miniSASS

Share-Net

This pack supports the Eco-Schools theme of 'Nature and Biodiversity'

Grade 9

This pack contains:

Activity One: In this LANGUAGES activity, learners find out more about the state of South Africa's rivers. A newspaper article forms the focus point for a general class discussion around river health.

Activity Two: Following on from Activity One on river health, learners investigate suitable equipment needed for water quality monitoring in a local river or body of water. During this TECHNOLOGY lesson, they will design, cost and build some of the necessary equipment.

Activity Three: During this NATURAL SCIENCES exercise, learners investigate the water quality, based on visible animal life, of a nearby stream, river or body of water. They use the miniSASS toolkit and their equipment from Activity Two to undertake this activity.

Activity Four: During this MATHEMATICS activity, learners find out how water finds its way to the taps in their homes. They also collect and summarise information on two important South African laws around the provision of water services.

Activity Five: During this NATURAL SCIENCES lesson, learners develop a River Action Plan with aims, goals and objectives. They then implement the Action Plan, evaluate it and review it.

WESSA
PEOPLE CARING FOR THE EARTH

This pack of lesson plans is part of a series of lesson plans which focus on water quality and the miniSASS toolkit. This resource development project has been funded by the Water Research Commission, Private Bag X 03, Gezina, Pretoria, 0031 (Website: www.wrc.org.za).

Water Research Commission

Activity	Learning Area covered in this activity	Learning Outcomes covered in this activity	Assessment Standards covered in this activity
1. Learners find out more about the state of South Africa's rivers. A newspaper article forms the focus point for a general class discussion around river health.	Languages	**Learning Outcome 2:** Speaking: The learner will be able to communicate confidently and effectively in spoken language in a wide range of situations. **Learning Outcome 3:** Reading and Viewing: The learner will be able to read and view for information and enjoyment, and respond critically to the aesthetic, cultural and emotional values in texts.	Demonstrates a range of complex interaction skills by participating actively in group discussions, conversations, debates, group interviews and surveys, and while so doing: • tackles important issues (e.g. social and ethical issues related to the environment and human rights); • asks probing questions. • reads independently, both aloud and silently, for a variety of purposes, consolidating the appropriate reading strategies developed in earlier grades.
2. Following on from Activity One on river health, learners investigate suitable equipment needed for water quality monitoring in a local river. During this lesson, they will design, cost and build the necessary equipment.	Technology	**Learning Outcome 1:** Technological processes and skills: The learner will be able to apply technological processes and skills ethically and responsibly using appropriate information and communication technology.	• analyses existing products relevant to an identified problem, need or opportunity based on safety, suitability of materials, fitness for purpose, cost, manufacturing method. Makes: • develops plans for making that include all of the following: resource lists, formal drawings showing dimensions or quantities, manufacturing sequence.
3. Learners investigate the water quality, based on visible animal life, of a nearby stream, river or body of water. They use the miniSASS toolkit and their equipment from Activity Two to undertake this activity.	Natural Sciences	**Learning Outcome 1:** Scientific investigations: The learner will be able to act confidently on curiosity about natural phenomena, and to investigate relationships and solve problems in scientific, technological and environmental contexts.	Conducts investigations and collects data: Contributes to systematic data collection, with regard to accuracy, reliability and the need to control a variable. • discusses the meaning of the data being collected, comparing them with the focus question. Evaluates data and communicates findings: Seeks patterns and trends in the data collected and generalises in terms of simple principles. • suggests further investigations which would help to confirm the generalisation.
4. Learners find out how water finds its way to the taps in their homes and how it leaves their homes. They also collect and summarise information on two important South African laws around the provision of water services.	Mathematics	**Learning Outcome 5:** Data Handling: The learner will be able to collect, summarise, display and critically analyse data in order to draw conclusions and make predictions, and to interpret and determine chance variation.	• selects, justifies and uses appropriate methods for collecting data (alone and/or as a member of a group or team) which include questionnaires and interviews, experiments, and sources such as books magazines and the Internet in order to answer questions and thereby draw conclusions and make predictions about the environment.
5. Learners develop a River Action Plan with aims, goals and objectives. They then implement the Action Plan, evaluate it and review it.	Natural Sciences	**Learning Outcome 3:** Science, society and the environment: The learner will be able to demonstrate an understanding of the interrelationships between science and technology, society and the environment.	• understands sustainable use of the earth's resources: Responds appropriately to knowledge about the use of resources and environmental impacts.

ACTIVITY ONE: SICK RIVERS = SICK CITIES?

In this LANGUAGES activity, learners find out more about the state of South Africa's rivers. A newspaper article forms the focus point for a general class discussion around river health.

CLASS ACTIVITY:
Photocopy *The Witness* newspaper article *'Rivers of filth across KZN'* (on page 2) and hand a copy to each learner in your class to read.

ASK YOUR LEARNERS *(this can either be a class or small group discussion)*

1. What was your reaction to the newspaper article?
2. Do any of you live near a river? What is the river like?
3. Have you seen effluent (sewage or waste) going into the river (either because of a broken/blocked pipe) or because someone was illegally dumping into the river? How did you feel? What happened? Did you tell your parents, a friend, the municipality? Did you not know what to do?
4. What seemed to be the main issue in the newspaper article?
5. What needs to be done to solve this problem/issue?
6. Is this an important issue? Why? Why not?
7. What are practical things that you, as an individual, and your family can do in the home, to be part of the 'solution' and not 'part of the problem'?
8. The famous conservationist, Dr Ian Player once said "if the river running through your city is sick, then your city is sick". What do you think he means by this statement? Do you agree with it? Why? Why not?
9. What effect does sewage and waste going into a river, have on the biodiversity (the variety of life in an area, including the number of different species) of the river?
10. Does this affect people? How?
11. What are ways that we can test whether a river is 'sick' or not?
12. Have any of you ever done water testing? What did you find/see?
13. Ask each learner to pose a water or water quality question, related to the newspaper article, to the rest of the group/class.

INDIVIDUAL ACTIVITY:

- If your school has access to **Google Earth**, then type in the name of your village, town or city and see if you can find your school. Next, see if you can find the nearest river to your school. If there are no rivers near your town or city, then choose a place that you have visited and see if there are any rivers near/in/around it.

- Once, you have located and identified a stream, river or dam, do an Internet search and find out if anything has been written on that stretch of water, especially its 'health'. Print out the articles and make a display in your classroom. Happy river health 'surfing'!

Rivers of filth across KZN

09 Oct 2008

Nalini Naidoo

"The sewage problem in Howick is an absolute disaster and is totally unacceptable. If allowed to continue, it will make Delmas look like a Sunday school picnic".

This dire warning came from Lin Gravelet Blondin KZN pollution control director in the Water Affairs and Forestry Department.

Delmas is a town in Mpumalanga that experienced a typhoid outbreak in September 2005. More than 287 cases of typhoid were reported; four people died and more than 1 400 had diarrhoea. The cause? The groundwater system had become polluted with sewage.

Gravelet Blondin said it is unacceptable that sewage is flowing freely through people's gardens and streets where children play.

The springs the Siphumele and Thokoza communities near Howick use are at times immersed in sewage-polluted water and the pump stations are not working properly, resulting in raw sewage regularly being dumped into the surrounding area.

He added that there are problems with sewage pollution right across the country as well as in KZN. "It is worse in smaller municipalities, who do not have the capacity, finance and expertise to deal with the problem. However, bigger municipalities have also experienced their fair share of problems, despite having a lot more finance and expertise."

Pietermaritzburg experienced a sewage overflow in Jesmond Road this week. The very vocal residents were quick to register their horror and the municipality's sanitation division reacted quickly. By yesterday morning, all signs of the mess had been cleared up. According to officials, the problem was caused by a blocked pipe. uMngeni Municipality was also hard at work carrying out repairs, following earlier reports on the situation there in ***The Witness***.

According to Gravelet Blondin, towns that have experienced severe sewage problems are Mooi River, Howick, Richmond and Kokstad. He said the day he visited Mooi River, the situation seemed more under control, but there was definitely evidence of past pollution from pump station failure. Work on the systems in Kokstad and Richmond is continuing, but a lot more needs to be done. The department and other role-players will meet next Wednesday to find more long term solutions.

Dave Still, chairman of the Duzi Umgeni Conservancy Trust (DUCT), has said the national Treasury gives municipalities grants equivalent to more than R60 per indigent family per month to help them to maintain sanitation services to the poor. He believes this money needs to be appropriately utilised. Municipalities can also apply for funding from national government to repair and renew sewerage infrastructure. "If they cannot find the money to fix these problems, they should take the money from their budget for bonuses for senior management," he said.

Local municipalities can take a leaf out of Johannesburg's book, where the water utility has started a R5 billion upgrade of the city's sanitation and water system.

According to reports, the project is part of the city's R1 billion annual programme over the next five years to upgrade and rehabilitate infrastructure in the city to reduce both water and sanitation pipe bursts.

Source: The Witness newspaper

Criteria to assess learners during this languages lesson

Criteria	Exceeded requirements of the Learning Outcome	Satisfied requirements of the Learning Outcome	Partially satisfied requirements of the Learning Outcome	Not satisfied requirements of the Learning Outcome
The learner read the article *'Rivers of filth across KZN'* on his/her own.				
The learner actively participated in the group/class discussion after having read the article *'Rivers of filth across KZN'*.				
The learner's answers to the questions were accurate and thoughtful.				

ACTIVITY TWO: PREPARING FOR OUR RIVER HEALTH INVESTIGATION

Following on from Activity One on river health, learners investigate suitable equipment needed for water quality monitoring in a local river or body of water. During this TECHNOLOGY lesson, they will design, cost and build some of the necessary equipment.

South Africa has been a world leader in biomonitoring techniques using macroinvertebrates. The most successful of these is the South African Scoring System version 5 (SASS5). miniSASS is based on SASS and also uses the presence of macroinvertebrates to indicate the "health of a river". Where SASS contains 90 different macroinvertebrate classes, miniSASS only has 13 different classes, allowing for simpler identification and understanding.

Macroinvertebrates

What are they?

Macroinvertebrates are animals that have no backbone and can be seen without using a magnifying glass.

Why are they used for biomonitoring?

- Different macroinvertebrates have different sensitivities to pollution. The higher their score, the more sensitive they are.
- They are generally easy to collect and identify.
- They are relatively sedentary which allows the source of the pollution to be detected.
- They integrate the water quality conditions at a site, providing an overall measure of the "health" of a river.
- They can provide a picture of the historical water quality at a site.

What is the importance of water quality monitoring and management in South Africa?

Fresh water is essential for the daily life of all aquatic and terrestrial organisms. It is used in all spheres of life, namely agriculture, industry, biodiversity conservation, sanitation and hydration. However due to the amount of rainfall that South Africa receives, it is classified as a water stressed country. This means that if we do not monitor, manage and conserve our current water bodies, we will be placing them and the population under tremendous stress in future!

As the general public, we can play a part in making a difference to managing freshwater resources in a community. miniSASS has the potential to be a powerful **'red flag'** indicator for the identification of aquatic pollution sources. By using miniSASS we can actively take an interest and management in the health of freshwater bodies in our community.

Your interest and knowledge can be enhanced by adopting a local river in your community and monitoring it over time, identifying sources of pollution and taking **local action** to make a difference. You could also encourage more members of the community to take positive action towards monitoring and conserving water.

Additional resources:

- The Water Research Commission - www.wrc.org.za
- GroundTruth – biomonitoring services and environmental consultants - www.ground-truth.co.za
- Wildlife and Environment Society of South Africa - www.wessa.org.za
- Department of Water Affairs and Forestry – www.dwaf.gov.za
- Share-Net resources for fieldwork and environmental learning - sharenet@wessa.co.za

Glossary:

- **Biomonitoring**: The monitoring of biodiversity using biological organisms.
- **Biodiversity**: Diversity within species, between species and of ecosystems.
- **Ecosystem:** A complete community of living organisms and the nonliving materials of their surroundings.
- **Sedentary**: Inactive, motionless, not moving.
- **Conservation**: The maintenance of environmental quality and functioning.

INDIVIDUAL ACTIVITY:
In Activity Three, learners will investigate the health of a nearby stream or river using the miniSASS toolkit. Some of the equipment that will be needed includes the following:

- Safety gloves to collect specimens
- Score sheet
- Container to keep small water creatures in, for the duration of the water quality monitoring period
- Net to capture water creatures

In preparation for Activity Three, learners need to choose two pieces of equipment (listed at the bottom of page 3) and do their own research (either through the Internet, store catalogues or by visiting relevant shops in town) on this equipment in terms of their:

- Safety
- Suitability of materials
- Fitness for purpose
- Cost
- Manufacturing method

They need to bear in mind that they will be 'designing' and building at least one piece of equipment themselves so they should keep notes on all the equipment they see. They may find that they are able to integrate the different ideas into one design.

All learners need to share their findings by reporting back to the rest of the class what they found during their research.

INDIVIDUAL ACTIVITY:

- Design, cost and make a piece of water quality monitoring equipment, based on your earlier research.

Learners need to write clear instructions for the development of their piece of equipment. This needs to include all materials needed, formal drawing or drawings with dimensions or quantities and a manufacturing sequence (such as flow diagrams or charts).

All drawings and work needs to be kept in a file and handed in – this can be added to learners' assessment files.

Criteria to assess learners during this technology lesson

Criteria	Exceeded requirements of the Learning Outcome	Satisfied requirements of the Learning Outcome	Partially satisfied requirements of the Learning Outcome	Not satisfied requirements of the Learning Outcome
Learner was able to analyse existing products needed for water quality monitoring in terms of safety, suitability, fitness, cost and manufacturing method.				
Learner was able to develop a plan of clear instructions, together with all materials needed, formal drawings and manufacturing sequence for making their piece of water quality monitoring equipment.				
Learner successfully constructed their chosen piece of water quality monitoring equipment				

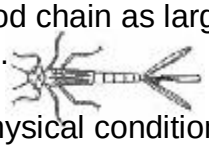
ACTIVITY THREE: INVESTIGATING RIVER HEALTH USING THE miniSASS TOOLKIT

During this NATURAL SCIENCES exercise, learners investigate the water quality, based on visible animal life, of a nearby stream, river or body of water. They use the miniSASS toolkit and their equipment from Activity Two to undertake this activity.

ACTIVITY:
Photocopy the following information for your class:

Streams, rivers, wetlands and dams are homes for many small animals called macroinvertebrates. These animals generally include insects, crustaceans, molluscs, arachnids and annelids. The term macroinvertebrate describes those animals that have no backbone and can be seen with the naked eye.

These animals live in the water for all or part of their lives, so their survival is related to the water quality. They are significant within the food chain as larger animals such as fish and birds rely on them as a food source.



Macroinvertebrates are sensitive to different chemical and physical conditions. If there is a change in the water quality, perhaps because of a pollutant entering the water, or a change in the flow downstream of a dam, then the macroinvertebrate community may also change. Therefore, the richness of macroinvertebrate community composition in a water body can be used to provide an estimate of water body health.

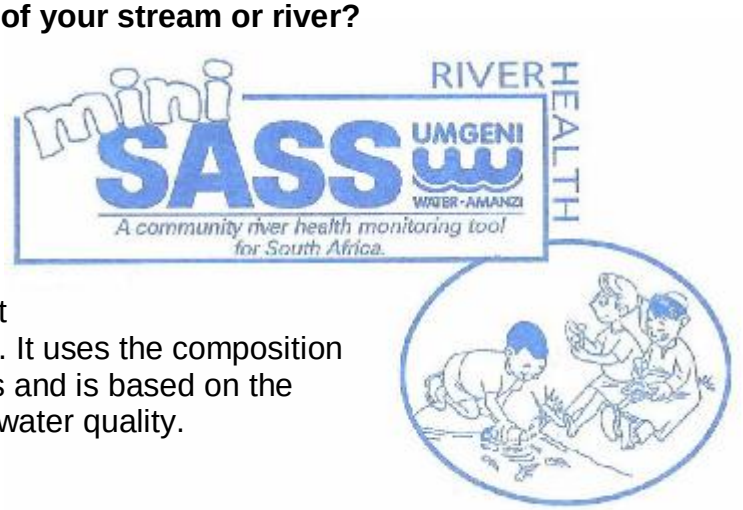
Water conditions and macroinvertebrates
Environmental modifications or pollution can alter macroinvertebrate communities. Poor catchment management can exaggerate the turbidity (clarity) of water. In highly turbid water, the light penetration is reduced affecting the photosynthesis of plants and also increases the temperature of water. The suspended solids may clog respiratory surfaces or interfere with feeding appendages. Filter feeders receive reduced nutritional value and expend more energy to collect food, as otherwise they will starve. High levels of suspended solids may begin to settle and change the composition of the bed of the water body as it coats rocks and vegetation. This can affect movement, feeding, habitat and reproduction of some macroinvertebrates.

The riparian vegetation (plants growing along the edge of a river) balances the temperature in a healthy aquatic system. If this vegetation is cleared, it gives rise to more light penetration and an increase in turbidity from exposed soil. Industrial discharges or stormwater runoff from hot surfaces (such as roads and carparks) could increase the temperature quickly and discharges from dams could release cooler water. Some macroinvertebrates such as stoneflies cannot cope with such changes.

High levels of nutrients in the form of nitrogen and phosophorus from fertilizers and wastewater can activate excessive algal growth (algal blooms). The death and decay of these algae can produce toxins and stagnant conditions. In these conditions, macroinvertebrate community diversity is

usually reduced but there is generally an increase in the abundance of a few species. These macroinvertebrates are able to take advantage (they are opportunistic) of the altered conditions and exploit the excess of food supply.

So, are you ready for some environmental action and to find out the condition of your stream or river?



miniSASS is a simplified form of the South African Scoring System. It is a technique that can be used to measure the health of a river and the general quality of the water in that river and it is a technique that has been developed in South Africa. It uses the composition of macroinvertebrates living in rivers and is based on the sensitivity of the various animals to water quality.

Safety:
Safety considerations are very important. You must never sample at any site that might be unsafe and never sample alone. At the end of the sampling session, wash your hands thoroughly before eating food.

Remember:

- Never sample alone
- Never go into the water above your knees
- Avoid contact with polluted water
- Choose safe sites
- Wear appropriate clothing
- Take safety gear and a first aid kit

Equipment list:

- net
- white container/ice-cream box
- pencil
- magnifying glass (optional)
- shoes/gumboots

Note to teacher: The focus question for this exercise is to examine the water quality of your chosen river/body of water using visible animal life.

Method:
The best sites are those with rocks in fast flowing water. Not all sites have rocks (**rocky type** rivers), but may be largely sandy (**sandy type** rivers).

1. Whilst holding a small net in the current, **disturb** the stones, vegetation, sand etc. with your feet or hands.
2. You can also lift stones and **pick** insects off gently with your fingers or

forceps.

Do this for about **5 minutes** whilst ranging across the river to **different habitats** (places).

3. Rinse the net and turn the contents into a plastic tray/container and **identify** each group using the identification guide on page 9.
4. **Mark** the identified insects off on the identification guide on page 9.
5. Use the score sheet below to determine the average score. Write these scores on the chalkboard*.

** To see how reliable and accurate the learners' investigations and data collection was, ask all the learners (or groups if they did this activity in groups) to write up their scores on the chalkboard. If the learners were conducting this investigation within a small area, their results should be similar. If the results differ greatly, find out why.*

Scoring:

1. On the table below, circle the sensitivity scores of the identified insects.
2. Add up all of the sensitivity scores.
3. Divide the total of the sensitivity score by the number of groups identified.
4. The result is the average score, which can be interpreted using the table on page 8.

GROUPS	SENSITIVITY SCORE
Flat worms	3
Worms	3
Leeches	2
Crabs or shrimps	7
Stoneflies	14
Minnow mayflies	6
Other mayflies	13
Damselflies	4
Dragonflies	7
Bugs or beetles	6
Caddisflies	9
True flies	2
Snails	4
TOTAL SCORE	
NUMBER OF GROUPS	
AVERAGE SCORE (Divide 'Total' by 'Number of groups')	

Interpretation of the miniSASS score:
Although an ideal sample site has rocky, sandy, and vegetation habitats, not all habitats are always present at a site. If your river does not have rocky habitats use the **sandy type** category below to interpret your scores.

ECOLOGICALCATEGORY (CONDITION)	**RIVER CATEGORY**	
	SANDY TYPE	**ROCKY TYPE**
Unmodified (**NATURAL** condition)	> 6.9	> 7.9
Largely natural/few modifications (**GOOD** condition)	5.8 to 6.9	6.8 to 7.9
Moderately modified (**FAIR** condition)	4.9 to 5.8	6.1 to 6.8
Largely modified (**POOR** condition)	4.3 to 4.9	5.1 to 6.1
Seriously/critical modified (**VERY POOR** condition)	<4.3	<5.1

5. Write a paragraph on **the meaning of your data** (scores), comparing them with the focus question.

6. What other investigations (other than investigating visible animal life) could you do to confirm your findings about the health of this river/body of water?

*Send your results to **minisass@ground-truth.co.za** to contribute to a developing picture of river quality in South Africa.*

Criteria to assess learners during this natural sciences lesson

Criteria	**Exceeded requirements of the Learning Outcome**	**Satisfied requirements of the Learning Outcome**	**Partially satisfied requirements of the Learning Outcome**	**Not satisfied requirements of the Learning Outcome**
The learner conducted the water quality monitoring investigation.				
The learner collected and interpreted data from the water quality monitoring investigation.				
The learner was able to write a paragraph on the meaning of his/her data.				
The learner was able to suggest further investigations which would help confirm the findings of the miniSASS investigation.				

Flat worms

Flat worms are characterised by their flattened shape and soft bodied, worm-like form. They have an arrow shaped head with two dorsal eyespots and are generally mottled or dark grey in colour. Flatworms move with a gliding action and are generally scavengers or carnivores.

Leeches

Leeches are segmented organisms that have very flexible bodies. When moving they expand to become long and thin, and then contract to become short and stubby. They have suckers on both ends of the body that are used for feeding and locomotion. Leeches are variable in colour, from grey, to red-brown and black. They swim with a fast, snaking movement and are found under stones, vegetation and debris

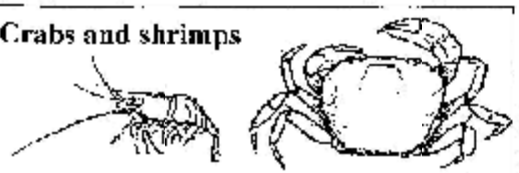
Worms

Worms are long and segmented and have a cylindrical shape much like small earth worms. Their colouring is usually pink to brown. They are usually seen writhing around in debris digesting the substrate they fed on.

Snails

Snails are molluscs with hard shells that vary in size, shape and colour. Habitats vary, with some snails such as limpets clinging to rocks, whereas clams and muscles are found in sand. The more common snails move over stones and vegetation. Some snails are host to bilharzia, a serious health hazard for humans.

Crabs and shrimps

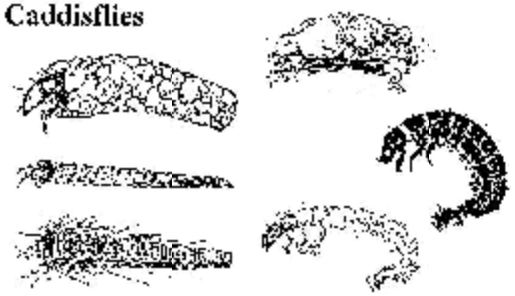


Crabs and shrimp form part of the order Decopoda (ten legs) and have bodies and legs hardened to form a tough shell. They have four or five pairs of legs, and eyes that are carried on stalks and are movable. Crabs are scavengers that feed mainly on leaf litter but will feed on animals when given the chance. Shrimps are mostly scavengers or deposit feeders.

Stoneflies

The nymphs of adult stone flies usually have two long tails and three pairs of legs each having two claws at the tip. A characteristic feature of stonefly nymphs are the tufts of gills on the side of the body as well as gills between the two tails. Wing pads on the thorax are often dark and obvious. Some species run across the substrate very efficiently and are potent predators on other invertebrates. Other species are smaller and feed on plant material. Most live in well oxygenated, clean water.

Caddisflies



The aquatic larvae of adult caddisflies have a hard head with three pairs of legs which are attached to an elongated, soft body. Finger-like gills on the abdomen and anal appendages can be seen with the naked eye. Some caddisflies construct portable shelters/cases from sand grains, bits of vegetation and/or silk that are glued together to form a characteristic case shape. Most of the case-building types cannot swim whereas the case-less type swim freely across the substrate. Some feed on algae and detritus whereas others are predators.

Damselflies

Damselflies have elongated bodies with generally three broad tails/gills on the tip of the abdomen. Damselflies are carnivorous and have a 'mask' over the lower part of the face which hinges out to reveal a pair of pincers with which they catch their prey. They are often to be found in vegetation growing on the edge of rivers.

Dragonflies

Dragonfly nymphs are robust creatures that are stout and have a large head and protruding eyes. Some have short legs whilst others have long legs. They do not have tails, but swim using 'jet propulsion' by forcefully ejecting water from the abdomen. Dragonfly nymphs are usually the largest organisms found in a sample and are the most powerful invertebrate predators in the water.

Bugs and Beetles

Bugs can be defined as having a piercing and sucking beak for mouthparts, and two pairs of membranous wings. Beetles on the other hand have 'jaws' and outer wings that are hardened to protect the inner wings. Some bugs and beetles are well adapted to swimming, such as water boatmen, backswimmers, pond skaters and water striders. Most bugs and beetles are carnivorous, but some feed on algae.

Mayflies

Mayfly nymphs vary greatly in shape and size and live only for a day or two. In this time they will never feed and live to mate and lay eggs in the water. Mayflies fly close to rivers and lakes, usually swarming in the early evenings.

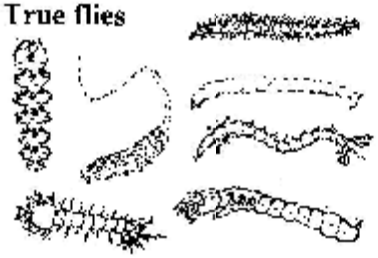
Minnow mayflies

These mayflies have a narrow head and a small, slender, but not flattened body. They have leaf shaped gills on both sides of the abdomen and two but more commonly three tails, depending on the species.

Other mayflies

Other mayflies are characterised by an elongated body, large head, well-developed mouthparts and stout legs. They live in a variety of habitats including burrowing in mud, crawling amongst decaying leaves, and scurrying over stones in fast flowing currents

True flies



Most fly larvae have a fairly indistinct head but elaborate tail ends. They often have small, soft legs (prolegs), segmented bodies and have the appearance of maggots. Some have bristles/ spines and antennae. True flies live in a variety of habitats including sand, mud and stones in fast flowing water. They can either be carnivorous or filter feeders.

ACTIVITY FOUR: SO … WHO'S RESPONSIBLE FOR WATER AND WATER QUALITY IN SOUTH AFRICA?

During this MATHEMATICS data handling activity, learners find out how water finds its way to the taps in their homes and how it leaves their homes. They also collect and summarise information on two important South African laws around the provision of water services.

According to the Constitution of the Republic of South Africa enacted in 1996, everyone has the right to have access to 'sufficient food and water.'

Water, our national resource

Water falls from the sky as rain. It flows across the surface of the land into streams, then rivers and out to the sea. Humans collect water from the streams and rivers for drinking and irrigating their fields and for use in manufacturing and mining. In a country like ours which does not receive much rain, it is necessary to try and save as much of the rain water as is possible for these uses.

So, we build dams which store water and make it available all year round. To make it easier for people living in towns and cities to have access to this stored water it is led from the dams in pipes to storage areas (reservoirs) in the cities.

Here it is purified (treated) and then piped (reticulated) into homes and factories. For this to occur various institutions and well-managed infrastructure must be in place.

Water Services Institutions

The government has the primary responsibility of creating the institutional arrangements and structures for ensuring that the people's rights to water are satisfied.

The national government has created a department known as the Department of Water Affairs and Forestry (DWAF) under the direction of the Minister of Water Affairs and Forestry. This department is responsible for establishing, throughout the country, dams for the storage of the national water resource and establishing norms for preventing the pollution of water flowing into the rivers. The department also establishes bodies known as Water Boards whose task it is to provide water services to local government.

According to the Constitution, the responsibility for providing water to towns and rural communities rests on local government authorities. This means that the Regional Councils and Municipalities must undertake responsibilities for obtaining supplies of water from the Department's storage dams, or a Water Board, and purifying and reticulating that water.

ACTIVITY:

1. Find out how piped water gets to your house and how it leaves your house. Does it come from a dam or reservoir? You may need to contact your local municipality or water board. You might want to interview people in the area using a questionnaire, or conduct an Internet search. (Keep a record of all the methods you use to gather your data.) Draw the pathway of water from rain/groundwater to your bathroom. Remember to include any purification that takes place. (If some learners live on farms and have streams/springs on the farm, show how it is pumped to the house – is it filtered, chlorinated?) Draw the pathway of the water leaving your house – where does it go?

2. There are two very important laws around the provision of water services in South Africa. (***Teacher:*** *they are the National Water Act of 1998 and the Water Services Act of 1997*). What are they? And what are their main objectives? Do an Internet search or use your local library. You may even decide to telephone or write to the Department of Water Affairs and Forestry.

Criteria to assess learners during this mathematics lesson

Criteria	**Exceeded requirements of the Learning Outcome**	**Satisfied requirements of the Learning Outcome**	**Partially satisfied requirements of the Learning Outcome**	**Not satisfied requirements of the Learning Outcome**
The learner was able to select and use different and appropriate sources in order to find out how water reached and left his/her home.				
The learner's drawing accurately reflected the pathway of rain/groundwater to their bathroom and included the appropriate information.				
The learner was able to select and use different and appropriate sources in order to find out what important South African laws there are around the provision of water services.				

ACTIVITY FIVE: CREATING A WATER QUALITY ACTION PLAN

During this NATURAL SCIENCES lesson, learners develop a River Action Plan with aims, goals and objectives. They then implement the Action Plan, evaluate it and review it.

NOTE TO TEACHER: Now that learners know the quality of their stream or river, they can create their own River Action Plan. If their water quality monitoring showed a "poor" or "very poor" stream or river, they may consider an Action Plan which involves constant water testing and water quality monitoring, as well as community meetings, litter clean-ups and removing invasive alien plants and trees. Some rivers/streams will have shown good conditions, even approaching natural conditions and learners may then decide

to have a River Action Plan to promote the enjoyment of the river and its surrounds, such as a small field guide trail book which identifies all the plants, trees and birds in the area or appropriate environmental information signage along a well maintained and managed river trail.
This can be done either in a group or as an individual activity. Learners will need to write up their Action Plan and submit it to you, the teacher, for guidance and assessment. You may like to make this a term-long or year-long project for learners – Write up an Action Plan, Implement the Action Plan, Report on the Action Plan.

GROUP OR INDIVIDUAL ACTIVITY:
Learners need to formulate an action plan for the river or stream they monitored in Activity Three. Once formulated, with guidance from you the teacher, they need to implement their Action Plan (over a term or a year), and then review and report on it.

What is an Action Plan?
An action plan is like a road map – it shows you where you are, where you are going, and how you are going to get there.

The aim of an action plan is to allow your group to move from what you know, to eventually co-ordinating and implementing actions that will have a beneficial impact on the river and its water quality. An action plan will help to focus your activities.

Getting everyone involved
Before you even begin drawing up an action plan, you need to make sure that all stakeholders, people who live, work, go to school or run a business near the river you investigated, are aware of your activities. You will achieve much more when the whole community understands what you stand for, and what you are trying to achieve. Also, ensure that relevant government water and land managers, local government and conservation groups are involved.

Remember not to exclude groups or individuals that may be contributing to the decline of water quality or groups who are already working on water issues in your area. Good outcomes are based on the principle of co-operation not confrontation.

From Awareness to Action
The nature of the problem will usually determine what actions are most suitable. Depending on the situation you may wish to promote better farming practices, replant trees, remove litter or gain media coverage for your activities.

Aims
An aim is a broad statement that says what you are trying to achieve. For example, you may aim to:

- Create a cleaner, less polluted waterway
- Improve water quality by reducing erosion
- Promote the natural beauty of the river for use by the community and tourists

Goals
You now need to set your goals, which should flow from your aim. Make sure the goals are achievable, tangible and positive. Place realistic time frames on your goals, and remember to prioritise them.

Possible goals could include:

- Increasing indigenous vegetation along the waterway
- Removing litter and exotic species from the waterway
- Developing a river walking trail
- Developing a trail booklet

Objectives
Once you have created your goals, you should create one or more definable and measurable objectives for reaching each goal. Using the existing example, objectives could be to:

- Plant at least 10 indigenous trees
- Remove at least 50% of exotic plants from the waterway

Once you have determined specific objectives, you might like to create a timetable for each, and place someone in charge of reaching each objective.

Evaluate your Progress
Once you begin putting your plan into action, you will need to evaluate your progress by reviewing your aims, goals and objectives. This evaluation can be quite simple, you should go through each of your objectives and determine if that objective was met or not. If you did not meet your objective, try to work out reasons for this.

Review your Plan
Even if you have achieved what you originally planned, you need to go back and examine the whole process. Even the most successful programme can be critically reviewed and improved.

Criteria to assess learners during this natural sciences lesson

Criteria	Exceeded requirements of the Learning Outcome	Satisfied requirements of the Learning Outcome	Partially satisfied requirements of the Learning Outcome	Not satisfied requirements of the Learning Outcome
The learner contributed to formulating a River Action Plan which included aims, goals and objectives.				
The learner implemented the River Action Plan.				
The learner evaluated his/her River Action Plan.				
The learner reviewed his/her River Action Plan.				