**Turbidity and erosion**

Lesson plan

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| Victorian Curriculum F–10[[1]](#footnote-1) links:  **Science**  **Levels 3 and 4**  **Science Understanding**  **Science as a Human Endeavour**  Science knowledge helps people to understand the effects of their actions  **Biological sciences**  Different living things have different life cycles and depend on each other and the environment to survive  **Chemical sciences**  Objects are made of materials that have observable properties  **Earth and space sciences**  Earth’s surface changes over time as a result of natural processes and human activity  **Geography**  **Levels 3 and 4**  **Geographical Knowledge**  **Diversity and significance of places and environments**  Types of natural vegetation and the significance of vegetation to the environment, the importance of environments to animals and people, and different views on how they can be protected; the use and management of natural resources and waste, and different views on how to do this sustainably  Similarities and differences in individuals’ and groups’ feelings and perceptions about places, and how they influence views about the protection of these places |

## Introduction

Water may flow directly into a waterway, over land as run-off or through drains as stormwater. Either way, this water can collect silt, clay or soil particles and become a significant contributor to waterway pollution. An increase in turbidity results in a decrease in the water clarity. Increased turbidity has harmful effects on aquatic animals and plants. Identifying the causes and effects of increased turbidity on the local catchment helps the community to understand and appreciate the influences of their own actions on waterway health.

This lesson plan explores the link between turbidity (a measure of water clarity) and erosion. It highlights the effect of high levels of turbidity on the survival of living things in freshwater environments and the link between turbidity and erosion.

**Activity 1: Turbidity explained**

Students explore the factors that affect turbidity in waterways.

### Activity 2: Linking turbidity and erosion

In this activity students investigate how streambank erosion affects the turbidity of a waterway.

### Activity 3: Measuring and interpreting turbidity

Students measure and compare turbidity readings using a turbidity tube.

### Activity 4: Erosion in action game

Students identify ways in which we can minimise the impacts of erosion on the quality of water in the creeks around Melbourne.

### Equipment

Three water samples in large jars e.g. tap water, a relatively clear creek water sample and a turbid creek/river water sample.

A second jar of tap water

Containers of sand, silt, clay, soil, milk, tea and/or soy sauce

Images of creek or river banks showing varying degrees of erosion damage

At least one turbidity tube (and a turbidity rating chart, if required)

Three buckets of water samples of varying turbidity (i.e. tap water, clear creek water, turbid water)

Whiteboard and markers

### Preparation

Organise to collect the water samples from different sites.

## Activity 1: Turbidity explained

In this activity, students explore the factors that affect turbidity in waterways.

Activity steps

### Encourage students to connect with freshwater environments by asking them to recall activities they do in and around rivers and creeks. Explain that rivers and creeks can differ in water clarity with some being clear and others murky, stained brown, muddy or cloudy.

### Ask: Why are some rivers and creeks clear and others murky? Discuss what might contribute to waterway clarity.

### Explain and define stormwater and run-off. Water running overland into waterways is called run-off (or surface run-off), and ‘stormwater’ may be differentiated as water flowing in through drain outlets.

### Explain that we are going to investigate different types of water clarity today and also how it is measured.

1. Show the two freshwater creek samples and the sample of tap water. Ask students to describe each sample. Descriptions may include:

* turbid creek water: muddy, cloudy, dirty, brown, murky and unhealthy
* clearer creek water: quite clear, quite healthy
* tap water: clear, see-through, healthy.

1. If students say that tap water, which will always be clearest, is the healthiest discuss this and make the point that some particulate matter is important for the food web.
2. Ask students if all clear water is safe to drink and to explain their reasoning. Ensure that students understand that even if creek water looks clear and safe that it could still contain lots of microscopic disease-forming microscopic bacteria. Don’t drink it. Tap water is very safe to drink.
3. Explain that the scientific term for cloudy water is ‘turbid’ i.e. muddy water has a high turbidity and clear water has a low turbidity. Define units of measurement nephelometric turbidity units (NTUs). The term was named after the Greek word for cloud (Nephel) so ‘nephelometric’ means measuring cloudiness.

## Activity 2: Linking turbidity and erosion

In this activity students investigate how streambank erosion affects the turbidity of a waterway.

### Activity steps

1. Ask what makes the water turbid? (Particles of clay, silt, mud, sand and soil). Explain that some of these particles are suspended in the water and affect its clarity. Show each of the different samples in jars (sand, silt, clay, soil, milk, tea etc.) and observe the differences in suspended particles.
2. Ask how could soil get into the water? Discuss the process of erosion with students.
3. Show pictures of different creek or river banks and discuss the amount of erosion they can see. Discuss how plants (vegetation) help to prevent erosion.

Field hints: If you have the opportunity to take the students to a creek, in pairs, they could investigate the hypothesis that vegetation on the creek banks reduces the amount of erosion. Students could explore the banks and record their ideas with photographs, drawings or field notes. The root systems of grasses, trees, shrubs and water plants will hopefully be present. They may find an area with no plants and see an ‘erosion scar’. Have students define the waterway you are visiting as clear or turbid.

## Activity 3: Measuring and interpreting turbidity

Students measure and compare turbidity readings using a turbidity tube.

### Activity steps

1. Demonstrate the key points to guide students in measuring the turbidity of the water samples:

* Mix/shake the water sample
* Hold the opening of the turbidity tube level with your belly button.
* View the wavy lines and gently pour the sample down the tube, stopping just as the wavy lines are no longer distinguishable.
* Take a reading using the scale on the side of the tube.

1. Students use the turbidity tube to measure the turbidity of the three water samples. Record the results either in centimetres from the bottom of the tube or in NTUs Share each group’s results, highlighting consistency between results and any differences in their rating. Discuss how differences in measurements could occur and how to ensure accurate measurements. Ask: Why is accuracy important?
2. Explain that while there may be small over- or under-estimations, a turbidity tube provides a good estimate of turbidity. If your turbidity tubes are not calibrated in NTUs you could introduce the turbidity rating chart to interpret results. Note that in a classroom situation, you can compare the results in centimetres from the bottom of the tube.
3. Ask students: Why might turbidity be a bad thing? Explain that suspended particles reduce the amount of light that passes through water. This can reduce the growth of submerged aquatic plants (underwater plants) by limiting photosynthesis. A lack of light can also make it difficult to see, so predators that feed in the water like fish and birds cannot hunt as successfully.
4. Also particles absorb heat so the water temperature rises faster than it would in clear water. Warmer water can affect plant growth, the behaviour or animals and at extreme levels, animals may die.
5. Sediment particles will eventually settle on the riverbed, on and in between the gravel and rocks. This decreases the amount and type of habitat available for creatures that live and lay eggs on and in those crevices.
6. Sediments can clog fish gills, inducing disease, slower growth and, in extreme cases restrict oxygen and cause death. Other pollutants may also stick to the sediment particles. (If a whiteboard is available, you can draw a diagram to explain these effects.
7. The fact that sediments enter a waterway is a natural process but there are factors that can affect how much enters the water. In Australia, compared with overseas countries, we have old soils that are more likely to erode into our waterways.
8. Discuss different types of land use that students have seen or heard of being nearby rivers. Discuss how these areas may affect turbidity in upstream and urban areas.
9. Ask: What might the effect on turbidity be from the following groups:

* builders
* farmers
* Landcare groups? Note that you might need to explain what a Landcare group is.

1. Ask: how might these groups improve the turbidity in nearby waterways?

## Activity 4: Erosion in action game

Students identify ways in which we can minimise the impacts of erosion on the quality of water in the creeks around Melbourne.

**Activity steps**

1. Divide class into 3 groups:

Group 1 are shrubs, they kneel down in a line and can only move their arms (leaves).

Group 2 are trees, they line up behind the shrubs and can only move their arms (branches).

Group 3 are dirt, they must try to enter the river (behind the trees) and get past the vegetation without being stopped (touched by the shrubs/trees).

1. No-one (or not many) will get through the first time, so next round cut down some trees and pull out some shrubs (these can now become dirt).
2. Replay game with fewer plants, and then start to re-vegetate and see what difference the plants make to dirt entering the river.
3. Ask students to reflect on how vegetation affected how much dirt could enter the waterway. Ask what might have been the effect on the waterway each time something changed? What effect might there have been on the living things in the waterway?
4. Ask students what actions they could take to help prevent erosion and improve waterway health, for example:

* participating in local creek or river revegetation program, for example, through a community Landcare project.
* stay on paths when walking along rivers, avoiding trampling vegetation.
* make sure litter goes into the bin and not into stormwater.
* cover stormwater drains with scrunched-up sheets of paper to stop dirt when doing garden, building and driveway works at home that need lots of digging and dirt piling.

1. Further questions could include:

* How might turbidity change over time?
* What can the effect of pollution be in a creek?
* How might forestry impact on erosion and turbidity?
* How could we reduce the amount of stormwater at school?

## Teacher background

### Key messages

Rivers and creeks are the backdrop to lots of recreational activities (walking the dog, riding a bike) and an important part of Melbourne’s liveability.

Our waterways support a diverse range of plant and animal life, including native fish, frogs and platypuses. They are worth looking after.

Reducing the amount of stormwater that can runoff in our city can improve waterway health.

Installing rainwater tanks or wetlands can help slow and reduce stormwater.

### Turbidity

Turbidity is a measure of the clarity of water. As suspended particulate matter including clay, silt, detritus and plankton in the water increases, the clarity decreases and the water takes on a muddy appearance. Turbidity does not measure the quantity of suspended matter in the water. This is measured as suspended particulate matter (SPM), also called suspended solids (SS). While turbidity is not a direct measure SPM, they are highly correlated and turbidity can be used to indicate the likely effects of suspended matter.

### How is it measured?

There are several ways turbidity can be measured but all relate to nephelometry, which is a measurement of the size and concentration of particles in water by analysis of light scattered by the water. The greater the scattering of light by suspended particles the greater the turbidity. The measurement unit for turbidity is the nephelomeric turbidity unit (NTU).

Correlations between turbidity and SPM are difficult because differences in size, shape and composition of the suspended particles will affect reflective and absorbance characteristics and hence the scattering of light. Therefore, SPM and turbidity measures within a single site may show a reasonable correlation (as long as the sediment sources are consistent) but this correlation is unlikely to be transferrable to other sites.

Turbidity should be measured as soon as a sample is taken, as suspended matter may stick to the walls of the container or bind together through physical and chemical processes (e.g. temperature).

Turbidity tubes measure the absorbance of light rather than the scattering of light. While they will at times overestimate or underestimate turbidity and do not measure very low levels accurately, they are generally a good estimate of the true turbidity. The Secchi disk has been used extensively in the past to measure water clarity, particularly in deep water environments such as lakes. Secchi disks are not recommended for monitoring turbidity as there are no related water quality guidelines.

**Sources of turbidity**

Most of the sediment in rivers and streams comes from catchment and stream bank erosion. Sediment entering waterways is a natural process but human land use can result in excessive quantities entering waterways. Agriculture, forestry and housing developments can all lead to extensive soil disturbance, erosion and sediment runoff to rivers and streams. Unsealed roads can also contribute substantial quantities of sediment to waterways. Carp, an introduced pest fish species, can increase the mobilisation of sediment due to its habit of digging in stream sediments and dislodging macrophytes, resulting in unstable stream beds.

Other sources of sediment include sewage effluent discharges, industrial discharges, septic tank discharges and destabilisation of bed and banks after the removal of snags and macrophytes.

**Natural variation**

Levels of turbidity in water will vary depending on the physical and chemical activities in the river. Typically, turbidity levels increase from headwaters to lowlands. The old geology and associated high levels of clays result in naturally higher levels of turbidity in our rivers and streams compared to those overseas. Extensive clearing has made Australian soils more prone to erosion, increasing sediment loads and turbidity.

Turbidity levels vary over time. High flows (whether seasonal or episodic) are typically associated with increased inputs of sediment. If storms follow bushfires, even higher sediment loads can be expected.

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