Chapter 5.

Water conservation, recycling & reuse

Syllabus Links

- Geography Stage 1, 2, 3, 4 and 5.
- Curriculum Priority Sustainability – Geography Stage 1, 2, 3, 4 and 5.
- Science and technology and Science Stages 1 and 4.
- Curriculum Priority Sustainability – Science – Stages 1 and 4.

Terms and concepts

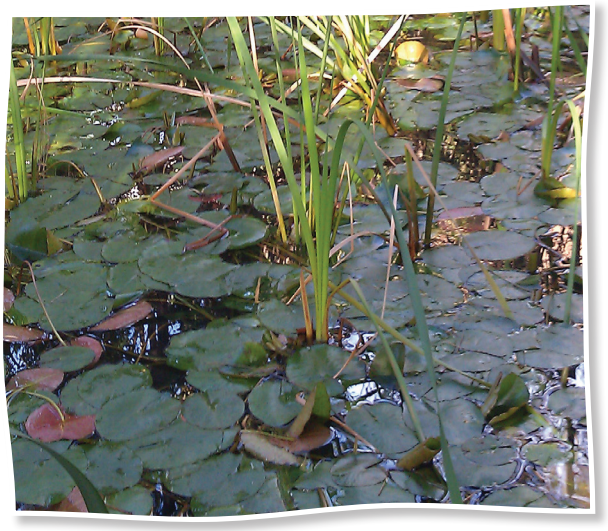
Water conservation, recycling, irrigation, Water Efficiency Labelling and Standards (WELS), remediation, potable, devices, rainwater, water cycle, macrophytes, emergent plants, submergent plants, floating plants, stormwater.

Background Information

Water is an extremely precious resource. Of all the water in the world, 97% is salt water and only 3% is fresh water. Of this 3%, a tiny amount (less 0.01%) is available for human use. The rest is frozen in glaciers or polar ice caps, or is deep within the earth, beyond our reach. To put it another way, if 100 litres represents the world's water, about half a tablespoon of it is fresh water available for our use.

At the Coal Loader Centre for Sustainability there is a strong emphasis on water conservation, recycling and reuse. A 50,000 litre underground water tank (pictured) captures rainwater from the roofs of surrounding buildings. The water is used for toilet flushing, garden and nursery irrigation and general washing-down. If the tank is full it overflows into the adjacent wetland. This thriving wetland now occupies the former site of one of two Union Steam Shipping Company fuel tanks.

Other water saving measures at the Coal Loader include the use of water saving devices such as tap aerators, dual flush toilets and water saving appliances eg dishwasher. Devices we use when we use water such as taps and toilets are now measured in stars using the WELS (Water Efficiency Labelling and Standards) rating. This refers to how much water a device uses. The more stars means that the device is more water efficient and uses less water. The bathroom includes 4 star WELS rated toilets which use only 3.5L water per flush compared with 12L for a traditional toilet, and 6 star WELS rated taps, using only 4.5L water per minute compared to a normal tap using up to 18L per minute.



By visiting the Coal Loader site you will also be able to see the wetland developed in the 1990s on the sandstone bedrock as part of site remediation works, by the site caretaker. The wetland is fed by stormwater runoff from adjacent buildings and is home to wildlife including fish, turtles, ducks and a vocal colony of frogs.

In the past, wetlands were often thought of as wastelands. They were often drained, filled and used for parks, playing fields and housing developments. This meant that stormwater was no longer filtered through the wetlands but instead piped directly to our local waterways through a system of human-made concrete stormwater drains. This is why our waterways became polluted.

In urban areas today, one of the primary functions of wetlands is to improve the stormwater quality that enters our oceans. Wetlands remove pollutants from our stormwater such as nutrients and suspended solids such as soil. By doing so, it assists the health of our coastal waterways.

Further Information

- Wetland Australia *www.wetlandcare.com.au*
- Sydney Water *www.sydneywater.com.au*
- NSW Waterwatch *https://nswwaterwatch.org.au/resources/water-bug-id-charts-and-posters*

Watch the three minute video! The Water Conservation, Recycling & Reuse video will give your class an overview of what you can expect to see and learn about water conservation, recycling and reuse at the Coal Loader.

North Sydney Council thanks Sydney Water for providing advice and information on this chapter.

Activity 1 – How does the Coal Loader precinct operate as a catchment?

Activity Summary:

This activity requires students to understand the processes which operate in a catchment.

Students are encouraged to recognise and locate how catchment processes operate on a local scale in the Coal Loader catchment.

Inquiry questions:

1. How do humans interact with the processes operating in a local catchment such as the Coal Loader?
2. How have humans managed stormwater at the Coal Loader to improve water quality?

Syllabus Outcomes:

- Identify ways in which people interact with and care for places. GE1-2
- Describe the ways people, places and environments interact. GE2-2
- Describe processes and influences that form and transform places and environments. GE4-2
- Explain interactions and connections between people, places and environments. GE3-2
- Recognise observable changes in the sky and on the land and identify Earth's resources. ST1-10ES-S

Materials and Preparation:

- Teachers and students view the You Tube clip showing how students at a local school thought about rubbish in the local catchment. *https://youtu.be/VOrdjlvLIE4*
- Teachers use the following posters for class discussion and/or as a laminated class set at the Coal Loader. See online at North Sydney Coal Loader Learning Guide Appendix *. Poster headings are:
  1. 'Top tips for healthy catchments'
  2. 'Can you find our rainwater tanks?'
  3. 'Be a good neighbour, protect our harbour'
  4. 'Coal Loader wetland'
- Students bring a clipboard and writing equipment.
- A4 Coal Loader Map.

References:

- Australian Government – Department of Climate Change, Energy, the Environment and Water – website
- Australian environmental education website
- EZEEC website, *greeNSchools* *https://youtu.be/VOrdjlvLIE4*
- Sydney Water website

Activity 1 – Student Worksheet
How does the Coal Loader precinct operate as a catchment?

Location: Outside the Caretakers cottage or on Jacaranda Square

Background information

A catchment is an area of land where water is collected and flows through the processes of the water cycle. The water cycle explains how water is moved through different locations on earth eg. a river and clouds and, through different states, eg, ice, liquid and gas.

The Coal Loader precinct, including the cottage, pathways, drains, hillside, bushland, wetland and harbour can be considered a small scale, local catchment.

Read the poster 'Can you find our rainwater tanks?' to help you answer the following questions:

a. From the word bank below, underline or write the correct term next to the matching feature on Diagram X below – 'Stormwater is collected and harvested in the Coal Loader catchment'.
b. Draw arrows to show the flow of water from the roof to the harbour (some have been done for you).
c. What is the difference between rainwater and stormwater?

_____

_____

_____

Word Bank:

Caretaker's cottage, pathways, gutter, down pipe, lawn, stormwater, grate/drain, wetland, bushland, precipitation, run-off, evaporation, infiltration, rainwater tank, underground tank.

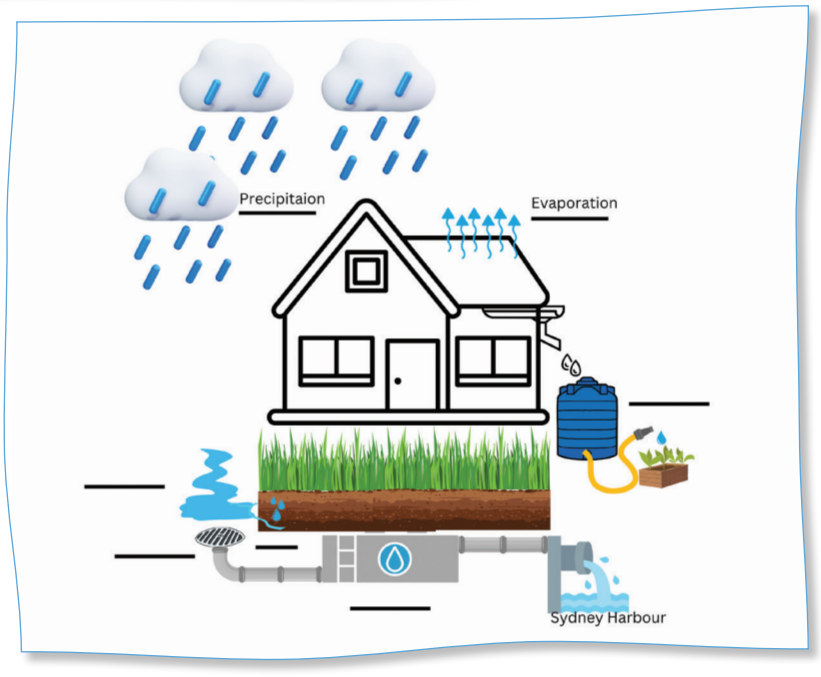


Diagram X shows how stormwater is collected and harvested in the Coal Loader catchment.

Activity 1 – Student Worksheet
How does the Coal Loader precinct operate as a catchment? *continued*

d. Name two of the activities the stormwater in the underground and rainwater tank is reused for:

_____

_____

e. How does this help in water conservation?

_____

_____

_____

f. On the Coal Loader map below, label Jacaranda square (JS) above the water tank (at P) and underline, **I.** Genia McCaffery Building (Caretaker's Cottage) **P.** Water Tank **Q.** Wetland

Diagram X shows features of the Coal Loader site.

g. Describe the flow of water (rainfall, run-off and piped) between these four locations – Jacaranda square, Genia McCaffery Building (Caretaker's Cottage), Water Tank, Wetland.
(Diagram X can help you)

_____

_____

_____

Read the poster 'Top tips for healthy catchments' and

h. Suggest why it is important to remove rubbish, chemicals and pet waste from the ground?
(Hint: Use the term stormwater in your answer)

_____

_____

_____

Activity 1 – Student Worksheet
How does the Coal Loader precinct operate as a catchment? *continued*

i. Describe one action you would recommend to other students to follow either at school/home/Coal Loader to keep their catchment healthy. Justify your answer.

_____

_____

_____

j. Share your recommendation with other students by using the inner circle and outer circle technique. Here students form two circles, and students in the outer circle start first by sharing their recommendation with the student opposite them. Students take turns to share. The circles rotate after students have shared their recommendation with at least 3 people.

Activity 2 – How does the Coal Loader wetland filter stormwater? Is it a healthy wetland?

Activity Summary:

This activity requires students to understand how stormwater can be captured, harvested and used to create a wetland.

Students are encouraged to understand how the wetland both filters stormwater and provides a habitat for species.

Students are guided by their teacher to observe the qualities of the wetland to assist them in assessing the health of the wetland.

Inquiry questions:

1. How can a wetland system be used to improve the quality of stormwater and what are some benefits?
2. How do humans transform the quality of the local catchment?
3. How healthy is the Coal Loader wetland?

Syllabus Outcomes:

- Describe the ways people, places and environments interact. GE2-2
- Describe processes and influences that form and transform places and environments. GE4-2
- Explain interactions and connections between people, places and environments. GE3-2
- Check Recognise observable changes in the sky and on the land and identify Earth's resources. ST1-10ES-S
- Examines how the environment affects the growth, survival and adaptation of living things. ST3-4LW-S

Materials and Preparation:

- Teachers use the following posters for class discussion and/or as a laminated class set at the Coal Loader. See online at North Sydney Coal Loader Learning Guide Appendix 2. Poster headings are:
  - 'Top tips for healthy catchments'
  - 'Can you find our rainwater tanks?'
  - 'Be a good neighbour, protect our harbour'
  - 'Coal Loader wetland'
- Students should bring a clipboard and writing equipment.
- Students to be given a copy of the worksheet before visiting Coal Loader.
- A4 Coal Loader Map

Activity 2 – Student Worksheet
How does the Coal Loader wetland filter stormwater? Is it a healthy wetland?

Name .....

Location: Jacaranda Square or on steps above the wetland.

Introduction:

The wetland at the Coal Loader was constructed by a former caretaker of the site in the footprint of an old oil tank. The wetland acts as a filter, helping clean stormwater runoff from the site before it enters Sydney Harbour.

When it rains, the water from roofs and pathways, plus overflow from the rainwater tank, all flow into the man-made wetland. The water flows through a litter basket that strains out larger pieces of litter and debris, and then enters a pond which spreads and slows the gush of incoming water. This allows some of the debris and sediment in the stormwater to settle to the bottom of the pond.

The reeds and rushes planted in the pond filter out dissolved pollutants such as nitrates and phosphates, further slows down water flow, and draws floating solids to the bottom, which mixes with leaf litter. The sediment is soon converted to rich humus, much the same way as a compost heap works.

Appropriate water levels are maintained with a weir, through which cleaned water passes before flowing down a pipe and into Sydney Harbour.

1. As you walk down to the wetland with your teacher, name three buildings or activities which are directly above the wetland. (Refer to the Coal Loader site map in Activity 1 or your laminated copy if needed)

_____

_____

Activity 2 – Student Worksheet
How does the Coal Loader wetland filter stormwater? Is it a healthy wetland? *continued*

Name .....

Location: Wetland – Keep at least one metre away from the edges of the wetland as they are muddy and unsafe.

2. Observe and record some basic site information in the table below before you start analysing the wetland's function. Some information has been done for you.

Site Information

Site Name	Coal Loader Wetland		
Date			
Your school name			
Your name			
Water body type			
Location			
Site access			
Landowner name			
Former land use		*Native vegetation*	casuarinas, paperbark trees, sedges, reeds
Current land use		*Weeds*	few
Site width	10 metres	*Native animals*	frogs, birds, macroinvertebrates eg, back swimmers, flatworms, dragonflies and beetles
Water depth	1-2 metres	*Other observations*	eg, what do you hear?

Activity 2 – Student Worksheet
How does the Coal Loader wetland filter stormwater? Is it a healthy wetland? *continued*

Name .....

3. In the box below draw a sketch of the wetland, including these elements: trees, water, shrubs, reeds and rushes, evaporation, rocks and floating plants.
The plants living near or in the wetland are known as **macrophytes**.

There are three categories of **macrophytes**: emergent (grow in wetlands and along shore), submergent (underwater plants) and floating.

Try to include examples of each category in your sketch.

My sketch of the Coal Loader wetland, including:
trees, water, shrubs, reeds and rushes, evaporation, rocks, floating plants.

4. Analyse the small diagram on the poster 'Coal Loader wetland' and add arrows and labels to your sketch of the wetland indicating 3 sources of runoff which fills the wetland.
Name two pollutants which could be washed down from these areas:

i _____

ii _____

Activity 2 – Student Worksheet
How does the Coal Loader wetland filter stormwater? Is it a healthy wetland? *continued*

Name .....

5. From the poster 'Coal Loader wetland' read 'How our wetland works'.

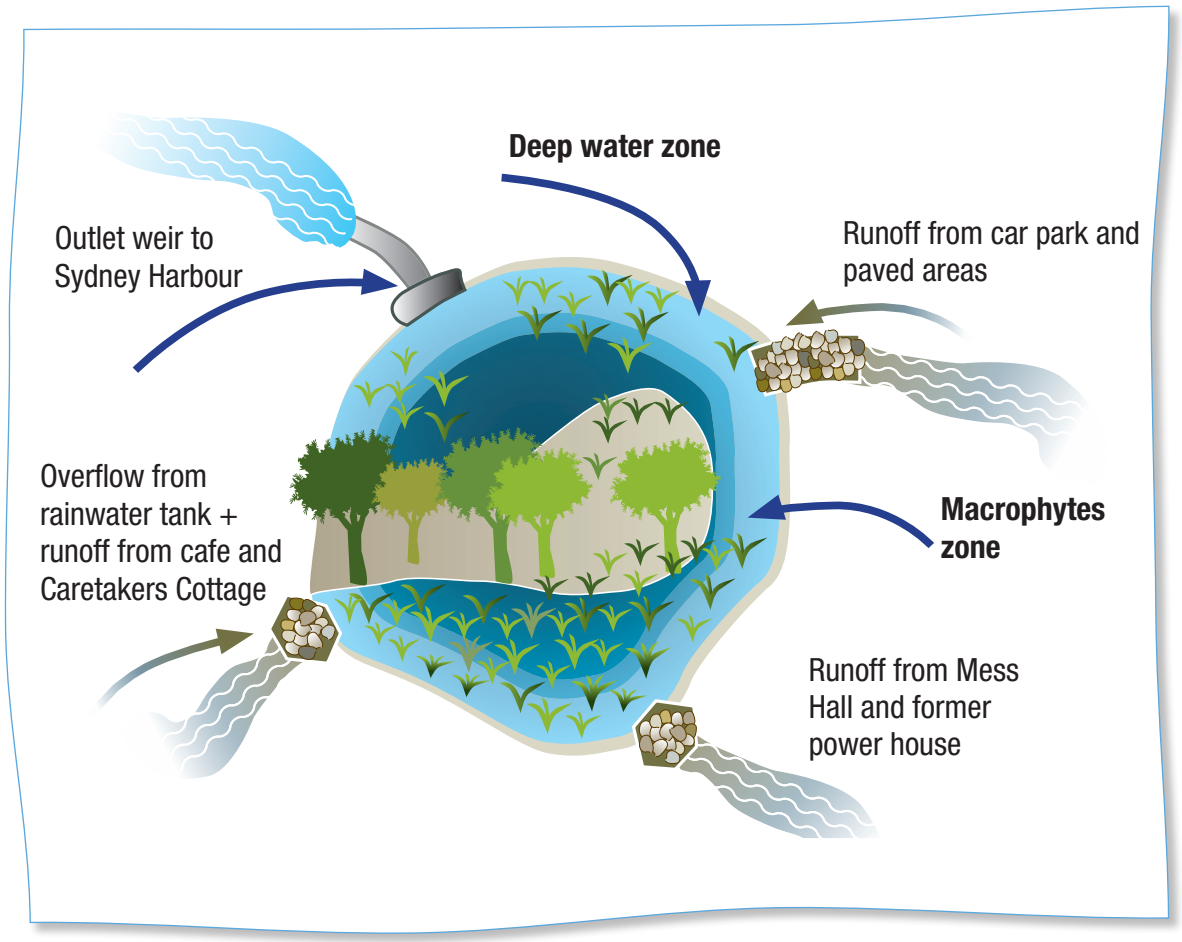


Diagram X shows How the Coal Loader wetland works.

On the diagram above also label / annotate these features:

- rubbish,
- a litter basket/rack,
- a deep pond,
- leaf litter, and
- reeds/rushes.

Activity 2 – Student Worksheet
How does the Coal Loader wetland filter stormwater? Is it a healthy wetland? *continued*

Name .....

6. How harvested/collected stormwater helps to create a wetland.

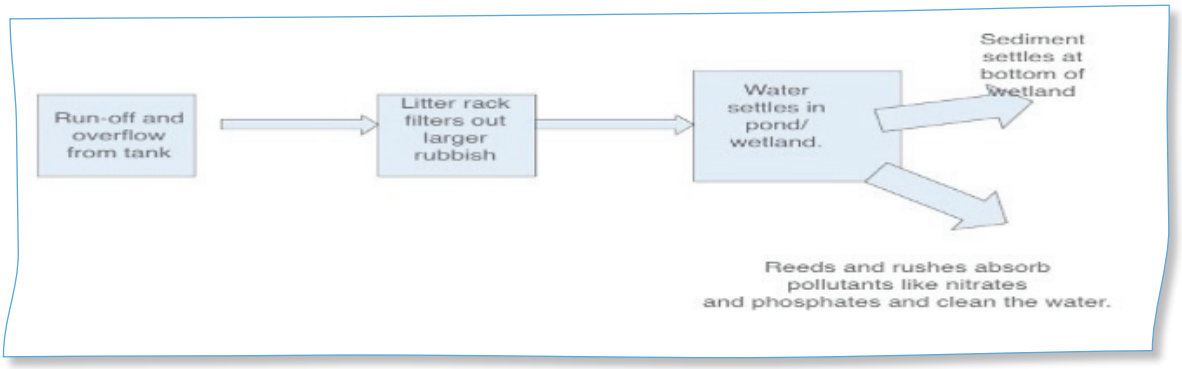


Diagram X is a flow diagram indicating how harvested (collected) stormwater helps to create a wetland.

a. From the poster and the diagram explain how the Coal Loader wetland cleans stormwater. (Hint: read what do reeds and rushes do?)

_____

_____

_____

_____

_____

b. The Coal Loader wetland has two main functions:

1. Cleans stormwater before it flows to the **harbour.**	2. Creates **habitat** for animals and plants
Three animals that live in Sydney harbour are:	Three animals or plants that live in the Coal Loader wetland are:

Fill in the table by naming 3 animals which live in the harbour and 3 animals or plants which live in the wetlands and rely on clean water.

Read the poster 'Be a good neighbour protect our harbour' for the name of one species.

Activity 2 – Student Worksheet
How does the Coal Loader wetland filter stormwater? Is it a healthy wetland? *continued*

Name .....

7. Wetland Health Assessment
Is the Coal Loader Wetland healthy?

Assess the health of the wetland by filling out the questions below and counting up the points to create a total score.

Use your observations skills and other skills to notice features and qualities of the wetland.

Location Name	
Date and Time	

Circle the number that best fits the Coal Loader wetland.

Underline the matching points you give to this answer.

a. Land Use: What is the area around the Coal Loader used for?

Factories	1 point
Houses and no trees	2.
Houses and parks	3.
Mainly bushland	4

b. Rubbish: How much rubbish is there in the wetland and surrounds?

i. A lot	1 point
ii. Some	2.
iii. Little or none	3.

c. Smell: Sit near the wetland and sense what it smells like?

i. Strong and unnatural odour	1. point
ii. A bit smelly	2.
iii. No smell	3.
iv. Strong, natural odour.	4.

d. Water Clarity: It is not safe to go near the wetland, so ask your teacher to look at the wetland's surface from a safe spot and tell you what it looks like.

i. Dirty with scum on top	1 point
ii. Murky	2.
iii. Mainly clear	3.

e. Vegetation: How healthy do the plants look?

i. Unhealthy	1. point
ii. Mainly healthy	2.
iii. Very healthy	3.

f. Animal Noises: Listen for animal noises eg, bird and frog calls. Did you hear:

i. None	1 point
ii. Some	2
iii. Many	3.

Activity 2 – Student Worksheet
How does the Coal Loader wetland filter stormwater? Is it a healthy wetland? *continued*

g. Animal evidence: Look around (but don't touch) for scats (poo), tracks (footprints), or traces (feathers,burrows, webs, insect exoskeletons, chewed leaves, cocoons):

a. None	1 point
b. Some	2.
c. Many	3.

h. What was your wetland score?

Add your scores up to work out the health of the Coal Loader wetland.

If you scored less than 8:	your wetland needs help
If you scored 9-14:	your wetland is on the way to becoming healthy
If you scored over 15:	your wetland is healthy

i. Write down one action you can do to help this wetland or a wetland near you.

_____

_____

_____

Activity 3 – Spot the water wise design features.

Activity Summary:

This activity requires students to locate water saving technologies or devices at the Coal Loader.

Students are encouraged to think not only about systems and devices but also consider water use behaviours and their impact on water consumption eg waiting until the dishwasher is full before use or hand washing if there are only a couple of items.

Inquiry Questions:

- Why should we all be water wise?
- How can we conserve, recycle and reuse water?

Syllabus Outcomes:

Students will be able to

- Describe the ways people, places and environments interact. GE2-2
- Describe processes and influences that form and transform places and environments. GE4-2
- Explain interactions and connections between people, places and environments. GE3-2
- Recognise observable changes in the sky and on the land and identify Earth's resources. ST1-10ES-S
- Examines how the environment affects the growth, survival and adaptation of living things. ST3-4LW-S

Materials and Preparation:

- Teachers to use the poster 'Can you find our rainwater tanks?' for class discussion. See online North Sydney Coal Loader Learning Guide Appendix 2 or as a laminated class set at the Coal Loader.
- Students to bring a clipboard and writing equipment.
- A4 Coal Loader Map.

Activity 3 – Student Worksheet
Spot the water wise design features.

Introduction:

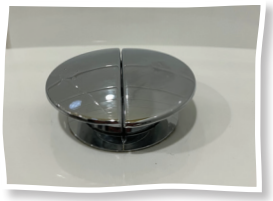
This activity asks you to locate water saving technologies or devices at the Coal Loader, and to consider the water use behaviours of people at the site and their impact on water consumption eg waiting until the dishwasher is full before use or hand washing if there only a couple of items.

Location – Outside the Caretakers cottage or on Jacaranda Square.

1. Start discussion with students based around Inquiry questions, that is,
   - Why should we all be water wise?
   - How can we conserve, recycle and reuse water?
2. Below are photos of water saving devices and systems that the Coal Loader uses at the cottage and in the gardens to save rainwater and reduce consumption of water from Warragamba dam.
   Match the photos of the water saving devices or systems to the words in the **WORD BANK BELOW. Write your answer underneath each photo.**

Word Bank:

Toilet half – flush, drip line irrigation pipe, tap aerator, water meter, water refill, rainwater garden, underground concrete rainwater tank, tap timer, wicking bed, mulch, water recycling.

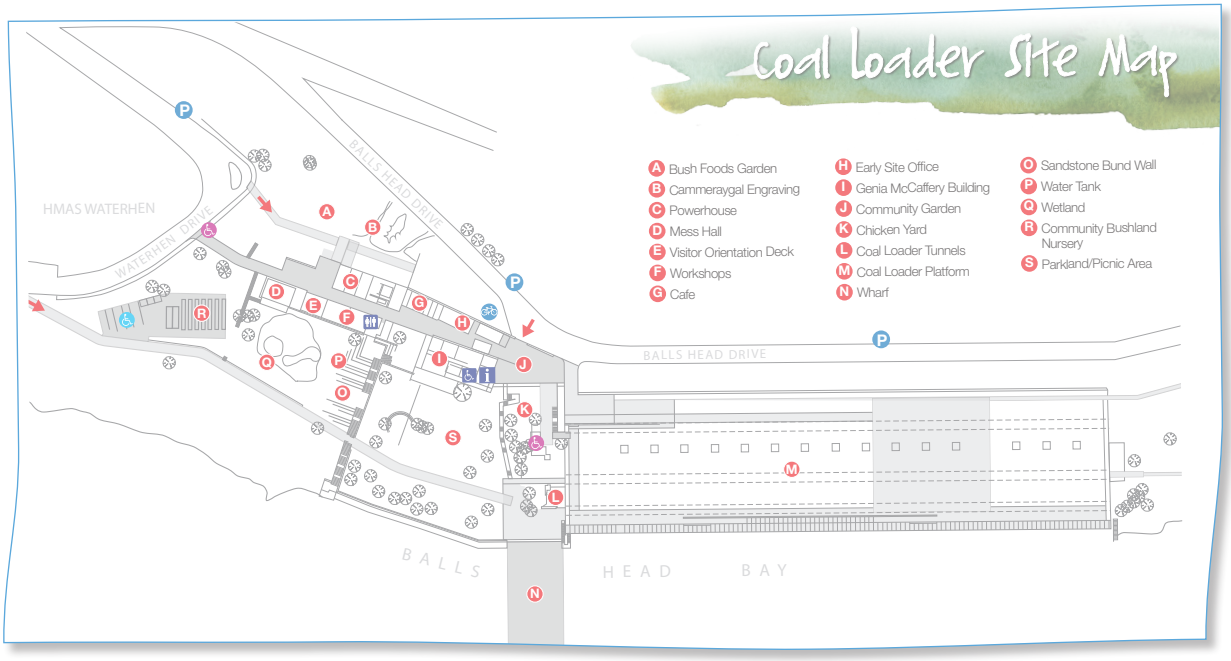
			
.....	.....	.....	.....
			
.....	Key Handle tap	.....	.....
			
.....	SWALE	.....	

Activity 3 – Student Worksheet
Spot the water wise design features. *continued*

4. Teacher to guide students around the Coal Loader's caretaker's cottage and gardens.
Hand out the A4 Coal Loader laminated maps so that students can view a larger map, and find out where they are.

a. Let's take a walk around the Coal Loader site to find the water wise features.
Tick them off ✓ and fill out the questions below.
It's best to start at the (**i**) outside the Caretakers cottage, walk around the community garden, through Jacaranda square and then down to the wetland, before walking back up the stairs past the chickens.

b. On the Coal Loader map below, circle or underline:
- The Community garden (at J),
- Caretakers Cottage /Genia McCaffery Building (i) and (l).
- Water tank (P)



Use the map above, diagram X to mark the start of your water wise trail.

As students walk around the area add each feature to the map, by writing the number below onto the correct location on the map.

Start outside the Caretaker's cottage and discuss the kitchen inside the cottage without going into the cottage.

Fill in the BLANKS in the table showing the water saving devices or systems from the WORD BANK BELOW. Some have been done for you.

Word Bank:

Toilet half – flush, drip line irrigation pipe, dripping taps, mulch, rainwater garden, underground concrete rainwater tank, tap timer.

Activity 3 – Student Worksheet
Spot the water wise design features. *continued*

Location	Water saving device/system (Tick when spotted ✓)	How does it work ?	What water saving behaviours at school/ home could save even more water?	Mark on the map. Use 1,2,3 etc.
Kitchen	1. Aerator tap 2. Five star dishwasher	1. Works like a filter. Saves 2L per min. 2. Uses less water in each cycle.	a. Reuse sink water on plants. b. Wait until the dishwasher is full before turning it on.	
Bathrooms	3. ……..….. 4. Automatic stop taps.	3. Uses a few litres of water only per flush. 4. Taps turn off themselves.	c. Fix any …….. d. Turn the tap off when brushing teeth. e. ?.....	
Community gardens	5. ..... 6. Rainwater tank. 7. ..... 8. Wicking garden pot/bed. 9.	5. Uses a narrow pipe to direct the right amount of water to the plants. 6. Collects rainwater that would otherwise flow into the drain. 7. Redirects stormwater into pipe and garden bed. 8. Holds water at bottom of plant pot. 9. Reduces evaporation.	f. Install more rainwater tanks. g. Water early in morning to reduce evaporation. h. Use plants in the garden that don't need much water. i. ?.....	
Jacaranda Square	10.	10. Collects 50 000 litres of rain and stormwater to be re used for the garden, toilets and cleaning.	j. Use the water collected sparingly. k. ?.....	

Activity 3 – Student Worksheet
Spot the water wise design features. *continued*

Other locations eg, pathway	11. Key handle tap. 12. ..... 13. Water meter. 14. Water Bottle refill station.	11. Stops water being used and wasted. 12. Turn the dial to the time you want the garden watered and for how long. 13. Device that measures your water use. 14. Water fills up bottles with very little waste.	l. Have a staff member regularly check that the timers, handles, hoses and pipes are working properly and there are no leaks. m. Research how much water your plants need. n. ?.....	

5. From what you have observed around the cottage, what are 2 water saving devices, systems or behaviours that you would recommend to the manager? Justify.

Activity 4 – School Water Audit

Pre and post activities and resources – for home or back at school

Activity Summary:

This activity will use a water audit to survey the quantity and quality of all the school's water devices, check where water is used, and identify opportunities for saving water.

In this activity students will learn how to conduct an audit and then work in groups around the school to collect data. They will then return to the classroom to collate results. A template audit recording sheet has been provided for your use. A simple video produced by Sydney Water can be watched beforehand to help explain the audit process.

Inquiry Questions:

1. How can a water audit help us recognise the water efficient devices and strategies our school uses?
2. Consider the water use at your school. What devices or systems could be utilised to reduce water consumption?
3. Are there further actions our school can take to improve our sustainable water management?

Student Outcomes:

- Describe the ways people, places and environments interact. GE2-2
- Describe processes and influences that form and transform places and environments. GE4-2
- Explain interactions and connections between people, places and environments. GE3-2
- Recognise observable changes in the sky and on the land and identify Earth's resources. ST1-10ES-S

Materials and Preparation

- Read Sydney website 'How to do a water audit' and view Youtube clips with helpful hints.
- Water audit recording sheet (provided)
- Map of school grounds. The school should be divided into five roughly even areas and each group's audit area individually marked with a highlighter pen (Tip – the group that has the least number of buildings/rooms to be audited could also be allocated all outside taps)
- Five measuring jugs
- Blackboard, overhead or interactive whiteboard to collate results.

Reference:

The water audit methodology has been adapted from *Sydney Water School Water Audit Guide*. It is recommended that teachers read this guide as background information before commencing the activity.

Further Information:

Sydney Water website *https://www.sydneywater.com.au/education.html*

Activity 4 – Student Worksheet School Water Audit

Introduction:

Do you know how many taps your school has or how many bubblers are leaking? This activity gets you to conduct a water audit on your school. You will collect information about your school's water system to see how efficient it is.

By doing a water audit you can find out:

- how many water fixtures and fittings your school has
- how many are efficient
- which areas of the school could be improved.

After conducting the water audit you are encouraged to present your findings to the school and prioritise any areas that that could be improved to save water and money.

Activity:

1. Organise yourselves into five groups and name them. Your group will be provided with a Water Audit Student Worksheet and an A3 map with your audit area highlighted. It is important that your group stays in your area to avoid double counting.
2. Allocate a scribe for each group.
3. Familiarise yourselves with the Audit Worksheet. These will be tallied as a class total at the end of the audit period.
4. Hints on filling in the Worksheet:
    - Column 2 – Tally all water devices in your survey area under column two.
    - Column 3 – For each device, record any water saving features eg spring-loaded taps, headless taps, waterless urinals, low flow showerheads or dual flush toilets.
    - Column 4 – Tally any broken/leaking appliances and write their location in the appropriate column. Broken devices cannot be turned off.
    - Column 5 – Dripping devices are those that are not turned off tightly enough. These can be turned off during the audit.
5. If rooms (particularly storerooms) are locked, you could ask a nearby teacher to unlock it or help them fill in the sheet.
6. If your school is mixed gender, ensure at least one boy and one girl are in each group to cover any toilets in your area. Note – each urinal is counted as one device even though there may be several water outlets.
7. You will have around 30 minutes to complete your audit. You must return to the classroom when you have finished auditing or when time is up.
8. Complete the audit and write your results in the Water Audit Student Worksheet opposite.

Activity 4 – Student Worksheet
School Water Audit *continued*

Our School's Water Audit – Student Worksheet

Water devices	Number of devices	Number of water efficient devices	Number broken or leaking and their location	Number dripping
Toilets				
Urinals				
Bubblers				
Taps				
Zip hot water heaters				
Showers				
Other				
Group total				
Class total				

If possible, find a dripping tap and use the measuring jug and watch/timer to work out how much water is wasted in one minute. Fill in the table below to work out how much water is wasted from the tap.

A	B	C	D	E
Water lost in one minute	Water lost in one hour (A x 60)	Water lost in 24 hours (B x 24)	Converted to litres (C/1000)	Water lost in one year (D x 365)
mL	mL	mL	L	L

Water Audit Results:

- Copy the audit sheet either onto the blackboard, an overhead or an interactive white board. Ask each group's scribe to fill in their results in the appropriate area to get a class total.
- Prepare a list of broken or leaking appliances to give to the school's general assistant to fix.

Extension

- Discuss the class results and devise an action plan to improve school water efficiency.

You may like to use the Water Efficiency Action Plan template from Sydney Water *https://www.sydneywater.com.au/education/programs-resources/primary-school.html*

Activity 5 – Macroinvertebrates at the Coal Loader Wetland

Activity Summary:

This activity will illustrate how a wetland system works and how it can be used to improve the quality of stormwater on the Coal Loader site. During the activity students will be able to examine the macro-invertebrates living in the wetland and use a simple water testing kit to determine water quality. They will use their results as an indicator to determine the overall health of the wetland.

Inquiry Questions:

1. What adaptations do macroinvertebrates have in a small wetland?
2. How does a food chain operate in a small wetland?

Syllabus Outcomes:

- Describes the diverse features and characteristics of places and environments. GE3-1
- Locates and describes the diverse features and characteristics of a range of places and environments. GE4-1
- Examines how the environment affects the growth, survival and adaptation of living things. ST3-4LW-S

Equipment (provided by North Sydney Council):

- Dip net
- Rubber boots
- Rubber gloves
- Bucket
- Large open container
- Spoons
- Pipettes
- Magnifying glass
- Streamwatch Water Bug Guide
- Water quality testing kit (extension activity)

Students need to bring a notepad and writing materials and a copy of the Student Worksheet.

Reference Material:

- Poster – Coal Loader Wetland – *www.northsydney.nsw.gov.au/coalloader* or see Appendix 2
- Guide – Streamwatch Water Bug Guide
  Guide – How to perform basic water quality tests
  – *https://www.nswwaterwatch.org.au/resources/waterwatch-manuals*

Background Information:

Aquatic macro-invertebrates or water bugs are animals that have no backbone, are visible with the naked eye and spend all or part of their life in water. Aquatic macro-invertebrates are a very diverse group of animals that include worms, molluscs, arachnids, crustaceans and insects.

Why test aquatic macro-invertebrates?

Aquatic macro-invertebrates are excellent indicators of water quality and ecosystem health. This is because:

- They spend most or all of their lives in the water
- They are an important part of the aquatic food chain and therefore the wetland ecosystem
- Different species have varying sensitivities to pollution.

In highly polluted waterways only the most pollution-tolerant water bugs are able to survive. In pristine waterways all species are able to survive, even those that are very sensitive, resulting in a higher diversity of species.

Aquatic macro-invertebrates are relatively easy to collect and identify, and have been used extensively by environmental managers and researchers to assess water quality throughout Australia. Depending on the species found they can give an indication of the specific pollutants impacting on a body of water.

Further Information:

- Wetland Australia – *https://www.dcceew.gov.au/water/wetlands*
- Streamwatch – see Greater Sydney Landcare website – *https://www.greatersydneylandcare.org/streamwatch/*
- NSW Waterwatch – water bug-id-charts-poster

Activity 5 – Macroinvertebrates at The Coal Loader Wetland *continued*

Students are to investigate the macroinvertebrates found at the Coal Loader wetland by answering these points:

A. Research 'wetland macroinvertebrates' and name each species shown in the diagram.
B. Tick off ✓ the macroinvertebrates you name, on the list of species found in the table titled 'Streamwatch Pollution Index Sheet' (the table over the page, see below).
C. For each macroinvertebrate research its adaptations to an aquatic (watery) environment. Label and annotate two of its adaptations on the drawing above.
D. Choose 5 of the species to research two things it eats.
E. Construct a food chain for the Coal Loader wetland by naming a producer, primary consumer, secondary consumer and apex predator.
F. What is one action humans could do that could help the wetland ecosystem?
G. Predict whether the Coal Loader wetland is healthy or not. Justify your answer.

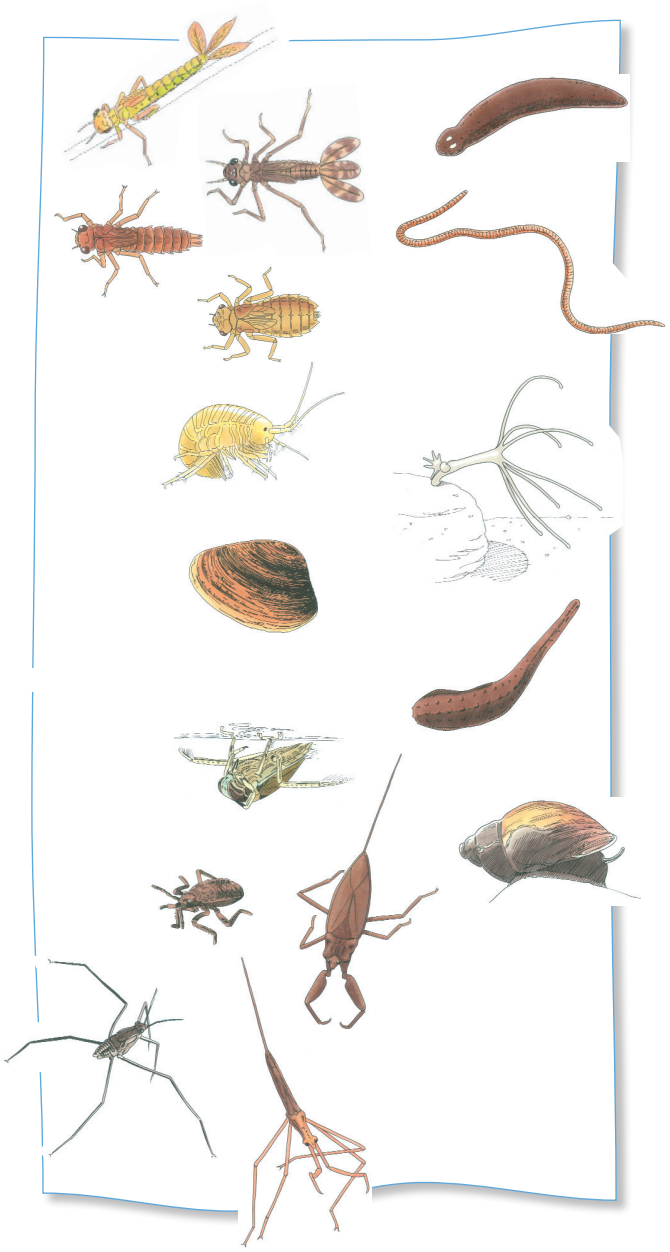


Diagram X shows macroinvertebrates found at the Coal Loader wetland.

Activity 5 – Macroinvertebrates at The Coal Loader Wetland *continued*

Direction: If you are not catching water bugs at school, simply tick off the bugs in the table that you identify from the Macroinvertebrates Diagram above.

If you are completing a Waterbug identification with your teacher, fill out the whole table.

How to calculate weighting:

Abundance	Weighting
1-5	1
6-15	2
>15	3

Streamwatch Pollution Index Sheet

	Common name	Scientific name	Bug value (tolerance measure)	Abundance (number of each bug)	Weighting	Bug value x weighting
Very sensitive	Mayfly nymph	Ephemeroptera	10			
	Cadisfly larvae	Tricoptera	10			
	Stonefly nymph	Plecoptera	9			
	Freshwater crayfish	Parastacidae	8			
Sensitive	Dobsonfly larvae Scorpionfly larvae	Megaloptera Mecoptera	7			
	Water mite	Acarina	6			
	Beetle larvae	Coleoptera	6			
	Beetles adult	Coleoptera	5			
	Freshwater sandhopper	Amphipoda	4			
	Dragonfly larvae	Odonata	4			
	Damselfly larvae	Odonata	4			
	Freshwater shrimp	Atyidae	4			
	Nematodes, Nematomorpha	Nematoda	4			
	True bug – water strider/ measurer/ treader	Hemiptera – on water surface	4			
Tolerant	Flatworm	Turbellaria	3			
	Freshwater slater	Isopoda	3			
	Freshwater mussel	Bivalvia	3			
Very tolerant	Hydra	Hydrozoa	2			
	Fly larvae (flies, mosquitoes, bloodworms)	Diptera	2			
	True bugs – back swimmer boatman, water scorpion	Hemiptera – found under water	2			
	Leeches	Hirudinea	2			
	Copepods, seed & clam shrimps, water fleas	Copepoda	1			
	Freshwater snails	Gastropoda	1			
	Aquatic earthworm	Oligochaeta	1			
						TOTAL

Source: How to calculate weighting: Streamwatch Manual *https://www.nswwaterwatch.org.au/resources/waterwatch-manuals*

Make sure you add up the column total!

Water Wise Wander

Walk around the Coal Loader site and find these features: