinking tools and graphic organisers are provided to assist students to clarify their processes and explore each subject completely. Specific worksheets are found directly following the relevant activity, and graphic organisers are kept together in the Templates section of the resource. An outline of the graphic organisers and their applications can be found at the beginning of the Templates section of this document.

Icons have been used in the Table of Contents to indicate the subject area to which the activity belongs. An Activity Matrix has also been included to allow you to easily identify the learning style and area to which each activity belongs.

Hands on Activity

ICT

Pen and Paper

Out and About

Suggestions, links and additional information are provided where deemed appropriate, however specific references have generally been avoided to insure against broken links or superseded information, and to allow for flexibility in using your favourite sites and programs. There are a variety of online sites for your students to create their works, including flipbooks, stop motion, animations, films and cartoons. Just use an online browser to find the information or program you require.

Activity Matrix

Activity Name	Pg	Activity Type			
		Main	Engage	Connect	Explore
1. Collecting Water					
Catchment Protection	12	✋	✏️ ⏻	✏️	⏻ ✏️
Storing Water Naturally	14	✋	✋ ✏️	✏️	✋ ✏️
Water Storage Features	15	✏️	✏️	✏️	✏️
Melbourne's Reservoirs	17	🚶	✋	✏️	✏️ ⏻
Future Water Supply	24	✏️	✋	⏻ ✏️	✏️
Collecting Rainwater	26	⏻ 🚶	✏️	✏️	✏️
2. The Water Journey					
The Urban Water Cycle	32	✏️	✏️	✏️	✏️
Catchment to Tap	33	✋	✋	✏️	✏️
What Happens Next	34	✋	✏️	✏️	✏️
Pipes	38	✏️ ✋	✏️	⏻ ✋	✏️
The Ins and Outs of Drains	41	🚶 ✏️	✏️	✏️	✏️ ✋
Melbourne's Sewage History	43	⏻ ✏️	✋	✏️	⏻ ✋
3. Water Coming and Going					
Stormwater Campaign	48	⏻	✋	✋	✋ ⏻
Recycled Water	49	⏻ ✏️	✏️	✏️	✏️
What's Desalination?	52	⏻ ✏️	✏️	✏️	✏️
Removing the Salt	55	✋	✋	⏻ ✏️	✋ ✏️
Trade Waste	57	✏️	✏️	✏️	✏️
Sewage	58	🚶 ⏻	✏️ ✋	✏️	✏️
4. Water Industry - Innovation and Careers					
Water Innovation	63	✏️	✏️	✋	✋
Water Sensitive Urban Design	65	✋ ⏻	🚶	⏻ ✏️	⏻ ✏️
Careers	66	✏️	✏️	✏️	✏️

Melbourne's Water Businesses

City West Water

City West Water

City West Water provides drinking water, sewerage, trade waste and recycled water services to approximately 342,000 residential and 36,000 non-residential (industrial and commercial) customers in Melbourne's central business district and inner and western suburbs.

City West Water's boundaries contain the local government areas of Brimbank, Hobsons Bay, Maribyrnong, Melbourne (north of the Yarra River), Moonee Valley, Wyndham, Yarra and parts of Melton and Hume.

Relative to the other metropolitan Melbourne water retailers (South East Water and Yarra Valley Water), City West Water has a smaller customer base and geographic area, with a greater proportion of non-residential customers. These non-residential customers come from a range of sectors, including brewing, chemical manufacturing, oil refining, textile and automotive manufacturing.

South East Water

South East Water

South East Water provides water and sewerage services to over 1.6 million people in Melbourne's south east. Across a region spanning 3,640 square kilometres and fronting 300 kilometres of coastline, South East Water provides drinking water, sewerage, trade waste and recycled water services.

South East Water is responsible for $3.2 billion of assets. This includes managing over 23,000 kilometres of water and sewer pipeline.

South East Water's vision is to provide healthy water for life. This includes educating our schools and community about the value of water.

Yarra Valley Water

Yarra Valley Water

Yarra Valley Water is Melbourne's largest water and sewerage business, providing services to over 1.7 million people and over 50,000 businesses in the northern and eastern suburbs of Melbourne.

Yarra Valley Water safeguard the community's health by effectively removing wastewater and running operations in a way that protects the environment. Its district covers around 4,000 square kilometres, from as far north as Wallan and extending to Warburton in the east and Malvern in the south.

Yarra Valley Water helps customers to enjoy a healthy, environmentally friendly and low-cost community lifestyle through the Choose Tap initiative. The program supports community sport, local festivals, education, parks and gardens, the business sector, and cafes and restaurants.

Melbourne Water

Melbourne Water

Melbourne Water is a water resource manager owned by the Victorian Government.

Melbourne Water manages Melbourne's water supply catchments, removes and treats most of Melbourne's sewage and manages rivers, creeks and major drainage systems throughout the Port Phillip and Westernport regions.

Melbourne Water is responsible for managing $8.7 billion of water supply, sewerage and drainage assets, as well as natural assets such as rivers and creeks. These assets service 3.4 million people in an area spanning 12,000 square kilometres.

Melbourne Water manages Melbourne's water resources in a way that aims to ensure that future generations enjoy one of the best urban environments in the world. This means that Melbourne Water plays a major role in the total water cycle.

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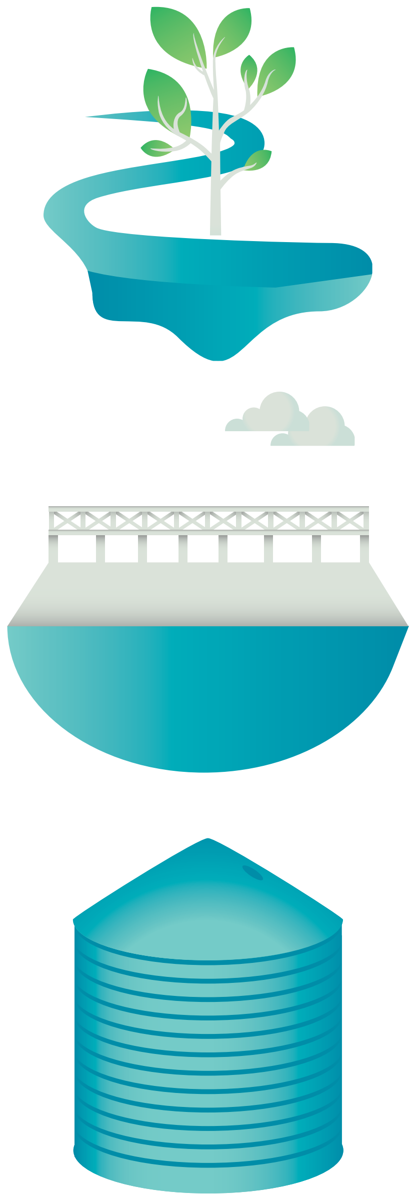
1

Collecting Water



Collecting Water

Melbourne has some of the cleanest drinking water in the world. What falls in the local catchments is pretty close to what comes out of our taps. This is largely due to the fact that the majority of water is drawn from large protected mountain catchments, where no agricultural or human activity is allowed. These are known as closed catchments; they include reservoirs and their surrounding areas. The general public cannot access these areas, ensuring our drinking water supplies are kept as clean as possible. The pristine natural forests within the closed catchment areas act as a natural filter to purify the water. Some cities aren't so lucky and must source water from areas that aren't as clean. They have to spend millions of dollars to treat the water before it is ready to drink.

Because most of Melbourne's water is already very clean, it only needs a small amount of treatment before it is sent through to customers' taps. Chlorine, fluoride and a small amount of lime (the powdery substance, not the fruit!) is added to balance the pH and prevent any waterborne disease. A small portion of Melbourne's water comes from open catchments (reservoirs that catch water downstream from towns and farms), so this water needs to be treated more thoroughly to make sure it is safe to drink.

We don't always have rain when we need it. There is often a great deal of rain in winter and spring, but very little in summer. Not all of the water that falls as precipitation is captured in natural or man-made stores, but flows from roads and footpaths into gutters and drains, travelling through the stormwater system to end up back in oceans and waterways. This means that Melburnians miss out on the opportunity to utilise this available water.

Melburnians are lucky that water is usually available when it is needed. To ensure a consistent supply of water throughout the year, water is collected and stored in a variety of structures. Natural systems include aquifers, oceans, lakes and rivers; man-made systems include rainwater tanks, dams and reservoirs. These are great ways to secure reliable sources of drinking water. Figure 1 shows Melbourne's network of reservoirs.

Reservoirs are one of the largest above-ground methods of storing water. They often look like a large lake, and may have a wall that impounds the water. Water is transported via a large network of pipes to treatment plants and then onto you, the customer.

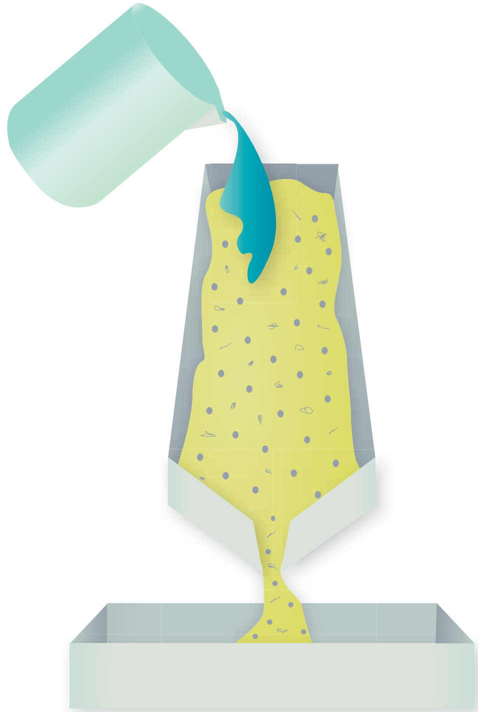
Water that seeps into the ground (from rain or water bodies) is stored beneath the ground in aquifers. This is called groundwater. Groundwater makes up around 30% of the world's freshwater, but can be difficult and expensive to access. To access this water, a hole is drilled deep into the earth to reach the aquifer. A pump is installed to draw this water to the surface.

The term 'bore water' refers to water that is accessed from underground stores, called aquifers. Water from rain and seepage from rivers slowly trickles through layers of soil and rock, and accumulates in these underground stores.
To access this water, a hole is drilled (or bored) deep into the earth, tapping into the aquifer. Pumps are installed to draw the water up to the surface. Bore water may need additional treatment before use, as it is often high in dissolved minerals and may contain natural hazards or pollution. Depending on the level of treatment, it may be used to water the garden, water livestock, to drink and to wash clothes.

Once collected from the various places mentioned, water goes on an amazing journey through the drains and pipes of the urban environment, and via treatment facilities before returning to the natural water cycle.

Figure 1: Melbourne's Reservoirs

Catchment Protection



Most of Melbourne's catchments are described as 'closed' catchments, meaning the general public is not granted access to the surrounding area or the water body itself. The natural forest in our catchments acts as a filter to cleanse and purify the water.

While some cities have to spend millions of dollars to treat water before it is ready to drink, in Melbourne the plants and bacteria of the forest do most of the work for us. Of course, a small amount of treatment is needed to make it safe for drinking.

Complete the main activity to explore how forests are able to purify and cleanse water naturally.

Main Activity

Materials

- beaker or jug (250 mL)
- collection container
- plants/vegetation
- rocks
- sand
- 3 x 1 L cardboard milk cartons cut in half lengthways and rinsed clean
- soil
- a source of clean water nearby
- a solid surface like plastic, laminate or glass
- something to prop up one end of your milk carton
- **POE template**

Method

1. Complete the **POE template** for each of the different substances.
2. Half fill each of the six milk carton halves with each of the following substances: sand, loose soil, compacted soil, rocks, vegetation and a solid surface (like plastic).
3. Prop up the bottom end of the milk carton with a door stop or a ceramic mug so that it creates a sloped surface towards the spout.
4. Place a collection container under the top end of the milk container.
5. Pour 250 mL of water onto the top end of the slope.
6. Record your observations for each surface.
7. Empty your collection tray, then repeat Steps 1–5 for each of the different surface types, then complete the rest of your **POE template**.

Engage

Complete the **Catchment Protection – Card Sorting worksheet** provided to understand 'healthy' and 'unhealthy' catchments. Now, let's draw opposites! First, draw a picture of a clean, protected and healthy Melbourne catchment. Now, imagine a city that doesn't have a closed catchment. Brainstorm all of the things that might make an unprotected catchment dirty, the water unsafe for drinking, or the area dangerous for native animals to live in. Draw a picture of this dirty, unprotected catchment. Include pictures of the things that would contribute to the area being unprotected. Compare your pictures and consider whether anything in the unhealthy catchment might ever happen in Melbourne.

Connect

What do we mean by the term 'closed catchments'? Use the **Problems and Solutions template** provided to list all of the different things that could negatively impact catchment health, and then provide a solution for the issues you've raised. Try to come up with 10 different ideas.

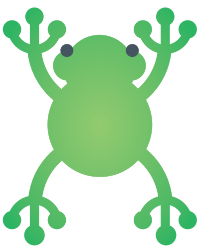
Explore

In small groups, play the *Catchment Detox* game at catchmentdetox.net.au. Use the 'How to Play' section to help you get started. Keep a record of your successes and failures. Compare your results with the other members of your class.

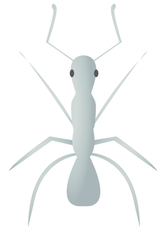
FACT: Melbourne is one of only five cities in the world with protected water catchments. Can you find out the others?

Catchment Protection – Card Sorting

Create a table with two columns. The headings should be 'healthy' and 'unhealthy'.
Cut out the squares below and paste them under the correct headings in your table.


Frog

Sunscreen

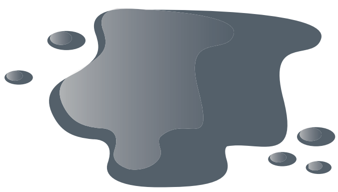

Insect

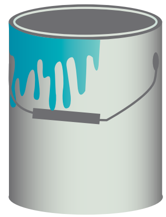
Soft drink bottle

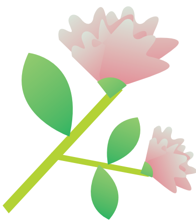

Plastic bag

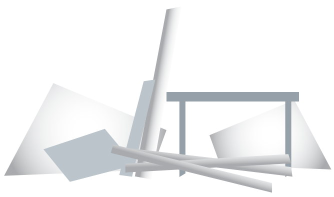

Native plant

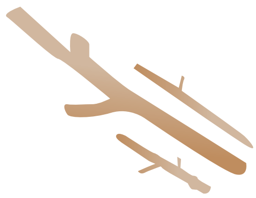

Native animal


Oil


Paint

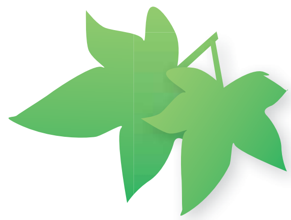

Flowers


Junk


Twigs


Tree


Rocks


Leaves

Storing Water Naturally

Bore water is groundwater that accumulates in aquifers; underground stores filled by the seepage of rain and rivers through layers of soil and rock. A water bore is a way of gaining access to these groundwater sources.

These stores can be accessed by boring or drilling down to the aquifer and using a water pump. Bore water may need further treatment before use, due to natural elements, hazards or pollution of the water.

Main Activity

Materials (enough for entire class)

- ice cubes (8-10 cubes for each cup)
- clear plastic cups (1 per student)
- drinking water coloured with food dye or cordial
- drinking straws

Method

1. Fill your cup with ice cubes. The ice cubes represent rock and soil materials underground.
2. Pour the coloured water into your cup. Fill it halfway up. The cup now represents an aquifer and groundwater. The bottom of the cup is the layer of rock or soil that keeps the water from seeping any further down, and the top of the water is the watertable.
3. Put your straw into the cup of coloured water and ice and take a small sip. This is a recreation of using a bore to access the groundwater for personal use. The sipping motion acts like a 'pump' to bring water to the surface.
4. Now that you've lowered the level of the water table, discuss how it might be raised again.
5. Complete a Venn Diagram to show the similarities between the experiment and the real world.

TIP: Conduct these experiments in conjunction with the Discovering Groundwater activities in Volume 1; the groundwater series of experiments review how groundwater travels, how it can be accessed, and how pollution can easily spread underground.

Engage

While it was easy for the cordial to fit in between the ice cubes in the Main Activity, not all surfaces are so easy to seep through. Go outside to a concrete or bitumen area to try a few options to see how different materials impact water flow and quality.

Materials

- sand
- gravel
- rocks
- cup
- 1 L water
- 3 ice cream containers
- chalk

Method

1. Collect sand, gravel and rocks in three separate ice cream containers.
2. Use chalk to draw a shape the same size as the base of one of the ice cream containers onto the concrete or bitumen outside.
3. Use your **POE template** to predict what will happen with each of the different materials.
4. Take turns to pour a cup of water into each of the containers (filled with sand, gravel or rocks) and onto the area you've drawn.
5. Observe how the water behaves with each of the containers and on the ground.
6. Use the **POE template** provided to write down your observations and explanations.

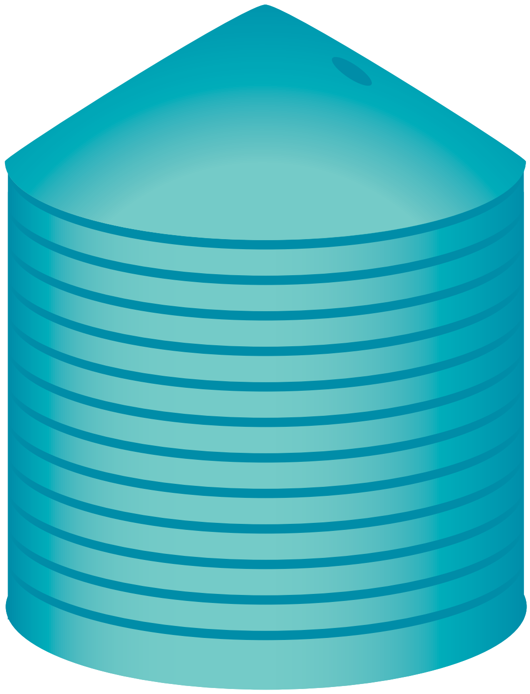
Connect

Visit the Department of Primary Industries website to research Victoria's major underground stores. Copy the main features of the map, then focus on an area close to you and find out whether the underground store is used within the local community. Share your findings with the class.

Explore

A 'bore water in use' sign was a common sight on lawns and gardens during Victoria's period of drought. Is this still a legitimate source of water for people to access? Use the provided **PMI template** to help arrange your thoughts and argue your point. Ensure you consider the treatment and extraction methods of bore water and review costs versus the impacts.

Water Storage Features



Water can be stored in many different systems. Natural systems include aquifers, oceans, lakes and rivers; man-made systems include rainwater tanks, dams and reservoirs. Of course, some water storages that are found naturally can also be man-made, like lakes and reservoirs.

Main Activity

As a class, brainstorm all types of water storage systems. Think about large areas (like reservoirs or the ocean) and small areas (like a rainwater tank). Create a mind map as a class. You may like to set it up in sections, for example, natural storage systems/man-made storage systems or large storage systems/small storage systems. Further brainstorm who or what would use each storage system. For example, a rainwater tank could be used by one family and a reservoir could be used by a whole town or city.

FACT: On average, a toilet uses about 6 litres of water for a full flush. A 3,000 litre rainwater tank provides enough water for 500 full flushes!

Engage

Use the **Engage - Water Storage Features worksheet** provided to link the storage system to its features. Cut out the pictures, then match them to the description of the water storage features, then paste these pairs onto a sheet of paper.

Connect

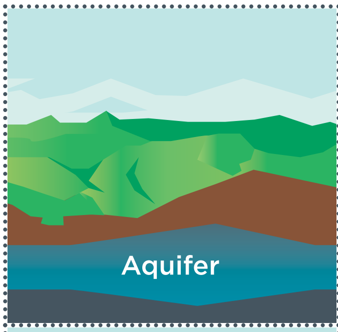
Invent, and then draw a diagram of, your own man-made storage system. Outline the features and explain why they're beneficial. You may like to take inspiration from the best parts of natural or man-made storage systems that already exist. Consider where you might use this storage (large or small) and who would be able to access the water. Present your final product to your class by creating a poster or brochure.

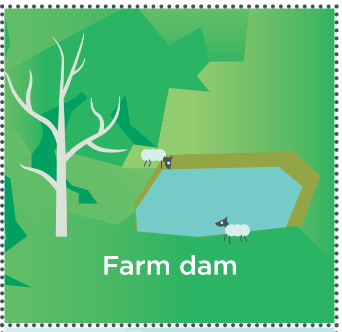
Explore

Research a variety of storage systems. Create a spreadsheet that compares the features, benefits and weaknesses of each. Consider things like cost, size, environmental impact, source of water, water yield, etc. Decide which storage system you think is best and discuss your thoughts in small groups. When you have a consensus, share the best idea from your group with your class.

Engage – Water Storage Features

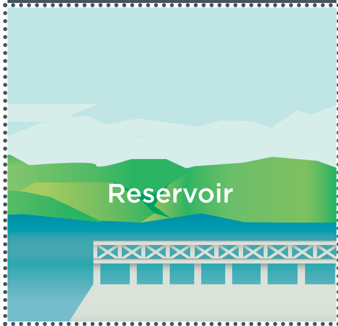
Cut out the match cards below. On a clean sheet of paper, paste the image next to the set of words that match it.





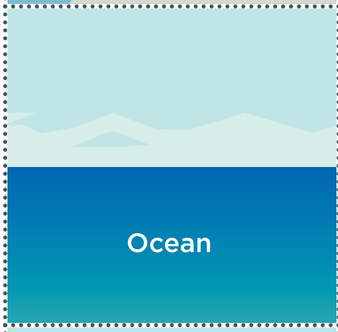
Largest water storage in the world.

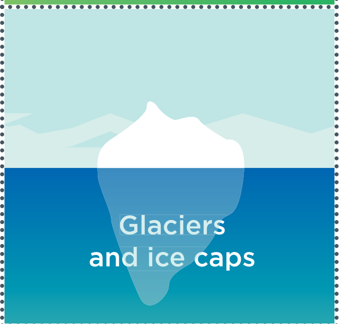
Needs water every day to drink, wash and to stay healthy inside and out!



Natural flowing water that eventually leads to the ocean.

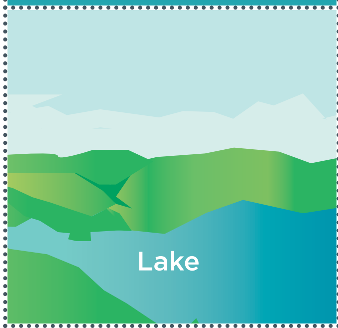
Plastic or tin structure that catches water from the roof of a shed or house.

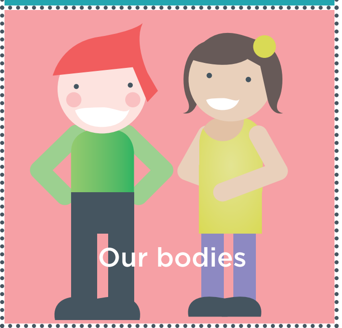




Stores water as a solid.

Underground store of water between earth and rocks.





Man-made water storage that provides water to towns and cities.

Made of water and ‘embodied’ water.

Man-made body of water on a farm.

Contained natural area of water that often attracts animals.

Melbourne's Reservoirs

People often think a dam is simply a large man-made body of water. However, *dam* actually refers to the large barrier that impounds water or underground streams and retains the water for storage and future distribution. Dams are used as a part of the structure of a reservoir.

In Australia, *dam* can also refer to man-made water storages on farmland. Although smaller than reservoirs used to store water for communal distribution, farm dams still require careful planning and construction.

Main Activity

Head outside to play the Water Relay game, outlined on the **Water Relay - Game Instructions worksheets** provided. This game will help you understand who uses water in Melbourne and the way water use impacts our drinking water supply.

FACT: The earliest known reservoir is the Jawa Dam in Jordan, which dates all the way back to 3000 BC.

Engage

Create a collage of how residents, businesses and farmers use water in different ways.

Connect

Complete the **Connect - Melbourne's Reservoirs worksheet** provided to find out more about dams in Victoria.

Explore

Should we build more reservoirs? Research the reservoirs in Victoria and determine whether you think we need to build more for the future. Present your evidence and reasoning in an interactive poster or infographic.

Water Relay – Game Instructions (4 pages)

Main Activity

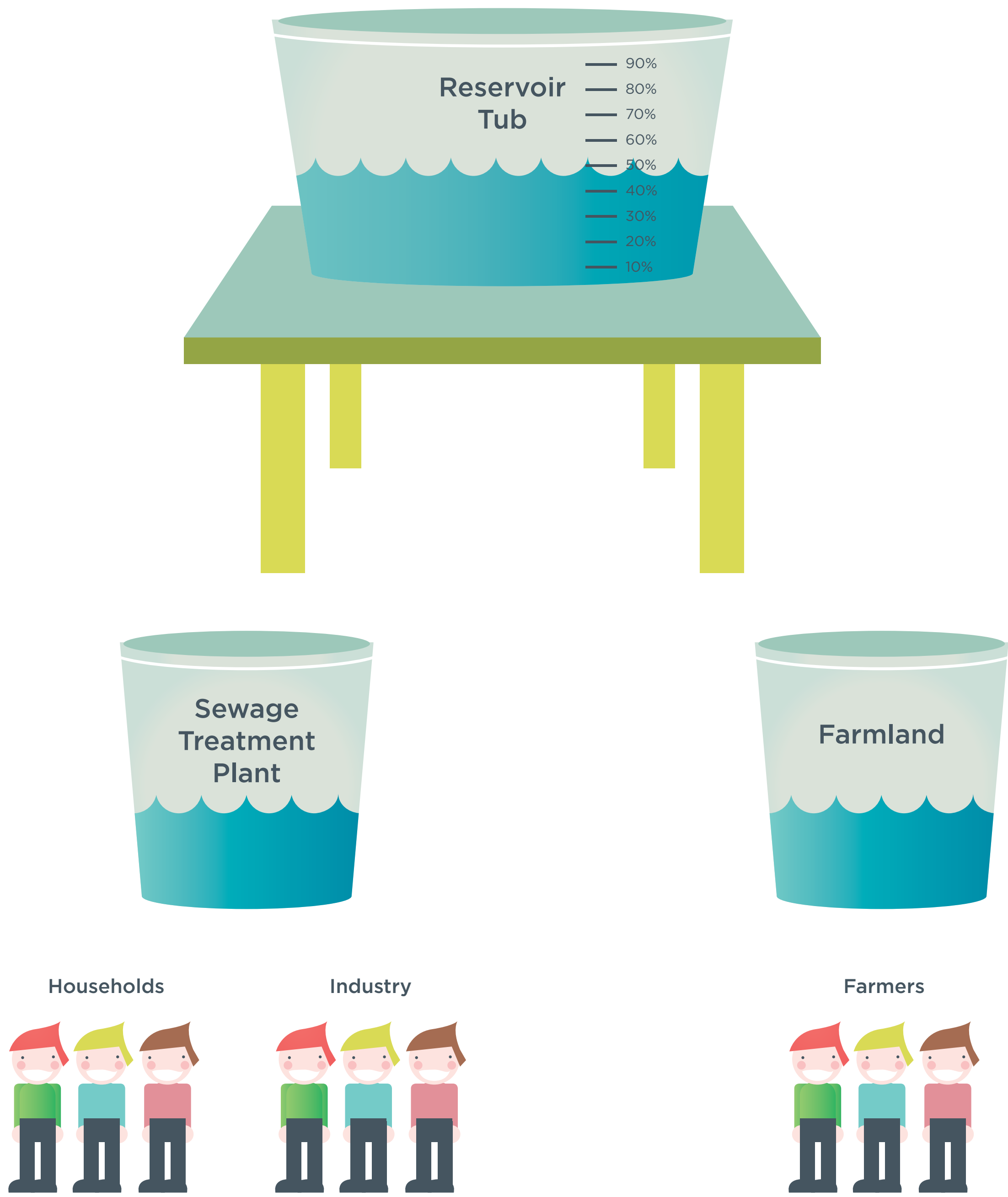
Materials

- 1 large (20 L+) clear plastic container labelled 'reservoir' and marked at 10% intervals
- 3 large (10-20 L) clear plastic containers labelled 'sewage treatment plant', 'farmland' and 'recycled water'
- 1 set of measuring cups (one each of 1 cup, ½ cup, ⅓ cup and ¼ cup)
- timer
- non-permanent marker

Method

Use the **Water Relay worksheet** to talk you through this race.

It is best to do this activity outside as it involves racing with water.



	Activity Instructions Questions for Students	Answers and Explanations
1.	Place the reservoir container at the front of the activity area on a chair or table. Fill the 'Reservoir' container with enough water to replicate current overall reservoir storage levels and mark it on the container. Q. Does anyone know the current reservoir storage levels for Melbourne?	A. Go online to find the current reservoir storage level for Melbourne, which is updated daily.
2.	Divide students into three groups and ask them to line up 2 m from the reservoir. Q. Who are the main users of water in Melbourne? Q. What do they each use water for? Give each group a name - Households, Farmers and Industry.	A. Households, industry and farmers. Allocate these groups to the three teams. A. Students will suggest a variety of responses for each.
3.	Q. Where does water go once it leaves your home or industry? Place the STP tub between the Households and Industry groups. Q. Where does water goes once it is used on a farm? Place the Farmland tub near the Farmers group.	A. Sewage Treatment Plant (STP). A. It goes into the farmland.
4.	Q. Would all of these groups use the same amount of water? Q. Who would use the most/least? Give the 1 cup to the Households group. Give the ½ cup to the Industry group. Give the ⅓ cup to the Farmers group.	A. No. A. Households use the most. A. Farmers use the least water. A. Industry sits in the middle. Extra info: - Households use over half of Melbourne's water. - Farmers use the least in Melbourne, but the most in Victoria.

Water Relay – Game Instructions cont…

	Activity Instructions Questions for Students	Answers and Explanations
5.	Teams. You will each collect water out of the reservoir with your measuring cup, and take it back to your allocated tub. Farmers, you have you own tub, as your water goes to your farmland; Households and Industry, you will share the Sewage Treatment Plant tub, as that's where your water ends up after it has been used. Once the first person in your team has deposited their cup of water, they should pass it to the next person in your team. Keep going until I stay stop – you'll have 1 minute (representing 1 year of water use).	
6.	Q. What happened to the level of the water in the reservoirs? Mark the change on the reservoir tub and determine the percentage drop with the help of the students. Subtract the new level from the original level. Q. How long would this water last if you used the same amount for the following year/s and there wasn't any rain? Divide the number from above into the new level. This will tell you how many years the water in the reservoir will last if each group keeps using the same amount of water and no rain is received, e.g. original level 85%, new level 63%. Difference 12%. The reservoir would have water for another 5 years. Q. What could we do to make this important drinking water last longer?	A. Water levels have gone down. A. Students estimate how long water would last by using level on the reservoir tub. A. Students may suggest use less water, have restrictions, etc.
7.	Q. In the current teams (Households, Industry and Farmers), come up with three ways you could reduce the water use in your area.	A. (some suggestions) Households – shorter showers, dual flush toilet, turn of tap while cleaning teeth, efficient whitegoods, fix leaks. Farmers – what they grow, how often they water, the use of recycled water. Industry – (incl. schools) – buckets under bubblers, native plants in garden, dual flush, recycled water.
8.	Q. If all of these areas reduce their water use (as per your suggestions), let's see what happens to the reservoir level. Use these smaller cups to see what happens in a second year of more efficient water use! Give the ½ cup to the Households group. Give the ⅓ cup to the Industry group. Give the ¼ cup to the Farmers group.	A. The level does not go down as much.

	Activity Instructions Questions for Students	Answers and Explanations
9.	Q. Is there any other source of water that these different areas can access? Farmers can use recycled water for many purposes – so I'll add a Recycled Water tub up the front (next to the reservoir) for Farmers to collect their water. Add Recycled Water tub next to Reservoir tub.	A. Recycled water.
10.	Race again for one minute (one year) and make sure you don't drip any water when you carry the water back to your container – we have people monitoring our pipe system all the time who fix any leaks promptly, so we shouldn't have much leakage at all!	
11.	Mark the change on the Reservoir tub and determine the percentage drop. Q. What happened in the second year? Can you notice a difference from last time? Q. What do you think might happen to water use in the future?	A. The water went down, but by less than the first inefficient year, due to the use of recycled water and more water efficient practices. A. It will depend on many different things, including climate change, population growth and alternative water sources. Discuss further.
12	Let's go back inside. I'd like you to reflect on any information you collected during the activity that you didn't know before. You might like to write down some thoughts or draw a picture that expresses how you feel.	

Connect – Melbourne's Reservoirs

People often think a dam is a large man-made body of water. However, 'dam' actually refers to the large barrier, or wall, that contains the water in one place as a way to store it before it is distributed.

The area where the water is kept is called a reservoir.

Using the space provided, research answers to the questions and statements below.
(Hint – the Melbourne Water website should be able to help you with these answers.)

1. Which is Melbourne's largest water storage reservoir?

2. When was it built?

3. What type of dam is built at this reservoir?

4. List 3-4 other details specific to this dam (e.g. height, length, depth).

5. What other types of dams are there?

6. Use the list you discovered in the previous question to find an example of each, either in Australia or from the rest of the world

7. Choose one of the dams from the list above. How is the water taken out of the reservoir?

Connect – Melbourne's Reservoirs cont...

8. What happens when the reservoir fills? What mechanism does the dam have to deal with the water it cannot hold?

9. What are some important points to consider when designing and building a farm dam? Use the **Ranking Ladder template** to help arrange your answers.

10. Find out which reservoir is Victoria's largest.
Note: the capacity of a reservoir is usually measured by the volume of water it can hold.

11. Find the largest reservoir in Australia and the world.

12. Find out which dam is the tallest in the world.
Note: height refers to the height of the dam—the large barrier that holds the water.

13. Not all dams are built just to hold water in the reservoir they create.
What other uses do dams have?

14. Imagine you are an engineer, leading a project on designing and building a new dam. On a separate piece of paper, see if you can create a new design (or a better way to store water) for Melburnians.

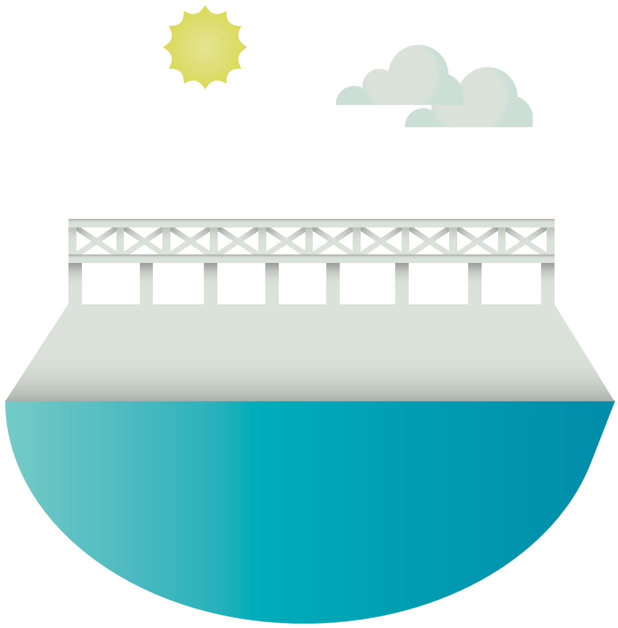
Future Water Supply

Climate change suggests weather patterns may become more severe in the future than they have in the past. That means flooding and drought could impact us harder and for longer periods of time. Every living thing needs water, so it's important to have an available supply at all times. A reservoir is one type of system that helps us catch and store water for future use.

Main Activity

While some people believe that building new reservoirs could help maintain a water supply for homes and businesses, others think reservoirs are too expensive to build and cause environmental damage. Use **De Bono's Hats template** to explore the positive and negative impacts of building more reservoirs.

FACT: Did you know that the Thomson Reservoir holds the amount of 628 MCGs when full?



Engage

Come up with an idea for something you could use to capture and store water. Think about how many people could use this water and how long it would last. Take turns in sharing your information with the class and then vote on the idea you liked best.

Connect

Research online to find out how reservoirs are made. What features make a good reservoir (e.g. depth, surface area and evaporation rates)? Consider where reservoirs are usually located and why. Create your own reservoir and make a presentation or infographic outlining the details of your reservoir and its features.

Explore

It's 2030 and Melbourne's reservoirs are down to 22% after eight long years of drought. Water consumption has dropped, but water use is still a huge contributing factor to the low levels of water in the reservoirs. The current government wants to determine whether a new reservoir will solve the water crisis, and have invited you to put forward your view.

Pick a stakeholder out of the hat (from the **Explore – Future Water Supplies worksheet** provided) and research them. You will need to ensure you investigate why your stakeholder would be for or against a new reservoir. Using the information you have found, write a letter to a government representative to outline your stakeholder's viewpoint.

Explore – Future Water Supplies

Randomly select one of the stakeholder positions below to research. Imagine this is your job, then use the dot points to note down any important points prior to writing your letter.

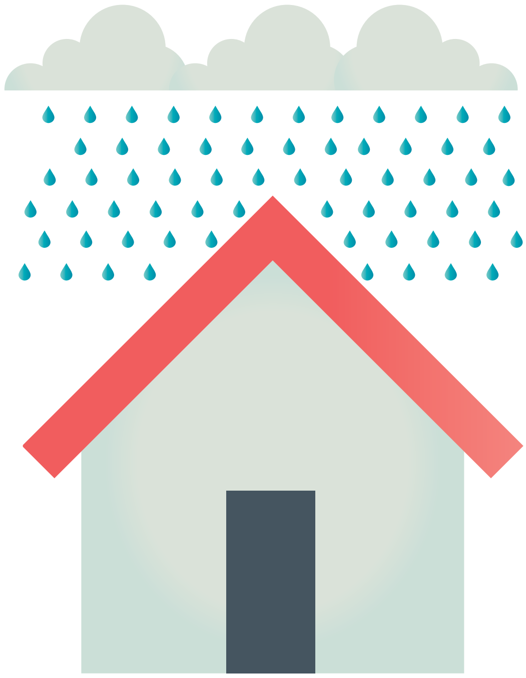
Farmer: Against	Local Resident: Against
• • • • • • • •	• • • • • • • •

River Community Member: Against	Tourism Industry: Against
• • • • • • • •	• • • • • • • •

City Resident: For	City Industry: For
• • • • • • • •	• • • • • • • •

Building Industry: For	Politician: For
• • • • • • • •	• • • • • • • •

Collecting Rainwater



Rainfall is inconsistent and out of our control. We don't always have rain, so we need to store the rain that does fall by storing it for the future. When there is heavy rain, not all of the water can be used. This excess may flow into gutters and drains, travel through the stormwater system and flow back into the oceans and waterways.

By building reservoirs and using rainwater tanks, we are able to store water that we don't immediately need. Even the rain that seeps into the ground can enter the groundwater stores for later use.

Main Activity

Find out how many people in your class have a rainwater tank on their property, and how they use the water they collect.

TIP: Calculating Water Collection Amounts

To calculate how much rain you can collect from your roof (at school or at home), find out the area of your roof in square metres. You'll also need the amount of rainfall for your town or suburb in millimetres (you can find this on the Bureau of Meteorology website).

Alternatively, find an online calculator to assist with calculating your total rainfall harvest.

Engage

Create a Venn Diagram to compare and contrast the use of tank water with tap water in Melbourne. What can each of them be used for?

Connect

Find an accurate map of your school (or other building). Your teacher might provide you with one, or you can use your search engine to find one.

Use the sum: m^2 x rain mL = x L collected per year to calculate how much water could be collected from the roofs and then consider the best use of this water. Where or how might water be lost in the process? Include suggestions with your results.

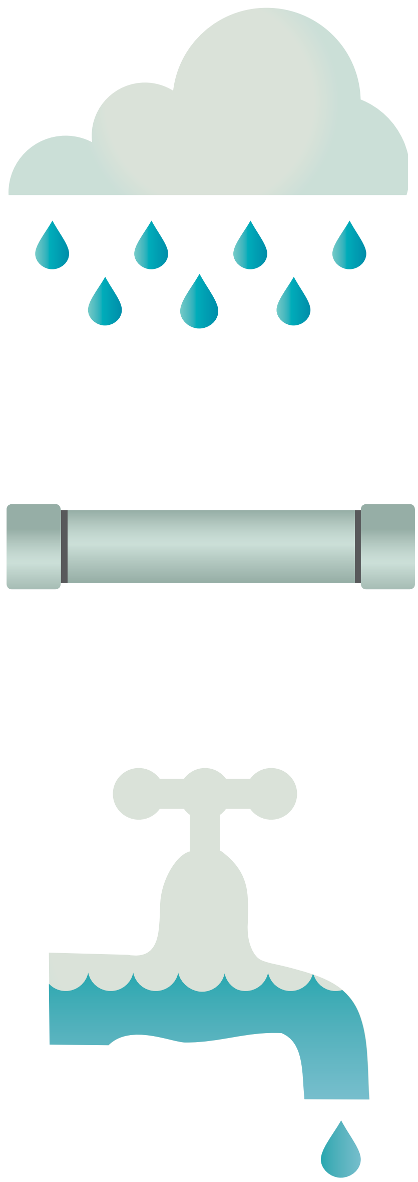
Explore

Find an accurate map of your school (or other building). Your teacher might provide you with one, or you can use your search engine to find one. Design an ideal tank to collect the most water possible. Your design should include details about material, shape, location of tap and site location. Present your findings to the class.

water
learn it. live it.

2

The Water Journey



The Water Journey

Much like the natural water cycle, the urban water cycle refers to the continuous journey of water. The difference between the 'natural' and 'urban' cycles is that the natural water cycle stages of precipitation, infiltration, transpiration, evaporation and condensation would happen even if people weren't on Earth. It is a natural process that ensures water is always moving. The urban water cycle, however, refers to the journey water takes from when it is collected in catchments and used by people, to when it is returned to the natural water cycle. The journey involves a network of pipes that transports water into our communities. The water is used for a variety of purposes before being cleaned and returned to the natural water cycle.

When Melbourne was first settled by Europeans, they drank water directly from creeks and rivers. Later, people ran water carting businesses and delivered untreated water straight from the Yarra River to homes and businesses in the area.

The removal of the wastewater products, or sewage, from homes created another problem. Back then, sewage from homes (including the kitchen, bathroom and laundry waste, along with the contents of chamber pots) was emptied into open drains that flowed into street channels and then into local rivers and creeks. Waste from farms and industries also flowed into these street channels, turning Melbourne's rivers and creeks into open sewers. This was a big problem, as the drinking water being delivered to homes was being collected from these rivers and creeks.

When people started dying from waterborne diseases such as cholera and typhoid, the government realised it had to offer a cleaner and more reliable source of drinking water, and a more sanitary sewage removal system.

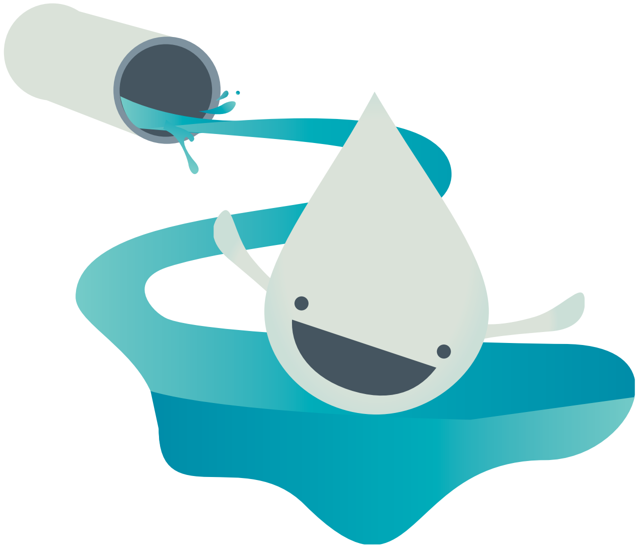
A Royal Commission was held in 1888 to find a solution to the smelly (and deadly) sewage issues. It was decided that a network of pipes would be built to carry sewage from homes and factories to a sewage treatment plant. Construction of a pumping station and treatment plant began in 1892, and by 1897 Melbourne homes were connected to the sewage system and the city became a cleaner, healthier and far more pleasant place.

Drinking water was originally stored in reservoirs and transported to homes via aqueduct. Later the water was piped to our homes via copper pipes. These pipes are increasingly replaced, when required, with concrete (large) and PVC or PE plastic (small) pipes. Concrete is extremely strong and can withstand high pressure. Plastic lasts for hundreds of years and can be made into pipes of all sizes. These products don't corrode or leach into the water, keeping the drinking water as clean as possible.

The delivery, removal and treatment of water and sewage continue to be important services that are utilised by most Melburnians. Thousands of metres of pipes and thousands of megalitres of water and sewage are travelling underneath greater Melbourne each and every day; moving through the Urban Water Cycle.

Figure 2: Melbourne's Urban Water Cycle

The Urban Water Cycle



You may have already explored the natural water cycle and the stages of precipitation, infiltration, transpiration, evaporation and condensation. This process would happen whether people were on Earth or not.

The urban water cycle refers to the journey of water from when it is collected in catchment areas to when it is returned to the natural water cycle. In between those times, a network of pipes transports water into our communities for use as drinking water, cooking and recreation, and then takes the water away as sewage to be cleaned.

Main Activity

Review the Water – learn it. live it. *Melbourne's Water Cycle* poster and discuss the different parts of the urban water cycle. Then, create a flowchart (as a class or individually) to follow the process of water starting at several different places around the home, both inside and outside, a farm, a business and ending up out in the ocean.

FACT: The presence of humans differentiates the urban and the natural water cycle. Humans take water from the natural water cycle for drinking, cooking and recreational purposes, making it the urban water cycle.

Engage

As a class, write a short story that takes us on a journey through the urban water cycle. Remember to include the natural water cycle in your story. Each student should select a different sentence from the completed class story, write the sentence at the bottom of the page and draw an image to go with it. Collate the pictures with the story to compile a class storybook.

Connect

Create an animation of a journey through the urban water cycle. Your main character should visit (or go through) each phase of the urban water cycle and explain what they're doing there. You may like to include other characters, such as litter, leaves, pumps, pipes or sewage debris.

Explore

In groups, use the **Storyboard template** to plot your story, and then create a claymation (or short documentary film) of a journey through the urban water cycle. The main character should visit (or go through) each phase of the urban water cycle and provide appropriate explanations for why they are there and what is happening in their surroundings.

Catchment to Tap

Most of Melbourne's water comes from protected water catchments and only needs minor treatment (because of debris and animal waste) before going to customers' taps. Small amounts of chlorine, fluoride and lime (the powdery substance and not the fruit!) are added to make the water safe to drink.

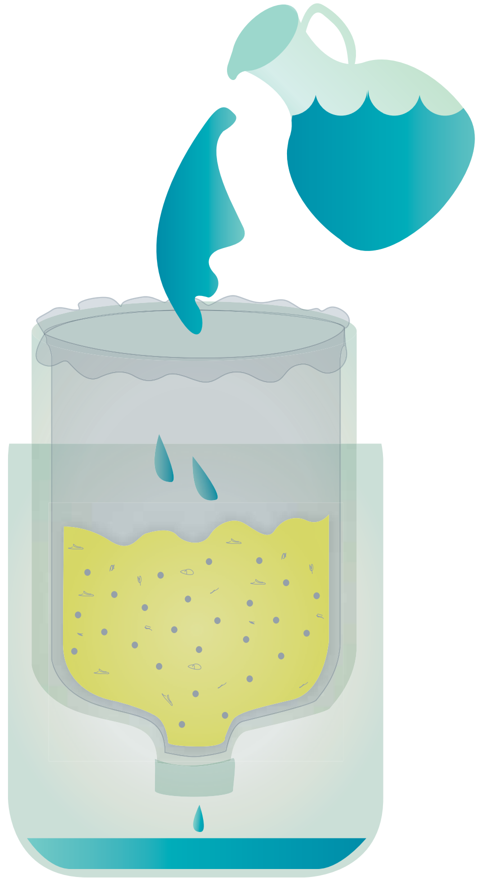
Main Activity

Materials

- 2 L plastic soft drink bottle without lid
- scissors
- hand towel
- gravel
- sand
- cotton wool
- 'dirty water' (add different items to some clean water: cooking oil, dirt, leaves, coffee grounds)
- glass

Method

1. Use your **POE template** to predict what will happen with each 'filter' used.
2. Cut the plastic bottle in half. Turn the top half upside down and put it inside the bottom half.
3. Put the hand towel into the plastic bottle. This will act as a filter.
4. Pour the dirty water through it.
5. Use the provided **POE template** to record and explain your results.
6. Remove the used filter and clean the plastic bottle.
7. Make another batch of 'dirty' water.
8. Change the filter type, and repeat your experiment for each new filter type.



Engage

In a big circle, take turns in coming up with an idea for any household items you might be able to use to filter water in an 'emergency' situation. You should think about all of the different rooms in your house and any materials that might have tiny holes to let the water through.

Connect

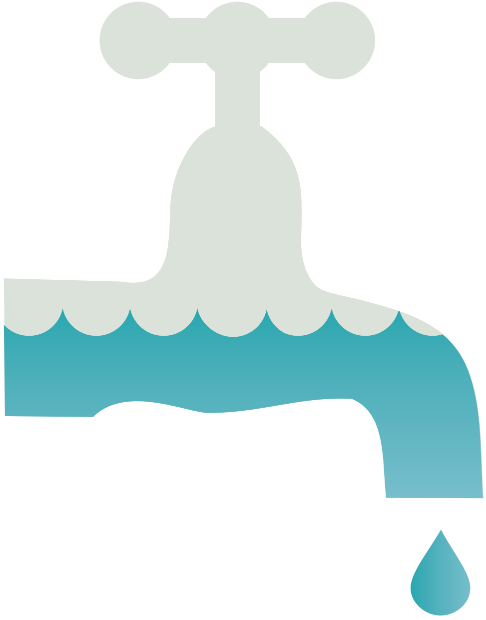
Undertake your own research to explore the different options used to purify water. Use a Venn Diagram to compare and contrast two of the options you discover.

Explore

Research why chlorine, lime and fluoride are added to drinking water in Melbourne. You may find there has been some public discussion over time about the addition of these elements. Find an article and summarise its main points.

What Happens Next

While the natural water cycle journey seems fresh and clean and clear, the urban water cycle journey can be a somewhat dirtier experience. This is caused largely by people. People cause both natural and man-made pollution to flow down our pipes and drains. It then travels to sewage treatment plants and recycled water treatment plants, and returns back into our waterways as clean water to start the natural water cycle again.



Main Activity

Read the story on the **Main – What Happens Next worksheet** provided, and follow the instructions to discover the influences on the urban water journey.

FACT: Did you know that more than 724 ML of sewage is treated at Melbourne's sewage treatment plants every day? That's more than 289 Olympic size swimming pools!

Engage

Think about all of the areas at home that have drains or pipes. As a class, brainstorm and create a list of outlets that connect to the sewerage system. Complete the **Engage – What Happens Next worksheet** provided to follow the sewage treatment process.

Connect

Create a flowchart, with words and images, to explain the journey of sewage from your home to a sewage treatment plant, and what happens to it next. Find some information online to help you explain each of the processes.

Explore

Find a definition for 'effluent', then investigate the destination of the treated effluent from your local sewage treatment plant. Consider the impacts on this area and review the role of the Environmental Protection Authority in making sure the effluent is safe for discharge. Create a fact sheet to display the information you've researched.

Main – What Happens Next

This story takes us underground to the sewers of Melbourne. As a class, sit around a clean bowl of water – this will represent the sewer. Your teacher will read the story out loud while some students will 'play' characters in the story. When your character name and story has been read out, empty the contents of your containers into the sewer. There are seven characters in this story.

Characters and their materials:

Tommy – apple juice

Norm – cocoa mixed with a little water

Tamara – water with some detergent

Dawn – cotton buds and a tissue

Chemical factory – water with detergent and some soy sauce

Joanne – water with some cooking oil and some food scraps

Bob – water with leaves and dirt

Main – What Happens Next cont...

The story

Our story begins high in the mountains north east of Melbourne, where rain collects and travels into catchment reservoirs. These reservoirs store all of the fresh, clean drinking water Melburnians have piped into their homes.

Tommy had just woken up before another day of school and was getting ready for school. His first destination every morning was ... the toilet. He had drunk a lot of water the night before and needed to do a really, really big wee. Tommy did his wee, then flushed the toilet and off went the wee, down the sewerage pipes and into the sewer. (Tommy empties his container into the sewer.)

In the ensuite of the main bedroom, Tommy's dad Norm was sitting on the toilet, wishing he hadn't eaten so much curry the night before. With a groan of relief, Norm flushed his deposit down the toilet. (Norm empties his container into the sewer.)

Down the street, Tamara was also getting ready for school. She was having a L-O-N-G shower. Along with hundreds of litres of water, all of the soap and shampoo she had used were now washing down the drain. (Tamara empties her container into the sewer.)

In the second bathroom, Tamara's mum Dawn was using a cotton bud to apply some makeup. When she had finished, she threw her cotton bud into the toilet with some other dirty tissues. (Dawn empties her container into the sewer.)

Down the road at the chemical factory, the first job of the day was to wash down the machine with lots and lots of hot water and some strong detergent. The used water washed into the drain, washing some of chemicals down with it. Because the used water had chemicals in it, it was considered trade waste, and the water had to go through some treatment at the factory before it joined the sewer. Not all of the chemicals could be removed, so some of them still went down into the sewer. (Chemical factory empties its contents into the sewer.)

At a nearby cafe, the owner Joanne was cooking up bacon and egg rolls for some customers. Once she'd finished, she placed the dishes and pans into the sink and rinsed the oil down the sink. (Joanne empties her container into the sewer.)

Joanne didn't realise that because she had been washing the oil down the sink (instead of using a grease trap like she was supposed to), her sewage pipes were getting blocked by a daily build-up of oily residue on the edges of the pipes. As Joanne rinsed the frypan, she was surprised to see murky water coming up out of her sink.

Outside, the sky was looking gloomy. The sky started to rumble and rain started to pour down. Bob had tried to save money by doing some of his own plumbing at home. Instead of hooking his roof gutters up to the stormwater system so that the water would join the water from the road and be taken out into the bay, Bob had hooked them up to the sewerage system. This meant that every time it rained, thousands of litres of water from his house, complete with dust and leaves from his gutters, were washed into the sewer. (Bob empties his contents into the sewer.)

Like many other people who had done the same thing, Bob didn't realise that the sewer wasn't designed to cope with so much extra water. Somewhere further down the sewer, the murky water had escaped into an overflow area, a freshwater creek on this occasion.

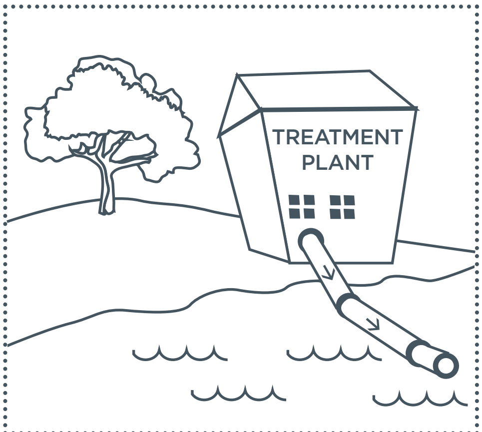
Eventually, the water in the sewer made it to the sewage treatment plant. At this stage, the water wasn't the clean freshwater that was transported from the catchments for us to use. It had become a soup of chemicals, human waste, rubbish, dirt, oils and other pollutants.

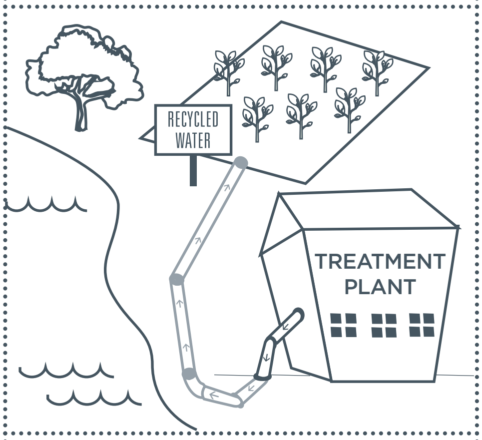
At the sewage treatment plant, most of the added pollutants were removed through lots of different processes so that the water could be recycled or returned to the environment via the ocean. Because there were so many different pollutants in the water, it was an expensive process that Norm, Dawn, the chemical factory, Joanne and Bob would all have to pay for.
By the time the water finally left the sewage treatment plant, it looked almost the same as the clean water that comes out of your tap. It could be used in the home as recycled water, but only for certain tasks like flushing the toilet or watering the garden.

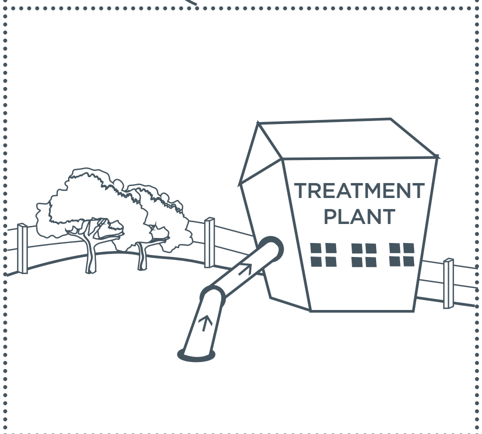
The end.

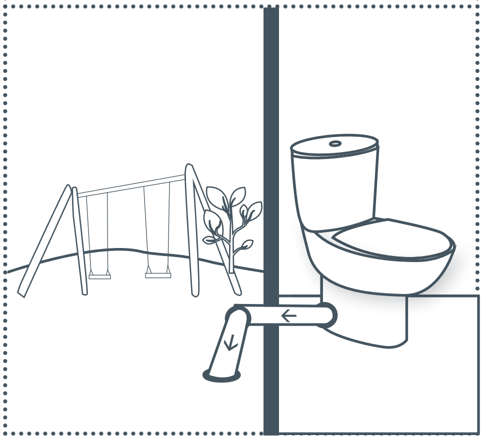
Engage – What Happens Next

Cut out and colour in the images below. Paste them in order and write a sentence next to each to explain which part of the urban water journey is happening in the picture.



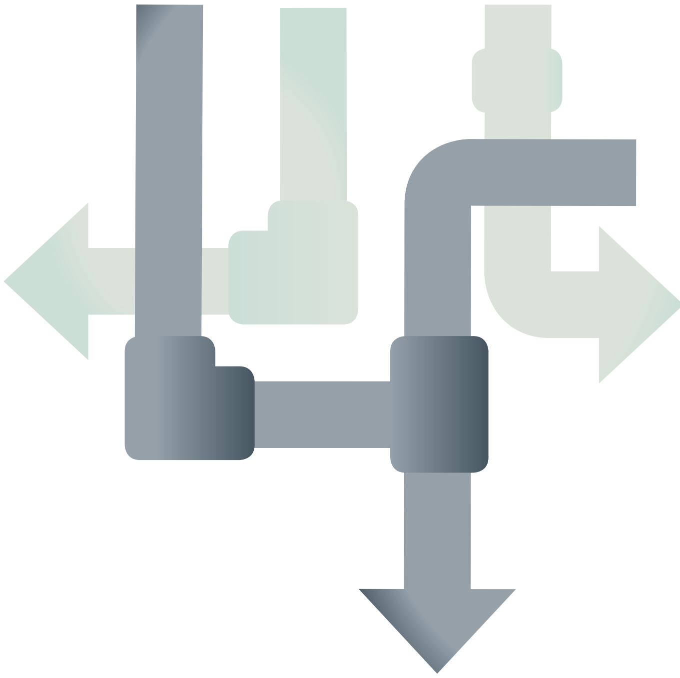






water
learn it. live it.

Pipes



In the past, water was transferred via aqueduct (a type of open channel) from reservoirs to our houses. When it got closer to our houses, it was piped through copper pipes. Today, after the water is treated, it travels through pipes for the whole journey until it reaches our taps. Copper pipes are increasingly being replaced with large concrete pipes and smaller PVC or PE (plastic) pipes. Plastic lasts for hundreds of years and can be made into pipes of all sizes. Another benefit is that plastic won't corrode or leach into the water. Transporting water through pipes means that it stays free of contaminants, evaporates less and ensures it stays safe to drink. Sewage is taken away from our homes and industrial sites by a separate network of pipes. Some households also have access to recycled water, which is piped through different pipes again.

Main Activity

In groups, select a country other than Australia, and research how they get their water. Do they have a network of pipes or do they collect water another way? Prepare a news article, TV report or documentary to share your findings with your class.

FACT: Sewer blockages are often caused by too much of the wrong thing going down the drain and into pipes! Nappies, cooking oil and paint are all common causes of sewer blockages and make later treatment far more expensive than it needs to be.

Engage

Use the **Engage - Pipes worksheet** provided to create a system of pipes to transport water from the reservoir to the house. You might like to go a step further and create your own section of pipes with straws and sticky tape.

Connect

Discuss household drains, stormwater drains and bins. What travels through these pipes and where do they all end up? Do some research online to find out, then create a collage using images and textures to show the final destination of one of these pipes.

Explore

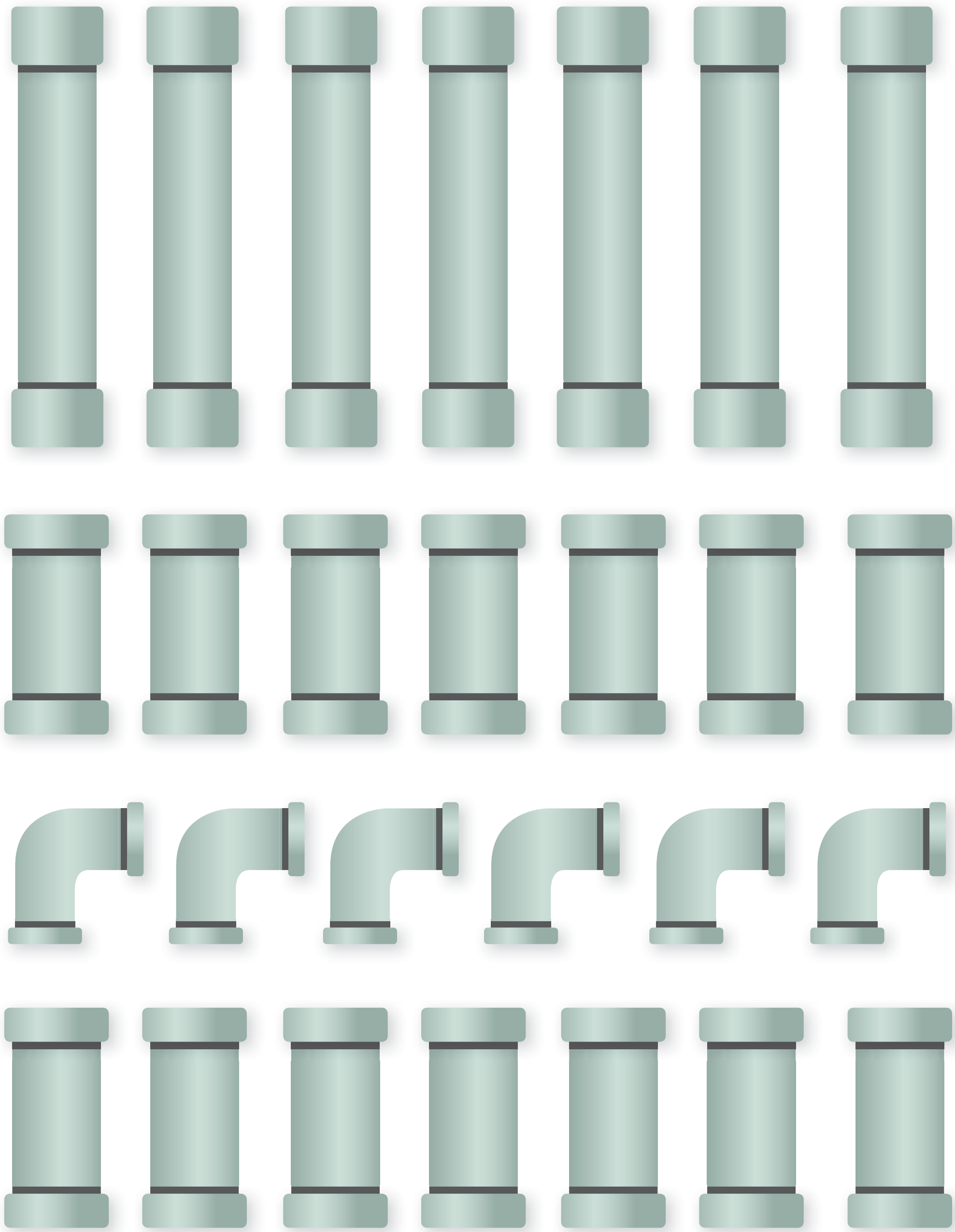
Break into groups and research the water and sewerage systems in your local area. Find out as much information as possible about how the water flows from homes and businesses to the appropriate treatment plants. What materials are used? How does the water move from place to place? How fast does it go? How much water and sewage is there? How long are the pipes? Where are the pipes situated, and why do you think this is so? Create a presentation with the information you find, including clips, images, facts and figures.

Engage – Pipes

Carefully cut out the pipes below. There are lots of different shapes of pipes so that they join together to go around objects and travel over long distances. Use these pipes to transport water from the reservoir to the home. The entire pipe should reach the distance between the reservoir and the house without using any of the same shapes twice in a row. Don't worry about going around the houses, trees or mountains. Remember, these pipes live underground!

Teacher Tip: Please print the following worksheets one-sided. You may like to also enlarge them to A3 to make it easier for cutting.

Tip: Only paste your pieces down once you are certain they can reach the whole distance by following the rules outlined.




START
FINISH

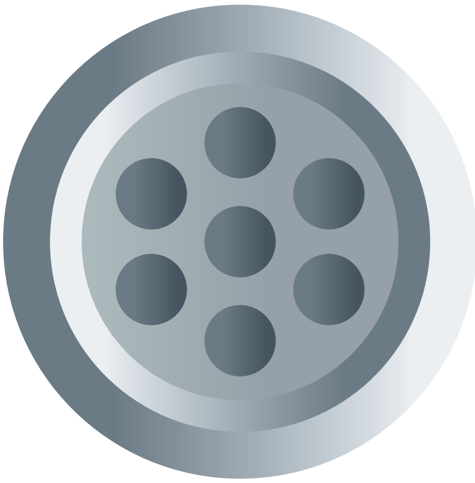
The Ins and Outs of Drains

Have you ever noticed how many different types of drains there are? Toilets, small drains at the bottom of the kitchen sink or shower, large grates on the side of the road, and a whole host of pipes that transport waste from our homes, schools, businesses as well as those outside. It's important to know which items should and shouldn't go down the drain so that we can keep the water that ends up in our waterways as clean as possible.

Main Activity

Take a tour of your school buildings and grounds to note all of the different drains that take water (and other nasties) away from your school. Make a list of the types of things that might go down the drain, then research and discuss why some are OK, while some of them should definitely NOT go down the drain.

FACT: Did you know that there is a patch of floating plastic in the Pacific Ocean estimated at 100 million tons? This floating pile of rubbish is the result of many years of marine pollution. It has already done a great deal of damage to marine wildlife populations, as the plastic gets caught in the stomachs of sea turtles and birds.



Engage

Discuss household drains, stormwater drains, toilets and bins. Complete the **Engage - The Ins and Outs of Drains worksheet** by drawing a line between the item and the place that it should go.

Connect

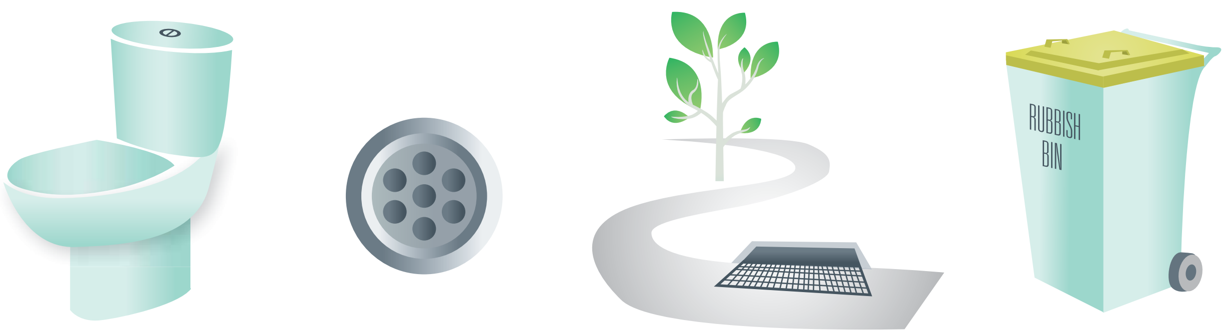
Write a story to explain how the false teeth (or another silly item) ended up at the local sewage treatment plant. Use the **Story Map template** to help you plan your story and the adventures of your mystery item.

Explore

Using the information you collected in the main activity, create a poster map of the internal and external drains at your school. Label them with added information boxes to list the items that CAN and CAN'T go down those drains. You may need to complete some research. Put your poster up around the school to inform others.

Engage – The Ins and Outs of Drains

Draw a line from each of the pictures above the line, to the destinations below the line, to show where the items or their contents should end up.



Melbourne's Sewage History

In the late 19th century, Melbourne was growing very quickly and issues of health and sanitation were becoming very important. A Royal Commission was held in 1888 to come up with a solution for the lack of sanitation, and it was decided that a network of pipes would be built to carry sewage from homes and factories to a sewage treatment plant. Construction of a pumping station and treatment plant began in 1892, and by 1897 Melbourne homes were connected and the city became a far more pleasant place.

Main Activity

Did you know that once upon a time (not so long ago), Melbourne was referred to as Smellbourne? Use the internet to discover how this name came about. Use a Venn Diagram to explore how Melbourne's water was transported then and now.

FACT: Floaters or Sinkers? Depending on what we eat, the bacteria that live in our gut produce different amounts of gas. More gas creates 'floaters', but most of us produce more 'sinkers'.

Engage

Research what people used before the invention of toilet paper (as we know it today). Consider what other options might be available today if you didn't have any toilet paper. Collect some items from home, then 'show and tell' your classmates what you chose and why.

Connect

Research the materials used to provide and take away water and sewage prior to the installation of pipes in Melbourne. Use the **Decision Making template** to consider the benefits and downfalls of three of the ideas you find.

Explore

Review Melbourne's urban water system and compare it with that of another city. You might consider a city with a long history, such as Pompeii or Rome (Italy), Athens (Greece), Pingliangtai (China) or a city of your own choice. Create a collage to highlight the differences.

water
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3

Water Coming and Going

Water Coming and Going

The combination of the natural water cycle and the urban water cycle mean that we receive water in many different ways. Precipitation produces rainfall, groundwater and stormwater. These are then harvested, collected and treated by local water authorities and sent through a network of pipes to provide Melburnians with water for all of their needs. Individuals can also play their part in the collection of water, which reduces the need to tap into drinking water sources unnecessarily. Once the water has been used, there are a number of different processes used to ensure that water is cleaned and available to re-enter the natural water cycle and begin the whole process again.

Treatment is essential to ensure that any wastewater (sewage and trade waste) doesn't impact the environment when it is returned at the end of the urban water cycle. Recycling of paper, glass, cans and plastic is commonplace in Melbourne. These used products are taken to recycling plants and turned into something new. Sewage can be recycled too.

In Melbourne, recycled water usually refers to fully treated sewage from sewage treatment plants. Like other recycled products, sewage can be treated and used again. This recycled water is used for a variety of useful purposes, including watering parks and gardens, irrigating farms, industrial processes, car washing and flushing toilets. Using recycled water takes pressure off the other drinking water supplies in Melbourne.

Harvesting water is another way to supplement the drinking water supply in Melbourne. Desalination is one form of water harvesting.

Desalination is the process of removing salt from seawater to make it suitable for people to drink. It is a rainfall independent source of water, and ensures water is available, even during periods of low rainfall or drought.

The desalination process used in Victoria is reverse osmosis. See Figure 3: Reverse Osmosis Process. This involves drawing seawater into a treatment plant and then screening and filtering it to remove any particles. Desalinated water must be remineralised to meet drinking water standards and make it the same as the treated water that comes from the catchments and reservoirs.

Stormwater can also be harvested. Stormwater is the water that comes from rain, hail, sleet or snow (precipitation) that flows into stormwater drains from rooftops and streets. It is also collected via other buildings and natural landscapes into water bodies like rivers, lakes and oceans. See Figure 4: Stormwater Diagram.

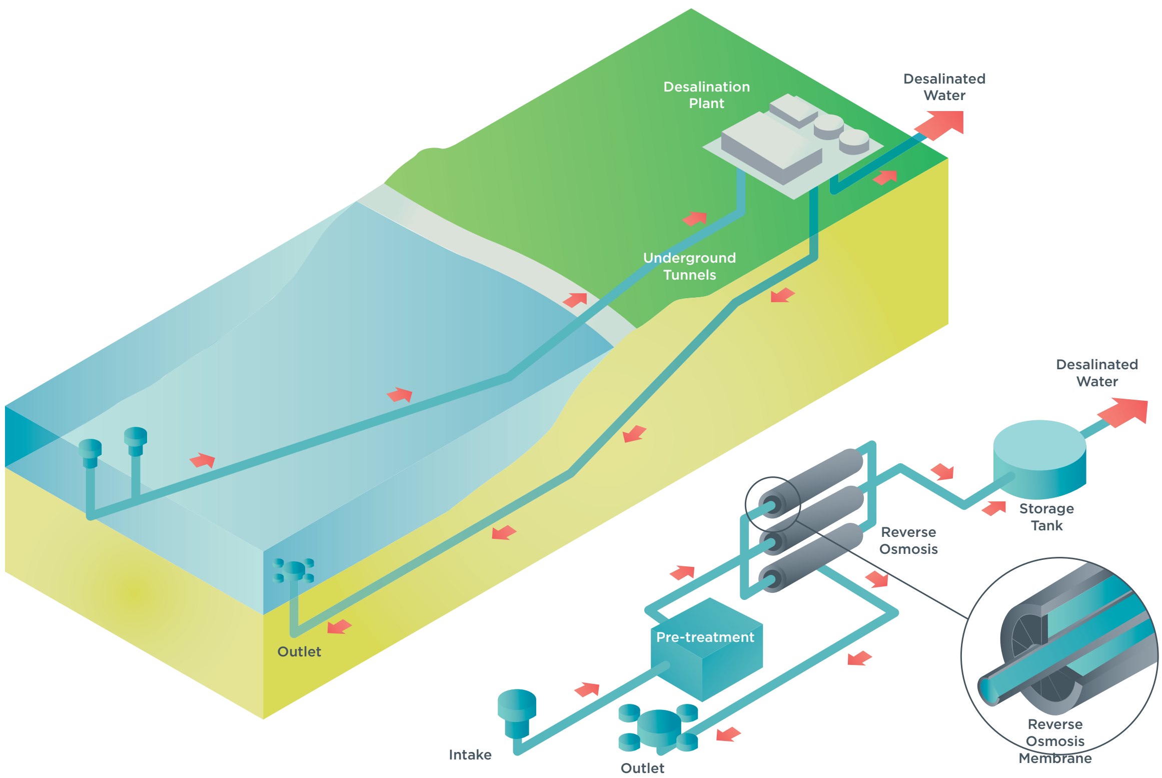


Figure 3: Reverse Osmosis Process

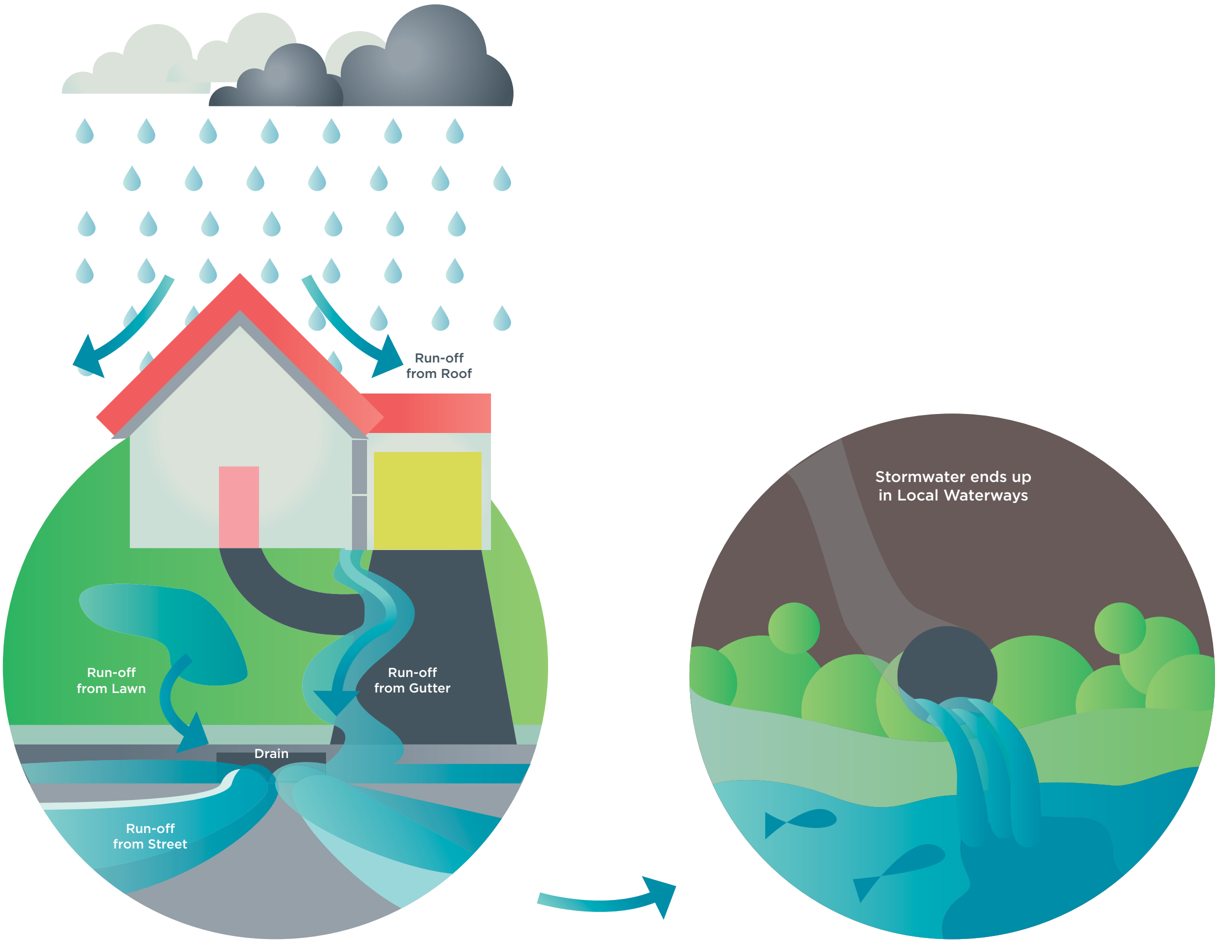


Figure 4: Stormwater Diagram

This water can pick up lots of different pollutants along the way, including leaves, sediment, oil, litter and any other substances it flows over. Gutters in our streets take the rainwater (and all the items it collects on its journey) through pipes and directly to our local waterways. The litter and debris on our streets or near our drains can end up in our waterways without any treatment, causing damage to the environment where it eventually ends up.

Stormwater is already being accessed on a small scale as a pilot water source in Melbourne, for processes like toilet flushing and for use through garden taps.

Melburnians can't rely on rainfall as our only source of water. The amount of water that falls can vary greatly, month by month and year by year. There are some other sources of water, such as aquifers and bore water, but these can be expensive and difficult to access. More effective water harvesting and finding alternative methods to re-use Melbourne's water sources are ways that can supplement drinking water supplies. These other sources of water almost always need treatment before they are suitable for people to drink.

Sewage and trade waste are two of the dirtier types of wastewater that must be treated before being returned to the natural water cycle.

Sewage is the water that comes from homes, shops, hospitals and other commercial and industrial businesses. It can include a high level and wide range of contaminants and other solid and dissolved materials. Sewage from our houses contains over 99% water. This high percentage of water is due to most of the contribution coming from showers, baths, toilets and washing machines.

It is important that sewage is collected, treated and disposed of safely, as it forms part of the urban water cycle. Proper treatment helps to maintain the natural water cycle by allowing water to keep moving between different locations and maintain clean water in the environment.

Trade waste refers to any liquid waste (other than domestic sewage like toilet waste) or water from the kitchen or laundry that is generated from a commercial or industrial business. Trade waste can contain substances like flammable liquids, grease, acid, solids, and has the potential to impact the environment, sewerage systems and treatment facilities.

Stormwater Campaign

Stormwater is the water that originates from precipitation (rain, hail, sleet and snow) that either becomes surface run-off from rooftops and roads and enters a natural water body or flows into stormwater drains. This water can pick up lots of different pollutants on its journey, including leaves, sediment, oil and any other substances it flows over, including litter.

The stormwater drains you see at the sides of the road take the rainwater (and all the items it collects on its journey) through pipes and into your local waterways without being treated.

Main Activity

Use your online search engine to find and review environmental campaigns from the past that encourage people to put rubbish in the bin or to clean up their local areas. Communications may have included posters, slogans and TV advertisements. Consider what makes a good campaign effective, and create a mind map to express your thoughts.

TIP: Writing a Slogan

A slogan is a memorable phrase or saying that is used to express an idea or message. Use the below information to help you come up with your own slogan:

- **What slogans do you remember? Why?**
- **Try to focus on just one message.**
- **Use creative language, but ensure it is clear.**
- **Short slogans are most memorable.**
- **Keep your art design simple.**
- **Try to link your artwork to your message.**

Engage

As a class, create a slogan then create posters to go up around the school to remind and encourage students that litter clogs up drains and pollutes our waterways.

Connect

In groups, come up with a campaign that shows ways to reduce rubbish in the playground. You may like to include a slogan, make up a jingle or sing a chant to help express your message. Present your campaign as a presentation or TV ad. You may like to play your ad at a school assembly, then complete a basic litter count before and after your ad is shown to see if you've achieved a positive result.

Explore

In small groups, research the impact of litter/pollutants in a local waterway. Then, come up with a slogan and a campaign to present at an assembly to influence students to reduce rubbish in the school grounds. You can present your campaign as a presentation or TV ad, and should follow up your campaign to see how effective it was.

Recycled Water

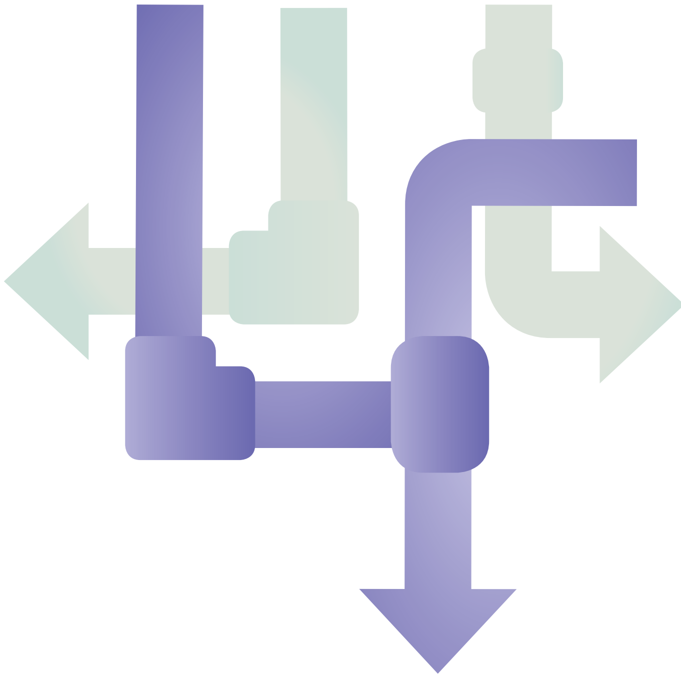
Recycling is a concept most of us are aware of. It means processing used products into something new. Many Australians already recycle paper and plastic, but did you know you can recycle water too?

In Melbourne, recycled water is used for many purposes like watering parks and gardens, irrigation for farms, industrial purposes and for flushing toilets or watering gardens at home.

Main Activity

In Australia, we use our recycled water for a variety of purposes. Using your internet search engine, research the different types of recycled water, often called 'classes'. List the class (A, B, C or D), its level of treatment and what it can be used for.

FACT: In Singapore, clean, recycled water is piped back into reservoirs for the local drinking water supply.



Engage

Complete the **Engage - Recycled Water worksheet** by cutting and pasting the images into the correct columns, either drinking water or recycled water.

Connect

Complete the **Connect - Recycled Water worksheet** by filling in the type of water that is appropriate for each activity.

Explore

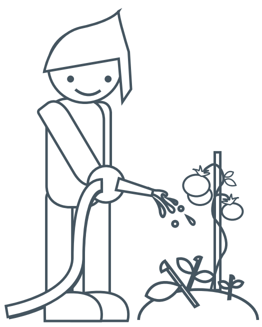
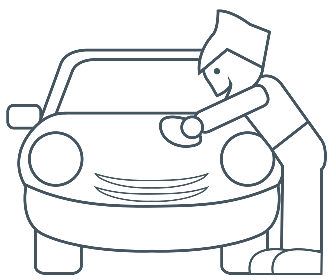
Research recycled water, then complete the provided **PMI template** outlining the features and uses. Continue your investigation by finding an interesting example of recycled water and how it is being used in a real life community. You may find something locally or search for some examples overseas.

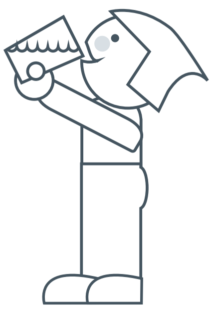
Engage – Recycled Water

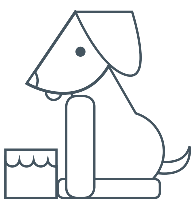
Which type of water is best used for each of these activities? Colour, cut and paste the pictures into the correct column. You may like to enlarge this sheet to A3 to make cutting and colouring in easier.

Drinking Water from Reservoirs	Recycled Water



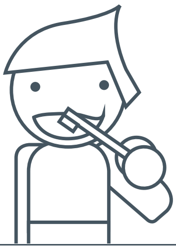
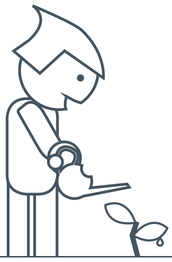
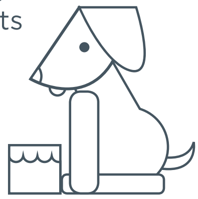
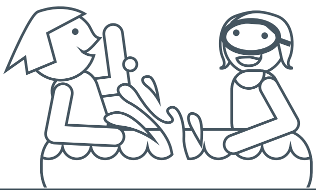








Connect – Recycled Water

Which type of water is best used for each of these activities? (In the water industry this is sometimes called ‘fit for purpose’.) Water uses include: drinking water (from the tap), seawater, tank water or recycled water). Colour in the pictures, then write your answer in the columns below.
Hint: there might be more than one for each!

Action	The type of water you should use	Action	The type of water you should use
Brushing your teeth 		Watering the vegie patch 	
Washing clothes 		Drinking 	
Watering the garden 		Flushing the toilet 	
Washing the car 		Feeding your pets 	
Cooking dinner 		Filling up your paddle pool 	
Washing yourself 			

What's Desalination?

The world's weather is becoming more and more unpredictable. Climate change and population growth are having a large impact on water supply in Melbourne and around the world. The possibility of long periods of drought and a growing population means it is important to find sources of water that are not rainfall dependent. Desalination is one process that is used to turn saltwater from the ocean into drinking water.

Main Activity

Brainstorm the different sources of water that might be available for us to use as drinking water if Melbourne's reservoirs were empty. Can you drink this type of water straight away, or would you need to treat it so it was safe to drink? Use your internet search engine to find out if any of the sources you came up with are available in your local area.

FACT: There are around 15,000 desalination plants currently functioning in the world.

Engage

Complete the **Engage – What's Desalination? worksheet** to find some words about desalination and alternative water.

Connect

Complete the **Connect – What's Desalination? worksheet** to find the definitions of the list of desalination related words, then use the words in sentences to help understand the meanings.

Explore

Create a table that outlines five desalination plants in Australia and elsewhere in the world. Include the location, where the water is being sourced, the method of desalination being used, how much water is being produced, what the water is being used for, the energy used by the plant, the costs involved in drinking water production and any other interesting information you can find.

Engage – What’s Desalination?

Water Treatment Words

Find each of the words listed in the Word Find below.

s	b	j	d	r	i	n	k	j	p	p	q	e	o	q
w	a	x	s	f	l	e	g	o	u	t	l	e	t	j
g	z	l	i	s	z	a	p	r	o	c	e	s	s	z
e	v	a	t	l	v	t	r	e	a	t	m	e	n	t
q	u	w	z	e	m	p	v	f	q	o	c	e	a	n
m	i	n	e	r	a	l	s	w	r	d	l	n	a	e
s	m	j	y	v	p	y	e	a	i	e	x	f	h	c
a	e	n	e	r	g	y	c	t	i	o	s	v	y	i
i	n	l	e	t	s	y	e	e	n	e	n	h	i	u
r	u	h	s	y	a	e	l	r	h	y	a	x	w	p
f	k	u	f	n	w	k	l	p	v	l	g	u	t	l
y	r	e	c	y	c	l	e	u	t	h	c	g	p	a
x	y	k	f	q	j	f	v	r	r	e	v	o	a	n
a	u	v	k	i	s	v	e	e	d	b	y	x	a	t
r	e	c	y	t	a	w	e	f	n	n	l	i	e	p

salt	treatment	fresh
water	process	recycle
ocean	inlet	drink
pure	outlet	energy
plant	minerals	cell

Connect – What's Desalination?

Find definitions for each of the desalination terms below.

Desalination: ....

....

Membrane: ....

....

Filter: ....

....

Molecule: ....

....

Solvent: ....

....

Seawater: ....

....

Freshwater: ....

....

Brackish: ....

....

Potable: ....

....

Permeable: ....

....

Diffusion: ....

....

Pure: ....

....

Inlet: ....

....

Outlet: ....

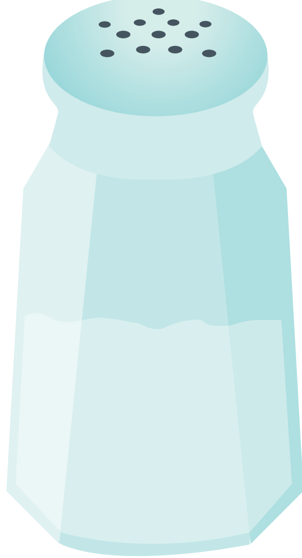
....

On a separate piece of paper, write a sentence or short paragraph using at least five of the terms to explain the desalination process.

Removing the Salt

The amount of water we receive through rainfall is never a sure thing. Branching out to include rainfall-independent sources of water, such as desalinated seawater, provides protection against the risk that dry conditions can have on our drinking water supply.

There are a number of ways salt can be removed from seawater to produce freshwater. The desalination process used in Victoria is reverse osmosis, and involves drawing seawater into the treatment plant and then screening and filtering it to remove any large particles before using energy to separate finer molecules, including salt. Desalinated seawater must be remineralised to meet drinking water standards.



Main Activity

Use the **POE template** provided to write down your predictions and observations about this activity.

Materials

- a strong steel sieve
- clear bowl
- coloured jelly (set in a container)
- uncooked rice
- a large metal spoon

Method

1. Mix the rice into your jelly. This mixture represents saltwater; the jelly as water and the rice as salt molecules. In real life, salt molecules are much smaller and are dissolved in seawater.
2. Place your sieve over the bowl and pour your jelly and rice mixture into the sieve.
3. Use the spoon to put pressure on the mixture and force the jelly through the sieve.
4. Complete the observations part of your **POE template.**

Engage

Play the **Removing the Salt Board Game** provided to make your way through the desalination process.

Connect

Research online to discover where desalination is used as a source of drinking water, in Australia and throughout the world. Collect as much information as you can. Use a Venn Diagram to help you with your thinking process. Now, create an informative poster that compares and contrasts the features of these plants.

Explore

Look at the pros and cons of desalination being used as an alternative process for producing drinking water in Victoria. You might like to undertake an oral debate or write an argumentative essay. Use the **SWOT template** provided to help you clarify your arguments.

TIP: Consider undertaking the Solar Stills activity offered in Volume 1 to further investigate this topic. Solar stills separate salt from water through evaporation.

Removing the Salt – Board Game

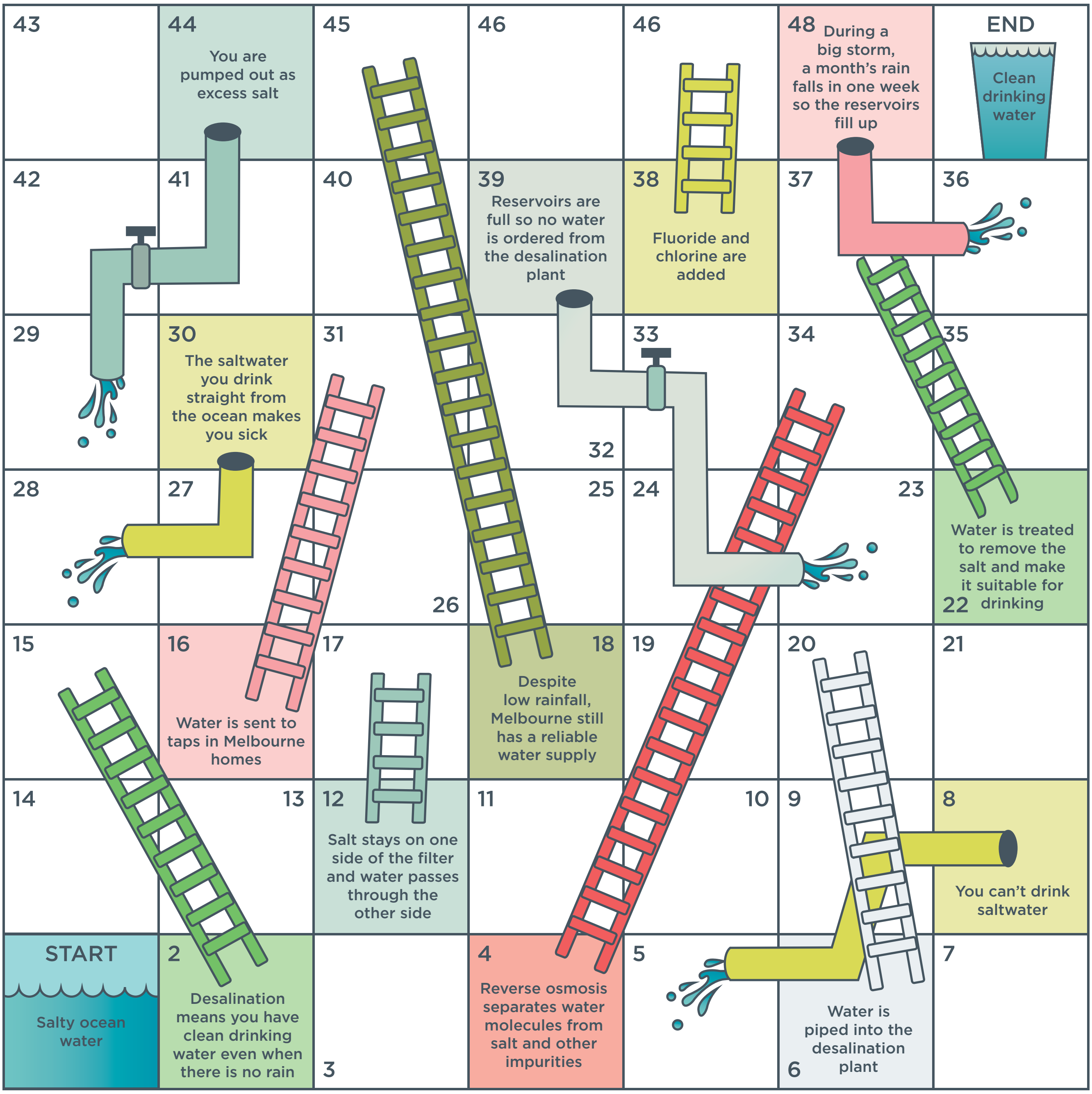
Seawater is piped to a desalination plant via an inlet structure out at sea. It draws in water at a low speed so as not to affect fish or other marine life.

The seawater passes through some very fine material which lets water through but stops salt and other particles. The desalinated water then goes through a treatment process so that it is safe to drink.

The salt that is removed from the treatment process is piped back into Bass Strait through an underground tunnel that is 1 km offshore, where it blends in with the seawater.

Enlarge the below board game to A3 size and paste onto cardboard so that you can re-use the game.

Instructions: If you're lucky enough to land on a square with a ladder, read the text then go up to the square at the top of the ladder. If you find yourself on a square with a pipe, read the text then follow it down to the square at the bottom of it.



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Trade Waste

Trade waste refers to any liquid waste (other than 'domestic' waste such as toilet water or water from the kitchen or laundry) generated from a commercial or industrial premise.

Trade waste can contain substances like flammable liquids, grease, acid or solids and has the potential to impact the environment, sewerage systems and treatment facilities.

Main Activity

Who produces trade waste? As a class, write a list of the different types of industries and businesses that might produce trade waste. This should help you get started on your next activity.

FACT: Dry wiping plates and utensils before washing them is a simple way of reducing the amount of fats, oils, grease and solids entering the sewer from a cafe or restaurant.

Engage

Think about what sorts of trade waste might be produced at a cafe or a toy factory. Make a list of the items and then decide whether they can go down the drain or if there is another way of disposing of them. Do you have any of these items at home? Write a list and share your answers with the class.

Connect

Pick a business or industry type that interests you. Research online to find out what sorts of products they make and what sorts of associated waste might be produced that would be considered trade waste. Create a table that outlines each material you find and explains an alternative way of disposing of it.

Explore

Complete the Connect activity, then investigate any solutions for the safe disposal of these. Come up with your own suggestions about how the business could be even more environmentally sound. Write a submission to a fictional company in the industry outlining their current issues and your proposed solutions. Use the **Problems and Solutions template** to help you clarify your ideas.

Sewage

Sewage is the used water that comes from domestic, commercial and industrial sources, and can include a wide range of contaminants and other solid and dissolved materials.

Sewage from households is made up of over 99% water because it comes mostly from showers, baths, toilets and washing machines.

The collection, treatment and disposal of sewage are important parts of the water cycle, and help to maintain the balance of clean water in the environment.

Main Activity

Visit your local sewage treatment plant or use your search engine to locate online footage that shows how a sewage treatment plant processes sewage. Use images collected on site or from the internet to complete a model or a flowchart of the systems and processes you saw.

FACT: Every minute, 1.1 million litres of raw sewage is dumped into the Ganges River, bordering India and Bangladesh. Amongst other things, this river is used for bathing and cooking.

Engage

With the information you remember from your tour of the sewage treatment plant, write a song about the process to inform others. Come up with some actions and create some costumes for a performance at your school assembly.

Connect

Why do we need to treat sewage? What impact would untreated sewage have? Use the **Cause and Effect template** to separate your ideas (environment, health of people and the health of animals). You may find information online to assist you.

Explore

After your tour, consider the benefits of the sewage treatment plant. Create a brochure outlining the features and benefits of your chosen treatment plant, and include any ideas you have for the future of sewage treatment.

4

Water Industry - Innovation and Careers

Water Industry – Innovation and Careers

From the smelly days of the late 19th century until today, many wonderful inventions have made water cleaner and more accessible in Melbourne. There have also been many innovations to assist people to be more efficient and maintain a healthier environment with their water practices.

An innovation is an idea or method of doing something in a new way. For example, before 1980, toilets in Australia had a single flush button, using up to 12 litres of water per flush. The dual-flush toilet was an innovation by Australian Bruce Thompson. It led to huge reductions in water use of an estimated 70%. Drip spikes, greywater systems, double drawer dishwashers and low phosphate laundry detergents are other innovations that have contributed to a more sustainable water future.

Education is another important factor in using water more effectively. Understanding how, where and what type of water can be used in a variety of situations, means there is less pressure on Melbourne's drinking water supplies. Planting water efficient gardens, recycling water and installing rainwater tanks are simple ways to use water more sustainably at home.

Water Sensitive Urban Design (WSUD) is a fairly new term used to describe the way urban areas are designed and planned to use water in an environmentally sustainable way. Its aim is to reduce the impact of development on our bays and waterways, and to increase the liveability of urban areas. The key principles of WSUD include protecting natural water bodies, directing stormwater, protecting water quality and reducing run-off. See Figure 5: WSUD. These initiatives improve the environmental values of an urban area and help make it a great place to live.

Inventions and innovation are often realised by individuals and groups within the water industry. The water industry has a plethora of different jobs that appeal to a range of people with different personalities and skills. There are jobs for people who like to work indoors or outdoors, for those who have just left school, are university graduates or have years of experience. Careers range from working in a pristine catchment area to developing plans to build a new sewage or recycled water treatment plant, to helping customers with enquiries. The diversity of careers available is almost endless.

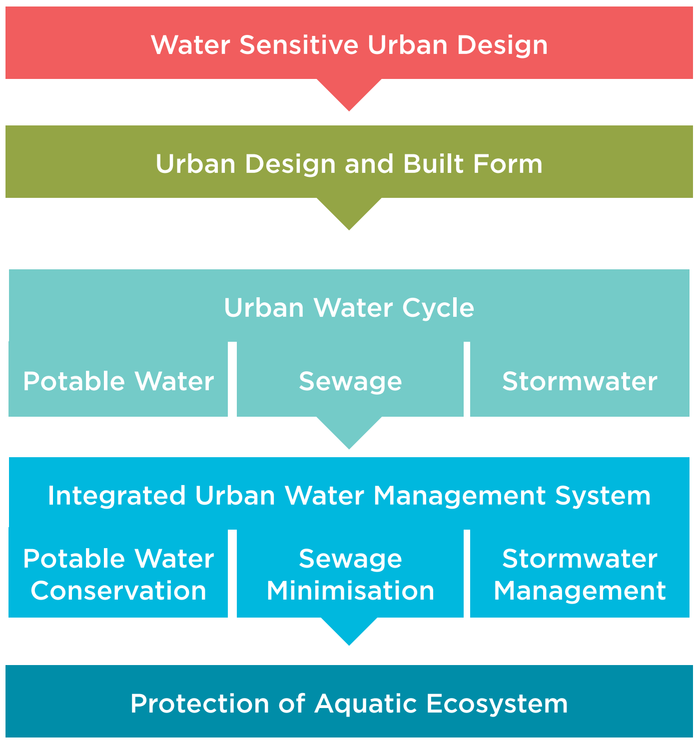
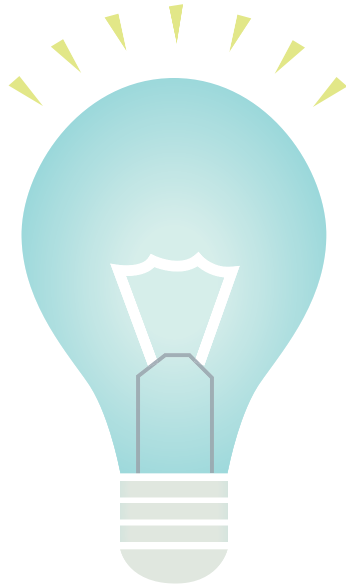


Figure 5: Breakdown of the different aspects of WSUD, from the concept of WSUD to the environmental end purpose.

Water Innovation

Innovations are ideas or methods of doing something in a new way; it may be an invention or just a change to a current design. There are many water efficient innovations in the market today, including the dual-flush toilet, which was invented in 1980 by an Australian, Bruce Thompson. His innovation was to use two different buttons or levers on a toilet, a full flush and a half flush. This is estimated to have reduced water usage in Australian homes by around 70%. Great work, Bruce!



Main Activity

Pick a water innovation (from the **Main - Water Innovation worksheet** provided) out of a hat. Investigate your product, including:

- The year of innovation/invention
- Who came up with it?
- What country does the innovator come from?
- How does the innovation/invention work?
- Does it save water, streamline processes or clean water better?

Present your information as a poster, brochure or presentation.

Engage

Think about any other water efficient products you already use, either at home or at school. Which is your favourite and why? Use the **PMI template** to help you organise your ideas.

Connect

In small groups, take a currently inefficient product and suggest how you might be able to make it more efficient. Draw a labelled diagram of your new, efficient product and present it to your class as a presentation you might see on a TV special about the environment.

Explore

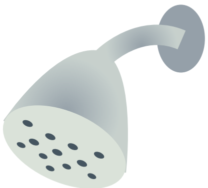
In pairs, create your own water efficient product and explain how it works. Your innovation can be fictional and there are no limits on cost, but try to make sure your innovation fills a gap in the market. Present your idea to the class as an oral presentation. You may like to include images, diagrams and models in your presentation. You could also consider how you would sell this product to your market audience.

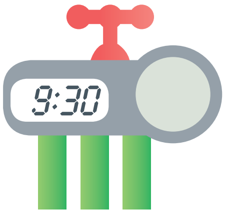
TIP: Watch the New Inventors *Saving Water Special* (DVD or online) for additional information and inspiration for this activity.

Main – Water Innovation

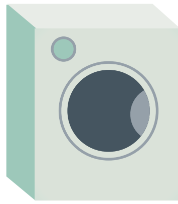
Make sure there are enough squares for everyone in the class to take one. Cut out the squares and place them in a hat. Each student should take one square and complete research to find out:

- The year of innovation/invention
- The person who came up with it
- What country the innovator comes from
- How the innovation/invention works
- Whether it saves water, streamlines processes or cleans water better

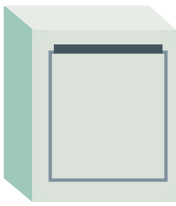

Low flow showerhead



Timer watering system

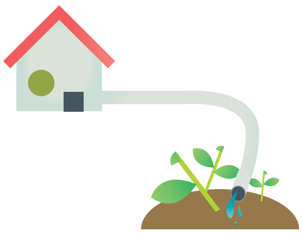

Front loader washing machine


Dual-flush toilet

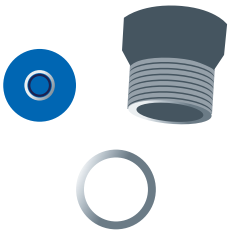

Sensor dishwasher


Trigger nozzle

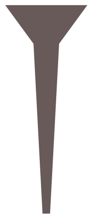

Mulch


Greywater system

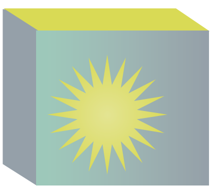

Toilet with in-built sink

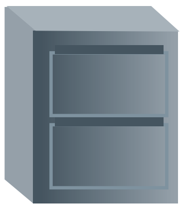

Flow restrictor

Water storage crystals


Drip spike

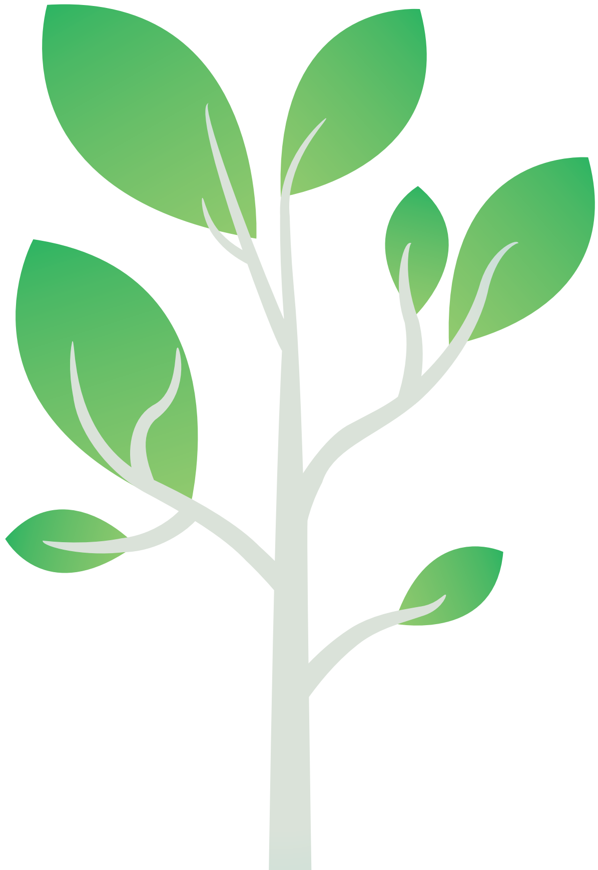
Shower timer


Low phosphate laundry detergent


Double draw dishwasher

Water Sensitive Urban Design

Water Sensitive Urban Design (WSUD) is a reasonably new term. It refers to the designing and planning of urban areas that use water in an environmentally sustainable way. Great care is taken to increase the liveability of urban areas and reduce the impact of development on our bays and waterways. The key principles of WSUD include protecting natural water bodies, directing stormwater, protecting water quality, and reducing run-off.



Main Activity

Use your online search engine to find out about raingardens. What are they? Why should we use them? Find some instructions on how to plan and build your own raingarden. As a class, use these instructions to plan and design a raingarden in your school. You might like to create a proposal or run a fundraiser to actually build your raingarden.

FACT: Raingardens reduce the amount of stormwater that would otherwise wash large amounts of pollutants into the stormwater drain and into your local stream. Raingardens also treat the quality of rainfall run-off and provide habitat for native fauna such as birds, butterflies and even frogs. Consider applying for a grant to help you install one in your school.

Engage

Walk around the school gardens after a period of heavy rain. Where is the water collecting? Are there puddles in some places? Why might a garden help? Think about what happens to the water once it has fallen. Where does it go? Try to come up with as many ideas as you can. Share your ideas and discuss them as a class.

Connect

Visit the Melbourne Water website to find out what sorts of techniques Water Sensitive Urban Design includes. Select one feature to research, and present this as an informative poster with some examples of the technique being used. You might like to draw it by hand or use a computer program to put it together.

Explore

Research the features of Water Sensitive Urban Design, then create your own town and incorporate at least three techniques of 'Water Sensitive Urban Design'. Explain your use of these techniques and present your project in a short video or interactive poster. You may like to explore further and look into the barriers of implementing these sorts of changes into your local area.

Careers

The water industry has many exciting career options. Imagine working in a pristine catchment area, or developing plans to build a new sewage treatment plant! Careers in the water industry are varied—people with all sorts of skills are needed.

Main Activity

Review the **Main – Careers worksheet** provided. Are there any careers that interest you? Any careers you didn't know existed? Discuss the careers that are listed, then brainstorm any other careers in the water industry that you know of or think might be required.

FACT: Over 2,000 people are employed in the water industry in Melbourne.

Engage

Complete the provided **Engage - Careers worksheet** that shows a range of different jobs in the water industry. Match the person to the professional equipment they use.

Connect

What type of job would you like to have when you leave school? Write the job title at the top of your page, and then write down a list of the ways you think you'll use water in that job.

Explore

Add to the list of careers you found in the main activity by searching online. You may find some jobs that you didn't know even existed! Select five that are of interest to you and then complete the **Explore - Careers worksheet** provided.

Main – Careers

There are many different jobs within the water industry.
We've asked just a few people to tell you a few things about their jobs.

Name: Annthea

Job Title: Graphic Designer

Three words that describe your job: creative, interactive, fun

Equipment you use: computers, pens/pencils, camera

Favourite part: coming up with inspiring ideas

Biggest challenge: appealing to everyone

Water interaction: communicating and educating about water and the water industry to the community

Something people might not know about your job: ideas can sometimes take a minute or sometimes a week!

Name: Kate

Job Title: Manager Stormwater Projects, Project Delivery

Three words that describe your job: engineer, design, build

Equipment you use: Laptop, mobile phone, car, hard hat, steel cap boots

Favourite part: working with a team of great people and seeing ideas become reality

Biggest challenge: creating a solution to a problem that everyone is happy with

Water interaction: creating ways to capture and use stormwater to water sporting ovals

Something people might not know about your job: that we work on a project long before you start to see construction taking place (sometimes years!)

Name: Lesley

Job Title: Environment Coordinator

Three words that describe your job: diverse, stimulating, rewarding

Equipment you use: telephone, computer, and my brain–this piece of equipment is in constant use!

Favourite part: helping to protect and improve the local environment

Biggest challenge: helping people understand how important it is to protect the environment

Water interaction: adapting to climate change to deal with a future of extreme weather events

Something people might not know about your job: that we consider the environment in all parts of the water industry and how we can all have a positive impact

Name: James

Job Title: Engineer, Project Delivery

Three words that describe your job: communication, problem solving

Equipment you use: phones, computers, tablets, fluoro vest

Favourite part: making decisions on site to help works keep going

Biggest challenge: keeping track of the details of lots of different jobs

Water interaction: replacing water mains, building new water mains and replacing sewerage pipes

Something people might not know about your job: sometimes when we lay a new pipe, we don't even need to dig a trench!

Name: Emilia

Job Title: Organisational Development

Three words that describe your job: help, growth, progress

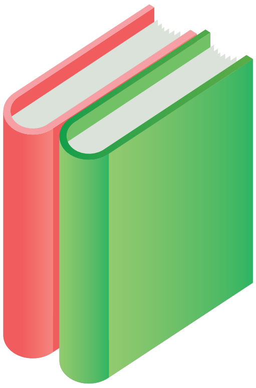
Equipment you use: laptop, whiteboard, data projector, flip charts and lots of coloured markers

Favourite part: meeting and working with lots of different people and helping them reach their potential

Biggest challenge: being flexible enough to switch between individual tasks and those for the whole organisation

Water interaction: I don't directly interact with water, but I work with people in the business who do. Of course, I shower every morning and have a drink bottle with me everywhere I go!

Something people might not know about your job: I help the organisation succeed by helping develop skills in staff today and for the future



Name: Georges

Job Title: Manager Water Quality

Three words that describe your job: water, quality, scientist

Equipment you use: brains, books, computer

Favourite part: solving problems and explaining water quality issues

Biggest challenge: explaining that Melbourne's water is perfectly safe to drink

Water interaction: sampling water to make sure it is safe for Melburnians to use

Something people might not know about your job: that water isn't a boring liquid; looking at it involves chemistry, biology and microbiology

Name: Ash

Job Title: Mechanical Engineer for Sewage Treatment Plants

Three words that describe your job: interesting, challenging, satisfying

Equipment you use: laptop, specialised software

Favourite part: finding solutions to repair equipment and ensuring it operates properly

Biggest challenge: prioritising works and ideas

Water interaction: sewage treatment

Something people might not know about your job: I get to travel to our sites, which offer some of the most beautiful scenery in Victoria

Name: Francis

Job Title: Manager, Research & Innovation

Three words that describe your job: Intellectually stimulating, rewarding

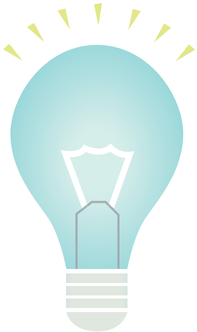
Equipment you use: internet, books, reports

Favourite part: the challenge of the unknown

Biggest challenge: translating concepts into reality

Water interaction: international water companies

Something people might not know about your job: As the challenges change, the nature of the job changes too



Name: Andrew

Job Title: Manager Innovation and Growth

Three words that describe your job: Challenging but rewarding

Equipment you use: PC and brain power

Favourite part: Introducing new ideas to the business

Biggest Challenge: ambiguity

Water interaction: new ways to save water

Something people might not know about your job: converting sewage into power is possible!

Name: Peter

Job Title: Demand Forecasting Manager

Three words that describe your job: numbers, trends, research

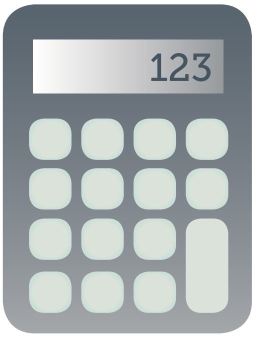
Equipment you use: databases, data loggers, Excel

Favourite part: understanding why/ how water use has changed

Biggest challenge: managing big research projects

Water interaction: forecasting Melbourne's water usage into the future

Something people might not know about your job: One of the things we need to forecast is how much nitrogen will need to be treated in the future in Melbourne's sewage treatment plants



Name: Nicole

Job Title: Taxation and Remuneration Accountant

Three words that describe your job: Variety, legislation-based, interactive

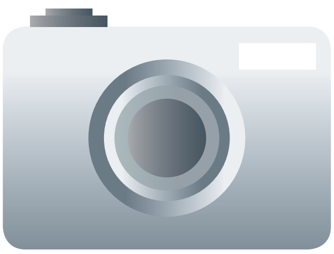
Equipment you use: Computer

Favourite part: The great culture and fantastic people that I work with

Biggest challenge: Interpreting and applying changes in legislation

Water interaction: I need to understand the water and sewerage transactions undertaken to determine associated Tax and GST treatments

Something people might not know about your job: I get to work with lots of other people in the business, which makes my job a lot more fun



Name: Emma

Job Title: Media Officer

Three words that describe your job: Fast-paced, creative, challenging

Equipment you use: Computer, camera, video recorder, Australian Media Guide!

Favourite part: Media launches, meeting celebs!

Biggest challenge: Getting your stories run in the media – and keeping the negative stories out

Water interaction: I inform the public of water related news through the media

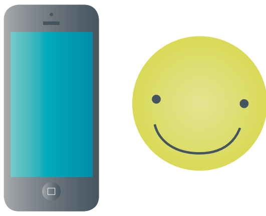
Something people might not know about your job: Every week I trawl through hundreds of press and broadcast media clips about water– you have to keep your finger on the pulse!

Engage – Careers

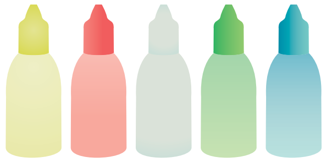
Match the water industry profession to the equipment they use by drawing a line from the name of the profession to the items. Remember, lots of professions may use the same sorts of equipment, so you can draw more than one line to each item.

Profession
Water quality monitor
Customer service officer
Communications officer
Information technology officer
Field services and maintenance
Human Resources
Engineer
Meter reader
Wastewater treatment plant operator
Sustainability officer
Diver

Telephone, personality

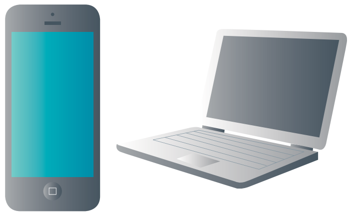


Water testing kit



Scuba Gear

Computer and telephone



Plans

Truck

Gloves

Computer server

Comfortable shoes, Electronic devices

Listening Ears

Hiking boots, outdoor clothes

Explore – Careers

Select five different careers in the water industry and write them in the left-hand column. Write down the tasks they do, then fill in the good, bad and interesting parts about each job. If you know someone who does a similar job you may like to chat to them to find out more. When the worksheet is completely filled, select your top choice and summarise why you think you might like to work in that profession.

Career Choice	Tasks	Good	Bad	Interesting
Choice 1:				
Choice 2:				
Choice 3:				
Choice 4:				
Choice 5:				

The job that most interests me from the list above is . . . . because

water
learn it. live it.

Templates

Template	Description
Cause and Effect	For each stage of a process or activity, write down the cause for each step and the resulting effect beside it.
De Bono's Hats	Use the different coloured hats to understand all of the different parts of an issue, including the good, bad, positive outcomes and 'hunches'.
Decision Making	Write down the full problem, then use the space provided to outline three alternative solutions, including the advantages and disadvantages of each. Using this information, extract a solution.
Plus, Minus, Interesting	Consider the different parts of your problem or issue and write them down in the sections provided. Review your lists and summarise your findings.
Predict, Observe, Explain	Complete each section (Predict, Observe and Explain) before, during and after each experiment.
Problems and Solutions	Use the columns to outline why an issue is a problem and the different possible solutions.
Ranking Ladder	Complete the pertinent details of your topic and use the ladder to rank your responses to the issues or problems, with the most important issue at the top and the least important at the bottom.
Storyboard	Plot out your film, play or animation with basic illustrations, a story outline, and notes about the mood, sounds and other effects required.
Story Map	Complete each of the boxes to outline and plan a story from start to finish.
SWOT	Use dot points or short sentences to outline the Strengths, Weaknesses, Opportunities and Threats for any given issue.

Cause and Effect

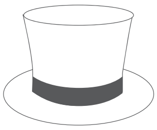
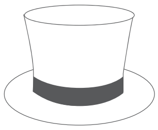
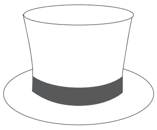
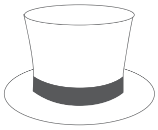
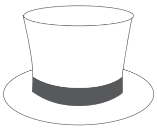
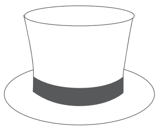
Issue: ....

Cause		Effect
	→	
	→	
	→	
	→	
	→	

De Bono’s Thinking Hats

Write down your issue at the top of the page. Then, use the thinking hats below to explore this issue. Start by colouring in the hats according to the colour noted.

Issue: . . . .

White Hat Information - what are the facts? 	Yellow Hat Positives – what are the best bits? 
Red Hat Emotions – what are your feelings or hunches? 	Green Hat Creativity – how can you solve the problems? 
Black Hat Negatives – what are the bad bits? 	Blue Hat Summarising – what are your final thoughts? 

Decision Making

Problem:

Alternative 1:

Advantages

Disadvantages

Alternative 2:

Advantages

Disadvantages

Alternative 3:

Advantages

Disadvantages

Solution:

Plus Minus Interesting (PMI)

Think about the different parts of your problem or issue and write them down in the Plus, Minus or Interesting columns. Once you have completed the table, summarise your findings with a conclusion.

Plus Write down the positive results of taking a particular action	**Minus** Write down the negative results of taking a particular action	**Interesting** Write down the implications and possible outcomes of taking a positive, negative or indecisive action
Conclusion:		

Predict Observe Explain (POE)

Repeat the Predict, Observe, Explain process for each experiment you undertake.

Title: . . . .

Topic/Activity	
Predict Before you start, think about what might happen. Write down your prediction.	
Observe During your experiment/activity, use your senses to observe what is happening. Record your observations. You may want to include diagrams.	
Explain After you have finished your experiment/activity, try to explain what happened. You may need to do some research to complete this section.	

Problems and Solutions

Topic: . . . .

Problem – Why is it a problem?	Solution/s – What are the different possible solutions?

Ranking Ladder

Ranking ladders help to consider all possible responses to a question or circumstance, rather than just an obvious response or knee-jerk reaction. This tool ensures you consider and justify your responses.

Complete the table below then use the ladder to rank your responses to the issue/problem, with the most important at the top and the least important at the bottom.

Task:

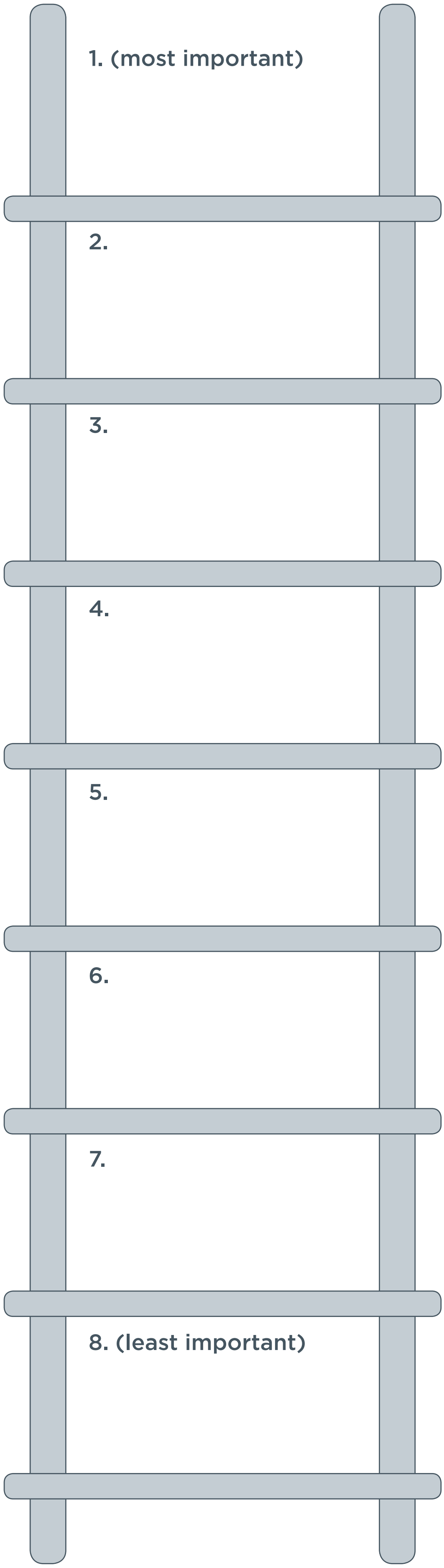
State the issue/problem in your own words:

Brainstorm all of the possible answers, then rank them using the ladder :

Justify your most important response:

Justify your least important response:

(If you can't justify a response, you should remove it from your list entirely.)



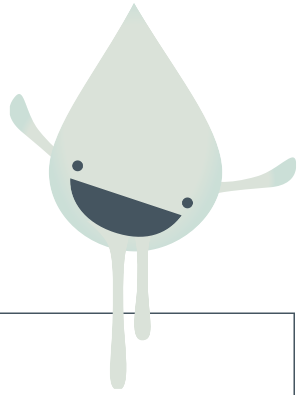
Storyboard

Plot out your film, play or animation by filling in the details for each scene below. You can draw images or write dot points to explain each scene. Print as many sheets as you need to plot out your entire storyline.

Title: . . . .

Scene	Scene	Scene
	Transition	Transition
Voice-over or Storyline	Voice-over or Storyline	Voice-over or Storyline
Notes – mood, sound, etc.	Notes – mood, sound, etc.	Notes – mood, sound, etc.

Story Map



Title: . . . .

SCENE

Where:

When:

CHARACTERS

Major Characters:

Minor Characters:

Challenge/Event 1

Challenge/Event 2

Challenge/Event 3

How the Challenges are Overcome:

Now that you've completed your plan, fill in the details and write your full story!

SWOT

Issue: . . . .

	Helpful	Harmful
Internal	**Strengths**	**Weaknesses**
External	**Opportunities**	**Threats**

Recommendations:

water
learn it. live it.

Glossary

Aquifer: an underground layer of permeable rock or other geological formation that holds water, especially one that supplies the water for wells, springs, etc.

Atmosphere: the gaseous envelope surrounding the earth; the air.

Bore water: water accumulated in aquifers below the earth's surface, but available for use by sinking a bore pipe in the aquifer. May discharge naturally to the surface or need to be pumped.

Brackish: a mixture of seawater and freshwater.

Catchment (open): a public area of land that collects rainfall and directs it to a low-lying body of water. Once the water is treated, it can be used as drinking water.

Catchment (closed): an area of land that is closed to public access, where rainfall water is collected and directed to a low-lying body of water. The water only needs minimal treatment before it can be distributed as drinking water.

Chlorine: a chemical element that helps to destroy disease-causing bacteria that can be found in water naturally.

Climate: the prevailing weather conditions of a region: temperature, air pressure, humidity, precipitation, sunshine, cloudiness, and winds throughout the year, averaged over a series of years.

Condensation: the change of the physical state of a substance from a vapour into liquid; when vapour cools, the molecular structure changes and it becomes a liquid.

Dam: a barrier built across a stream or river to control the flow or raise the level of water; small man-made water storages on farmland that capture stormwater run-off and groundwater that can be used in times of low or no rainfall for stock and domestic use or irrigation purposes.

Drought: a period of dry weather that is inadequate for the needs of crops, animals and humans, generally due to an extended period of low rainfall.

Ecosystem: a system formed by the interaction of a community of organisms with their environment.

Effluent: a stream or discharge from a body of water; often relating to liquid waste or sewage discharge.

Embodied water: the water used in the production of goods or services, e.g. 4,650 litres of water is required to produce 300 g of beef; this number considers preparation of food required to feed the beef, transportation, land management, etc.

Erosion: the process by which the surface of the earth is worn away by the movement of water, glaciers, winds, waves, etc.

Evaporation: the change of a substance from a liquid state to a gaseous state. This process is accelerated by an increase in temperature and a decrease in atmospheric pressure.

Flood: inundation of normally dry land by overflow of water from a usually confined area.

Fluoride: a chemical element that is added to drinking water to improve dental health and prevent tooth decay.

Freshwater: water with less than 500 parts per million (ppm) of dissolved salts. Freshwater can be found on Earth as ice caps, glaciers, billabongs, dams, lakes, rivers and streams, and underground as groundwater in aquifers and underground streams.

Groundwater: the water beneath the surface of the ground, consisting largely of surface water that has seeped down; the source of water in springs and wells.

Impermeable: a material through which substances, such a liquids or gases, cannot pass.

Infiltration: the seepage of water into soil or rock.

Infographic: a graphic representation of an idea or message that presents complex information clearly and efficiently.

Innovation: the development of an action, item or process that intends to make a current version of something better.

Invention: the development of an action, item or process that is newly created.

Irrigation: the supply of water to dry land and crops via a water system that may include ditches, pipes or streams.

Lime: a caustic alkaline substance used to reduce acidity in water to make the water more palatable and to minimise corrosion of pipes and equipment.

Natural disaster: any event or force of nature that has catastrophic consequences, such as avalanche, earthquake, flood, forest fire, hurricane, lightning, tornado, tsunami and volcanic eruption.

Natural hazard: the threat of a naturally occurring event that will have a negative effect on people or the environment.

Organic: derived from living matter; natural.

Permeate: to spread throughout something.

pH: the measure of acidity or alkalinity of a chemical solution. Anything neutral, for example, has a pH of 7. Acids have a pH lower than 7, bases (alkaline) have a pH higher than 7.

Pollution: the introduction of harmful substances or products into the environment.

Potable: water that is suitable for drinking.

Precipitation: any form of water, such a rain, snow, sleet or hail, that falls to the earth's surface.

Pumping station: a piece of equipment used to pump fluid from one place to another.

Reservoir: a natural or artificial place where water is collected and stored for use, especially water for supplying a community, irrigating land, furnishing power, etc.

Reverse osmosis: a process where a solvent is forced to pass through a porous membrane to remove any impurities or unwanted elements.

River: a large natural stream of freshwater flowing along a definite course, usually into another body of water (ocean, lake, sea, river), being fed by tributary streams. Small rivers may also be called a stream, creek, brook or tributary.

Run-off: the overflow of water that is not absorbed by the ground or other surfaces.

Salinity: the salt or dissolved salt content found in a body of water or soil.

Saltwater: water that contains approximately 350,000 parts per million (ppm) of dissolved salts; approximately 97% of Earth's water is saltwater, held in the major ocean areas of the Atlantic, Antarctic, Indian, Pacific and Arctic.

Secondary Treatment Plant: a series of machines and equipment that filter and remove contaminants from water intended for drinking.

Sewage Treatment Plant: a series of machines and equipment that remove contaminants from wastewater to produce environmentally safe liquid and solid bi-products to dispose of or re-use.

Solvent: a substance that dissolves another to form a solution.

Stormwater: water that originates from precipitation (rain, hail, snow). It may also include the debris or anything else the water carries with it. Stormwater flows through stormwater drains and into water bodies.

Trade waste: Liquid waste from any business industry, trade or manufacturing industry, other than 'domestic' waste from showers, baths, toilets and basins.

Transpiration: the passage of water through a plant from the roots through the vascular system to the atmosphere.

Turbidity: not clear or transparent because of stirred-up sediment or the like; clouded; opaque; obscured.

UV: ultraviolet; electromagnetic radiation with a wavelength shorter than visible light, hence invisible to humans; emitted by the sun's rays.

Volume: the amount of space, measured in cubic units, that an object or substance occupies.

Water cycle: the continuous movement of water on, above and below the Earth's surface.

Water table: the level below which the ground is saturated with water.

Water quality: the physical, chemical and biological characteristics of water; drinking water in Australia must reach the standards outlined in the Australian Drinking Water Guidelines (ADWG).

Wastewater: water that has been used, e.g. sewage.

Weather: the state of the atmosphere with respect to wind, temperature, cloudiness, moisture, pressure, etc.