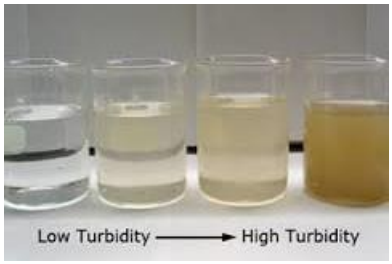
Station 3 – Dirty water

Students test the turbidity of a 'dirty' sample (a turbid sample which is analogous to polluted water). They then use a hand held carbon microfilter to purify the sample, re-testing and reflecting on the differences. Connections can be made to the difficulty of 10% of the world's population in accessing clean drinking water. Students choose from a variety of natural and artificial materials to design a filter, test a turbid sample and compare results.

Key concepts

The water we drink has been around for millions of years. It travels through time and space in the water cycle, from oceans, the air, the earth's surface and underground. During this cycle it is cleaned naturally but there are also many opportunities for it to become contaminated too.



Turbidity is a measure of how much light passes through water and it is caused by suspended solid particles that scatter light. These particles may be microscopic plankton, stirred up sediment or organic materials, eroded soil, clay, silt, sand, industrial waste or sewage. Bottom sediment may be stirred up by such actions as waves or currents, bottom feeding fish, people or animals wading or storm runoff. http://learnweb.harvard.edu

Turbidity is an important measure for water quality for several reasons:

- Suspended particles absorb heat, so water temperature rises faster in turbid water, which means turbid water is more susceptible to changes in dissolved oxygen than clear water. Oxygen diffuses to the atmosphere in warmer water.
- If penetration of light into the water is restricted, photosynthesis of green plants in the water is also restricted. This means less food and oxygen is available for aquatic animals.
- Suspended silt particles eventually settle into the spaces between rocks and gravel on the bed of a water body and decrease the amount of available habitat for aquatic animals.
- Fine particles suspended in the water carry harmful bacteria and attached contaminants, such as excess nutrients and toxic materials.

Turbidity is affected by:

- Rainfall and catchment runoff
- Catchment soil erosion
- Bed and bank erosion
- Bed disturbance e.g. by introduced fish species such as carp
- Waste discharge
- Stormwater discharge
- Excessive algal growth
- Riparian vegetation
- Flow
- Waterway type
- Soil types

http://education.dec.wa.gov.au/ribbons-of-blue

Turbidity is usually expressed as nephelometric turbidity units NTU. Nephos is the Greek word for cloudy. Turbidity is easily measured with a turbidity tube: a long thin plastic tube with a scale on the side. Alternatively turbidity may be estimated from Secchi depth determination or measured with a probe and turbidity meter.

Excessive turbidity in drinking water is aesthetically unappealing and may also represent a health concern. Turbidity can provide food and shelter for pathogens. If not removed, turbidity can promote regrowth of pathogens in the distribution system, leading to waterborne disease outbreaks such as gastroenteritis. Although turbidity is not a direct indicator of health risk, numerous studies show a strong relationship between removal of turbidity and removal of protozoa. The particles of turbidity provide "shelter" for microbes by reducing their exposure to attack by disinfectants. Microbial attachment to particulate material has been considered to aid in microbe survival. Fortunately traditional water treatment processes have the ability to effectively remove turbidity. water.usgs.gov/edu/turbidity.html

748 million people in the world do not have access to safe water. This is roughly one in ten of the world's population. (*WHO/UNICEF Joint Monitoring Programme (JMP) Report*).

Over 500,000 children die every year from diarrhoea caused by unsafe water and poor sanitation - that's 1,400 children a day. (*Inter-agency Group for Child Mortality Estimate (IGME) 2014, led by UNICEF and WHO).*

Women in Africa and Asia often carry water on their heads weighing 20kg, the same as the average airport luggage allowance. (*UNDP: Human Development Report, 2006: page 34-35*)

Clean water and hygiene education are some of the most effective ways to prevent child disease and death. The Water Lab is donating $20 a month (50 cents per participant) to Water Aid: www.wateraid.org to support their programs that help to improve the quality of water and decrease water related illnesses. Also by reducing the time needed to collect water it means there is more time for children to attend school and adults to work. WaterAid's vision is of a world where everyone has access to safe water and sanitation. They work in 26 countries across Africa, Asia, Central America and the Pacific region to transform lives by improving access to safe water, hygiene and sanitation in some of the world's poorest communities.

Images

http://www.fondriest.com/news/turbiditymeasurement.htm beakers
http://www.merchantcircle.com turbidity barrier
http://www.nyabushozi.org collecting dirty water
http://tap.unicefusa.org/ vendor machine
https://www.stanford.edu giardia

Water literacy list

Catchment: The area of land that catches the water and drains it to the lowest place. It is bounded by hills or mountains from which all runoff water flows down into a dam or the ocean.

Erosion: The process by which the surface of the Earth gets worn down. It can be caused by natural elements such as wind and rain or repetitive movement made by animals like cows or people.

Filtrate: The clear liquid that has been filtered. http://www.mikecurtis.org.uk

Filtration: The process used to separate a solid (or suspension) from a liquid. http://www.mikecurtis.org.uk

Microbe: Single-cell organisms so tiny that millions can fit into the eye of a needle. They are the oldest form of life on earth. www.microbeworld.org

NTU: Nephelometric turbidity unit. Nephos is the Greek word for cloudy.

Pathogen: A biological agent that causes disease or illness to its host e.g. giardia. www.sciencedaily.com

Protozoa: Single-celled eukaryotes (organisms whose cells have nuclei) that commonly show characteristics usually associated with animals e.g. mobility. They are too small to be seen with the naked eye. www.sciencedaily.com

Runoff: Occurs when there is more water than land can absorb. The excess water flows across the surface of the land and into nearby drains, creeks, rivers or wetlands.

Silt: Fine earth particles matter suspended and carried by moving water and deposited as sediment.

Turbidity: The measurement of how murky the water is i.e. the amount of suspended material in the water.

Teacher reference

Water Quality Teachers Notes Ribbons of Blue Waterwatch WA. Link to pdf

Background to water quality testing. Waterwatch NSW Teacher Manual Section 4. Link to pdf

Nightcap Water Treatment Plant: Rous Water's water treatment plant process explained. Link to pdf

AWA We all use water: Pathogens. Link to pdf

Hawa Oumarou Dicko from Mali talks about the challenge of walking miles every day to collect water.
http://www.youtube.com/watch?v=7s7pz_xdy38

This video shows the issues and positive impacts of World Vision with caped wells and pumps.
http://www.youtube.com/watch?v=p2qJA80E0Zk

Link to our local water supply and sustainable water use

Healthy catchments mean healthy water. Our daily actions can impact on the water quality as soils, oils, pesticides, dog poo, detergents, rubbish and other things wash down the drain and into the creeks and rivers. Our water supply mainly comes from Rocky Creek Dam (a healthy catchment) but also from the Wilsons River. Education and a Wilsons River Catchment Plan are helping to support the community to take action for a healthy catchment and improve the water quality in the river. This will have long term social, economic and environmental benefits for our community. Rous Water's vision for the future of our water catchment areas is for '*healthy, productive catchments with fully functioning ecosystems that produce clean water'.* Find out more at Protecting our Catchment: *http://www.rouswater.nsw.gov.au/cp_themes/default/page.asp?p=DOC-WRA-67-28-02*

Kids section

Catchment Detox: The challenge is to manage a river catchment so that after 100 years you have a healthy economy and a healthy environment. http://www.catchmentdetox.net.au/play-game/

Science scenarios - Research and design an experiment that will show each statement to be correct:

- Silt will settle to the bottom when the water is still.
- Turbidity makes the water warmer.
- There is less oxygen in turbid water.
- Rain runoff causes soil erosion.
- Plants growing along the edge of creeks help to reduce soil erosion and turbidity.

Experiments

1. Is the water really clean?

Even if you have managed to produce 'clear 'water, how do we know whether it is really 'clean'?
What you need:
Samples of clear liquids e.g. sea (salty) water, sweet water (sugary), tap water, distilled water, water coloured with blue ink and shallow dishes (or saucers) for evaporation
What you do:

1. Look at a selection of clear liquids and predict which are pure and which have material dissolved in them.
2. Put each type of liquid in a shallow dish (labelled).
3. Place the dishes in a warm place and leave to evaporate.
4. Once evaporation is complete observe and record what is on each dish. Discuss which of the liquids would be useable and for what purpose e.g. to drink, to cook, to wash, to water the garden etc.

PREDICT, OBSERVE & EXPLAIN.
Source: Primary Science pp129 Sept/Oct 2013

2. Make and measure turbidity with your own Secchi disk

A Secchi disk is a 20 cm disk with alternating black and white quadrants. It is lowered into the water until the observer can no longer see it. This measures the degree of visibility of the water. The degree of visibility is directly related to the turbidity of the body of water.

What you need: Paint can lid (or other metal disk), eyebolt, nuts, metal washers, fishing weight heavy string, black paint, white paint, permanent marker pen.
What you do:

1. Drill or punch a hole in the centre of the paint can lid for an eyebolt.
2. Place a metal washer and nut on the eyebolt on both sides of the disk and tighten. More washers may be added, if extra weight is needed. This is important, especially if you are collecting data in fast-moving water.
3. Attach fishing weight to bottom of disk with string.
4. Paint disk black and white for contrast. These are standard colours for conventional disks.
5. Attach heavy string to eyebolt and mark it at 1 meter intervals.

PREDICT, OBSERVE & EXPLAIN.

Go to the creek, river or waterway. (Remember to always take care around water). Lower the disk into the water until it disappears and take a depth reading at this point. Let the disk sink a few feet lower and then raise it slowly until it becomes visible. Take a depth reading at this point. The average of these two readings is the limit of visibility. http://www.dnr.sc.gov

3. Make your own catchment

What you need: Two 2 litre milk cartons, scissors, stapler, soil, two plastic containers, watering can with sprinkler end and mulch (leaves, bark, grass clippings etc.)
What you do:

1. Fold out spout on one side of both cartons.
2. Lay the carton on its side and staple bottom edge below spout.
3. Cut out top of carton and top of spout.
4. Place soil in the cartons, leaving about 2 cm gap at the top.
5. Place something under the back of one carton to form a gently slope.
6. Place a bigger thing under the other carton to form a steep slope.
7. Sprinkle water from your watering can at the top of each slope. The same amount on each carton. Keep pouring gently until water runs into the plastic container.
8. Put mulch on one carton and make the block size equal. Sprinkle water again.

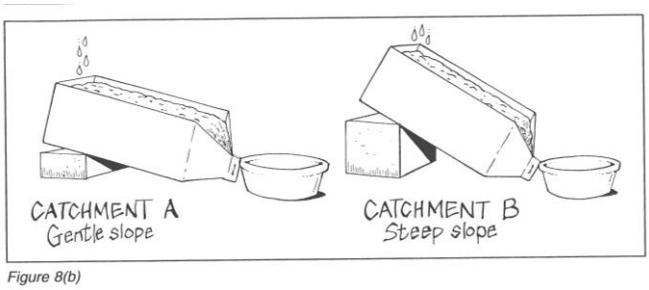
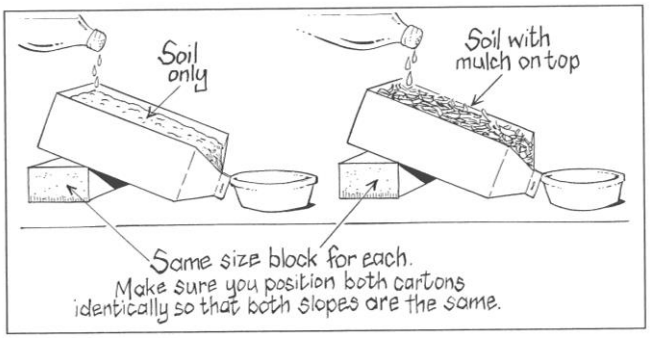


Figure 8(b)



PREDICT, OBSERVE & EXPLAIN.
Source: Catchment Care Education Kit, DPI, QLD, 1992.