Western Treatment Plant Virtual Tour

LEVEL 7-8 Geography

gtav

Melbourne Water
Enhancing Life and Liveability

Western Treatment Plant Virtual Tour

LEVEL 7-8 Geography

Note

This lesson sequence has been designed for use both by students who attend the tour at the Western Treatment Plant, and those who complete the virtual tour as a form of fieldwork. Teachers should select the lessons most suitable for their students.

Key Vocabulary

There are several unfamiliar terms in the virtual tour. It is recommended that you teach these before commencing the tour. Here are some suggestions for pre-teaching vocabulary:

- Mix and match activity – provide students with the terms and have them guess a definition, before comparing it with the correct one
- Play odd one out – provide students with groups of three or four terms and, in pairs, they discuss which of the terms is the 'odd one out'. There is generally no right or wrong, the discussion is the important part.
- Bingo – students draw up a 3x3 grid. Write the terms on the board and students choose where to put them (one in each box). Read out a definition only and students must work out what the term is and cross it off their list. The first student with two lines wins.

Sewage	Wastewater which normally includes grey water (from sinks, washing machines etc.) and black water (from toilets). It includes human waste along with toilet paper (and anything else that gets flushed down the toilet).
Ponds/lagoons	Large pools for treating the sewage and wastewater in. The sewage flows through the lagoons, gradually becoming cleaner as bacteria break down the organic matter in the water.
Activated sludge process	A sewage process in which solids are separated from wastewater using bacteria and aeration.
Aerator	A device for mixing air into the sewage
Biosolids	A sludge by-product of the sewage treatment process. Some of this is nutrient-rich and can be reused for many purposes including agricultural use or energy production.
Anaerobic	This is a process which does not require oxygen to occur. In this case some bacteria work without oxygen to break down the waste.
Aerobic	This is a process which requires oxygen. In sewage air is incorporated into the sewage to encourage certain bacteria to help break down the waste.
Anoxic	An environment without oxygen. Anoxic water has very little oxygen in it.
Effluent	Treated sewage
Waste water	Water that is discharged from homes and businesses and sent to the treatment plant

Lesson 1
Introduction to Western Treatment Plant

Curriculum links

- Classification of environmental resources and the forms that water takes as a resource (VCGGK105)
- Ways that flows of water connect places as they move through the environment and the ways this affects places (VCGGK106)
- Explain processes that influence the characteristics of places (VCGGC099)
- Identify, analyse and explain interconnections within places and between places and identify and explain changes resulting from these interconnections (VCGGC101)
- Collect and record relevant geographical data and information from useful primary and secondary sources, using ethical protocols (VCGGC102)
- Analyse maps and other geographical data and information using digital and spatial technologies as appropriate, to develop identifications, descriptions, explanations and conclusions that use geographical terminology (VCGGC104)

Learning intentions

For students to be able to:

- locate the Western Treatment Plan on a map of Melbourne
- explain the function of the Western Treatment Plant
- describe the Western Treatment Plant in relation to the water cycle
- apply mapping skills including transcribing location and BOLTSS.

Key inquiry questions

- Where is the Western Treatment Plant?
- What is the role of the Western Treatment Plant and how important is it to Melbourne?
- How does the Western Treatment Plant connect Melbourne?
- What role does the Western Treatment Plant play in the water cycle?
- How are the natural and urban water cycles different?
- How do we classify the water at the Western Treatment Plant?

Key vocabulary

Sewage, natural water cycle, urban water cycle

Time required

1–1.5 hours

Materials

Projector, computers, copies of *Lesson 1 Worksheet: Cloze and Mapping activities*.

Prior knowledge

It is expected that students will have studied the water cycle and classification of resources. Students should understand the elements of BOLTSS for maps.

Lesson 1
Teacher instructions

Starter

1. Students should start a mind map with the word ‘sewage’ in the centre. Using the following resources and discussion points, they should add to their mind map and understanding of the sewage treatment. (You might suggest some branch titles such as urban water cycle, Western Treatment Plant and importance or reasons).

2. Watch the video (until 3min 28sec) on the sewage treatment process: https://www.youtube.com/watch?v=8isr9nSDCK4. (note: the first section is relevant, the rest refers specifically to Unity Water Treatment plant which is different to the Western Treatment Plant). Discuss the idea of the urban water cycle.

3. Watch ‘Where your sewage goes’ https://www.youtube.com/watch?v=1TUk9GPR2M4

4. Students can explore the Melbourne water cycle interactive and game: https://www.educationsoutheastwater.com.au/resources/melbourne-water-cycle-interactive

5. More information on the natural and urban water cycles: https://www.melbournewater.com.au/community-and-education/education/natural-and-urban-water-cycle

6. Conduct a class discussion on the Western Treatment Plant. Pose the following questions:
   a. What do you expect the WTP to look like?
   b. How big do you think it will be?

7. Have students navigate to Google Earth (in Google Chrome). Have them locate their home or school. Using the measure tool to measure the area (in hectares). How big do you think a lagoon at the Western Treatment Plant would be? How big do you think the whole site is?

8. Have students find their way to the Western Treatment Plant. They should locate pond 1 and measure it (approximately 33ha!). Allow them time to check out the site on Google Earth.

Main activity

1. Load the virtual tour. Show students the introductory video and have them complete the cloze activity (*Lesson 1 Worksheet: Cloze activity*)
   http://westerntreatmentplanttour.melbournewater.com.au/

2. Students should complete the mapping activities (*Lesson 1 Worksheet: Mapping activity*).

Plenary

1. Encourage students to reflect on their previous learning and today's, by answering these questions:
   a. How does the Western Treatment Plant (WTP) fit into the water cycle?
   b. List one economic, one social and one environmental benefit of the Western Treatment Plant.
   c. How does the sewage treatment at the Western Treatment Plant influence the local area? Include positive and negative elements in your response.
   d. Write down two questions you have for future lessons – what else would you like to know about the WTP?

Differentiation

For less-able students:

- For the starter, these students might need some assistance with the mind map. Help them label branches and identify key points to add.
- For the plenary, provide them with three benefits and have them classify them.

For more-able students:

- They can explore the history of Cocoroc (see below links). Students can explore how the historical use of the site is linked to current use.

Suggested adaptations

- The mind map could be a lotus diagram instead.
- Have students conduct a quick poll at home or with friends prior to the lesson. Have them ask if people know what happens to their poo and wee after they flush the toilet. Ask students to report back to the class at the start of the lesson.
- Investigate the history of the Western Treatment Plant: video https://www.youtube.com/watch?v=Q1tH_hfUrII and reading about Cocoroc: https://www.geelongadvertiser.com.au/news/opinion/ross-mueller--the-secret-history-of-cocoroc/news-story/6c77583b2ad0b46a5c9ccb484b6b80d3
- https://www.smh.com.au/entertainment/art-and-design/art-project-stirs-the-pools-of-memory-at-werribees-western-treatment-plant-20151030-gkmkmi.html

Lesson 1 Worksheet
Cloze and Mapping Activities

Cloze activity

Watch the introductory video and use the words below to fill in the blanks.

wildlife *300,000* *million* *recycled water* *lagoons* *nutrients* *Phillip Island* *sustainability* *resources* *gas* *renewable energy* *50%* *Wadawurrung* *agriculture*

The _____ people are the traditional owners of the land where the Western Treatment Plant is located. The plant is approximately the size of _____. It treats about _____ of Melbourne's sewage. Each year _____ litres of sewage it treated by the Western and Eastern Treatment Plants. _____ provide water and _____ for _____ including animals, reptiles and birds. The sewage treatment program turns sewage into valuable _____ such as _____ which is used for _____ and wetland conservation. Sewage _____ is used to generate enough _____ to meet the plants energy needs. This contributes to the _____ and liveability of the region.

Mapping activities

Create your own symbols and legend rather than writing all over the map.

On **Map 1** – a blank map of Victoria – mark the following:

a. Melbourne CBD
b. Your home or school (you may need an atlas to help with this)
c. Western Treatment Plant (Google Earth or Google Maps may help)
d. Add any missing BOLTSS.

For **Map 2** – Western Treatment Plant – you will need to access the map in the virtual tour (it is linked in the bottom right corner of the screen). Note: find the north sign – it is not the top of the online map. Label the following:

a. the four stages of the sewage treatment process
b. where recycling takes place
c. Pond 1
d. Werribee farm district
e. two outlets
f. any missing BOLTSS.

Describe, using geographic terminology, the Western Treatment Plant's relative location in Victoria. (Remember relative location normally uses both direction and distance from a major feature or landmark).

Map 1: Blank map of Victoria

Map 2: Western Treatment Plant

Lesson 2
GIS Mapping Activities

Curriculum links

- Classification of environmental resources and the forms that water takes as a resource (VCGGK105)
- Ways that flows of water connect places as they move through the environment and the ways this affects places (VCGGK106)
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Learning intentions

For students to:

- navigate a GIS map including turning layers on and off and using a measuring tool
- analyse a GIS map to develop explanations and draw conclusions
- identify the catchment they live or go to school in
- make connections between their home or school and the WTP
- explain the spatial distribution of the sewerage network.

Key inquiry questions

- how am I connected with the WTP?
- how far is my home or school from the WTP?

Key vocabulary

Catchment, GIS, layers

Time required

40 mins

Materials

Computers, copies of *Lesson 2 Worksheet: GIS Mapping Activities*.

Prior knowledge

It is assumed that students will understand water catchments and the water cycle.

Lesson 2
Teacher instructions

Starter
Have students list three things they learnt last lesson. Students then turn and talk to a partner and share their knowledge.

Main activity
1. Show the students the GIS map 'Melbourne Water Education': https://melbournewater.maps.arcgis.com/apps/webappviewer/index.html?id=c6c2ea5762f04ba1a76936e702a9ed28
   Show them the basics of zooming in and out, navigating around and turning layers on and off.
2. Provide them with Lesson 2 Worksheet.

Plenary
Have students suggest two fields of data that they would add to the map OR write three quiz questions on today's material.

Differentiation
For less-able students:

- Have them select a couple of measuring activities. They may want to work with a partner to complete the tasks.

For more-able students:

- Have them compare the data to the Melbourne Water Frog Census site: melbournewater.com.au/community-and-education/waterwatch-programs/frog-census
  Students can navigate to the WTP and see what has been identified in WTP and surrounding area (Eastern Banjo & Common Eastern Froglet). They can also see what species have been recorded in their own areas. They can download the app and help locate species of frogs in their local area.

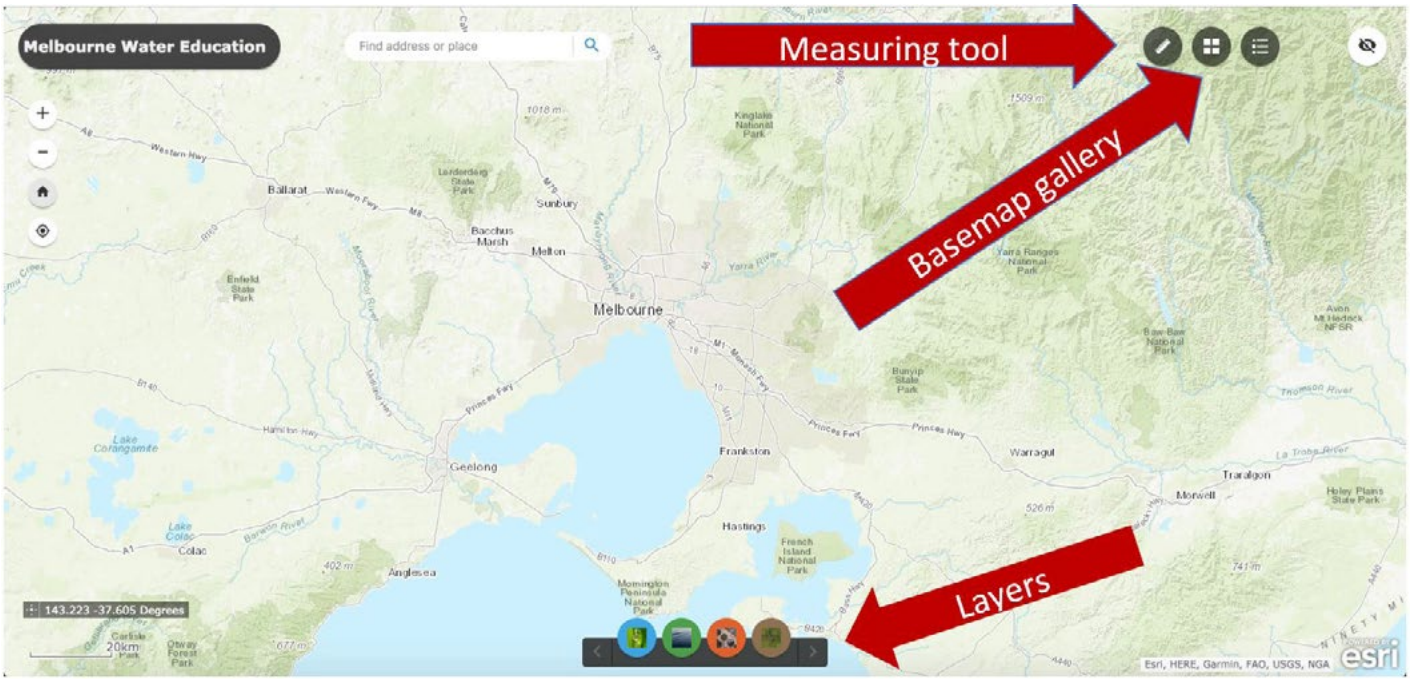
Suggested adaptations
Have students start with the Australian Museums Frog data and compare it with WTP. This could be completed as a class.

Lesson 2 Worksheet
GIS Mapping Activities

A GIS map uses data organised in layers of information. By turning layers on and off data and information is revealed, and patterns and relationships can be analysed.

1. Navigate to an interactive GIS map of Melbourne's waterways and catchments: https://melbournewater.maps.arcgis.com/apps/webappviewer/index.html?id=c6c2ea5762f04ba1a76936e702a9ed28

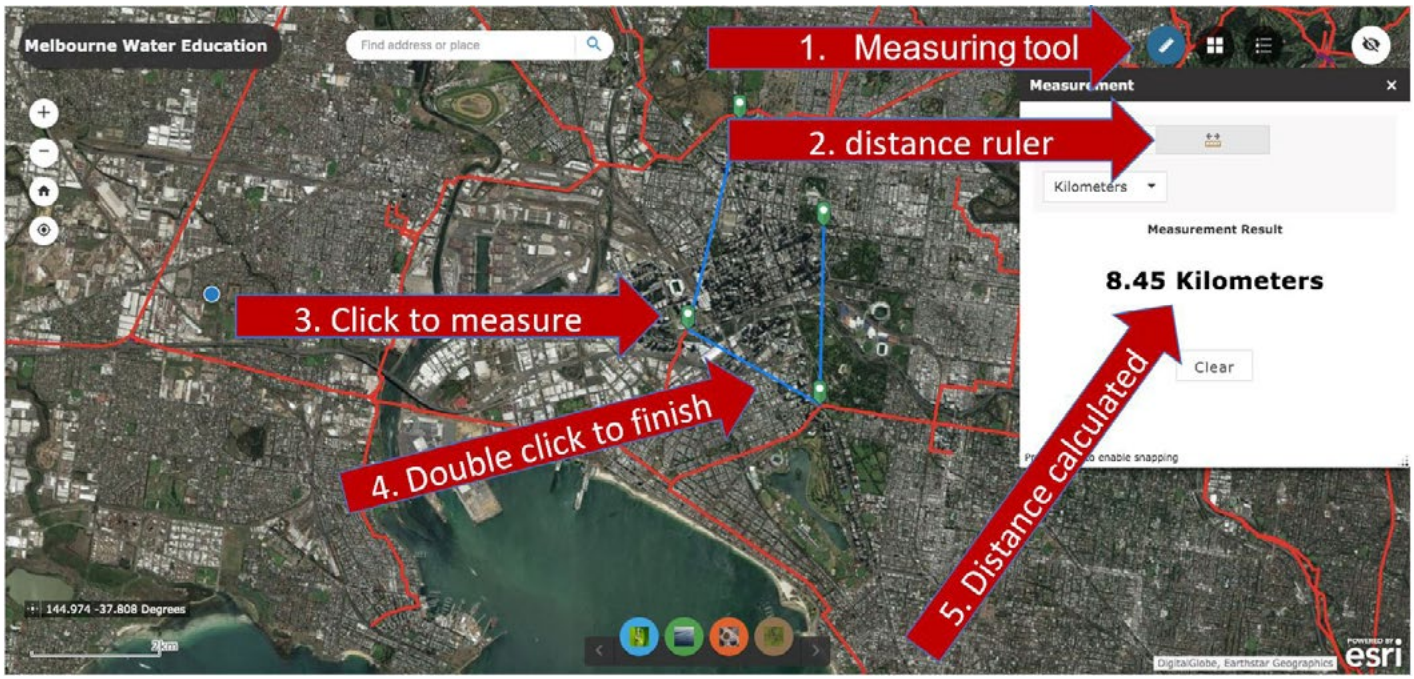
2. Explore the map. Click layers on and off. Look at the measuring tool and different base maps



3. Click 'Catchment, Rivers, Retarding Basins and Wetlands'. Click the layer 'Catchments of Major Waterways'. Explain what a catchment is.
   Can you identify the catchment where your home or school is? (Hint: the catchment is named after the major river running through it). Click the layer off again.

4. Click the 'Sewers and Sewage' icon. Click 'Western Treatment Plant Carrier and Mains'. What is this showing?

5. How far do you think it is, in a straight line – from your home or school to the Western Treatment Plant? Use the measuring tool to find out.



6. Click the ‘Sewers and Sewage’ icon. Click ‘Sewerage Network Mains’.
   a. What do you notice about the sewerage network?
   b. Explain the spatial distribution of the sewerage network.

7. Change the basemap to ‘imagery’ and describe the relationship between populated areas and the sewerage network.

8. Zoom in to the Western Treatment Plant to get a better view (you may want to refer to your maps from the previous lesson to help locate it). For best results the scale should show 2 km or 3 km. Locate Pond 1 on the map.

9. Estimate the distance between the end of the sewerage network and pond 1. Now use the measuring tool to calculate the actual distance.

10. **Challenge:** How far does your poo travel? Make a prediction and then check by using the measuring tool – from your house to the WTP (you can do it ‘as the crow flies’ (straight line distance) or challenge yourself to follow the sewerage network – make sure you turn that layer on).

Extension

1. Explore the frog species that live in the WTP. Click the ‘Flora and Fauna’ icon and then ‘Frog location’. Identify four different species of frogs in the WTP.

2. Turn on the layers for the Eastern Treatment Plant. Find similarities and differences between the ETP and the WTP.

3. Turn on the layer for the main water supply pipeline. Is there a correlation between those and the sewerage network? Explain your answer.

Lesson 3
Sewage Treatment Virtual Tour

Curriculum links

- Classification of environmental resources and the forms that water takes as a resource (VCGGK105)
- Ways that flows of water connect places as they move through the environment and the ways this affects places (VCGGK106)
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- Collect and record relevant geographical data and information from useful primary and secondary sources, using ethical protocols (VCGGC102)
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Learning intentions

For students to:

- gain an understanding of the sewage treatment process
- explore the virtual tour and watch videos to elicit information
- complete a 'field' sketch.

Key inquiry questions

- What are the main stages of sewage treatment?
- What role does the Western Treatment Plant play in the water cycle?
- How can we classify the water at the Western Treatment Plant?

Key vocabulary

Sewage, biosolids, lagoons, bacteria, activated sludge, discharged, aerators, anaerobic, aerobic

Time required

1 hour

Materials

Computers (or projector), blank paper for field sketches, copies of *Lesson 3 Worksheet: Virtual Tour - Sewage Process*.

Prior knowledge

It is assumed that students will have an understanding of the water cycle and how water can be classified.

Lesson 3
Teacher instructions

Starter

This lesson contains a lot of meta-language. Start with pre-teaching it using the vocabulary list and definitions at the beginning of the unit. There are activity suggestions provided.

Main activity

1. http://westerntreatmentplanttour.melbournewater.com.au/
   Students should watch the video of stages 1–4 and complete the questions on the worksheet. They can navigate the stages using the bar on the left. The main video can be accessed by clicking on the orange 'Start Video' button.

2. If students haven't completed a field sketch before, then you will need to instruct them on how to do this. Lesson 7 of the Geographer Online's 'My Place' has some great resources on this. https://www.thegeographeronline.net/my-place.html. Remind students that real field sketches are completed 'in the field' and discuss the advantages of physical fieldwork.

Plenary

Ask students to write a 'tweet' about what they learnt today. They have a maximum of 140 characters.

Differentiation

For less-able students:

- The activity for section 3 could be turned into a cloze activity. You might also consider providing them with the questions for section 4.

For more-able students:

- Extension activities are included on the worksheet.

Suggested adaptations

- You could watch the videos as a class and discuss each stage.
- For the plenary, students could write a text message rather than a 'tweet'. They could also draw a mind map if time allows.

Lesson 3 Worksheet
Virtual Tour – Sewage Process

Sewage Inflow

1. Identify two reasons Werribee was chosen as the site for the Western Treatment Plant.
   a. Provide three interesting facts about this stage.
   b. Explain how the water used to be treated ‘in the olden days’.
   c. How does this stage now work?
   d. How would you classify the water as a resource at this stage?

2. Primary Treatment
   a. What is the role of Pond 1?
   b. How does it achieve this?
   c. What is biogas and what is it used for?
   d. What are biosolids and what are they used for?

3. Secondary Treatment
   a. In your own words, explain what happens here. Include the terms ‘process’, ‘activated sludge plant’, ‘bacteria’, ‘gas’, ‘discharged’ and ‘aerators’.

OR

   b. Draw a flowchart to explain this stage.

4. Tertiary Treatment
   a. Write three questions (and answers!) on this stage. Vary the start of each question. You may want to use the terms ‘what’, ‘why’, ‘how’, ‘explain’, ‘identify’.
   b. Swap your questions (not answers) with a partner and then mark their responses.
   c. How would you classify the water as a resource at this stage?

Skill development: Photo sketch

   a. Choose one part of the Western Treatment Plant to complete a photo sketch – if you are at the site, this is called a field sketch. Remember that it should be annotated with the key features.
   b. Why did you choose that location to complete the sketch?
   c. The virtual tour includes some close-ups of various locations. Choose any three and describe what you can see in each (observations).
   d. Which area/stage do you think would be most smelly and why?
   e. What role does the Western Treatment Plant play in the water cycle?
   f. How is the Western Treatment Plant connected it’s surrounding environment?

Extension

- Choose one stage and draw a comic strip depicting it.
- Write down five questions you would have for a ‘poo diver’.
- Explore the virtual tour in more detail. See if you can find some species that live here. Can you write three questions on it to stump your teacher?

Lesson 4
Going deeper into sewage treatment

Curriculum links

- Classification of environmental resources and the forms that water takes as a resource (VCGGK105)
- Ways that flows of water connect places as they move through the environment and the ways this affects places (VCGGK106)
- Explain processes that influence the characteristics of places (VCGGC099)
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Learning Intentions

For students to:

- gain a deeper understanding of one stage of the sewage treatment process
- work in groups to create a role play of one stage of the sewage treatment.

Key inquiry questions

- What are the stages of the sewage treatment process?
- How can we classify water at various stages of the sewage process?

Key vocabulary

Sewage, biosolids, lagoons, bacteria, activated sludge, discharged, aerators, anaerobic, aerobic.

Time required

1 hour

Materials

Computers, copies of *Lesson 4 Worksheet: Treatment Stages and relevant Factsheets*.

Prior knowledge

An understanding of the sewage treatment process.

Lesson 4
Teacher Instructions

Starter

1. Ask students to draw on their prior knowledge from last lesson and complete the True/False quiz. This could be done as a class (heads and hips – students stand up and close eyes. Heads for true, hips for false), individually written, or turned into an online quiz (Kahoot, Socrative etc).
   a. 500 million litres of raw sewage comes to the WTP every day (T!)
   b. Poo peak hour is 9–11 am (F. It's 2–4pm)
   c. One of the reasons Werribee was chosen as a site was because it was cheap land (T)
   d. Pond 1 is 22 m deep. (F. It's 6–8m deep)
   e. The first stage of the treatment process is to get rid of the solids. (T. They settle to the bottom as sludge)
   f. The secondary treatment happens in Pond 1. (F. It happens in Pond 5)
   g. If the equipment breaks people must get in and fix it. (T! They're called pond divers)
   h. The ponds use UV light to disinfect the effluent (T).

Main activity

1. Organise students into four groups and allocate each group a stage (1–4).
2. Provide students with the extra written information (factsheets) for their specific treatment stage. Have them read it aloud with their group, highlighting key information.
3. Have students explore their stage of the virtual tour (they might do this in pairs). http://westerntreatmentplanttour.melbournewater.com.au/
   They should pan around to get to the different interactive parts, watch all the videos and read all the information. Then, using both the handout and virtual tour, have them complete the questions on *Lesson 4 Worksheet: Treatment stages*.
4. Students should perform their role plays to the class.

Plenary

Complete a 3, 2, 1 activity - students note down 3 things they learnt, 2 questions they have and 1 thing they already knew.

Differentiation

For less-able students:

- Reduce the amount of written information for them to read through. You could read it aloud to that group to help them, telling them what to highlight.

For more-able students:

- Have students write down three questions they have about this stage and find the answers.

Suggested adaptations

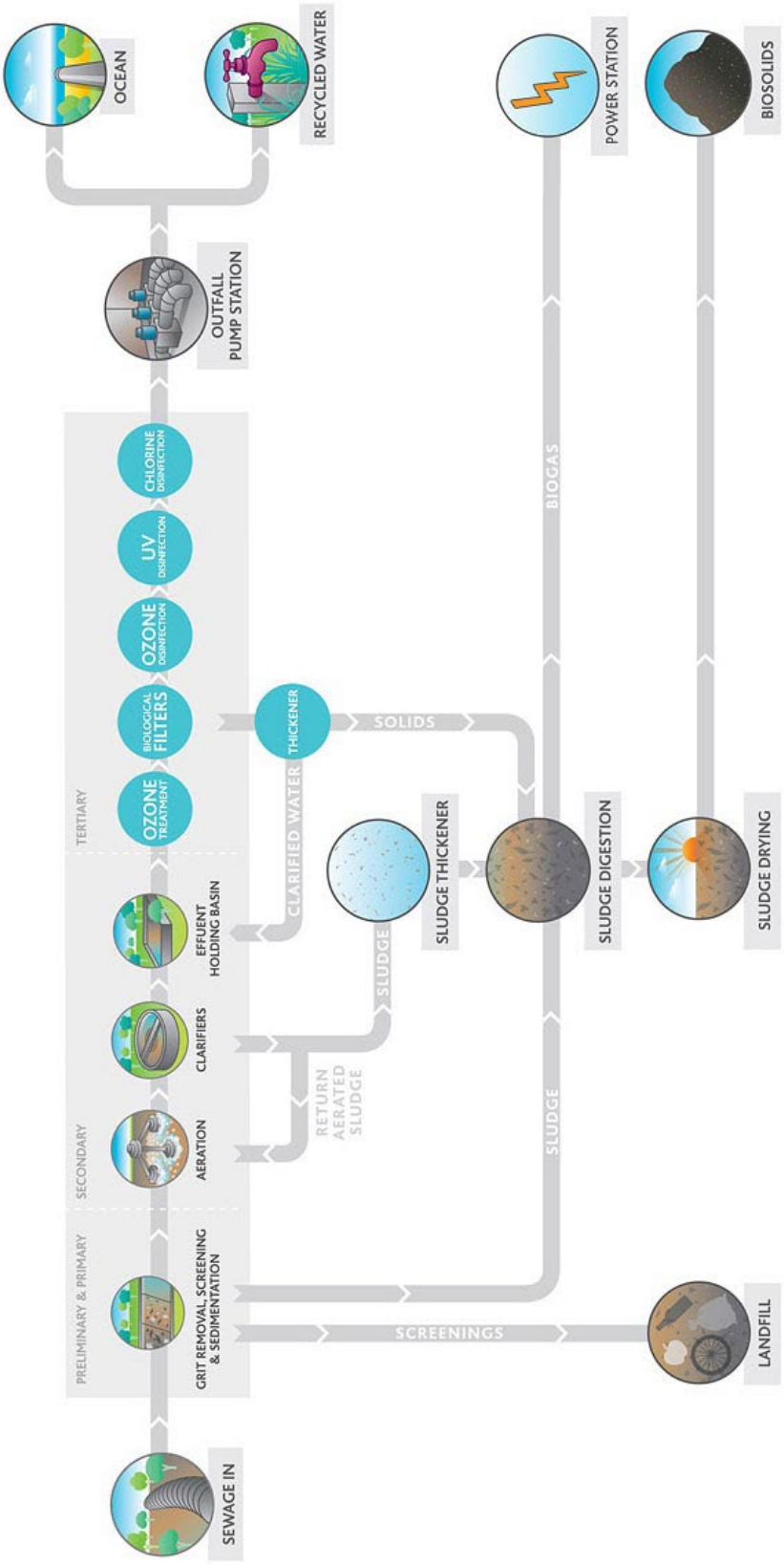
- If a role play isn't suitable, have students create a poster or presentation on the information.
- Students could create a flow chart of the stages based on this lesson and the previous one.
- Students could choose two stages and complete a Venn diagram comparing them.

Extension

Ask students to find out what should not be flushed down the toilet. Go to https://www.melbournewater.com.au/community-and-education/about-our-water/sewerage and make a list. Why do you think these items should not be flushed?

Show students the flow diagram. Discuss at what point unwanted items (plastics etc) get removed from the sewage? Where do these items go?

Melbourne Water Sewage Flow Diagram



Lesson 4 Worksheet
Treatment Stages

Name the treatment stage you are exploring

_____

Questions

1. Describe what the stage looks like.
2. What do you think it would sound like?
3. Summarise the key information.
4. Provide three interesting facts about this stage.
5. How would you classify the water at this stage of the process?
6. Design a role play to explain this stage to the group. The role play plan might help scaffold it for students. It should be 2–3 minutes long and include a commentary as well as actions/ movement to help explain the processes involved.

Role play plan

Your role play should be approximately 2–3 minutes long and help the rest of the class understand the stage you are exploring. You should explain each of the important elements of that stage and act it out, so students get a visual.

Script (the things you will say)
Actions (describe what people will do to demonstrate the process)

Lesson 4 Treatment Stages Factsheet
Stage 1: Raw Sewage Inlet

The Western Treatment Plant began operating as the Werribee Farm in 1897. In the late 19th Century, the people of Melbourne had outside 'dunnies' that were emptied about once a week by nightmen who carted the waste to dump sites or for use as a fertiliser on market gardens. However, nightmen were paid by the number of loads, so they often dumped waste into the Yarra River. Other wastewater – including water from kitchens, laundries, bathrooms, chamber pots, farms and industries – was dumped directly into yards and open drains in the streets, which flowed into local rivers and creeks.

Melbourne needed a sewage treatment plant for two main reasons: to reduce both smell and disease. A Royal Commission was held in 1888 to identify a solution and the Melbourne and Metropolitan Board of Works (MMBW) was formed in 1891. The construction of the sewage farm, the pumping station at Spotswood and the sewerage system began in 1892. The first homes were connected and started sending their sewage to Werribee in 1897.

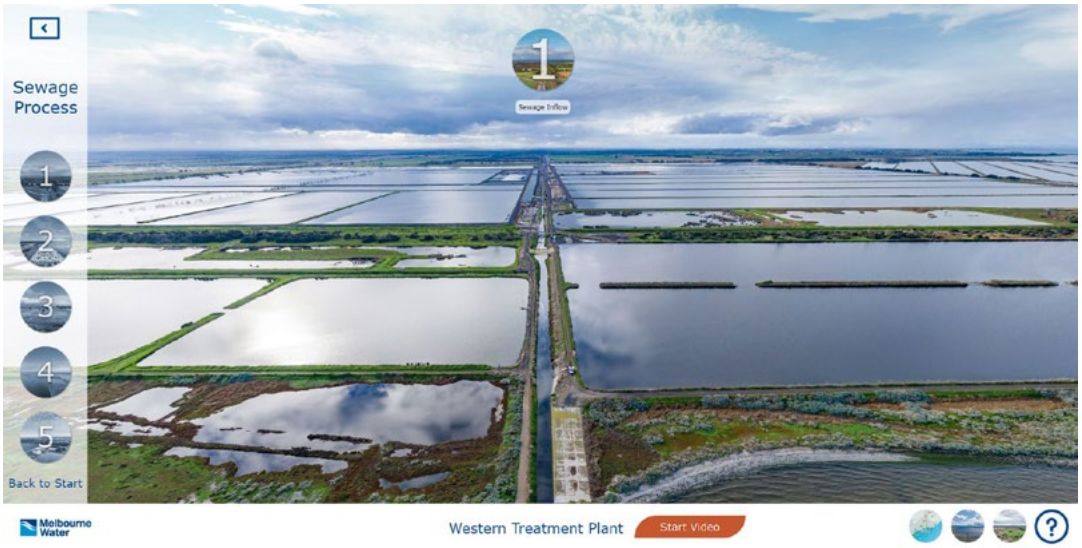
Initially, the system used involved land filtration and then grass filtration. This meant the sewage was left to dry out in the open fields and gradually trickle down to the bay, filtering out the many of the pollutants on the way.

At the Western Treatment Plant about 78 per cent of sewage comes from domestic users and 22 per cent from industrial sources (trade waste). Sewage is over 99 per cent water and one per cent solids. It comes from four rooms in your home (toilet, bathroom, kitchen, laundry).

Sewage travels via gravity feed to the Western Treatment Plant in underground pipes. There are two major pumping stations on the way to Werribee, where sewage is pumped up (at Brooklyn and Hoppers Crossing). The old Spotswood Pumping Station, which can still be seen at Scienceworks, is no longer used for pumping sewage.

The Air Treatment Facility (ATF) was built in 2006 as part of Melbourne Water's commitment to reducing odour.

The ATF extracts the foul air from the enclosed sewer pipes using bacteria to neutralise it. Over 95 per cent of odours are eliminated within the ATF.



Lesson 4 Treatment Stages Factsheet
Stage 2: Primary Treatment

Lagoon treatment

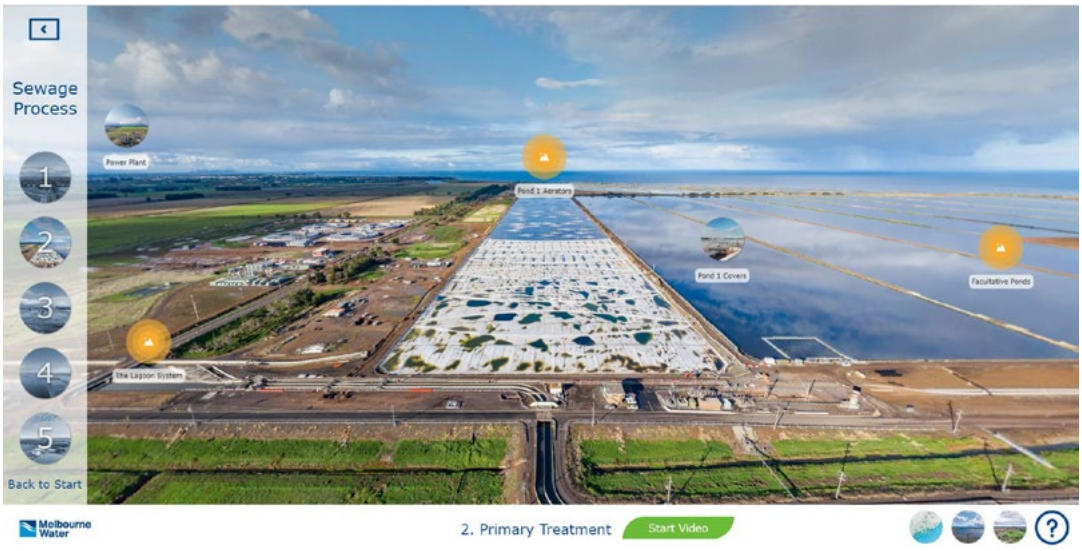
In the 1930s, treatment lagoons were introduced to treat water. Today all sewage at the Western Treatment Plant is treated in modern lagoons, replacing old lagoons and traditional land and grass filtration methods.

Pond 1 is the deepest pond (6–8m deep). Raw sewage enters here and slows down. When the moving water from the channel slows down, most of the solids settle out of it, forming a layer of sludge on the bottom of the pond.

The first section of pond 1 is covered by thick plastic covers. This creates an anaerobic environment (an environment with no oxygen). Anaerobic bacteria live in the area under the covers. These bacteria help clean the sewage by breaking down organic matter.

A gas produced by the anaerobic bacteria is called methane. Methane is trapped by the covers, which allows the Western Treatment Plant to harvest it and use it as biogas for power generation. They pipe the biogas to a small power plant run by AGL Energy, where it is used to run generators to produce electricity. This electricity is used to run the plant (aerators, pumps, offices, etc.). Sludge is one of the by-products of sewage treatment. Once the sludge is removed from the ponds and dried it is known as biosolids. The covered sections of the lagoons need to be desludged every five years to maintain performance and biogas production.

Each pond is lower than the one before it, so gravity is still helping move the sewage around. Water flows down the length of the pond and drops down to the next one, then flows back the other way. These ponds are about 2 m deep.



Lesson 4 Treatment Stages Factsheet
Stage 3: Secondary Treatment

The Activated Sludge Plant's (ASP) main objective is to turn the nitrogen or ammonia in the sewage into nitrogen gas, which is released to the atmosphere.

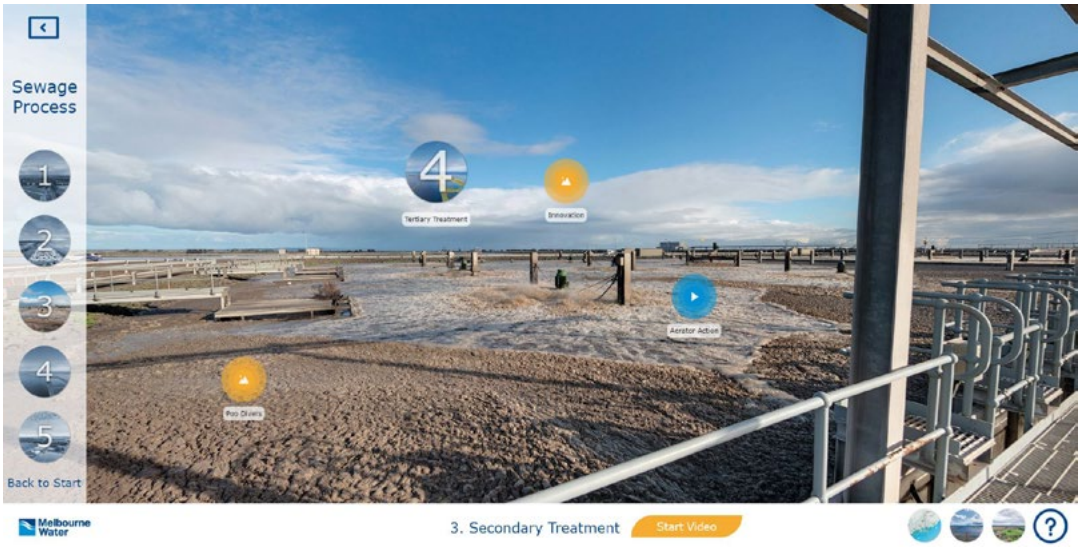
There is a lot of ammonia, a form of nitrogen, in sewage. Ammonia comes from urine, cleaning products and industrial waste. It is also a by-product of some of the earlier treatment processes. Nitrogen is one of the nutrients plants need to grow (it is found in many fertilisers). Too much nitrogen can cause eutrophication (excessive plant growth caused by too many nutrients), so the nitrogen in the sewage needs to be removed before it is discharged into the bay.

The ASP is 4–5m deep and consists of two zones – an aerated zone and an anoxic zone – one with oxygen and one with limited oxygen. Different types of bacteria live in each zone, and they do different jobs in the process of removing nitrogen. Propellers help move the water around. In the aerobic zone aerators help to introduce air (and hence, oxygen) into the water. These are the 'milkshake makers' or beaters that you can see. The process of nitrification/denitrification to convert ammonia to nitrogen gas occurs in several stages:

- ammonia is converted to nitrites
- nitrites are converted to nitrates
- nitrates are converted to nitrogen gas.

Nitrogen gas makes up about 78 per cent of our atmosphere, so it is safe to release in this form, whereas it could be harmful to the bay if it was left in the water as ammonia.

Clarifiers are large tanks located behind the ASP. Sludge containing bacteria settles to the bottom of the tank, separated from the wastewater by gravity and change in water speed. The water is skimmed from the top and travels to the end of Pond 5 and through the rest of the system. Large scraper arms remove the sludge from the bottom of the clarifier and return it to the ASP to continue the process.



Lesson 4 Treatment Stages Factsheet
Stage 4: Tertiary Treatment

The purpose of ponds 6 10 is maturation and disinfection. These ponds are quite shallow, only 1–2m deep. Aerobic breakdown of fine organic particles by bacteria and algae occurs here. When the remaining algae and zooplankton die, they settle out and help to bind the sediments together. The ultra-violet rays in the sunlight help to sterilise the water.

As bacteria numbers drop there is an increase in phytoplankton, algae and water plants in the ponds. These provide food for zooplankton and macroinvertebrates (water bugs) that live in the water. These, in turn, provide food for birds, frogs and other animals. Because of the heightened nutrient levels in the water, the Western Treatment Plant is a rich food source for many creatures.

Pond 10 is the end of the basic treatment process. The water in this pond is referred to as effluent (treated sewage) or Class C recycled water. It has taken 30–40 days to reach this stage. Class C recycled water is used for various purposes on the property or released to Port Phillip Bay.

In 1992, Melbourne Water commissioned the Port Phillip Bay Environmental Study, a four-year study undertaken by the CSIRO. One of the major aims of the study was to determine the impact of the Western Treatment Plant on the Port Phillip Bay environment. At the completion of the study in 1996 it was identified that:

- the bay was healthy and coping well with a city of 3.2 million people
- water quality was ‘good by world standards’, in fact it stood out in comparison to other bays around the world with similar population sizes
- a reduction in nitrogen load would be beneficial for the ongoing sustainability of the bay.

You are now seeing the actions undertaken, as a result of this study. The Western Treatment Plant underwent a $160 million upgrade in 2004 to reduce the nitrogen load into the bay.

Lesson 5
Sustainability

Curriculum links

- Classification of environmental resources and the forms that water takes as a resource (VCGGK105)
- Ways that flows of water connect places as they move through the environment and the ways this affects places (VCGGK106)
- Nature of water scarcity and the role of humans in creating and overcoming it, including studies drawn from Australia and West Asia and/or North Africa (VCGGK108)
- Collect and record relevant geographical data and information from useful primary and secondary sources, using ethical protocols (VCGGC102)
- Analyse maps and other geographical data and information using digital and spatial technologies as appropriate, to develop identifications, descriptions, explanations and conclusions that use geographical terminology (VCGGC104)

Learning intentions

For students to:

- gain an understanding of recycled water
- understand the environmental benefits of reusing wastewater
- make the link between water scarcity and recycled water
- discuss the ethical considerations of drinking recycled water

Key inquiry questions

- What happens to the water after treatment?
- Why do we need to consider drinking recycled water?
- What are the environmental benefits of recycled water?
- What is the relationship between the Western Treatment Plant and sustainability?
- Should we drink recycled water?
- What role could the Western Treatment Plan play in reducing water scarcity?

Key vocabulary

Water scarcity, recycled water.

Time required

1 hour

Materials

Computers, copies of *Lesson 5 Worksheet: Recycling Water*.

Prior knowledge

It is assumed that students will have completed the virtual tour and have an understanding of the sewage treatment process. It is also assumed that students have an understanding of water scarcity.

Lesson 5
Teacher instructions

Starter

1. Have students complete a 'Quickwrite' on recycled water. They should silently write as much as they can on the topic in two minutes. Invite students to share with the class if they wish.
2. Conduct a class continuum – one side of the classroom is strongly agree, and other side is strongly disagree. Students move along the continuum based on their views. They should be prepared to justify their position.
   a. Water scarcity is a big problem in Australia.
   b. There is more that individuals can do to reduce water scarcity.
   c. There is more that governments and organisations can do to reduce water scarcity.
   d. Melbourne should investigate other methods of providing drinking water to the city.

Main activity

Have students complete stage 5 of the virtual tour and Worksheet 5.

Plenary

1. Have a class debate on the topic 'We should drink recycled water in Victoria'. Divide the class into two teams and have students write down 3–4 key points each for their team. Conduct a line debate or philosophical chairs discussion on the topic. At the end have them vote in favour of which team 'won'.

2. Students should finish with some individual reflection. Have them answer these questions:
   a. What side were you on? Did you agree with that position?
   b. Identify three key arguments from your position.
   c. Did the debate change your mind at all?
   d. What did you do well in the debate and what could you work on for next time?

Differentiation

For less-able students:

- These students might just take some notes during the debate if they don't feel confident participating. Have them identify three main points from each side.

For more-able students:

- For the debate, have these students predict the other teams' arguments and prepare rebuttal.

Suggested adaptations

You could complete a fishbowl/Socratic seminar on the debate topic. Provide students with a reading as a basis for the discussion.

Further reading

- http://theconversation.com/recycled-drinking-water-what-australians-need-to-know-7216
- https://blogs.ei.columbia.edu/2011/04/04/from-wastewater-to-drinking-water/

Lesson 5 Worksheet
Recycling Water

Range of uses for recycled water

A. Urban (non-potable): with uncontrolled public access. Agricultural: e.g. human food crops consumed raw. Industrial: open systems with worker exposure potential.

B. Agricultural: e.g. dairy cattle grazing. Industrial: e.g. wash down water.

C. Urban (non-potable) with controlled public access. Agricultural: e.g. human food crops cooked/processed, grazing/fodder for livestock. Industrial: systems with no potential worker exposure.

D. Agricultural: non-food crops including instant turf, woodlots, flowers.

Activity

http://westerntreatmentplanttour.melbournewater.com.au/

Watch the video on stage 5, Recycling Water, and answer the questions below.
1. Explain the relationship between classification and use of recycled water. Provide examples.
2. What are the advantages of recycling water?

Explore this stage by panning around, clicking on the various parts, and answer these questions:
3. How did the Mason Brothers in the Werribee Agricultural district benefit from recycled water?
4. How are ultraviolet light and chlorine used?
5. Would you drink class A recycled water? Why/why not?
6. What role does the Western Treatment Plant play in the food chain?
7. THINK! Explain how the Western Treatment Plant is sustainable.
8. IMAGINE! What do you think Melbourne's water future looks like?

Extension

Choose one case study of a place recycling drinking water to investigate: Singapore, Namibia, London or California. Complete the PMI chart.

Positive	Minus	Interesting