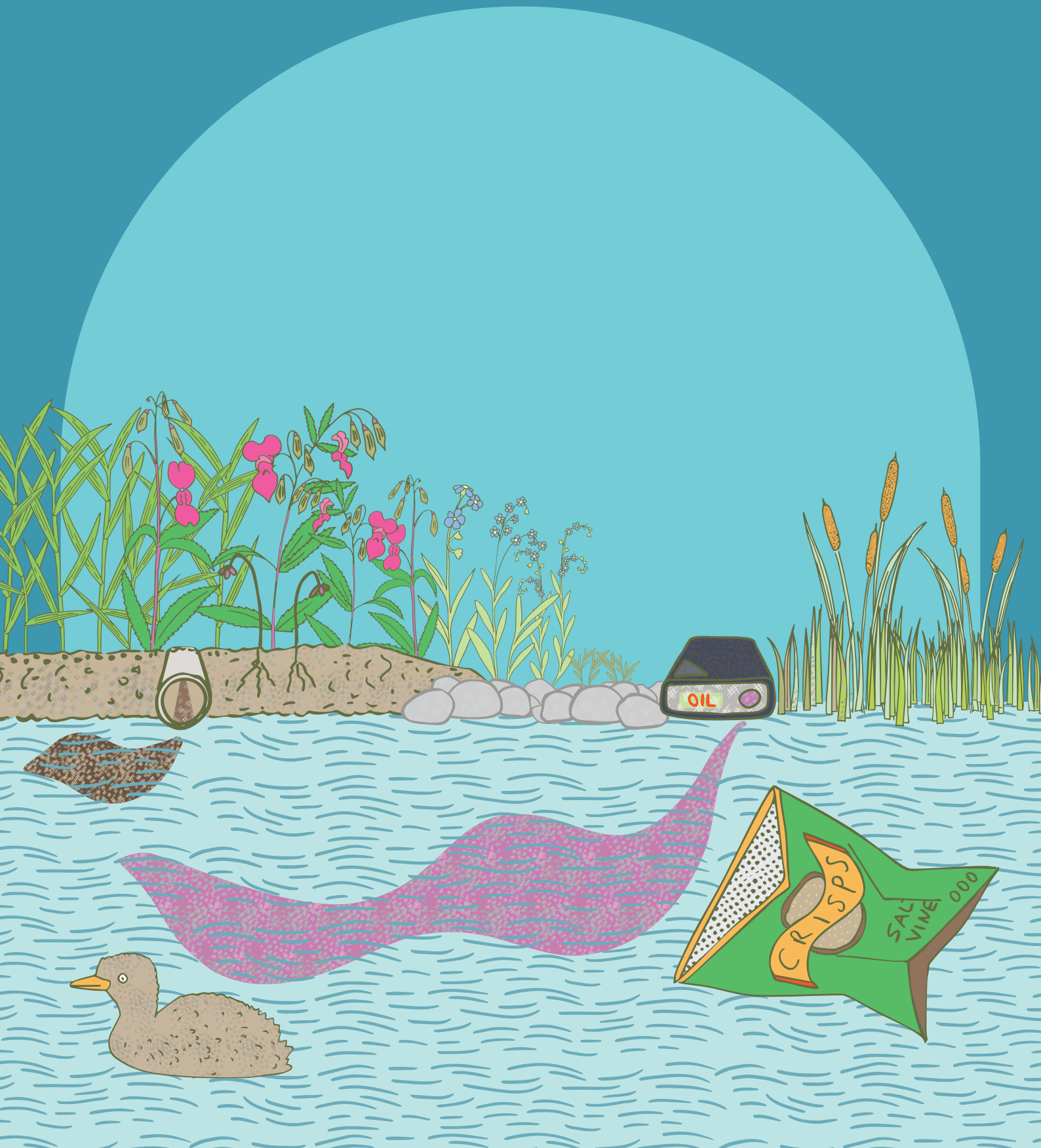
# Water Pollution

## Discovering the River Tweed and its Tributaries




CRISPS
SALT VINEGAR

# Contents

## Water Pollution | TweedWATCH Education Pack



SECOND LEVEL KS2

Image: Rawpixel

# Introduction

## Water Pollution: Keeping our Rivers Healthy

**The activities in this section of the Education Pack aim to explore the importance and scarcity of freshwater as a resource for people and wildlife. This will encourage learners to consider their use of water and ways to take action to conserve and protect it.**

Learners can also investigate the health of their local freshwater ecosystem, discovering how to spot and test for signs of water pollution. By the end of this topic, learners will have developed their scientific enquiry and investigation skills using practical techniques.

The lesson plans in this pack have been written with flexibility in mind. Mix and match the activities that are relevant for your group or class, apply the techniques to any blue space you have access to and carry out the activities over a timeframe that suits you.

## Introducing Water Pollution: Resource Signposting

### Short Videos

**BBC Teach: The Water Cycle (1m)**
**BBC Bitesize: Water & Sustainability (3m)** Where does our piped water come from, and what can we do to help conserve it?
**TedEd: Water Scarcity: An Introduction to the Problem (3m)** Thinking globally about the causes and impacts of water scarcity.

### Films

**Our Planet: Freshwater (49m)**
This film can help you link a topic about a local blue space to global examples of freshwater habitats. It shares engaging stories of some of the creatures that live in these habitats and highlights the threats caused by humans. Highlights include:
**The Tisza River, Hungary: Impact of Polluted Rivers on Mayflies (16:30m)**
**Lake Tanganyika, Africa: A Freshwater Habitat That Holds a Fifth of the World's Accessible Freshwater (27:32m)**

### Picture Books

**The Mess We Made by Michelle Lord & Julia Blattman:** This beautifully illustrated, rhyming picture book examines the impact of litter on the sea and its creatures. The second half of the book offers a positive message about the actions we can take together to protect our oceans.

**WATER: Protect Freshwater to Save Life on Earth by Catherine Barr & Christine Engel:** This non-fiction book looks at the global story of freshwater. It includes topics such as the first water on Earth, the importance of freshwater and the impact of pollution.

**Planet S.O.S by Marie G. Rhode:** This book engages readers with various environmental issues represented by mythical monsters. Water pollution is one of 22 monsters and is depicted as 'The Aqualik', a greedy frog who appears when humans waste or pollute freshwater.

Check out the **TweedWATCH Education Pack Resource Signposting Padlet** for links to all of the resources referenced.

# The Importance of Freshwater

Lesson Plan

## Learning Objectives

- Learn about the scarcity of accessible freshwater and the importance of water conservation.
- Identify some of the threats facing our freshwater habitats.
- Describe actions that can be taken to save water and reduce pollution.
- Develop a personal pledge to take action to protect freshwater.

## Equipment & Resources

- 1 litre bottle of water, clipboards and pencils

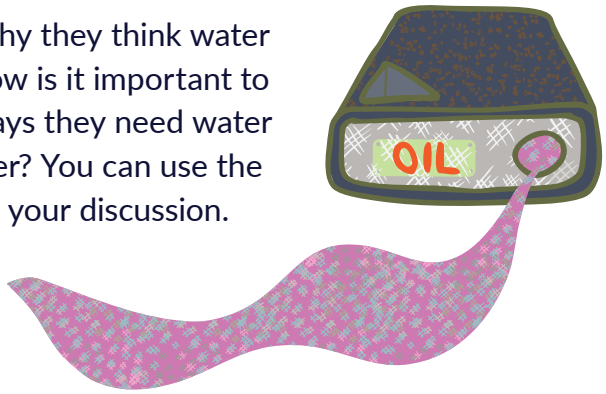
*Refer to specific activity instruction pages for more information on equipment needed.

## Vocabulary

**Freshwater, saltwater, scarce, water cycle, pollution, conservation**

## Introduction

Start by opening up a discussion with your learners about why they think water is vital to life on Earth. How is it important to nature, and how is it important to people? Ask the group to pair and share to discuss all the ways they need water in their daily lives. What are their favourite ways to use water? You can use the **Importance of Freshwater Worksheets (p.10-13)** to support your discussion.




## Activities

**Earth Apple: (15m)**

Despite its importance, freshwater is much scarcer than it appears. Only 1% of the water on the planet is accessible freshwater. Use the **Earth Apple Demonstration Activity Instructions (p.8)** to illustrate to learners how precious our freshwater is.

**Water Cycle: (30-45m)**

Exploring the natural cycle of water can help learners picture how water moves around the world, how it is made available to living things, and how our freshwater ecosystems are replenished. Use the **Water Cycle Worksheets (p.15-17)** as a refresher on the various stages of the water cycle.

You can also watch the video signposted on the Introduction Page or look for real-world examples to see the cycle in action.

**For example:**

- Monitor a puddle by drawing around it with chalk and checking it regularly to see it shrink through evaporation.
- If you have a set of sensory mirrors, take them outside on a cold day and breathe on them to see the condensation.
- Head out in the rain and experience precipitation on your skin. Watch the flow of the rainwater over the ground. Does it soak into the soil or run along the concrete?

**Threats to Freshwater: Habitat Hoops (15m)**
Freshwater habitats face a variety of threats, including habitat loss and fragmentation, over-exploitation and climate change. This activity focuses on the threat of pollution entering a river and the ways we can take action to prevent this from happening. See the **Habitat Hoops: Threats to Freshwater Activity Instructions (p.9)** for guidance on how to play and use the **Freshwater Habitat Hoop Card Resource** during the activity.

## Why is clean water important to us?

**School Water Diary: (40m)**
Ask your class for suggestions about how, where and why your school uses water. You might want to highlight some of the main spaces in your building to help prompt their ideas. Using the **School Water Use Map Worksheet (p.18/19)**, your class can go on a water hunt around your school to discover and record the different ways water is used. Using the worksheet, they can draw and label a rough map of the building and grounds, drawing a blue water drop wherever they find water. Once you are back in your classroom, ask your group if there were any surprising ways water was being used at school. Do they feel that a lot of water is being used? If so, are there any ways that you could help your school save water?

**Home Water Diary: Completed over a day**

- Learners can complete some of this activity during school hours, but should also take their worksheet home to consider their water use there.

Discuss with your learners the different ways they use water at home. How does this compare with water usage at school? How much water do they use in a day? Show the class what a litre of water looks like to help them visualise this, and ask them to estimate how many litres of water they think they would use in a day.

Introduce the **Water Diary Worksheet (p.20-21)**, explaining that this will be a way of tracking water use for a day. You could use this sheet over several days if you'd prefer to get an average daily usage figure. This will help them see if they are close to their estimate, and it will also show which activities use the most water. Discuss ways that they could reduce their water usage at home.

## Positive Actions for Freshwater

**Positive Action Bingo: (15m)**
Identify and celebrate the actions your learners already take to conserve water and protect freshwater habitats using this game of **Freshwater Action Bingo (p.22-23)**. Each square on a card describes a positive action for freshwater.
Your learners must match the bingo statements to different people in the group by asking each other questions about how they save water or reduce pollution. They can only include a person once on their card. The first person to fill a line horizontally, vertically, or diagonally is the winner. To extend the game, see if anyone can fill their card. Review some examples of the two different bingo cards and discuss with the group how these actions would help to protect our freshwater habitats.

## Plenary

**Water Pledge: (30m)**
Ask your class to reflect on the ways they use water and how much they use. Are there any ways they could reduce the amount of water that they use? For this activity, ask your learners to complete the **Freshwater Guardian Pledge Worksheet (p.14)**. See the **Positive Action Bingo Cards (p.22-23)** for inspiration and ideas to include in the pledge.

# Earth Apple

Activity Instructions

## Freshwater scarcity demonstration

### What you'll need

- Chopping board
- A large apple
- A sharp knife with a blade cover
- A bowl
- (Optional) Picture of the Earth for reference

### Description

This simple demonstration will help your learners to visualise and put into context how little accessible freshwater we have available on Earth. Freshwater is vital for sustaining life on this planet. It may seem abundant in places, but it is a precious and finite resource.

### Instructions

- Hold up the apple and tell your learners that it represents Planet Earth.
- Place the apple on the chopping board and use the knife to cut it into quarters.
- One of these quarters represents land; move this piece into your bowl.
- This leaves you three pieces that represent all of Earth's water (71% of the Earth).
- Remove the skin of one of the apple pieces and put it aside for now.
- Two of the apple pieces and the skinned piece of apple represent all of Earth's salt water (97.5% of all water). This includes the oceans and estuaries. Humans and most types of plants and animals cannot drink this water as it is too salty for us to process. Place the saltwater apple pieces in the bowl.
- This leaves us with the skin of one of the apple pieces. This represents all of the freshwater on the planet (2.5% of all water).
- Cut this piece into three equal strips. Two of these strips represent the water that is locked up in ice, like glaciers found in the polar and mountain regions (69% of freshwater). Put these two strips in the bowl.
- This leaves us with this one strip that represents the liquid freshwater that is available for us and so many of Earth's living things to access and use to survive, grow and reproduce. This is approximately 1% of all of Earth's water. It includes the water in lakes, rivers and streams as well as water under the ground, in the soil and the air.
- Much of this water gets wasted or polluted by human activity. This is why it is so important to use only what we need and to keep it as clean as we can.

### Reflection Questions

- What is the difference between saltwater and freshwater? What are some examples?
- How did it make you feel to learn about how scarce freshwater is?
- Can you think of ways that water can be wasted?

# Habitat Hoops

## Activity Instructions

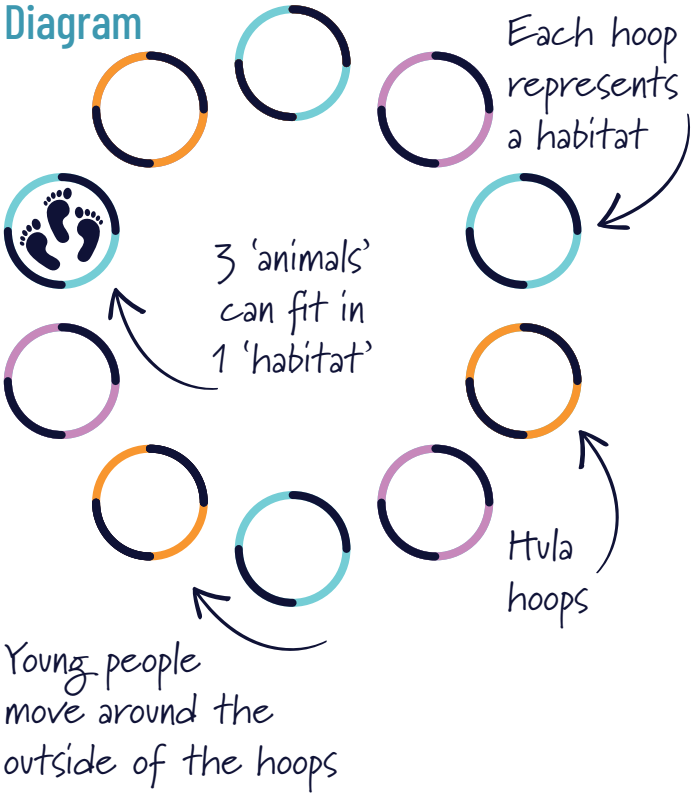
### Setting up

Set the hula hoops out in a circle formation (adjust the number of hoops to your group size). Each hoop represents a section of river or other body of freshwater. If you don't have hula hoops, you could use chalk, string circles or carpet tiles. Just ensure that the items you choose will not be a slip or trip hazard on the surface you're playing on.

### What you'll need

- Hula hoops (10 for a class of 30)
- Habitat Hoops cards
- A whistle
- A large indoor/outdoor space

### Diagram




### How to play

**The goal is to find a freshwater habitat where the chosen animal can survive.**

- Choose a river animal to imitate as your group move around the outside of the circle.
- When the whistle is blown or you shout 'find a home', they need to find a habitat hoop and jump in (or place one foot in the hoop to avoid collisions). Each river habitat hoop can only sustain 3 animals. During the first round, everyone should be able to find a home.
- Before starting the second round, ask someone to choose a **Habitat Hoops Threat Card**. Read out the scenario and take away a couple of habitat hoops. Ask your learners to move around the outside of the circle again, blowing your whistle after a minute or two. Some won't be able to find a home and should stand in the middle. Decide whether they join in the next round or if they are 'out'.
- Continue the rounds like this until there are only a few habitat hoops left.
- The final round will show positive actions that can protect against water pollution. Ask the learners if they know how we can get these habitats back. For any right answers, replace one of the hoops. Use the **Habitat Hoop Action Cards** to replace the remaining missing habitat hoops and play one last round where everyone finds a home again.

### Reflection questions

- What actions can we take to help reduce water pollution in our rivers, lakes & ponds?
- Are there any other threats to the river that were not mentioned during the game?
- How does water pollution affect the wildlife living in and near the river?
- What would you miss most about your river if it were to be threatened?

# Freshwater Ecosystems

## What is freshwater?

Freshwater is water that has a naturally low amount of salt. It is found in bodies of water on land or stored between layers of rock and gravel underground. Only 2.5% of the water on the planet is freshwater, the rest is saltwater found in our oceans and estuaries. Not all freshwater is available to us, much of it is locked away in glaciers or ice caps. The freshwater that is left is vital to life on Earth.

## Where can we find freshwater?

Freshwater is found in many inland habitats, while saltwater is found in seas and estuaries by the coast. Both are examples of aquatic ecosystems, where living things like plants and animals interact with non-living things like soil and water.

**Label these pictures of aquatic ecosystems with an F for Freshwater or an S for Saltwater**

River

Sea

Pond

Loch/Lake

Bog:
a type of wetland

Estuary:
where river meets the sea

**There are 2 types of freshwater habitats; still or flowing. Can you list the freshwater habitats from the pictures above in the right group? Can you think of any that are not listed already?**

### Still water

### Flowing water

# Freshwater Ecosystems

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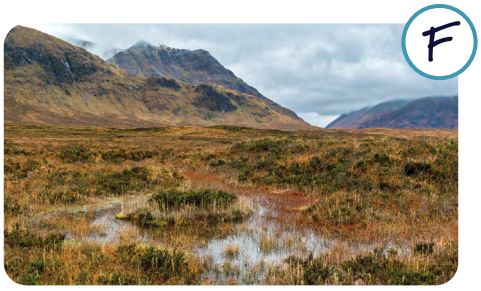
**Loch/Lake**




**Bog:**
**a type of wetland**


**Estuary:**
**where river meets the sea**

**There are 2 types of freshwater habitats; still or flowing. Can you list the freshwater habitats from the pictures above in the right group? Can you think of any that are not listed already?**

### Still water

Pond, loch, bog, marsh,

### Flowing water

River, streams, creeks,

ANSWER SHEET

# Freshwater

## Why is freshwater so important for nature?

Freshwater ecosystems play an important role in biodiversity. They cover only 1% of the Earth's surface but are home to 10% of Earth's species. They are also very important to the water cycle.

**Can you name some plants and animals that need freshwater ecosystems to survive and reproduce?**

.....

.....

.....

.....

## Why is freshwater so important for people?

Clean water is vital for our health and well-being, and for the activities we carry out every day. The water we use is taken from freshwater ecosystems as well as from underground. This water is used for agriculture, industry, and energy production. It is also delivered to our homes and schools following treatment at a water purification plant.

**List some of the ways that you use freshwater and describe why it is important to you.**

.....

.....

.....

.....

.....

**Hint:**
Look at the pictures for inspiration.





# Freshwater

ANSWER SHEET

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**Can you name some plants and animals that need freshwater ecosystems to survive and reproduce?**

**Plants:** Algae, river trees like willow and alder, aquatic plants.

**Animals:** Fish like salmon, eels and trout. Animals like frogs and mayflies whose lifecycles begin in the water. Birds that feed on the water like ducks, kingfishers and dippers.

Mammals that make their homes on the riverbank like otters and water voles.

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**List some of the ways that you use freshwater and describe why it is important to you.**

**Examples include:** Using water for livestock, to grow food and other plants, and in making products in factories. It is used for hygiene like taking a shower or brushing teeth.

We need it to drink to keep us healthy and alive.

**Hint:**
Look at the pictures for inspiration.

# River Guardian Pledge

My name is .....

and I'm ..... years old.

This is me!

Things I love about the river

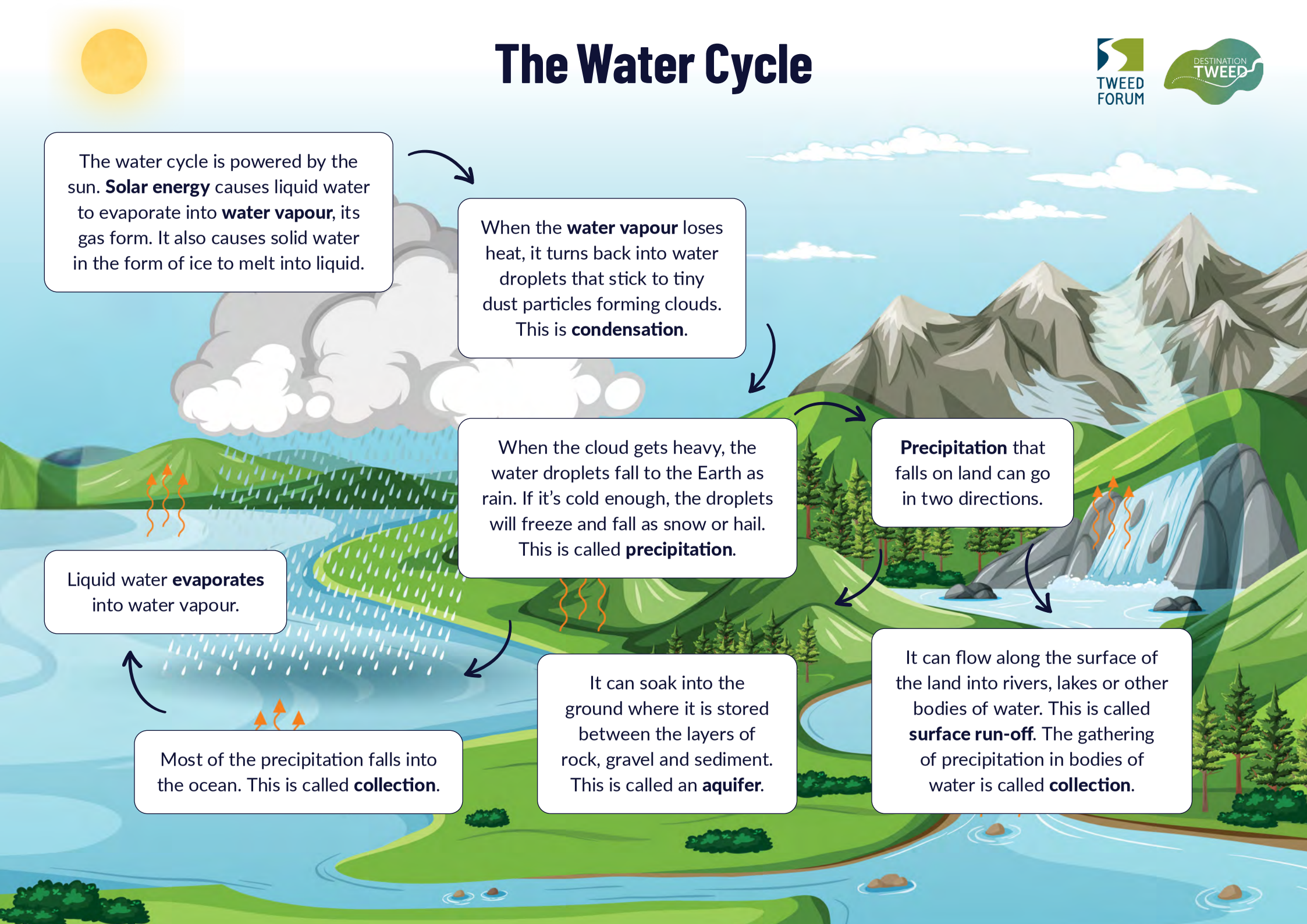
My favourite river fact!

My pledge to reduce pollution

This is my river wildlife mascot

My pledge to save water

# The Water Cycle



The water cycle is powered by the sun. **Solar energy** causes liquid water to evaporate into **water vapour**, its gas form. It also causes solid water in the form of ice to melt into liquid.

When the **water vapour** loses heat, it turns back into water droplets that stick to tiny dust particles forming clouds. This is **condensation**.

When the cloud gets heavy, the water droplets fall to the Earth as rain. If it's cold enough, the droplets will freeze and fall as snow or hail. This is called **precipitation**.

**Precipitation** that falls on land can go in two directions.

Liquid water **evaporates** into water vapour.

It can soak into the ground where it is stored between the layers of rock, gravel and sediment. This is called an **aquifer**.

It can flow along the surface of the land into rivers, lakes or other bodies of water. This is called **surface run-off**. The gathering of precipitation in bodies of water is called **collection**.

Most of the precipitation falls into the ocean. This is called **collection**.

# The Water Cycle

## What is the water cycle?

When we think of water, our minds usually picture it in its liquid form. However, water is constantly moving around the planet through a solar powered cycle, changing between its gas, liquid, and solid form. A healthy water cycle provides the living things of our world the water they need to survive and thrive. **Use the Water Cycle Poster to help you answer the questions on this page.**

**Name the processes of the water cycle picture, as described in the labels below**

Heat from the sun turns liquid water into water vapour.

.....

Water vapour turns back into water droplets.

.....

Precipitation gathers in rivers, lakes or the ocean.

.....

Water droplets fall to the Earth from clouds in the form of rain, snow or hail.

.....

## How does pollution enter the water cycle?

- Surface run-off happens when precipitation lands on the ground and makes its way to a river or lake.
- Pollutants on the ground can be carried along with this water, especially during heavy rainfall.
- They enter the river or lake ecosystem and pollute the water.

**Tick the pollutants you think could enter a river during the surface run-off stage of the water cycle.**

Sewage ☐

Pesticide ☐

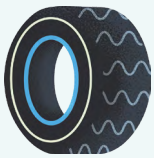
Greenhouse gases ☐


Oil ☐

Plastic bottles ☐

Manure ☐

Fertiliser ☐



Pieces of tyre ☐


Soil ☐

**Hint:** Think about where these pollutants are used and if they could be washed away by the rain.

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ANSWER SHEET

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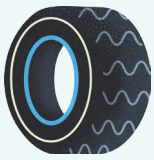
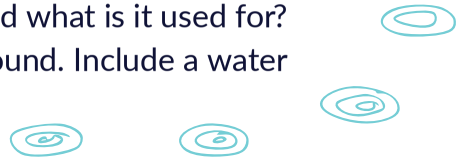


Pieces of tyre ☑


Soil ☑

# School Water Map

Where in your school is water used and what is it used for? Draw a map to show what you have found. Include a water drop wherever you found water use.



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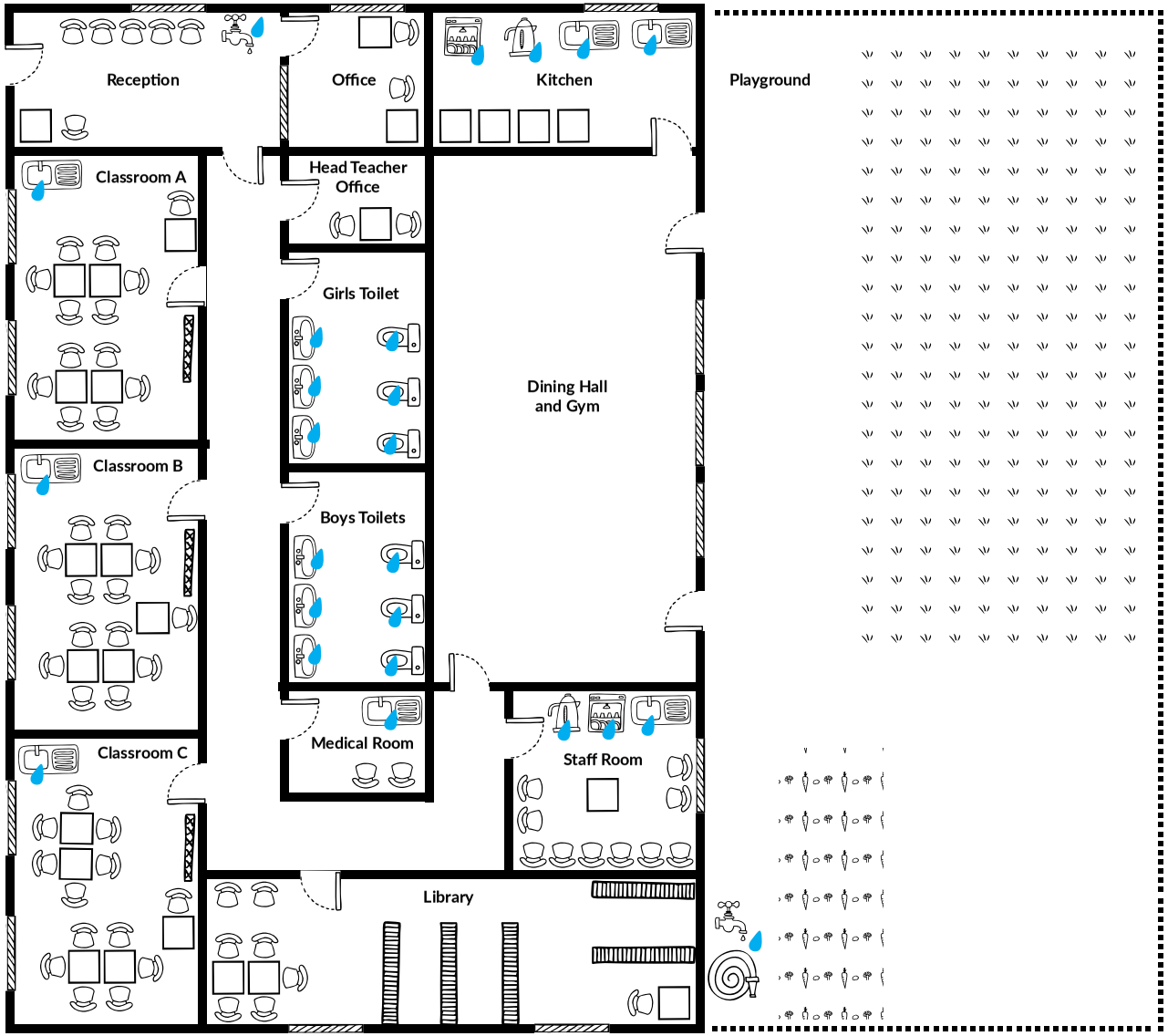



## Key

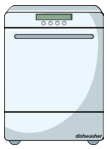
- Door
- Toilet
- Wash Hand basin
- Sink
- Dishwasher
- Tap
- Kettle
- Window
- Hose
- Fence
- Table
- Bookcase
- Chair
- Whiteboard
- Grass
- Vegetable Garden
- Water Found

# Water Diary

**Colour in a water droplet every time you do one of these activities today.**

## How much water do you use in a day?

If an activity has this star * you'll need to time how long you do it for and colour in 1 droplet for every minute.

| | | |
|---|---|---|
|  | **Glass of water/juice**<br>0.25 Litres | |
|  | **Flushing the toilet**<br>5 Litres | |
|  | ***Washing hands or face**<br>6 Litres/min | |
|  | **Dishwasher**<br>9 Litres | |
|  | **Washing up (1 bowl)**<br>8 Litres | |
|  | ***Using a hosepipe**<br>17 Litres/min | |
|  | ***Brushing teeth/tap on**<br>6 Litres/min | |
|  | **Brushing your teeth**<br>1 Litre | |
|  | ***Having a shower**<br>12 Litres/min | |
|  | **Having a bath**<br>80 Litres | |

# How much water did you use in a day?

## For each activity calculate:

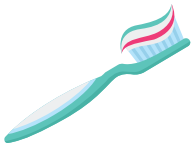
Number of Litres x Number of droplets
= Total number of Litres used for that activity.

## Then:

Add all of your activity totals together
= Daily water use.

**Add your answer in the blue box below.**

## For example:

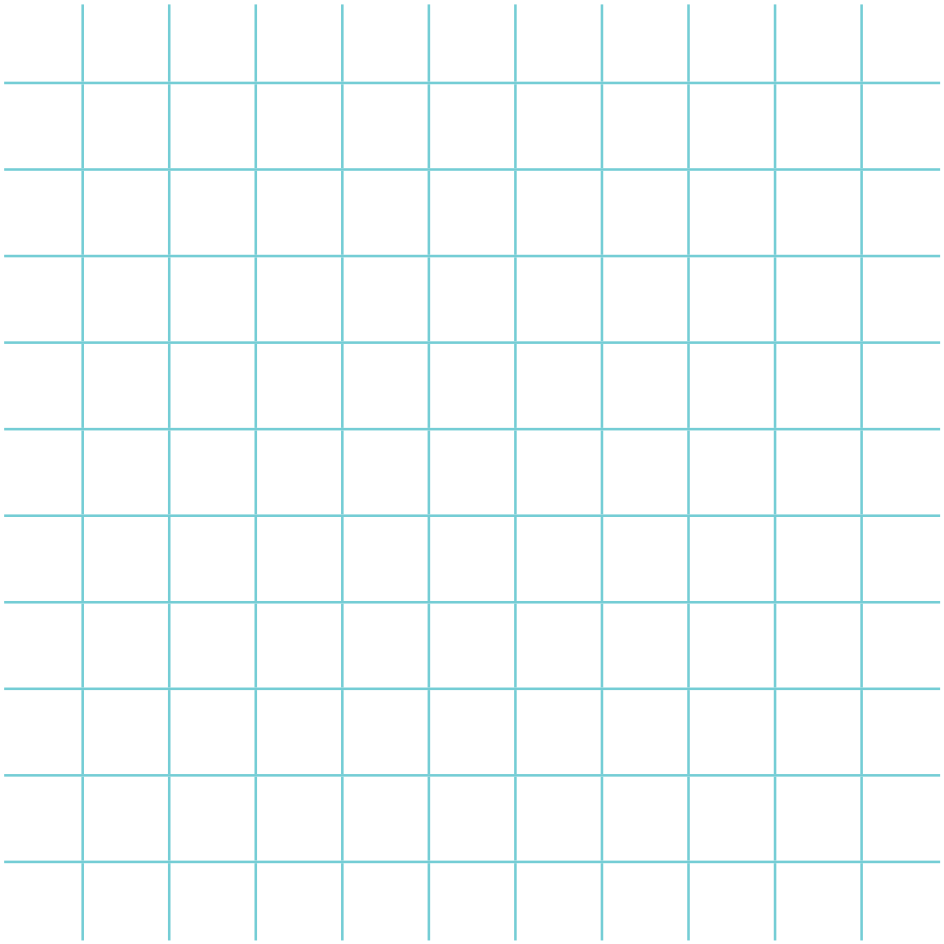
| | | |
|---|---|---|
|  | **Brushing your teeth**<br>1 Litre |  |
|  | ***Having a shower**<br>12 Litres/min |  |

Brush teeth 1 x 2 = 2

Shower 12 x 1 = 12

**Total water used** 14 litres

Use the grid to help you add up your total.



**Litres:** Daily Water Use

# Freshwater Action

## BINGO 1

| | | | |
|---|---|---|---|
| I turn the tap off when I brush my teeth | I recycle instead of littering | I collect rainwater to water my plants | I have joined an eco-club |
| I have taken part in a litter pick | I make sure to turn off dripping taps | I re-wear my clothes if they are still clean | I have learnt about water pollution |
| I have carried out a water pollution survey | I have planted a native tree | I put wet wipes in the bin and not down the toilet | I spend time enjoying the river |
| I have worked out how much water I use a day | I am careful about what I pour down the drain | I have helped others learn about the river | I shower in 5 minutes or less |


Talk to people in your group about what they do to save water and reduce pollution. If they match any of the boxes on your bingo card you can cross it off. You can only cross off one box per person.

# Freshwater Action

## BINGO 2

| | | | |
|---|---|---|---|
| I wash veggies in a bowl and then reuse the water for my plants | I use a reusable water bottle | I only flush the 3 Ps! Pee, paper and poo | I use a watering can to water my garden instead of a hose |
| I wear second hand clothes | I bag & bin my dog's poo when we walk along the river | I take my litter home instead of littering | I have short showers instead of baths |
| I water garden plants in the morning to reduce evaporation | I have planted native plants in my garden | I have reduced my food waste | I have shared ways to save water with my family |
| I have learnt about saving water | I only fill the kettle with the amount of water I need | I encourage others to enjoy time by the river | I collect rainwater in a water butt to use in the garden |


Talk to people in your group about what they do to save water and reduce pollution. If they match any of the boxes on your bingo card you can cross it off. You can only cross off one box per person.

# River Health Check

Lesson Plan

## Learning Objectives

- Describe how to spot the signs of pollution in a local river.
- Identify river features that can help protect rivers from water pollution.
- Discuss how we can make changes to help keep our river clean.

*Refer to specific activity instruction pages for more information on equipment needed.

## Equipment & Resources

- Clipboards & pencils, water sampling equipment — pipettes, small tubs, small bucket & rope

## Vocabulary

**Water quality, pollution, pollutants, habitat, ecosystem, healthy**

## Introduction

**Ask your group to think about what we mean by a healthy river (or freshwater) ecosystem and ask them to describe how this would look. A healthy freshwater ecosystem has clear, clean water, diverse plants and animals, a functional food web, and a lack of invasive species. Inform your group that they will investigate how clean the water is in your local river.**

**What is Pollution? (15 mins)**

During this word association game, you can encourage learners to consider the meaning of pollution whilst gauging their current knowledge of the topic. If you have a large group, split your learners into smaller groups of around 10 people. Inform them that they will be learning about pollution and that you would like them to consider what this term means. Each group is to stand in a circle, facing one another. The aim is for each person to say a word associated with pollution as they go around the circle. If someone takes more than 5 seconds to answer or repeats a word, they are out. Play until one person is left in the game. They are the winner.

## Activities

**Walk to or from your local river spot: (Length of time depends on the distance of the walk)**

As you walk to or from the river, ask your learners to look out for signs of pollutants that could end up in the river. They can share their thoughts with their walking partner and provide feedback to the class once they reach the river or return to school. Are there any ways we can stop these pollutants from reaching the river?

**Healthy & Unhealthy River Signs: (20m)**

To prepare for this activity, read the **Healthy River Signs Background Notes (p.26)** for details on each sign's meaning. Use the **Healthy River Spotter Resource (p.40/41)** to look for clues about the quality of the water in the river. Once your learners have explored and identified signs, use the following questions to reflect on the activity. You could ask your learners to reflect on these during their walk back to school, ready to discuss them in class.

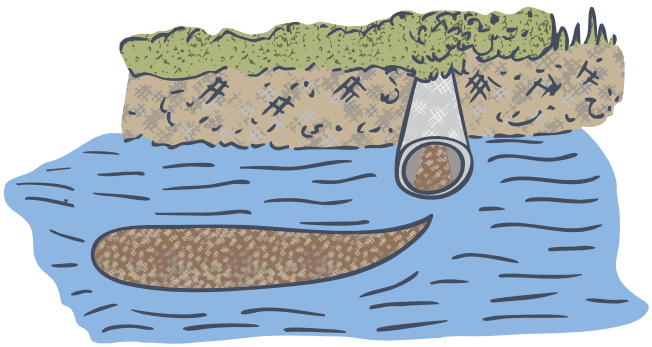
- Is there a mix of healthy and unhealthy signs?
- How healthy do you think this part of the river is?
- What impact might this have on the whole river?
- What can we do to improve the health and water quality of the river?

## Activities

**Sample collecting: (15m)**
Read the River Health Check Background Notes (p.30-32) in advance. Use this information to decide which method of sample collection works best for you. Decide which chemicals or abiotic factors you'd like to test the samples for. Collecting water samples can be done in advance of your activity or, if appropriate, this can be included in the session with your group.

**River Health Check: (45m)**
Using the River Health Check Worksheets (p.52-54), investigate the water quality in your chosen freshwater ecosystem. Begin by dividing your group into pairs or small groups and talk through the instructions on the cover page of the worksheet. The first worksheet focuses on visual features and clues about the river's health. This is best done whilst near your freshwater habitat, though it could also be done with pictures if needed.

The second page provides a table where students can collect data while testing water samples. This could be done on-site if you take equipment with you, but it can also be carried out back at school if you take your water samples with you. The River Health Check Background Notes will guide you on how to test the water samples and how to interpret the results. Discuss the findings with your group. Did everyone collect similar data? Would they classify this habitat as 'healthy' for wildlife?



**Field Sketch: (20m)**
Carrying out a field sketch at the site you'd like to study is a good way of gathering information that will give context to the data collected when testing the water samples. It will also help to develop your learner's observation skills and connection with the environment. Use the River Health Check Field Sketch Worksheet (p.50) as a template. You'll find step-by-step instructions on field sketching on the back of the worksheet.

**Nutrient Pollution Spotlight: (20m)**
Nutrients are vital for plant growth and therefore play an essential role within an ecosystem. The idea that nutrients can be a source of pollution may seem confusing to learners. Use the Nutrient Pollution Worksheets and Poster (p.55-59) to support a discussion with your learners about the importance of a healthy balance of nutrients and what can happen when excess nutrients reach the river.

**Pollution Clean-Up Game: (20m)**
Play the pollution clean-up game to encourage learners to think about the origin of common pollutants in the water. See the Pollution Clean-Up Game Activity Instructions (p.38) for details on how to play. Play in a safe, open space near your river spot or once you are back at school.

## Plenary

Reflect with your group on what they have learnt about water pollution. How does water pollution affect wildlife and people? How can learning about water pollution and testing for pollutants help us to keep our rivers, lakes and ponds clean?

# Healthy River Signs: Indicators of Water Quality in our River Ecosystems

## Background Notes

If you live near a river but don't have safe access to gather water samples, you can still visually assess the water's cleanliness and determine whether it is a healthy habitat for wildlife. The Healthy River Spotter Resource highlights signs of high and low water quality that learners can spot from a riverbank or bridge. This includes ways that pollution can enter the water, signs of pollution, and river features that can protect against pollutants. It is important to note that these signs will help to evaluate the river's health as an ecosystem, but they can't tell us if the water is safe to drink or swim in.

## What are we looking out for when visiting the river and why?

**The Healthy River Signs Spotter Sheet Explained**
The first row of healthy river signs contains features of the river that can help reduce the amount of pollution reaching the water.

**Native broadleaf trees and a variety of plants**
The area of plants and trees along a riverbank is also known as a riparian buffer zone. It intercepts pollutants that could be washed into the river when it rains. This is known as surface run-off and can wash in pollutants from farms, towns, roads and industry. The roots absorb many of the nutrients (nitrates and phosphates) present in some pollutants like fertiliser and sewage. A small amount of these nutrients in water is essential for aquatic plants to grow, but too much can lead to an algal bloom (see p.55). In turn, this leads to a significant drop in dissolved oxygen levels (oxygen gas mixed into the water), which are vital for the survival of many plant and animal species living in the water.

The roots of trees and smaller plants also help give structure to the bank, preventing erosion and stopping soil and other sediment from entering the water. The broad leaves of the native trees help to keep the water cool, helping the river maintain dissolved oxygen levels, which is especially important in polluted water. Low-lying plants slow the flow of surface run-off and encourage the infiltration of polluted water into the soil. The benefits of this are that the pollutants can be filtered out of the water, and the groundwater below can be replenished.

**Deadwood** in the water can slow the flow of the river, reducing the erosion of the riverbank and lowering the amount of soil and sediment particles entering the water.

**A meandering channel** helps to slow the flow of the water and reduce erosion of the riverbank. As the water slows, any sediment it was carrying sinks to the bottom of the river. Many meandering sections of a river have floodplains beside their channels. These can act as natural filters for polluted water.

The **second row of healthy river signs** are all pollution indicator species, animals that are highly sensitive to water pollution. Their presence tells us that they can live, find food and breed in this section of the water, meaning it is not likely they are exposed to pollution in their habitats. They indicate that the water is of good quality.

**Salmon** need clean water to survive. Water pollution can reduce the amount of available food and levels of dissolved oxygen and increase their vulnerability to disease.

**Mayflies** famously live for only a day as adults (sometimes a little longer, depending on the species). They spend this time finding a mate and laying their eggs in freshwater. These eggs hatch into mayfly nymphs, which will spend a year or more underwater before turning into adults. The nymph's gills are sensitive to silt and other types of pollution, so it is very unlikely they will be found living in polluted water as they struggle to get enough oxygen to survive.

**Dippers** are small, brown river birds with a white breast and a short tail. They can be seen bobbing up and down on rocks along the river and have an amazing ability to hunt for their prey underwater. Due to the strong impact that river pollution can have on their prey (freshwater invertebrates), dippers cannot find enough food to survive in polluted waters.

**Otters** are apex predators in the river ecosystem. They are classed as an indicator of good water quality due to the impact that water pollution can have on their survival. Any build-up of pollutants or toxins in their prey can quickly impact these animals through poisoning. They can also struggle to find food as the pollution starts to negatively impact their food chain.

# Unhealthy River Signs

## Background Notes

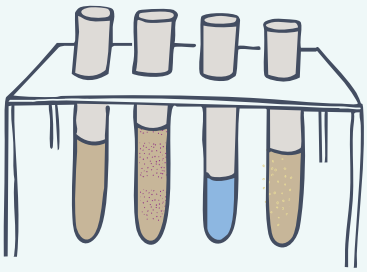
The **first row of unhealthy river signs** shows us possible sources of pollution for the river. As these are visible and have a single location, we call these a pollution 'point source'. The other type of pollution is 'diffuse', which enters the river over a large area. For example, when surface run-off following heavy rainfall washes fertilisers used in agriculture into the water over large areas. This type is harder to spot.

**Discharge pipes** can originate from several different sources. Some knowledge of the local area you're exploring will help you work out the type of pollution that it may be carrying.

- A road drain could be a source of road run-off and contain petrol, brake fluid or bits of tyres.
- If there is a nearby factory, then the pipe could be a source of industrial pollution.
- Is there an area of housing close by? This could be a sign that household run-off is entering the river. This could include garden pesticides, car oil, pet waste or car shampoo.
- It could be a 'combined sewage overflow' pipe, which can discharge untreated wastewater in the event of heavy rain. This is done to prevent the sewage system from being overwhelmed and flooding people's homes, though there have been incidents of discharges during dry weather too. You can find the location of storm overflow pipes and sewage discharge times on the River Trust Website.

**Livestock waste** in the water increases the level of nutrients. Too much of this can lead to harmful algal blooms, reducing levels of dissolved oxygen in the water. Livestock can also physically damage the riverbank as they access the water for a drink, eroding the soil and increasing the amount of silt and soil in the water.

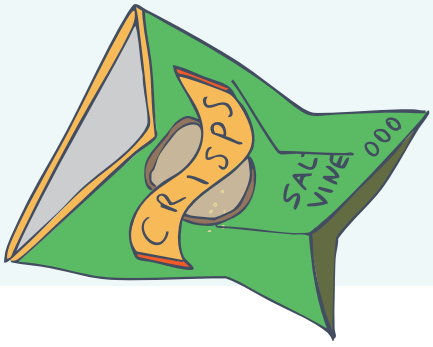
**A nearby road** can be the source of pollutants like petrol, diesel, brake fluid and tyre chemicals being washed into the river after heavy rainfall.

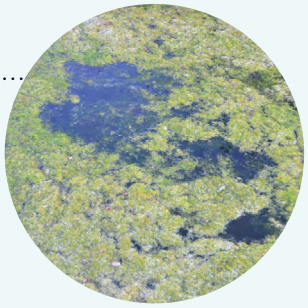


The **second row of unhealthy river signs** occurs when pollutants have arrived in and impacted the river.

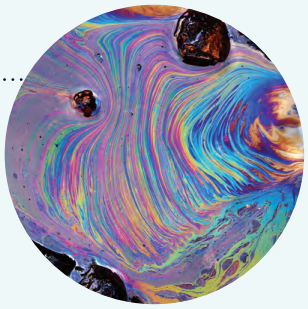
**White, fragrant foam** is a sign that manmade products like detergents are polluting the water. It can be difficult to tell the difference between natural and unnatural foam, but if the colour is bright white and has a fragrant smell, it is likely to be synthetic.

**Litter** dropped on land can get blown by the wind or washed into the river with rainwater. It can release toxins (like BPA) into the water and break down into microplastics that are ingested by wildlife. If litter gathers in mounds on the surface, it can block the light needed by aquatic plants below the surface of the water.



**Algal bloom** occurs when chemical fertilisers and sewage containing high levels of nitrates and phosphates enter the river, causing the water to become too rich in nutrients (eutrophication). This can cause algae to grow rapidly, blocking out light for aquatic plants and depleting vital dissolved oxygen levels as it decays. Some types can even produce toxins that are poisonous to both human and aquatic life.



**A rainbow patch** on the surface of river water indicates that it has been contaminated by pollutants from road run-off. The oils present in this don't mix with the water, but instead sit on top like a film. This film acts like a prism when hit by sunlight, creating a sheen of rainbow colours. It reduces the oxygen exchange between the air and the water, meaning lower levels of dissolved oxygen.

**See which of these signs you can find with your class and decide together whether you think your local river spot is a healthy ecosystem with good water quality.**

# River Health Check

## Background Notes

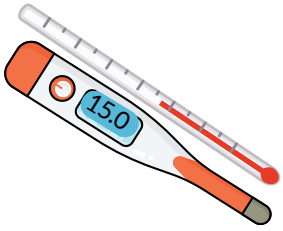
## Measuring the quality of water

There are a range of things that we can test for in the water that will tell us whether it has been affected by pollution. Some of these things need testing in a lab by specialist scientists, but some things we can test for ourselves using simple equipment.

## Collecting water samples

Firstly, decide where to collect your water samples, making sure that the area is safe and accessible. See the **Health and Safety Outdoors document** for factors to consider here.
Avoid collecting from areas where the water is stagnant and stick to free-flowing sections of the river. If this spot is on privately owned land, you'll need to ask for permission from the landowner before you collect your samples.

If you can crouch to access the water, you can use a handled jug to collect a sample; otherwise, use a small container attached to a stick with some string and use this standing up. It is important to be mindful of your footing to stay safe and avoid damaging the riverbank. If you're collecting water from a bridge, use a rope to lower a small bucket into the water. You may also need to add a pebble to the bucket to make sure it doesn't float on the surface.
If taking your water off-site to test, make sure your container has a lid and label it with where and when you collected your sample.




## Temperature

**Why measure water temperature?**
Water temperature is a physical characteristic that tells us how hot or cold water is, or in other words, the levels of thermal energy it contains. It controls the rates of many of the biological, physical and chemical processes in the river. Warmer water, for example, holds less dissolved oxygen than cold water. This means that sensitive species of fish and invertebrates are unable to live in water when the temperature increases, as they struggle to get the oxygen they need to survive. It is an important factor to measure as it has an impact on many other water quality measurements, including pH.

**How to measure the temperature of water**
Collect a water sample and use a thermometer as soon as possible to record a measurement in degrees Celsius. Handle your sample container at the top to avoid transferring heat from your hands to the water. Allow a few minutes for the reading to stabilise before recording your result. Find an average temperature by totalling the measurements of three samples from the same area and dividing by three.

**How to interpret your results**

| | |
|---|---|
| 0°C–10°C | Very cold, typical during winter, usually good oxygen levels |
| 10°C–20°C | Healthy temperature range for many freshwater species |
| 20°C–25°C | Sensitive freshwater species may begin to struggle |
| Above 25°C | Risk of death for sensitive freshwater species, lower levels of oxygen |
| Above 30°C | Dangerous for most aquatic species |

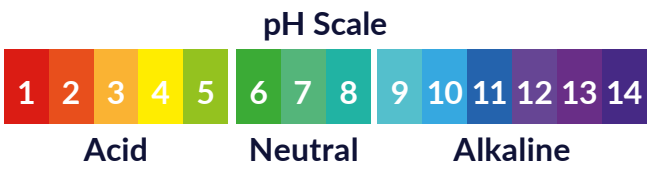
Take into account factors such as time of day, season and the weather when reflecting on your results.

## Measuring pH

**Why measure water pH?**

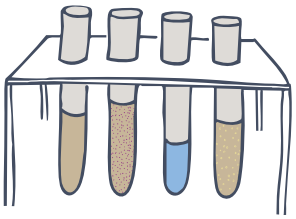
pH is a measure of how acidic or alkaline the water is. It affects many biological, chemical and physical processes and is highly impacted by pollutants. pH levels can be affected by run-off from industry and agriculture, as well as acid rain caused by fossil fuel emissions.

Different species will be adapted to thrive at varying pH levels, though mostly this will range from 6.5 to 8.0 on a scale of 0 to 14.0. If the water's pH rises or drops to more extreme levels, the river environment will become too toxic for many plants and animals to survive, drastically reducing the biodiversity of the ecosystem.



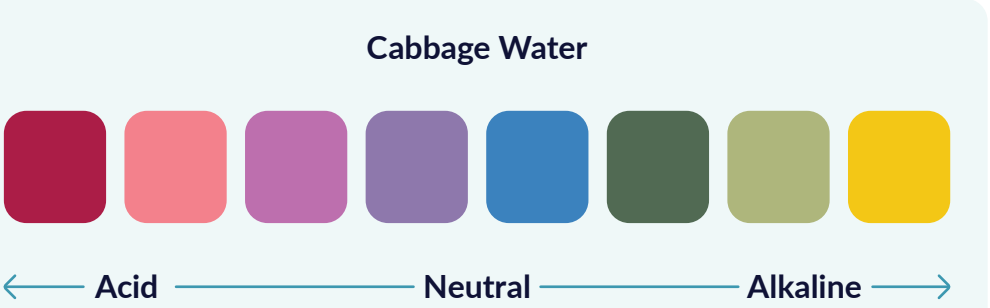

## How to measure pH

- **Litmus paper:** When added to a water sample, this paper strip changes colour to red in acidic solutions and blue in alkaline solutions.
- **pH strips:** Similar to the litmus paper, these strips will change colour when dipped into an acidic or alkaline solution. These strips are more accurate as they have a wider range of colour variants.
- **Digital pH meter:** This will give the most accurate reading as it measures down to 0.01th of a pH unit and reduces the risk of human error by removing the colour comparison aspect of the test.



## How to make red cabbage pH indicator

Anthocyanin pigments give red cabbage its colour. These pigments are pH-sensitive and can be used as a pH indicator. To make this, boil a roughly chopped cabbage for a few minutes, allow to cool and strain. The remaining liquid will change colour based on the pH of whatever is added. The corresponding colours differ from the usual pH strips; see the colour chart below for reference. Try it out with different household solutions like lemon juice (acidic), black coffee (acidic), hand soap (alkaline) or bleach (alkaline).




## Phosphates & Nitrates

**Why measure phosphates & nitrates?**

Phosphates and nitrates are both types of nutrients. Phosphates contain phosphorus and other minerals, and nitrates contain nitrogen and oxygen. Both are found naturally in soil and are essential for animal and plant life. When high levels of these nutrients enter the river, they can cause major problems for the ecosystem. The increase causes algae to bloom, blocking light from aquatic plants growing on the river bed, and leading to their dying off. This, in turn, leads to an increase in bacteria feeding off the dead plants, decreasing the levels of dissolved oxygen in the water. This negatively impacts the food web and biodiversity levels and poses a threat to human health.

Excess phosphates and nitrates enter the water through agricultural fertilisers, animal waste, sewage, and waste from industry. Phosphates are also present in soap and detergents and can be discharged into the river along with used household water through storm pipes.

## How to measure phosphates & nitrates

- **Test strips:** There are separate test strips for phosphates and nitrates, but both work the same way. Dip the strip in your sample and compare the colour to the the guide on the pack. The results are measured as either PPM or mg/L.

## How to interpret the results

| | | | | | |
|---|---|---|---|---|---|
| **Phosphates** | <0.05 | 0.05-0.1 | 0.1-0.5 | 0.5-1.0 | > 1.0 |
| **Nitrates** | <0.5 | 0.5-1.0 | 1.0-2.0 | 2.0-10.0 | > 10.0 |
| | **No signs of pollution** | **Some nutrient pollution** | **Moderate nutrient pollution** | **High nutrient pollution** | **Very high nutrient pollution** |

**For more information on interpreting nutrient levels, check out the following resources:**

- Clean Water for Wildlife project from the **Freshwater Habitats Trust**
- Citizen science project Freshwater Watch from **Earth Watch Europe**

## Useful equipment

**Pipettes**
Transferring water between containers.

**Sample containers**
For testing water samples.

**Notepads & pencils**
To record results and observations.

**Portable table**
A work surface for testing water samples.

**Laminated instructions**
To guide learners.

**Rucksack**
To carry your equipment.

Image: Airborne Lens Photography

## PPM

**Parts Per Million**

A result of 1PPM means there is 1 drop of nitrate or phosphate in every 1 million drops of water.

# Causes of Water Pollution

## Background Notes

**What is Water Pollution?**
Water pollution occurs when harmful substances contaminate a river, lake, ocean or any other body of water. Any human activity has the potential to cause pollution.

**Why is it a problem?**
Freshwater is a vital yet scarce resource for many organisms on the planet, with only a tiny percentage available for us to access. Water pollution increases this scarcity by reducing the health of our freshwater ecosystems. It does this through contaminating drinking water, accumulating pollutants in food chains, reducing biodiversity and degrading habitats.

**Sources of pollution can be divided into two categories: diffuse and point source.**

**Diffuse pollution**
Diffuse pollution occurs when small amounts of pollutants enter the river over a large area. Rainwater or melting snow carries pollutants off the land and into rivers, lakes, and oceans. This could include rain run-off from farms, homes, roads, and community green spaces. As diffuse pollution is difficult to trace due to its widespread nature, it is a difficult problem to tackle.

**Point source pollution**
Point source pollution enters rivers and other aquatic habitats through a single, usually identifiable location. The pollution could be discharge from a factory or a release of wastewater from an overflow valve after heavy rainfall, for example. Point source pollution is easier to track and control than diffuse pollution; it can be monitored and legally regulated to help reduce water pollution.

## Industry: Factories

There is a wide range of pollutants that can be introduced to our waterways from manufacturing industries. The type of pollutants are dependent on the product being made.

**Possible pollutants and their impacts on waterways**

- Some factories use water from rivers and lakes to cool their machines. This warmed water is returned to the river or lake, increasing its temperature. This not only hurts some of the more sensitive wildlife living in these habitats but also lowers the amount of oxygen in the water.
- Nutrient pollution from fertiliser manufacturers and food processing plants can lead to algal blooms and lower oxygen in the water.
- Oil from machinery or automotive plants can disrupt oxygen transfer between air and water and even coat and kill wildlife.
- Highly acidic or alkaline waste can leach from chemical or paper factories. This disrupts the pH of the water and impacts many of the biological, physical and chemical processes that are vital to the ecosystem.

**How do pollutants enter the river?**
Pollution from manufacturing industries can be discharged directly into the water, whether that's under licence, by accident or carried out illegally. Pollutants can also be washed into the water by rainwater from storage yards or sewer overflows.

**What can be done about it?**

- Restoring wetlands and planting trees along riverbanks to act as buffers against pollutants.
- Support a campaign organisation in taking action to protect our rivers from pollution. Take a look at the River Action UK website for ideas.

## Greywater & Sewage

Greywater is dirty water that leaves our homes from showers, sinks, baths, and appliances. The term covers any water used in the home except the toilet, which is classed as sewage. Greywater and sewage will leave a house's private drain and flow into a public sewer.

Depending on the type of sewer, this may also be joined by stormwater; rainwater from roofs, streets and roads. Sewers transport this wastewater and sewage to sewage treatment works, where it is filtered and treated. Once the water has been cleaned, it is released back into rivers, reservoirs, estuaries or the sea.

**Possible pollutants and their impacts on waterways**

- Untreated sewage can cause a wide range of damage to our waterways. As microbes break it down, oxygen levels in the water are drastically reduced. The nutrients it contains (nitrates and phosphates) can lead to algal blooms and a further reduction in oxygen levels when the algae die and are broken down. Sewage can also contain a range of pathogens that are dangerous to the health of both humans and wildlife.
- Untreated greywater: Household cleaning products can contain chemicals that are toxic to aquatic wildlife. Soaps and detergents can contain surfactants that damage the gills of aquatic animals and disrupt the oxygen exchange between the air and the water.
- Plastic pollution from the misuse of toilets can be dangerous to wildlife.

**How do pollutants enter the river?**

During heavy rainfall, combined sewage overflows (CSOs) are used to relieve the pressure on sewage systems and prevent flooding in people's houses. This means that rainwater mixed with untreated sewage is discharged into the river. When this happens, it also means that anything else flushed down people's toilets will enter the river too.

**What can be done about it?**

- Using eco-friendly cleaning products and avoiding the disposal of harmful chemicals down the drain can reduce the chemical impact of greywater on our waterways.
- Plant a rain garden under a roof downpipe to capture and filter rainwater before it enters the drain.
- Support The Rivers Trust campaign to #EndSewagePollution and write to your local political representative about protecting our rivers from sewage pollution.

## Transport/Roadside

**Possible pollutants and their impacts on waterways**

- Antifreeze that can leak from car radiators is toxic to aquatic life and humans.
- Oil and petrol from leaking engines leave a film on the surface of the water, disrupting oxygen exchange with the air and reducing oxygen levels for aquatic plants and animals.
- Roadside litter like plastic bottles and cigarette butts can cause injuries and damage to wildlife.
- Dog poo increases nutrient pollution whilst also introducing harmful pathogens into the water.

**How do pollutants enter the river?**

During and following heavy rainfall, pollutants from roads and vehicles are carried over roads and pavements and into our waterways along with rainwater.

**What can be done about it?**

- Wash your car with eco-friendly soap or use a professional car wash where they recycle the water.
- Recycle or bin rubbish so it doesn't end up as litter.
- Arrange a litter pick.
- Dispose of dog poo in an available dog waste bin.

## Agriculture

**Possible pollutants and their impacts on waterways**

- Artificial fertilisers (containing nitrates), pesticides (containing phosphates), and animal waste (containing phosphates and nitrates) leach into groundwater and are carried into waterways with rain run-off from the land. This can lead to nutrient pollution in the water, causing an overgrowth of algae. The algae block light from aquatic plants and deplete oxygen levels as they decay, harming wildlife in the process.
- Animal waste also contains pathogens, such as harmful bacteria, viruses, and parasites. These can contaminate the water, making it dangerous to human and wildlife health.
- Soil eroded from bare land and livestock trampled riverbanks can block sunlight for aquatic plants, and harm wildlife by clogging up gills. It also carries excess nutrients that contribute to algal blooms.

**How do pollutants enter the river?**

The majority of agricultural pollutants are gradually washed into groundwater and waterways by the rain (run-off) over a large area.

**What can be done about it?**

- Fast-growing cover crops can be planted during off-seasons to prevent soil erosion.
- A variety of plants and trees planted along waterways can act as a barrier to pollution by filtering out pollutants.
- Using water troughs away from the riverbank reduces trampling of the soil and lessens the amount of animal waste entering the water.

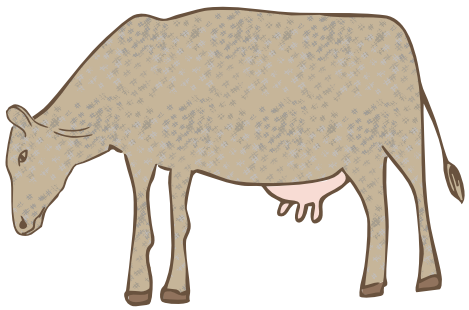


Image: Colin McLean.
Trees planted along Eddleston Water act as a barrier to pollutants

# Pollution Clean-up Game

Activity Instructions

## What you'll need

- A large, blue cloth/mat
- Litter pickers, nets or pegs (chopsticks if you want an extra challenge)
- Pollutant cards (p.42) or physical items to represent pollutants
- 6 x buckets or hula hoops
- 'Types of pollution' labels
- String and tape

## Setting up

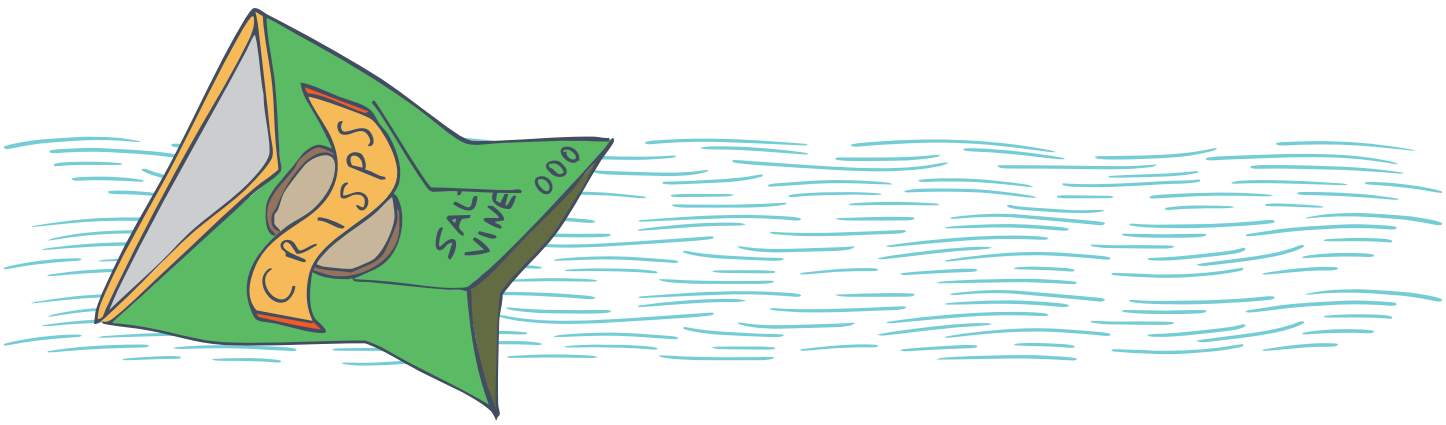
In your school grounds or a large indoor space, spread a blue cloth on the ground and scatter your pollutant cards on top. This will represent your polluted river. You may want to add a string to the cards to make them easier to pick up with your pollutant picker tool of choice.

If you're able to gather some physical items to represent the pollutants (real ear buds and plastic bottles, etc), it can make the game more engaging. Write each category of pollution (greywater, litter, etc) listed on the pollutant card resource on separate pieces of card. Set your buckets or hula hoops to the side of your 'river', each with a different category of pollution label attached to the front with tape.

## How to play

Explain to your group that you need help cleaning up this polluted river. Removing the pollutants is important, but working out where they came from and preventing them from entering the river again is just as important. Talk through the 6 different sources of pollution before starting the game. See the **Sources of Pollution Background Notes** to help with this.

- Divide the class into small teams of 4/5 and give each team an instrument for removing pollutants.
- Learners are to take turns to fish out a pollutant and sort it into the right bucket. Some pollutants have multiple sources.
- Anything natural and beneficial to the river should be left in the river.
- Groups have 5 minutes to catch and sort as many pollutants as they can.
- At the end of the game, points will be awarded to the class as a whole.
- 1 point for every pollutant caught and sorted into the right bucket, and 1 point for every natural item left in the river.
- 1 point lost for every pollutant caught and sorted into the wrong bucket, and 1 point lost for every natural item removed.
- Bonus 10 points if the class can clear the whole river of all of its pollutants.



## Make it more challenging!

Introduce a range of tool options for collecting litter from the river and ask your teams to decide together which one to use. A litter picker is designed for this type of task and would be the easiest tool to choose, but having pegs or chopsticks as an option will make the game more challenging.

## Game variations

If you don't have access to 'fishing tool' resources or would like a quicker version of this game, you could try these variations instead:

- Hide the pollutant cards in your school grounds for learners to find and then sort. If you want to cut down on printing, you could use stones to write pollutant names on and hide them instead.
- Jump straight to the sorting activity and ask pupils to sort pollutants into categories.

## Reflection questions

- Were there any pollutants that were hard to sort and why?
- Which instruments were the easiest to use and why?
- How would these types of water pollutants impact a river ecosystem?
- How can we help prevent some of these pollutants from entering our river?

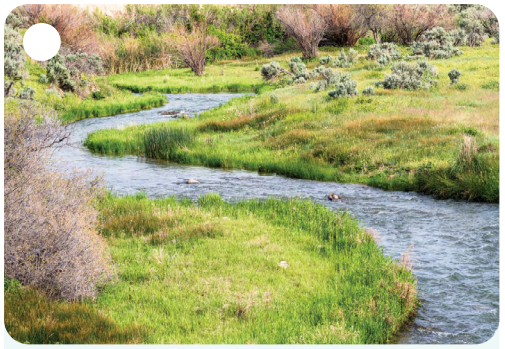
# Healthy River Signs

**Spotting these river features and wildlife can give us an idea about how clean the water is and how healthy the ecosystem is for wildlife in your local river spot.**

Native broadleaf trees keep the water cool and the riverbank stable.

A variety of native plants on the riverbank act as a barrier to pollution.

Deadwood helps to slow down the river and reduce riverbank erosion.



A meandering channel slows the water and reduces soil erosion.

Water pollution can make salmon and other types of fish more vulnerable to disease.

Dippers can only find their food in clean water.

Mayflies start their life in the water and are very sensitive to pollution.

Otters struggle to find food when water pollution affects their food supply.

# Unhealthy River Signs

**Spotting some of these can be a sign that pollution could enter the river or has already affected the water.**

Cows & sheep near the river trample the riverbank & contaminate the water with their waste.

A discharge pipe could be a sign of pollution if the discharge smells foul.

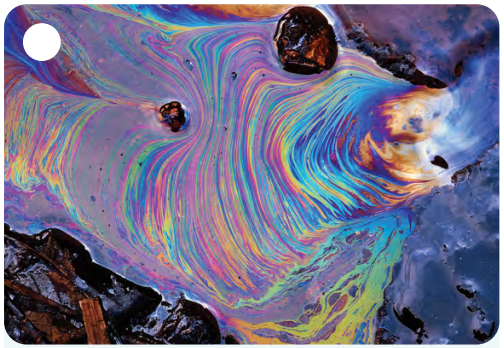
Pollution from a nearby road could wash into the river when it rains.

Straightened rivers have less water in dry seasons, so any pollution is more concentrated.

White, fragrant smelling foam could be a sign that household detergents entered the river.

Litter can release toxins & hurt wildlife.

Algal bloom is caused by fertilisers & sewage. The increase in nutrients causes algae to over-grow and use up too much oxygen.



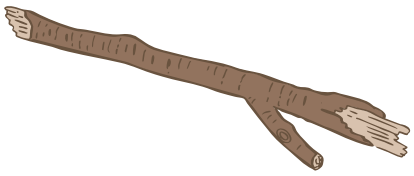
When petrol enters a slow river, it creates a rainbow film that stops oxygen from entering the water.

# Pollution Clean-up Game

## Pollutant Cards

**These cards can be used for the Pollution Clean-Up Game and sorted into different categories based on where the pollutants came from. Not all of the items are pollutants, some are natural and benefit the river.**

## Where did these water pollutants come from?



### Erosion
- Soil

### Agriculture
- Fertiliser
- Pesticide
- Manure
- Soil

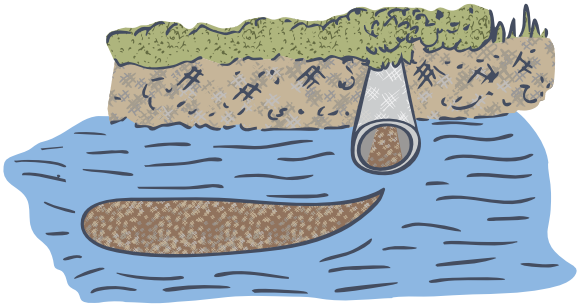
### Greywater & Sewage
- Wet wipes
- Ear buds
- Sewage
- Washing powder
- Soap
- Sanitary products
- Shampoo
- Dog Poo
- Dishwasher tablets

### Natural & beneficial
- Deadwood
- Pebbles
- Dead leaves

### Litter
- Wet wipes
- Ear buds
- Plastic bottles
- Sweet wrappers
- Cigarette packets
- Cigarette butts
- Nappies
- Takeaway containers
- Plastic straws
- Plastic bags

### Transport/roadside
- Oil
- Pieces of tyre
- Antifreeze

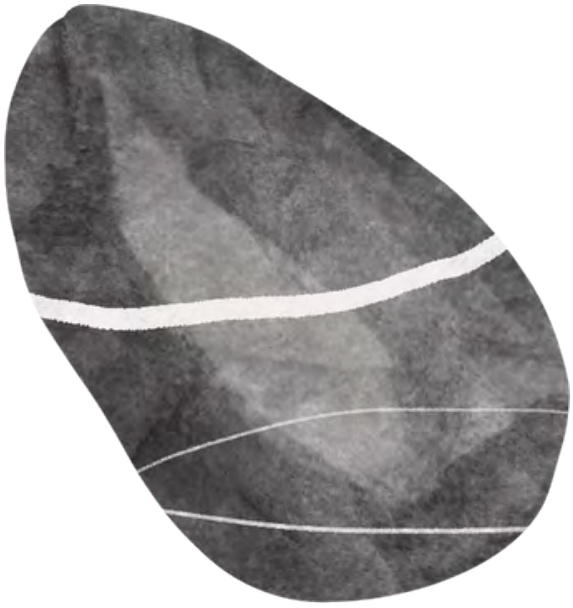
### Industry
- Hot water
- Oil
- Fertiliser
- Pesticides
- Soap



# Pollution Clean-up Game

Deadwood


Soil

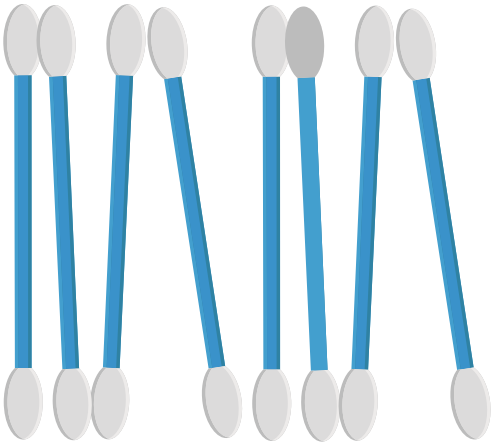


Pebbles

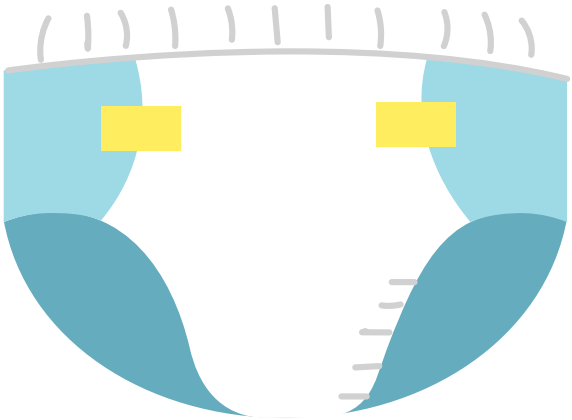
Dead leaves

# Pollution Clean-up Game

Wet wipes



Ear buds



Nappies

Cigarette butts

# Pollution Clean-up Game

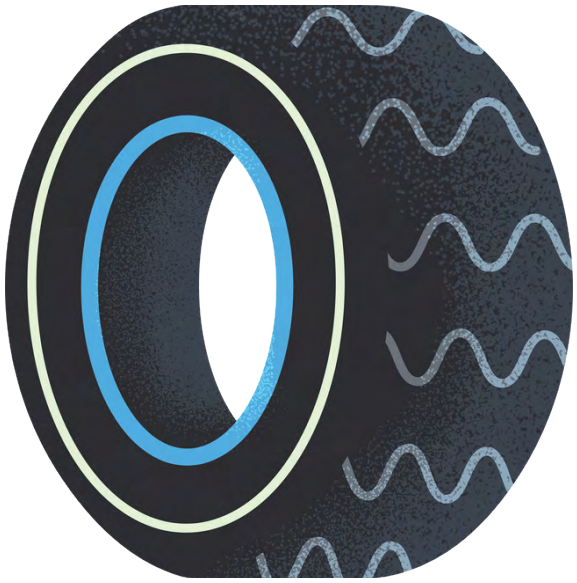
Plastic bottles


Sweet wrappers

Sewage


Oil

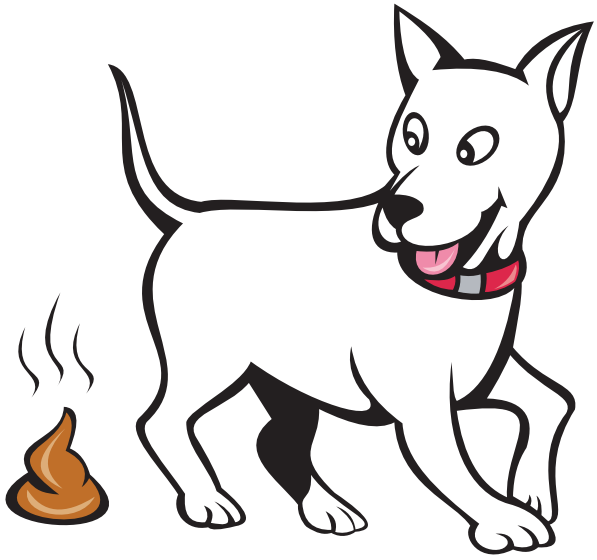
# Pollution Clean-up Game



Pieces of tyre

Manure

Antifreeze



Dog poo

# Pollution Clean-up Game

Fertiliser

Pesticide

Shampoo

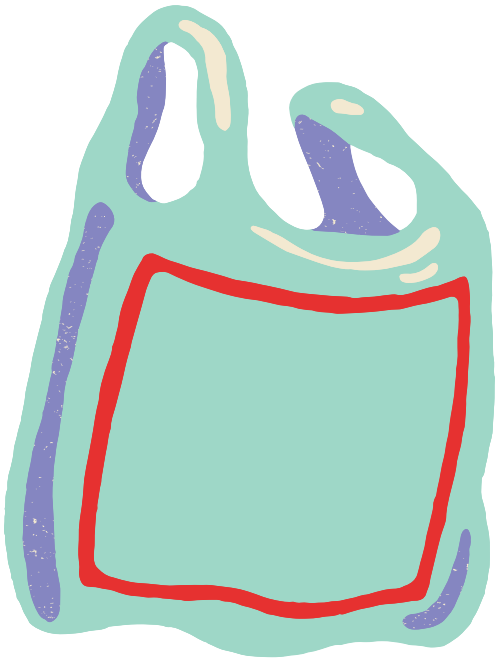

Washing powder

# Pollution Clean-up Game

Dishwasher tablets

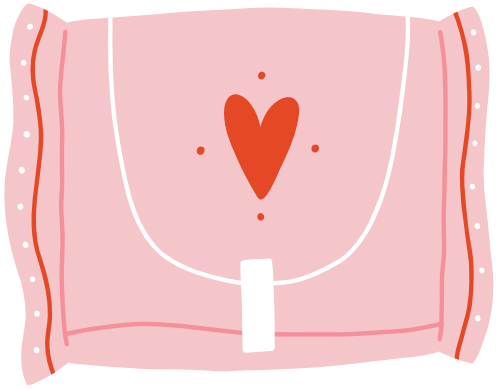

Soap

Takeaway containers



Plastic bags

# Pollution Clean-up Game



Sanitary products

Cigarette packets

Plastic straws

Hot water

# My Healthy River

| Location: | Team Name: | Weather: |
| --- | --- | --- |
| | | |

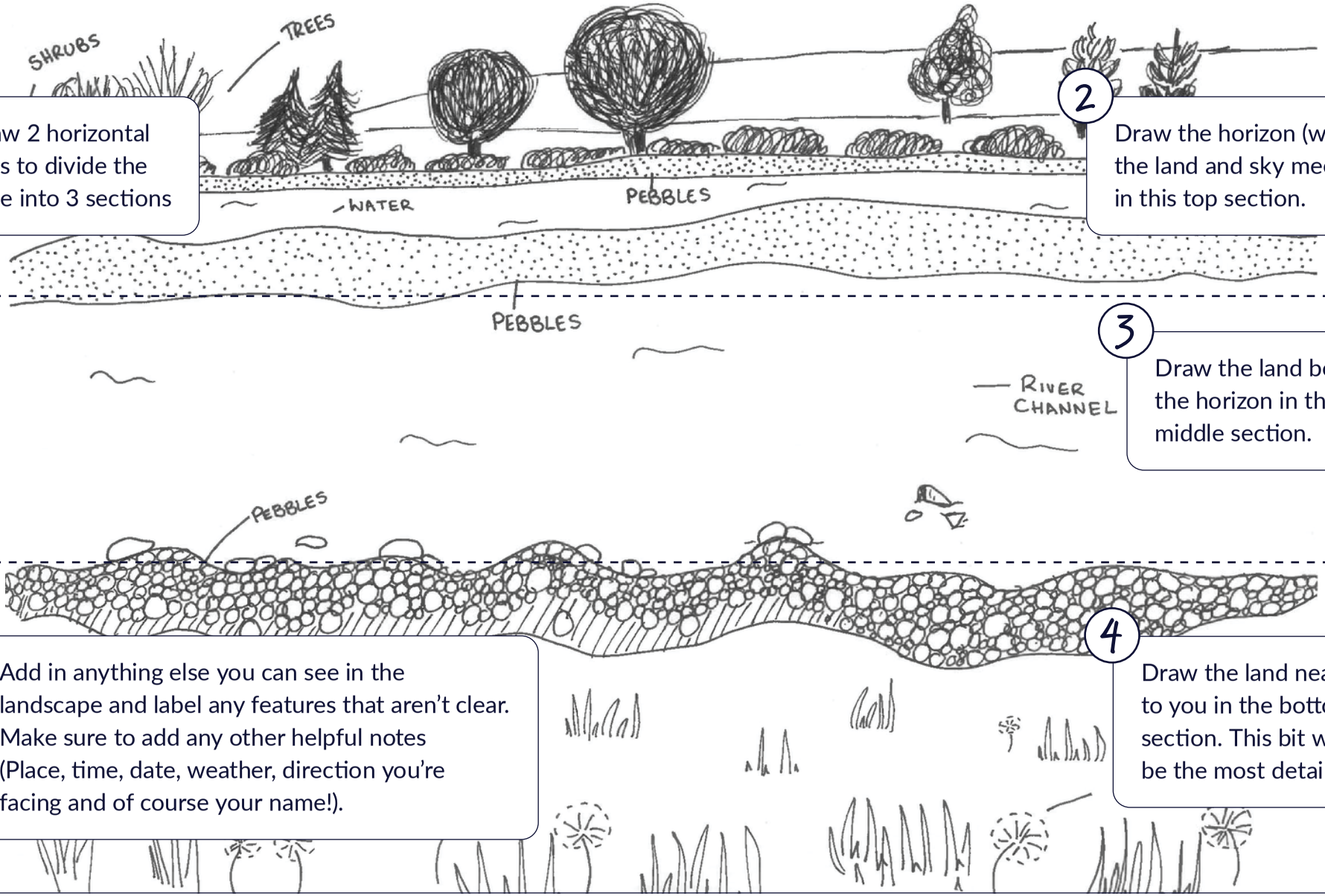
## Field Sketch

Image: Colin McLean

# My Healthy River

| Location: | Team Name: | Weather: |
|---|---|---|
| | | |

## Field Sketch




1. Draw 2 horizontal lines to divide the page into 3 sections

2. Draw the horizon (where the land and sky meet) in this top section.

3. Draw the land below the horizon in the middle section.

4. Draw the land nearest to you in the bottom section. This bit will be the most detailed!

5. 
   - Add in anything else you can see in the landscape and label any features that aren't clear.
   - Make sure to add any other helpful notes (Place, time, date, weather, direction you're facing and of course your name!).

# River Health Check

## Investigating Water Pollution: Instructions

### Page 1: Details & Signs

1. **Pollution Threats:** These are potential sources of pollution that can deliver pollutants into the water. Tick any you can see.

2. **Water Pollutants:** Here are signs that water pollution has entered the water. Tick any you can see.

3. **Trees:** Decide if the trees are conifer (most have needles and cones) or broadleaf (broad, flat leaves). If there is a good amount of both, tick both boxes. For the number of trees, choose a box closest to how the trees are set out along the river.

   **Trees act as a barrier to pollutants entering the water.**

4. **Animal Life:** Write down the names of any animal species you see; birds, invertebrates, mammals etc. Draw a tally for every new species you spot and add the total number in the circle. Tick yes if you see any dead fish as this can be a sign of water pollution.

   **A high number of animal species indicates good water quality for wildlife.**

5. **Litter:** Different types of litter can be found in our freshwater ecosystems. Those listed are some of the most common. These items can be washed into the river when it rains, enter through the sewage system, or are dropped directly into the water. Tick any you can see.

### Page 2: Testing Water Samples

1. **Collecting Water Samples:** Only collect water samples if you are with an adult. If it is safe to get close to the water, you can use a bucket and rope or a bottle attached to a stick to collect your sample. Transfer the collected water into smaller tubs or bottles for testing.

2. **Measuring Temperature:** Place your thermometer in your water sample and allow a few minutes before taking a reading.

3. **Measuring pH:** Use a pipette to add water drops from your sample onto your strip. A yellow litmus paper strip will turn red if the water is acidic and blue if it is alkaline. If you're using pH strips, compare the colours using the chart at the bottom of the 'testing water samples' page.

4. **Measuring Nitrates & Phosphates:** Use a pipette to add water drops from your sample onto your phosphate or nitrate strip. The colour chart on the test strip pack will guide you to read the results.

5. **Measuring the Smelly Scale:** Don't get too close to your sample, but hold it at chest height and see if you can smell anything. Some types of pollution have an unpleasant smell. Circle whether there is no smell, a slight smell, or a strong smell.

# River Health Check

## Investigating Water Pollution: Details & Signs

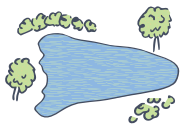
Name/ Team Name:

Weather:

Location:

### Type of freshwater ecosystem

☐ Pond:



☐ Lake:

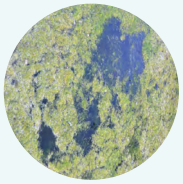
☐ River:

Other: .....

### 1 Pollution Threats

- ☐ Straightened channel
- ☐ Leaking Discharge pipe
- ☐ Nearby road
- ☐ Livestock

### 2 Water Pollutants



- ☐ Algal Blooms
- ☐ Rainbow oil sheen
- ☐ Litter
- ☐ Fragrant, white foam

### 3 Plant life: Trees

**Types of trees**

☐ Broadleaf ☐ Conifer

**Number of trees**

☐ Woodland ☐ Small groups

☐ Individual

### 4 Animal Life

**No. of species:**

**What animals can you see nearby?**

.....

.....

.....

Did you see any dead fish? ☐ Yes ☐ No

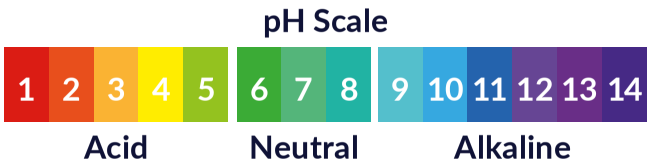
### 5 Litter

- ☐ Plastic bags
- ☐ Cotton buds
- ☐ Coffee cups
- ☐ Sweet wrappers
- ☐ Plastic bottles
- ☐ Wet wipes
- ☐ Drink cans
- ☐ Other: .....

# River Health Check

| Sample | 1. Water source<br>Describe where you collected your water sample from | 2. Temperature | 3. pH<br>°C | 4. Nitrates<br>PPM | Phosphates | 5. Smelly scale<br>Circle your answer |
|---|---|---|---|---|---|---|
| 1 | | | | | | No smell Slight smell Strong smell |
| 2 | | | | | | No smell Slight smell Strong smell |
| 3 | | | | | | No smell Slight smell Strong smell |
| 4 | | | | | | No smell Slight smell Strong smell |
| 5 | | | | | | No smell Slight smell Strong smell |
| 6 | | | | | | No smell Slight smell Strong smell |

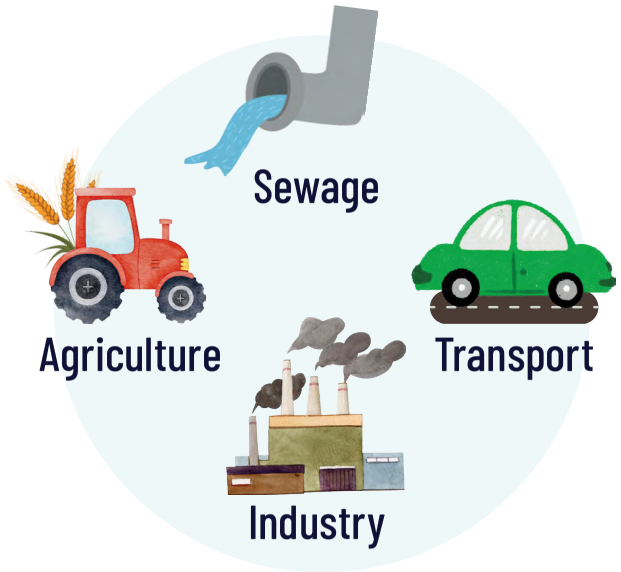
°C This symbol means temperature is measured in degrees Celsius

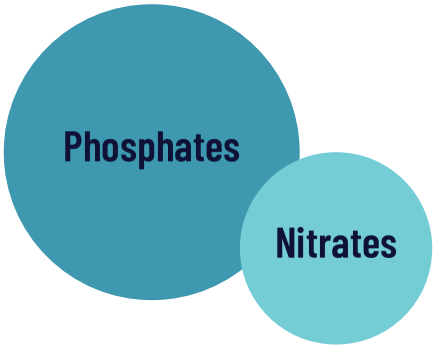



PPM This symbol means nitrates and phosphates are measured in 'parts per million'.

# Nutrient Pollution

## Where does nutrient pollution come from?




These pollutants contain phosphates, nitrates or both.

Balanced levels of phosphates and nitrates are important nutrients needed for plant growth. Too much of them can cause big problems, though, especially in our precious freshwater ecosystems.

Nutrients from pollutants on land are either washed into the river by rain or enter the water at a specific point, like a discharge pipe.

### Pollutants


Manure


Wastewater


Dog poo

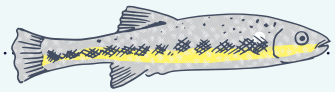

Pesticide


Fertiliser


Sewage

These things become pollutants when they cause harm to the environment.

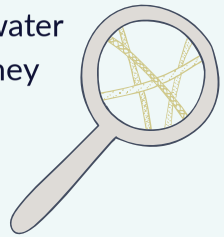
## How does nutrient pollution hurt freshwater habitats?



### Algal Bloom

**The fast overgrowth of a tiny plant called algae.**

Algal bloom can block sunlight, stopping plants in the water from getting the light they need to make food.



Sometimes these algal blooms produce toxins that make humans and animals ill. These toxins can enter the food chain and cause problems for the whole ecosystem.

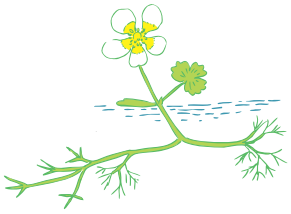
When the algae die, bacteria break them down. This uses up lots of the oxygen in the water. With less oxygen, fish and other animals may not be able to breathe and could die.

# Nutrient Pollution

**Nutrients are chemicals that help living things grow and stay healthy. There are many different types of nutrients, but here we will focus on nitrates and phosphates. In an ecosystem, these nutrients move through soil, water and sometimes air in a natural cycle. They are essential because they help plants grow.**

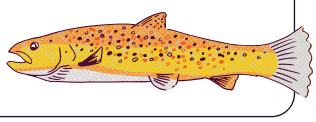
Have a go at answering the questions below.

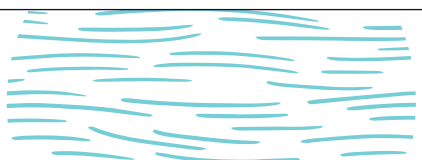
**In what ways do you think a healthy balance of nutrients is important to a river ecosystem?**
*Think about the importance of plants to an ecosystem.
What might happen to other living things if plants disappeared from the river?



Phosphates and nitrates (nutrients) are important for nature, but can cause big problems if there is too much of them.

**Can you think of something that is usually good, but can cause problems if there is too much of it? Write or draw your answers below.**





# Nutrient Pollution

ANSWER SHEET

**Nutrients are chemicals that help living things grow and stay healthy. There are many different types of nutrients, but here we will focus on nitrates and phosphates. In an ecosystem, these nutrients move through soil, water and sometimes air in a natural cycle. They are essential because they help plants grow.**

Have a go at answering the questions below.

**In what ways do you think a healthy balance of nutrients is important to a river ecosystem?**
*Think about the importance of plants to an ecosystem.
What might happen to other living things if plants disappeared from the river?

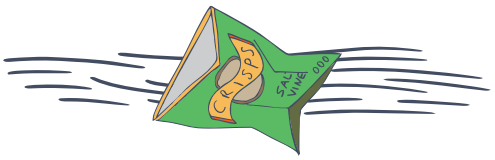
- Nutrients are important to help plants grow and stay healthy.
- If there are fewer plants, there will be less food and shelter for wildlife.
- Fewer plants will impact everything in the food chain as there will be less food to eat at every level.
- There will be less oxygen in the river (plants create oxygen whilst making their own food).
- There will be less biodiversity.

Phosphates and nitrates (nutrients) are important for nature, but can cause big problems if there is too much of them.

**Can you think of something that is usually good, but can cause problems if there is too much of it? Write or draw your answers below.**

- Sun: The sun provides energy for plants to grow, and it gives humans vitamin D. If there is too much, plants can lose water, and humans can get sunburnt.
- Water: Water is vital for a river (and for all life on Earth), but too much can cause flooding and soil erosion.
- Food: We need food to survive but too much all at once could make you sick.

# Nutrient Pollution



## Check out the 'Nutrient Pollution' poster on p.55 to help you answer these questions.

Name the 2 types of nutrients that are found in the pollutants on the poster.

Name 3 different pollutants that can cause nutrient pollution.

What is the name of the tiny plant that can overgrow when there are too many nutrients in the water?

How does an algal bloom affect plants growing in the water?

What can enter the food chain and cause problems for the whole ecosystem?

What other ways can algal bloom be bad for food chains in a river ecosystem?

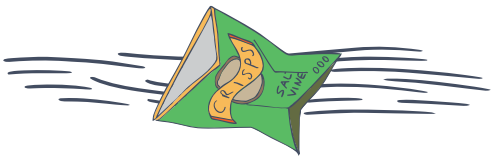
## How can we protect our freshwater ecosystems from nutrient pollution?

Nature plays an important role in protecting our rivers, lakes, lochs and ponds from water pollution. Planting native trees and plants along a riverbank will act as a protective barrier, filtering out pollutants before they reach the water.

**How do native trees and plants growing along riverbanks help protect rivers from nutrient pollution? (There might be more than one right answer. Tick every answer you think is correct.)**

- ☐ Their roots take in extra nutrients before they reach the water.
- ☐ They add extra nutrients to the river to help water plants grow.
- ☐ Their roots keep the soil together, so soil and nutrients don't get washed into the river.
- ☐ They stop all of the rain from reaching the water.
- ☐ They slow down any rainfall heading to the water, allowing time for it to soak into the ground.

# Nutrient Pollution



ANSWER SHEET

| | |
|---|---|
| Name the 2 types of nutrients that are found in the pollutants on the poster. | **Phosphates and nitrates** |
| Name 3 different pollutants that can cause nutrient pollution. | **Any 3: Manure, dog poo, wastewater, pesticide, fertiliser, sewage** |
| What is the name of the tiny plant that can overgrow when there are too many nutrients in the water? | **Algae** |
| How does an algal bloom affect plants growing in the water? | **It can block sunlight and stop river plants from growing** |
| What can enter the food chain and cause problems for the whole ecosystem? | **Toxins** |
| What other ways can algal bloom be bad for food chains in a river ecosystem? | **Without plants, there will not be enough oxygen or food for herbivores to survive. This could cause the whole food chain to break down.** |

## How can we protect our freshwater ecosystems from nutrient pollution?

Nature plays an important role in protecting our rivers, lakes, lochs and ponds from water pollution. Planting native trees and plants along a riverbank will act as a protective barrier, filtering out pollutants before they reach the water.

**How do native trees and plants growing along riverbanks help protect rivers from nutrient pollution? (There might be more than one right answer. Tick every answer you think is correct.)**

- [x] Their roots take in extra nutrients before they reach the water.
- [ ] They add extra nutrients to the river to help water plants grow.
- [x] Their roots keep the soil together, so soil and nutrients don't get washed into the river.
- [ ] They stop all of the rain from reaching the water.
- [x] They slow down any rainfall heading to the water, allowing time for it to soak into the ground.

# Water Pollution: Glossary

You can use this page for reference or print & cut out the rectangles for a plenary game of mix and match.

| | |
|---|---|
| Water Pollution | When harmful substances contaminate a river, loch/lake, ocean, or other body of water. |
| Water Scarcity | When there isn't enough freshwater to meet human and environmental needs. |
| Algal bloom | A fast overgrowth of algae caused by too many nutrients in the water. |
| Point source pollution | Pollution that comes from a specific location, like a discharge pipe. |
| Surface run-off | When rainwater is unable to soak into the ground, it runs over the surface. |
| Dissolved Oxygen | The amount of oxygen that is mixed into water. |
| pH | The measure of how acidic or basic something is. |

| | |
|---|---|
| Pollutant | Something that is introduced to the environment that causes harm. |
| Water cycle | The movement of water around Earth as it changes between its different states. |
| Reservoir | A man-made loch/lake that stores water. |
| Diffuse pollution | Pollutants that seep into the water over a large area. |
| Erosion | Water, wind or glaciers remove and transport rock and soil from the Earth's surface. |
| Indicator species | A plant or animal that helps us to understand the health of an ecosystem or the environment. |
| Temperature | A group of living things that share how hot or cold something is. It is measured in degrees Celsius. |

# Curriculum Links

## Curriculum for Excellence

| CfE Experiences & Outcomes | Freshwater | River Health Check |
|---|---|---|
| SCN 2-05a: The water cycle and changing states | X | |
| SCN 2-18a: Properties and uses of water | X | X |
| TCH 2-06a: Impact of lifestyles on environment & sustainable living | X | X |
| SOC 2-08a: Environmental impact of human activity | X | X |
| HWB 2-23a: Working with others | X | X |

## National Curriculum

| KS2 | Freshwater | River Health Check |
|---|---|---|
| **SCIENCE** | | |
| **Yr. 4:** The water cycle and states of matter | X | |
| **Yr. 4:** Potential threats of changing environments | X | X |
| **GEOGRAPHY** | | |
| Understand key aspects of rivers and the water cycle | X | X |

## Sustainable Development Goals (SDG)


### Freshwater

This lesson supports SDG 15 as learners explore the importance of conserving freshwater habitats and develop a sense of environmental stewardship through conserving water.

### River Health Check

This lesson supports SDG 15 as learners explore the importance of protecting an inland water-related ecosystem while developing a sense of environmental stewardship through water conservation.


This lesson supports SDG 6 through raising awareness of the scarcity of freshwater and the threat of pollution. Learners are encouraged to take action through saving water and reducing waste.

This lesson supports SDG 6 by exploring ways to protect freshwater habitats from pollution caused by human activity and improving water quality.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## Project Delivery Partners

## Project Funders

Co-funded by the European Union

**Tweed Forum:** At the heart of land and water management on Tweed.

**Destination Tweed:** Destination Tweed is a unique project which aims to celebrate and share the nature, history and stories of the River Tweed and deliver significant economic, environmental, educational and social benefits to the South of Scotland and North Northumberland.

**Co-funded by the European Union**. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

Original illustrations by Louise Kirby. Graphic Design by Gavin Reid Design.
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