River ranger

field information & materials

Global Environment Centre

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Acknowledgements
We give acknowledgement to the various sources of information and illustrations used in this booklet.

introduction

The RIVER Ranger programme was initiated by Global Environment Centre in 2004. RIVER Ranger is a comprehensive program on water resource management for schools, which focuses on rivers and river basin management. It also emphasizes not only about water pollution but every aspect of freshwater ecosystems including the functions, values, biodiversity and benefits to mankind.

objectives

1. To increase students' awareness and knowledge in managing resources
2. To provide living skills to students for use in local environment management
3. To coach students on ways to evaluate their river basins
4. To initiate localized water/river-based action/activities
5. To develop a database on local rivers by the schools

RIVER Rangers will undertake the following activities:

Conduct river mapping activities to identify issues and problems in the local river basin

To understand the sources of pollution and water flow in their river basin.

Develop a schedule for river observation and water quality monitoring

The compiled data will be exhibited in the www.gecnet.info website to be shared by all parties who are involved in the observation activity such as local communities and schools.

Start water management projects in school

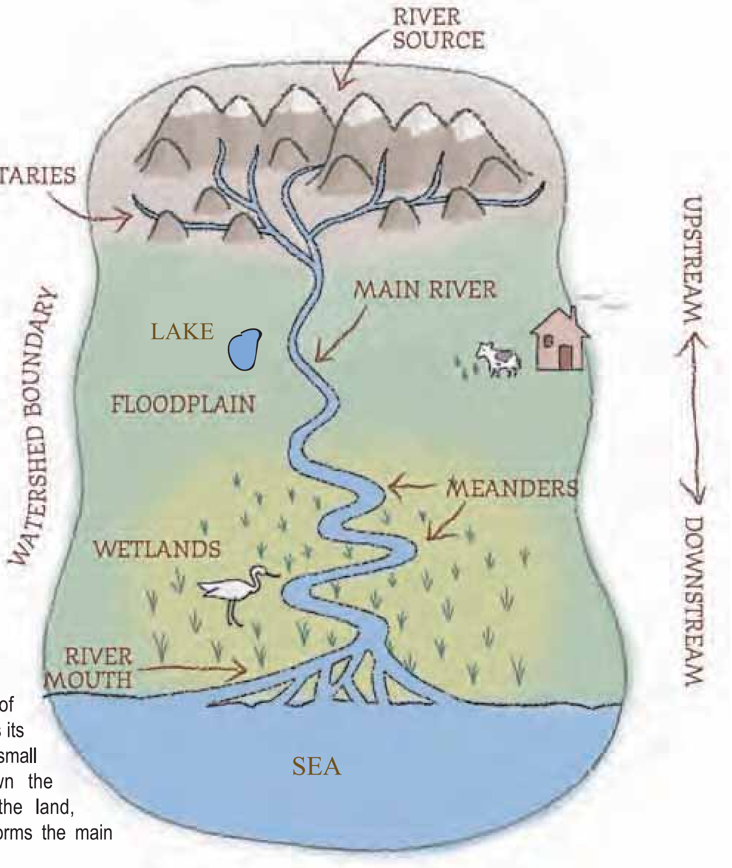
Rainwater harvesting
Water recycling

all about rivers

what is a river and a river basin?

A river is a natural waterway on the Earth's surface, which channels freshwater from the mountains to the sea. A river basin is the entire area drained by a river including its tributaries. That means, all water in the river basin area drains into the river and its tributaries. Therefore, the flow of water sets the boundaries of a river basin. They are also synonymously known as catchments or watersheds.

journey of a river

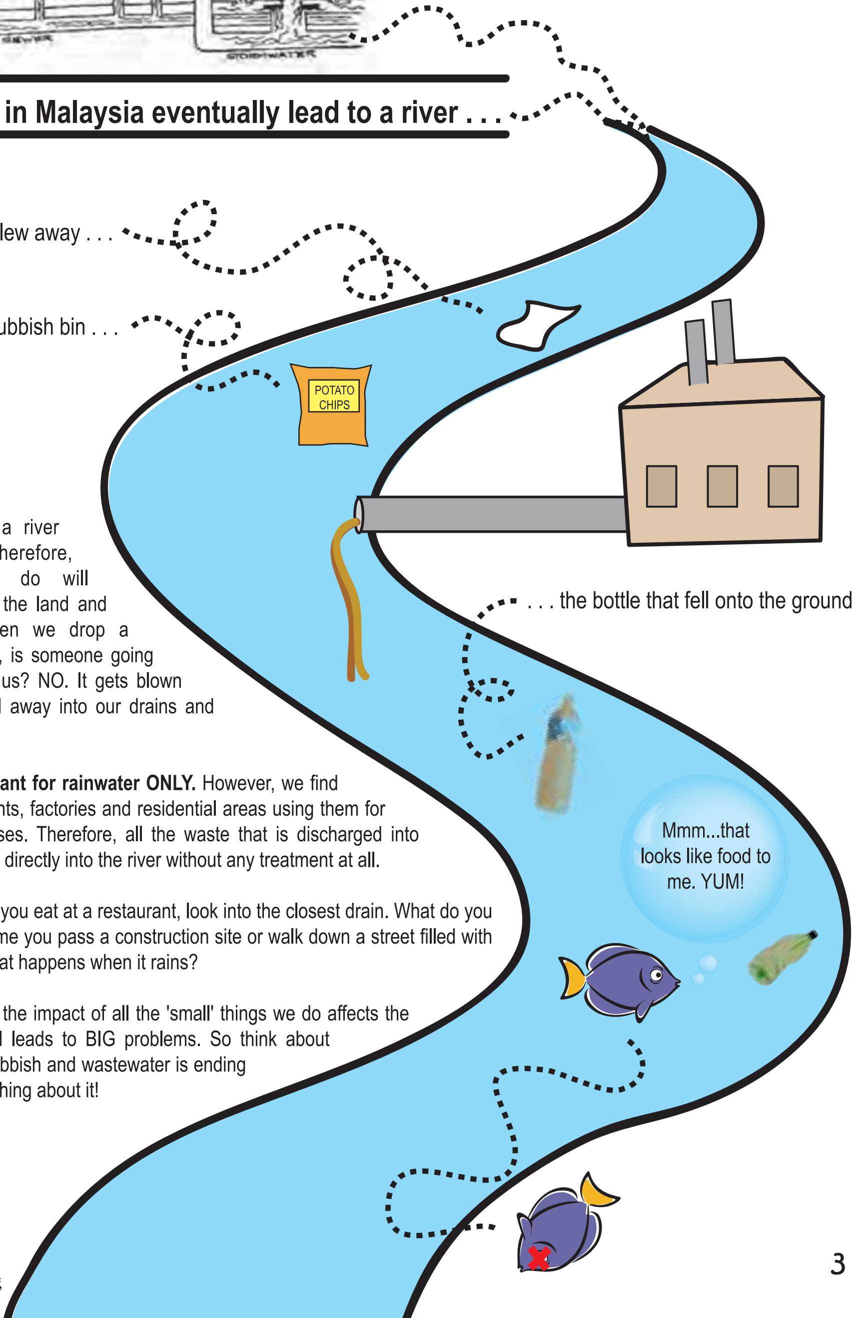


Rivers begin as small trickles of water up in the mountains. This is its source, and it eventually forms a small stream which then flows down the mountain. The water erodes the land, carving a bigger channel and forms the main river.

Upstream areas are characterized by steep V-shaped valleys, waterfalls, and fast flowing water among boulders and rocks. In the middle part, the river winds its way slowly through the flatter land, and continues to widen its channel by meandering and depositing material that is too heavy to carry in the water. As it makes its way out to the sea, it flows even more slowly and starts to deposit even more material in and around its own channel. At its mouth, where the river meets the sea, there is a sudden drop in velocity, and all the material that was being carried in the water column is deposited right there. As the material builds up from continuous deposition, the mouth of the river gets blocked and the river has to find new outlets into the sea by carving new streams wherever it can. This is the formation process of a delta and is characteristic of all river mouth areas.

impact of daily activities

ALL drains in Malaysia eventually lead to a river . . .



We all live in a river basin. Therefore, everything we do will somehow affect the land and waterways. When we drop a piece of rubbish, is someone going to pick up after us? NO. It gets blown away or washed away into our drains and into our rivers.

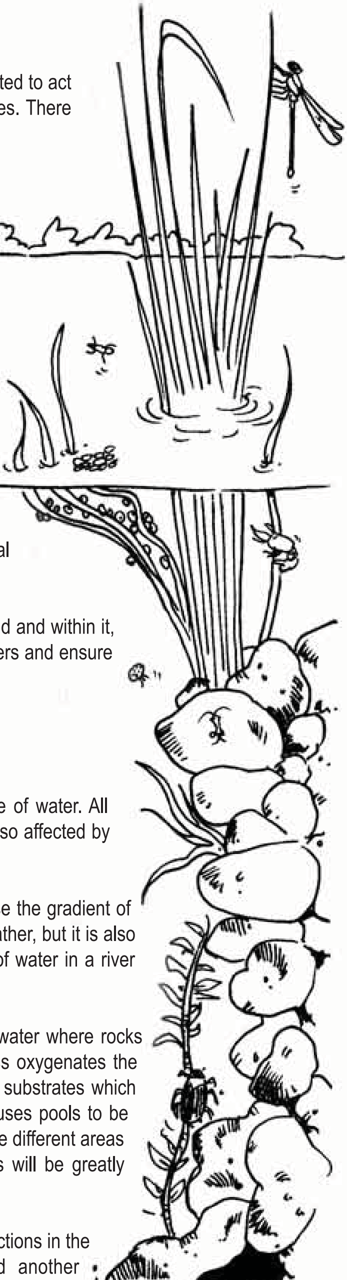
DRAINS are meant for rainwater ONLY. However, we find people, restaurants, factories and residential areas using them for their own purposes. Therefore, all the waste that is discharged into these drains flow directly into the river without any treatment at all.

So the next time you eat at a restaurant, look into the closest drain. What do you see? The next time you pass a construction site or walk down a street filled with litter, imagine what happens when it rains?

We must realize the impact of all the 'small' things we do affects the environment and leads to BIG problems. So think about where all your rubbish and wastewater is ending up and do something about it!

river studies

The scientific study of rivers are an important aspect in its conservation. We will be motivated to act when we have acquired the information and knowledge we gather from doing river studies. There are many different studies you can do, and they are outlined here.



ecology

A river is not merely a channel for water to flow. There are living things that depend on the river for survival, both in the water and on the land the river supports. The narrow area along a river is called the riparian corridor. This area supports a variety of plants and trees that contribute nutrients, shade, soil stability, habitat, and organic materials for small organisms to eat. Rivers contain living things inside, such as aquatic plants, fish, crustaceans, and mollusks, and also supports insects and mammals which utilize the river for many purposes. As such, rivers provide a great variety of habitats and services for all living things and it is important to maintain both physical and biological diversity in and around rivers.

It is important to recognize rivers as a living entity. Without the living things that live around and within it, rivers cannot function as nature intended it to. Therefore, it is important to care for our rivers and ensure that the quality of our rivers remain in a pristine state.

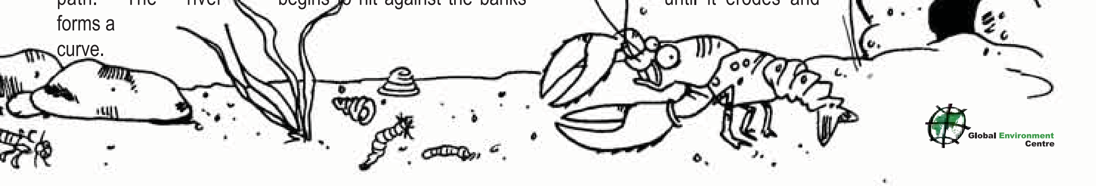
hydrology

The hydrology of a river involves aspects such as its depth, width, velocity and volume of water. All these characteristics constantly change because rivers are dynamic landforms and are also affected by climatic conditions.

When rivers begin high up in the mountains and hills, the velocity of water is fast because the gradient of the river is very steep. The volume of water is naturally dependent on the climate and weather, but it is also affected by dams and diversions for other uses. During periods of drought, the volume of water in a river can decrease drastically, and during monsoons, rivers will be full of water.

Riffles and pools are essential in any river ecosystem. Riffles are areas of fast flowing water where rocks and pebbles cause the water to flow above, around and under them, and in the process oxygenates the water. This also produces sound which becomes the voice of the stream. It also cleans substrates which are then colonized by bacteria and macro-invertebrates. The presence of riffles also causes pools to be formed and these are areas of slow flow. Living organisms in rivers are dependent on these different areas for their own needs, and without different velocity gradients, the diversity of organisms will be greatly reduced.

Meanders are also important features of a river and are products of obstructions in the land, such as trees or firm land, which causes the river to bend and find another path. The river begins to hit against the banks until it erodes and forms a curve.



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river mapping

Rivers, streams, and lakes are more than just parts of the environment - they are living entities that provide homes for wildlife and sustain life in this world. In Malaysia, they also happen to provide 97% of our water supply, and are used as places of recreation and enjoyment.

There must be a balance when we are using such fragile ecosystems for other purposes, as minor disturbances may cause problems within the system and may be detrimental to the environment. This is because each river does not work alone. They are all part of a bigger network called a river basin. All water will eventually flow into the waterways contained in this river basin area. Therefore, anything that happens within the basin will affect the rest of the basin because they are all connected.

The purpose of River Mapping is to encourage RIVER Rangers to:

- Learn about their local environment
- Develop skills in investigating the local environment
- Acquire a concern for the environment

Through the investigations in River Mapping, RIVER Rangers will collect information which may identify a problem or issue in their local area. For example, after identifying that a local stream is heavily littered, RIVER Rangers will need to ask a number of questions, such as:

- Where did the litter come from?
- What can be done about this?
- Who should i inform?

Structure of River Mapping

River Mapping makes use of your natural senses, such as sight and smell to identify the physical attributes of the river and its surroundings. The first step is to map out your local area and the location of the river within this area (use back page). Once you have done this, you can add in all the different types of land use you see in the area and activities that may affect the river.

Next, you should go to the river itself, and record its appearance. What colour is the water? Is there any oily sheen on its surface? Think about what could be causing this and refer to the table on the last page for help. Other things you should note is the type of vegetation found near the river, and how much there is, as well as whether there is any smell coming from the river.

Through the River Mapping programme, RIVER Rangers will learn how the action they take in their home, school or street can impact on their wider environment. By testing the quality of water in their local area, RIVER Rangers will be encouraged to investigate their environment and actively participate in improving the quality of their environment. The River Mapping activities will also encourage an interest in other environmental issues. These may include:

- The interaction between natural and developed environments
- Waste disposal and recycling
- Sustainable resource management

river health check

There are 3 methods that are most commonly used to check the condition of the river - visual observations, chemical monitoring and biological monitoring.

visual observations

The physical characteristics of a stream can give clues to the health of the stream. Healthy streams have lush riparian buffers, clear water and plenty of wildlife. Some of the physical characteristics of water quality are: water clarity, water colour, smell/odour, general land use, description of the stream origin & type, riparian vegetation (algae, wetlands), aquatic life (fish, prawns), and measurements of in-stream parameters such as width, depth, flow & substrate, drains, erosion and garbage.

a river's natural environment

in-situ chemical testing

chemical monitoring

Chemical monitoring and testing is one of the most accurate and reliable testing methods. Chemical testing is used to analyze drinking water. It is extremely useful for determining sources of pollution, as well as determining specific pollutants. For example, high concentrations of nitrogen and phosphorus may indicate fertilizer runoff from a nearby farm.

biological monitoring of rivers and streams

Biological monitoring of river and stream life provides remarkable insight into the functional quality of the environment studied. It can reveal important changes in the composition of biological communities caused by human activities. It asks the question: "Is this aquatic community showing evidence of harm?" The approach relies on the great diversity of benthic macroinvertebrate life in rivers and streams to determine how suitable a waterbody is for the support of aquatic life.

nets are great tools for biomonitoring

river health check form

This form allows you to record your physical, chemical and biological observations of the site and its environment. It is important to keep good notes on each site, recording the location, date and details on anything special that might vary from visit to visit.

You can then compare different rivers or different sites along the same river. This is important so you can compare your scores if you visit the site over time.

Summarise your results and send us a simple report on the health of your river every 3 months.

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Pull Out!

Site Description

Name of waterway / site :

Date :

Time :

Weather :

Has it rained in the past 24 hours?
(if yes, was it heavy?)

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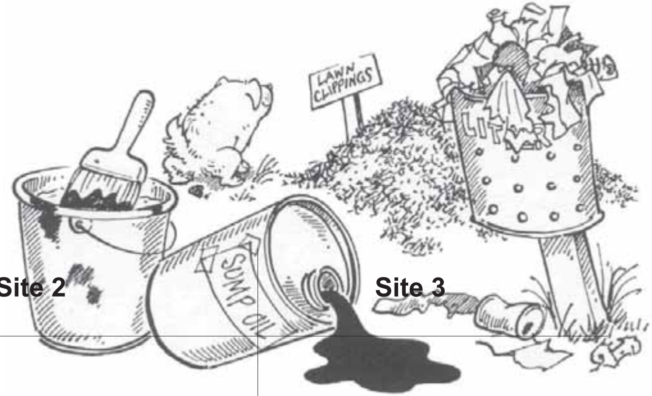
Name :
Contact details :
School / organisation :
Crew size :

physical monitoring

Please draw your local area map first (see back cover)

Now, look around you and describe what you see according to the different attributes.



Attributes	Site 1	Site 2	Site 3
Colour & Appearance			
Smell			
Vegetation			
Animals			
Activities *(land use, human activities, points of interest e.g. construction, industry, drain feeding river)*			

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chemical monitoring

Record your results from the water quality tests here.

Variable	Site 1	Site 2	Site 3
pH			
DO			
Turbidity			
Phosphate			
Nitrate			
Temperature			
Ammonia			

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biological monitoring

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Identify the organisms you have found using the biomonitoring cards and list them down here.

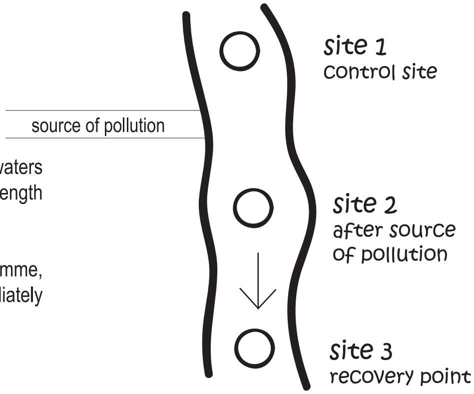
	Species	Indicator	Water Quality
Site 1			
Site 2			
Site 3			

being a young river scientist

Carry out a survey like a real scientist! A good scientist should make a plan for monitoring, so read on to find out how to be a good scientist!

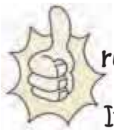
survey design

1. If you suspect pollution entering the river from a point source, then you should have 3 sampling sites (see diagram).
2. If you are interested in how your river changes from the headwaters to the mouth, sampling sites should be dispersed along the length of your river so that changes in water quality can be noted.
3. If you are interested in a local water quality monitoring programme, sampling sites should cover areas before, within and immediately after your subcatchment area.



where to sample

It is important to exercise care in the way samples are collected for analysis. A collected sample should be representative of the river reach being tested. Analytical values derived from river samples may vary with depth, velocity of current and the distance the sample was taken from source/shore. Samples taken are called grab samples, which are single samples representative of the river at a particular time and place.



rule of thumb

It is best to sample midway across the river and below the surface. It is best if you can sample in the main current, as long as it is safe to do so.

When choosing a monitoring site please consider the following:

- Confirm the site is located within your delineated watershed. Determine if the site is located on public or private property. Do you need to obtain permission before visiting the property to conduct water quality monitoring and watershed research?
- Check for any habitats or shelters where animals may be living such as snake holes etc., near your monitoring site.
- Identify a monitoring site that is at a safe distance from any nearby roads or traffic.
- Avoid deep water or fast currents for conducting monitoring unless standing on a bridge. Locate a riffle area instead which would likely support a greater abundance of aquatic life.
- Avoid steep, eroding shorelines by identifying a site with accessible banks.
- Be aware of nearby land uses or structures such as sewage treatment plants or heavy industrial areas which may require special covering of arms and hands for monitoring.

safety precautions

Ensure that students and others understand from the beginning the danger of treating chemicals casually or endangering others during "horseplay."

Wear safety goggles, particularly when running water quality tests that require shaking or swirling a chemical mixture.

Wash your hands after conducting water monitoring. Avoid placing hands in contact with eyes or mouth during monitoring.

Dispose of spent chemicals in an environmentally sound manner; hazardous waste should be deposited in accordance with the hazardous waste guidelines.


briefing

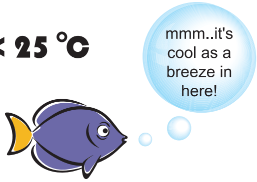
chemical monitoring

temperature

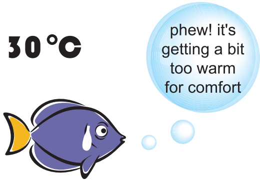
Warm temperature is one factor that can determine which species may or may not be present. Most aquatic organisms have adapted to survive within a specific water temperature range and many organisms cannot tolerate extremes of heat or cold. Fish larvae and eggs are even more sensitive to temperature than adult fish. Temperature affects the rate of photosynthesis by aquatic plants, the feeding, reproduction, metabolism and the sensitivity of aquatic animals to toxic wastes, parasites and diseases and also the oxygen levels in water. Warm water holds less oxygen than cool water, and this directly affects the amount of oxygen that is available to aquatic organisms.

The largest impact that people have on the temperature of water is **thermal pollution**. It is caused when warm water is added to a waterway.

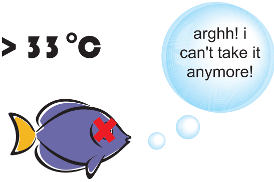
< 25 °C



30 °C

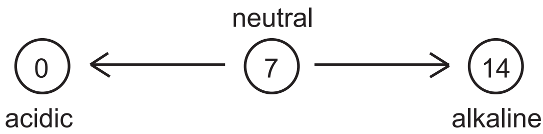


> 33 °C



pH

The pH test is one of the most common analyses in water testing. pH is a measurement of the activity of hydrogen ions in a water sample.



The pH of water is critical to aquatic life. Most organisms are used to living in water with a specific pH and may die if pH levels change even slightly. A pH range of 6.5 to 8.2 is optimum for most organisms. High pH levels (9-14) can harm fish by denaturing cellular membranes. Low pH levels accelerate the release of metals from rocks or sediments in the stream. These metals can affect a fish's metabolism and the fish's ability to take water in through the gills, and can kill fish fry.

dissolved oxygen (DO)

Dissolved oxygen (DO) is found in microscopic bubbles of oxygen that are mixed in the water and occur between water molecules. DO is a very important indicator of a water body's ability to support aquatic life. Natural waters with consistently high DO levels are most likely healthy and stable environments and are capable of supporting a diversity of aquatic organisms. Most fish cannot survive at concentrations below 4 mg/l of dissolved oxygen.

Most DO enters water from the atmosphere. In nature, pebbles/rocks, waves and wind whip up the water and mix it with oxygen in the air. Aquatic plants also add oxygen to water during photosynthesis. Oxygen is removed from the water by respiration and decomposition of organic matter. DO is also directly associated with temperature, as colder water can hold more DO than warm water.

When dissolved oxygen concentrations drop, major changes in the types and amounts of aquatic organisms found living in the water can occur. Species that need high concentrations of dissolved oxygen, such as mayfly nymphs, stonefly nymphs, and caddisfly larvae will move out or die. They will be replaced by organisms such as sludge worms, blackfly larvae, and leeches which can tolerate lower dissolved oxygen concentrations. Waters that have low dissolved oxygen sometimes smell bad because of waste products produced by organisms that live in low oxygen environments.

phosphate

Phosphate is usually found in natural water and is a necessary element for plants and animals. Phosphate naturally enters water from plant and animal by-products and is a nutrient that acts as a fertilizer for aquatic plants. It can also come from human waste, animal waste and industrial waste. Drains sometimes have illegal connections to sanitary sewers. Rain flowing into storm drains then carry sewage directly into waterways, bypassing the treatment plant. Detergent in household sewage is a large source of phosphate. Over half of the phosphate in lakes, streams and rivers comes from detergents. Phosphate can also enter waterways where animal waste or detergent from washing cars flows into storm drains. Even sewage that has been treated at a wastewater treatment plant and is purposefully or accidentally dumped into a river may contain phosphate.

Phosphate levels higher than 0.03ppm contribute to increased plant growth. When nutrient levels are too high, plants and algae grow out of control and create water quality problems. When large amounts of plants die and rot, oxygen levels drop and the area may eventually become an unfit habitat for the fishes, animals and insects that used to live there. Algae and aquatic plants also clog industrial intake pipes and equipment that use natural water to cool their equipment.

nitrate & ammonia

Nitrate is one of the main ingredients in fertilizer. If more fertilizer is applied than can be used by the plants, the extra nitrate is washed out of the soil and into nearby rivers when it rains. The decomposition of dead plants and animals and the excretions of living animals also release nitrate into the aquatic system. Sewage is the main source of excess nitrate added to natural waters, while fertilizer and agricultural runoff also contribute to high levels of nitrate. Excess nitrate increases plant growth and decay, promotes bacterial decomposition, and therefore, decreases the amount of oxygen available in the water.

Ammonia is a source of nitrogen (N), an important nutrient for plants and algae. Ammonia is excreted by animals and is produced during the decomposition of plants and animals. Ammonia is an ingredient in many fertilizers and is also present in sewage, storm water runoff, certain industrial wastewaters, and runoff from animal feedlots. If sufficient dissolved oxygen (DO) is present, ammonia can easily be broken down by nitrifying bacteria to form nitrite and nitrate.

Unpolluted water usually has a nitrate level below 4ppm. Nitrate levels above 40ppm are considered unsafe for drinking water. Drinking water containing high levels of nitrate can affect the ability of our blood to carry oxygen. It can poison babies by making them unable to get enough oxygen, inducing the blue-baby syndrome.

turbidity

Turbidity is a measure of the cloudiness of water- the cloudier the water, the greater the turbidity. Turbidity in water is caused by suspended matter such as clay, silt, and organic matter and by plankton and other microscopic organisms that interfere with the passage of light through the water. Turbidity should not be confused with colour, since darkly coloured water can still be clear and not turbid. Turbid water may be the result of soil erosion, urban runoff, algal blooms and bottom sediment disturbances.

Impact of turbidity on aquatic life:

1) Floating particles may clog fish gills.
2) When these particles sink, they can smother and kill fish and aquatic insect eggs that lay on the bottom.
3) Turbidity can also limit plant growth as sunlight cannot reach the plants' leaves and photosynthesise.

The combination of warmer water, less light and oxygen depletion makes it impossible for some forms of aquatic life to survive.

water quality testing procedures

dissolved oxygen (DO)

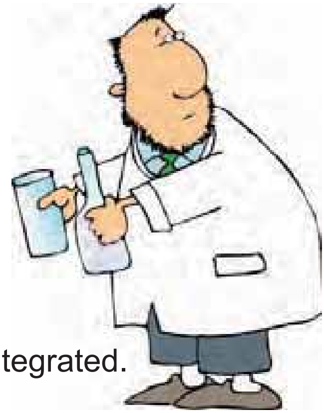
1. Fill the small vile (0125) until it overflows with sample water.
2. Add two Dissolved Oxygen TesTabs® to the test tube.
3. Cap the tube. Be sure no air bubbles are in the sample.
4. Mix by inverting until the tablets have disintegrated (about 4 minutes).
   Wait 5 minutes.
5. Compare the colour of the sample to the Dissolved Oxygen Colour Chart. Record the result as ppm Dissolved Oxygen.

nitrate

1. Fill the test tube (0106) to the 5ml line.
2. Add one Nitrate #1 TesTab® .
3. Cap the tube and mix until the tablet has disintegrated.
4. Add one Nitrate #2 CTA TesTab®.
5. Cap the tube and mix until the table has disintegrated.
   Wait 5 minutes.
6. Compare the colour of the sample to the Nitrate Colour Chart. Record the result as ppm Nitrate.

ammonia

1. Fill the test tube to the 5ml line.
2. Add one Ammonia #1 TesTab ®.
3. Cap the tube and mix until the tablet has disintegrated.
4. Add one Ammonia #2 TesTab®.
5. Cap the tube and mix until the tablet has disintegrated.
   Wait 5 minutes.
6. Compare the colour of the sample to the Ammonia Colour Chart. Record the result as ppm Ammonia.



phosphate

1. Fill the test tube to the 5ml line.
2. Add one Phosphorus TesTab®.
3. Cap the tube and mix until the tablet has disintegrated.
4. Wait 5 minutes.
5. Compare the colour of the sample to the Phosphate Colour Chart. Record the result as ppm Phosphate.

turbidity

1. Fill the kit container 3/4 full of sample water.
2. Hold the Turbidity Chart on the top edge of the jar. Looking down into the jar, compare the appearance of the disk icon in the container to the chart. Record the result as Turbidity in JTU.

temperature

1. Place the thermometer below water surface (4 inches) for 1 minute.
2. Keep the thermometer in the water until a constant reading is attained.
3. Remove the thermometer from the water. Read the temperature (green indicator) and record the results as C.

pH

1. Fill the test tube to the 10ml line.
2. Add one pH Wide Range TesTab®.
3. Cap the tube and mix until the tablet has disintegrated.
4. Compare the colour of the sample to the pH Colour Chart. Record the result as pH.

making water quality connections

chemical - water quality

Test results ranking*

Variable	Poor	Fair	Good	Excellent	Possible causes for poor readings
Dissolved Oxygen (ppm)	< 4	4	5 - 7	8	Volume and velocity of water flowing in the water body, climate/weather, riparian vegetation, the type and number of organisms in the water body, altitude, organic wastes, dissolved or suspended solids, amount of nutrients in the water.
Nitrate (ppm)	20	5	4 - 1	0	Wastewater and septic system effluent, fertilizer runoff, animal waste, fossil fuels, industrial discharge.
Phosphate (ppm)	> 4	4	2	0	Wastewater and septic system effluent, detergents, fertilizers, animal waste, development/paved surfaces, industrial discharge, phosphate mining, drinking water treatment, forest fires, synthetic materials.
pH	< 4 > 10	5 or 9	6 or 8	7	Geology and soils of the watershed, the concentration of carbon dioxide in the water, air pollution.
Turbidity (JTU)	> 100	40 - 100	0 - 40	0	High flow rates, soil erosion, urban runoff & flooding, wastewater and septic system effluent, decaying plants and animals, bottom-feeding fish, and algal blooms.
Temperature (°C)	> 35 < 20	30-35 20-25	25 - 27 29 - 30	27 - 29	Paved surfaces & industrial discharge cause increases in temperature, while overhanging trees and riparian vegetation cause decreases. The season and flow rate also matters. During dry seasons, there is less water in a river, and it flows more slowly. This allows the water to warm up more quickly, and to warmer temperatures.

* only applicable for water testing kit results provided by GEC

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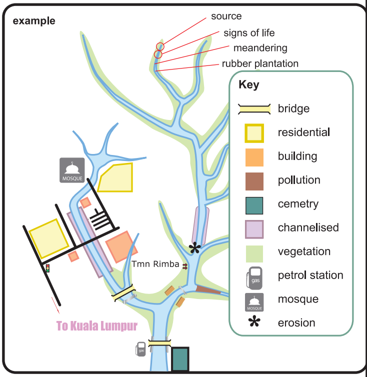
physical - appearance of the water

Appearance	Indicates	Possible Causes
Green, Green-Blue, Brown or Red	Growth of algae	High levels of nutrient pollution, originating from organic wastes, fertilizers, or untreated sewage
Muddy, Cloudy	Elevated levels of suspended sediments, giving the water a muddy or cloudy appearance.	Erosion is the most common source of high levels of suspended solids in water. Land uses that cause soil erosion include mining, farming, construction and unpaved roads.
Dark Reds, Purple, Blues, Blacks	May indicate organic dye pollution	Originating from clothing manufacturers or textile mills
Orange-Red	May indicate the presence of copper	Copper can be both a pollutant and naturally occurring. Unnatural occurrences can result by acid mine drainage or oil-well runoff.
Blue	May indicate the presence of copper, which can cause skin irritations and death of fish	Copper is sometimes used as a pesticide, in which case an acrid (sharp) odor might also be present.
Foam		Excessive foam is usually the result of soap and detergent pollution. Moderate levels of foam can also result from decaying algae, which indicates nutrient pollution.
Multi-Coloured (oily sheen)	Indicates the presence of oil or gasoline floating on the surface of the water. Oil and gasoline can cause poisoning, internal burning of the gastrointestinal tract and stomach ulcers.	Oil and gasoline pollution can be caused by oil drilling and mining practices, leaks in fuel lines and underground storage tanks, automotive junk yards, nearby service stations, wastes from ships, or runoff from impervious roads and parking lot surfaces.
No unusual colour	Not necessarily an indicator of clean water.	Many pesticides, herbicides, chemicals, and other pollutants are colorless or produce no visible signs of contamination.

map the land use

Draw your local area map here and record the land use on your map. A 'key' would be useful to identify the different types of land use and other points of interest.



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