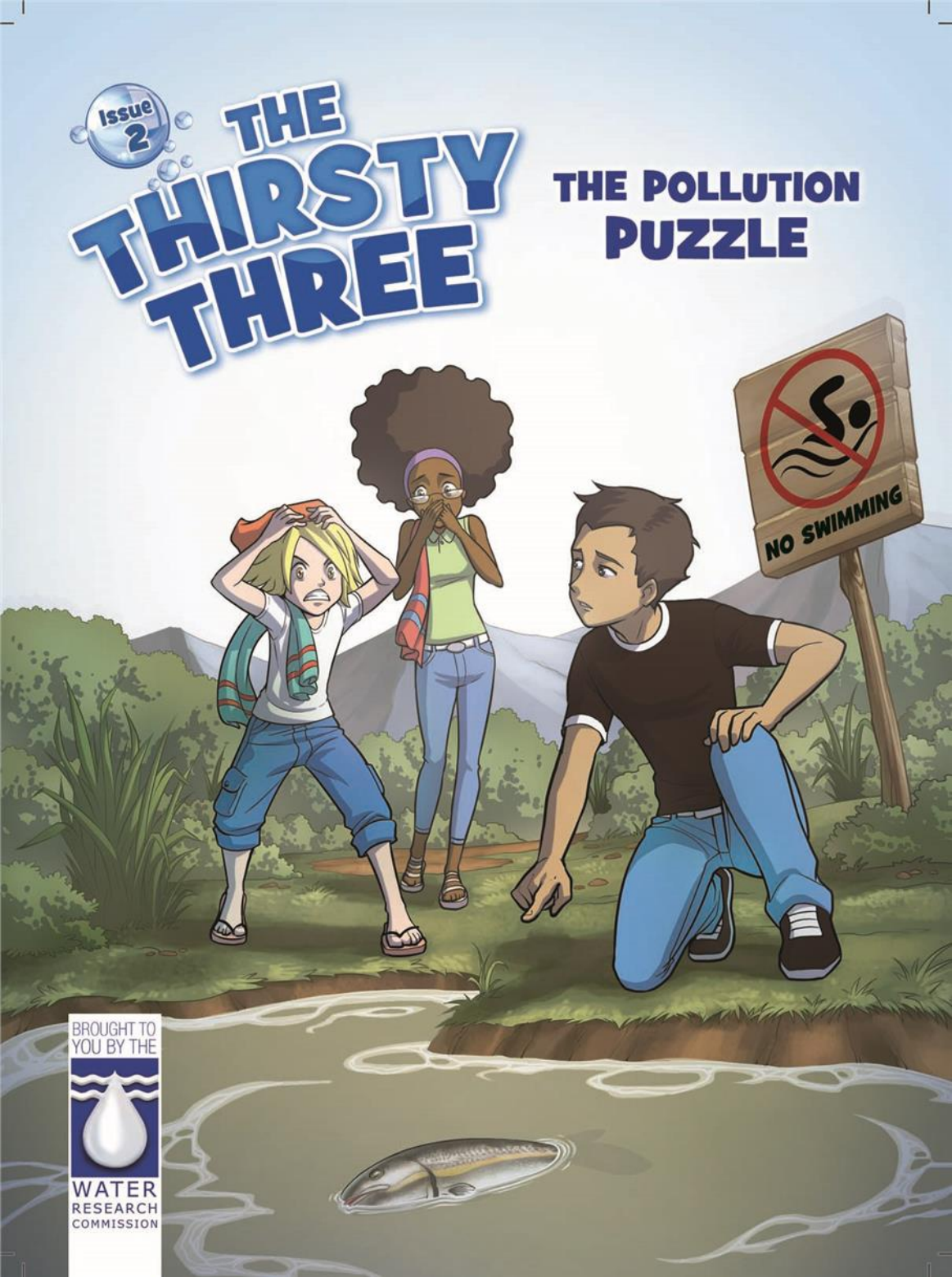
Issue 2

THE THIRSTY THREE

THE POLLUTION PUZZLE



BROUGHT TO YOU BY THE

WATER RESEARCH COMMISSION

THE THIRSTY THREE

Meet the characters

The Thirsty Three

Royston

As the oldest member of the Thirsty Three, he is the most responsible, so it falls upon him to come up with a good plan when the Thirsty Three need it most.

Mpho

A down-to-earth pretty young woman, Mpho is the smart one in the group. All the books she's read has given her a knack for solving even the most puzzling of mysteries.

Steyn

He is the youngest which means he likes to throw caution to the wind and jump head first into any situation. Steyn is a lovable little rascal, but his sense of adventure sometimes lands him in hot water too.

With

Jacob

The wise old dam caretaker does his best to keep the river and dam clean and is always there to give the Thirsty Three a helping hand when they're in trouble.

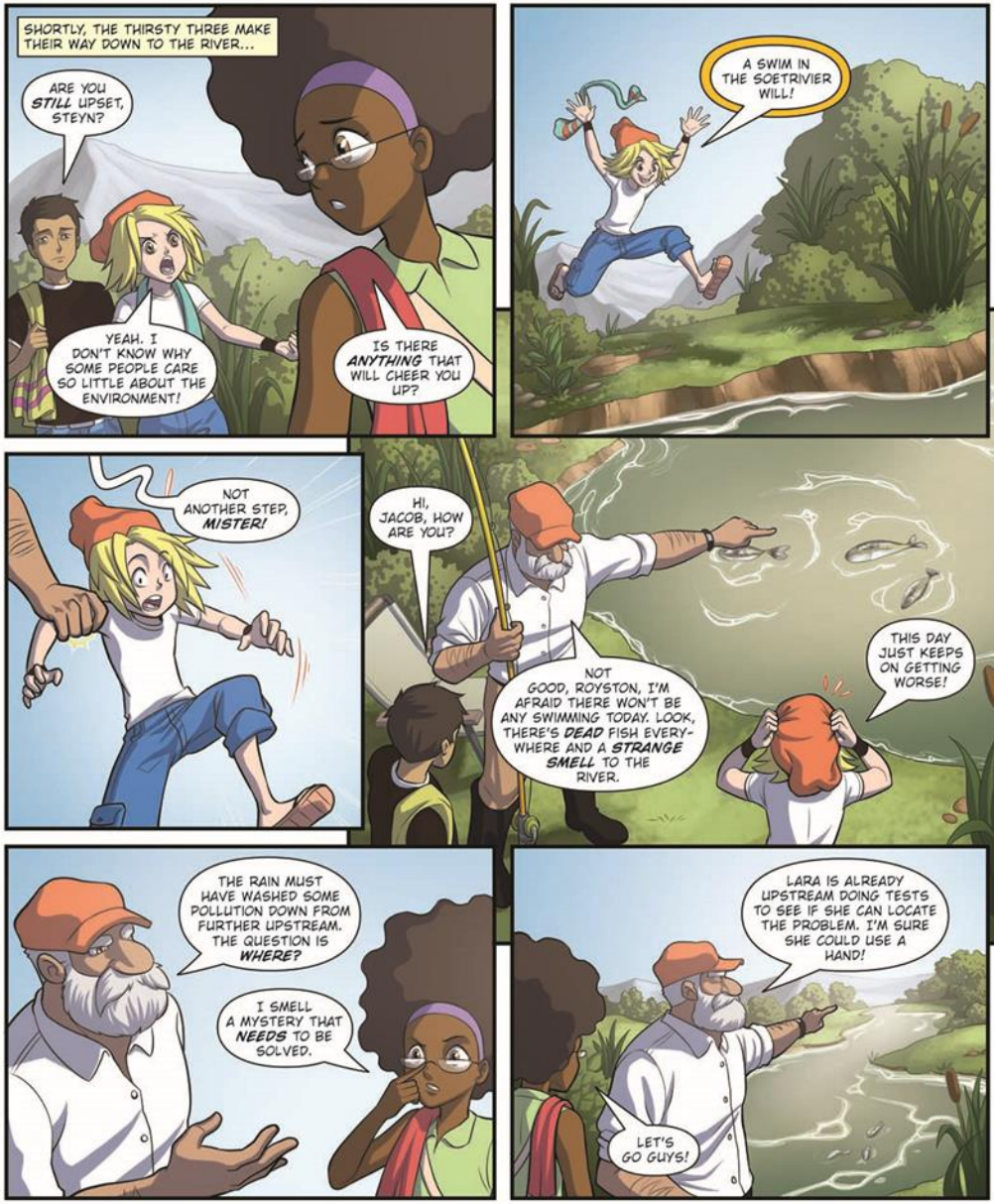
Lara

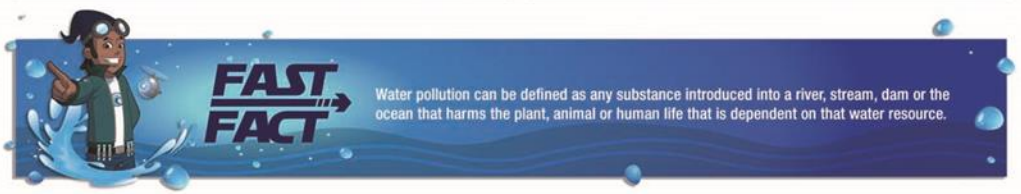
This water conservationist is working on several projects funded by the Water Research Commission (WRC) along the Soetrivier. She's passionate about water and always helpful, polite, and very informative.

and Lwazi

Lwazi is a clever teenage wizard who loves science and uses his magical water bending powers to preserve the country's most precious, dwindling resource: water. He is always accompanied by his beloved drone, W.E.B. (Water Experimentation Bot), and together they will be your guide through this book, offering helpful facts and knowledge along the way.


THE THIRSTY THREE WALK THROUGH TOWN ON THEIR WAY TO THE SOETRIVIER...
WOOHOO! I CAN'T WAIT TO GO FOR A SWIM IN THE RIVER!
ME TOO, STEYN! I'M GLAD TO SEE THE SUN AGAIN AFTER ALL THE RAIN.
WELL, I'M HAPPY WE HAD SO MUCH RAIN! YOU NEVER KNOW WHEN ANOTHER DROUGHT MIGHT HIT OUR VILLAGE.
GET OUT OF MY WAY, PUNK!
SORRY, GOGO, DO YOU KNOW WHO THAT RUDE MAN IS WHO JUST CAME OUT OF THE SHOP?
THAT'S TONY, THE OWNER OF THE NEW TANNERY THAT PROCESSES LEATHER FOR HANDBAGS AND SHOES FURTHER UP THE RIVER. EISH, MPHO! HE'S GOT NO RESPECT FOR THE LOCALS!
WHAT ARE YOU LOOKING AT?
TONY'S TANNERY
WHAT A RUDE MAN!
AND A LITTER BUG! LET GO OF ME, ROYSTON, I'LL SHOW HIM!
RELAX, DUDE. THERE'S NOTHING YOU CAN DO ABOUT IT NOW.
FAST FACT
South Africa is a water-scarce country, where rainfall is distributed unevenly. Most of our rain falls along the coast, while the rest of the country only receives 27% of the total rainfall.


SHORTLY, THE THIRSTY THREE MAKE THEIR WAY DOWN TO THE RIVER...
ARE YOU STILL UPSET, STEYN?
YEAH. I DON'T KNOW WHY SOME PEOPLE CARE SO LITTLE ABOUT THE ENVIRONMENT!
IS THERE ANYTHING THAT WILL CHEER YOU UP?
A SWIM IN THE SOETRIVIER WILL!
NOT ANOTHER STEP, MISTER!
HI, JACOB, HOW ARE YOU?
NOT GOOD, ROYSTON, I'M AFRAID THERE WON'T BE ANY SWIMMING TODAY. LOOK, THERE'S DEAD FISH EVERYWHERE AND A STRANGE SMELL TO THE RIVER.
THIS DAY JUST KEEPS ON GETTING WORSE!
THE RAIN MUST HAVE WASHED SOME POLLUTION DOWN FROM FURTHER UPSTREAM. THE QUESTION IS WHERE?
I SMELL A MYSTERY THAT NEEDS TO BE SOLVED.
LARA IS ALREADY UPSTREAM DOING TESTS TO SEE IF SHE CAN LOCATE THE PROBLEM. I'M SURE SHE COULD USE A HAND!
LET'S GO GUYS!


FAST FACT
Water pollution can be defined as any substance introduced into a river, stream, dam or the ocean that harms the plant, animal or human life that is dependent on that water resource.


I WONDER WHAT'S CAUSING THE POLLUTION IN THE RIVER?
IT COULD BE HAPPENING ANYWHERE. IT'S A PRETTY LONG RIVER.
HEY, YOU KIDS AREN'T ALLOWED HERE. YOU'RE TRESPASSING!
IT'S THE TANNERY OWNER! RUN, EVERYONE!
COME HERE SO I CAN TEACH YOU A LESSON!
TONY STAYS HOT ON THE THIRSTY THREE'S HEELS...
HE'S GAINING ON US!
YOU'LL NEVER TRESPASS AGAIN, ONCE I'M FINISHED WITH YOU!
FAST FACT
In South Africa, water pollution is caused by a wide variety of factors, ranging from the chemicals that you throw down your drain, to sewage which ends up in rivers causing life threatening diseases like cholera and diarrhoea.


I DON'T THINK SO.
THIS ISN'T THE LAST OF IT, DO YOU HEAR ME!
THANKS, JACOB. THAT WAS A CLOSE CALL!
NO PROBLEM! THERE'S SOMETHING FISHY ABOUT THAT GUY'S BEHAVIOUR.
YEAH! IT STINKS!
HEY, THERE'S LARA!
HI, LARA! HOW IS IT GOING WITH THE TESTS?
HI, GUYS! I'VE JUST STARTED DOING SOME MINISASS TESTS IN THIS SECTION OF THE RIVER. DO YOU FEEL LIKE HELPING?
WHY THE FUNNY FACE, STEYN?
IT'S MY SASSY FACE! I THOUGHT YOU NEEDED HELP?
FAST FACT
Lara is a scientist funded by the Water Research Commission (WRC), which was established in the early seventies following a period of serious water shortages. For more than forty years, their purpose has been to look towards the future and solve South Africa's water problems through funding and sharing of knowledge.


HA HA! NO, STEYN, MINISASS TESTS! SASS STANDS FOR STREAM ASSESSMENT SCORING SYSTEM AND WE'RE DOING A SIMPLIFIED VERSION OF IT THAT ALLOWS US TO DETERMINE THE HEALTH OF A CERTAIN SECTION OF A RIVER.
DO YOU GUYS REMEMBER WHY HEALTHY RIVERS ARE SO IMPORTANT?
SURE, FIRSTLY WE NEED DRINKING WATER! WITHOUT THAT, NO ONE WOULD SURVIVE.
WATER IS ALSO IMPORTANT FOR SUSTAINING ALL KINDS OF ECOSYSTEMS, LIKE THE PLANT AND ANIMAL LIFE NEXT TO THE RIVER!
AND IT'S IMPORTANT FOR THE FARMERS. THEY NEED WATER TO IRRIGATE THEIR CROPS SO THAT WE HAVE FOOD TO EAT!
THERE ARE ALSO A LOT OF PEOPLE WHO RELY ON THEIR FOOD FROM THE RIVERS AND SEAS. THAT'S WHY WE NEED TO FIND OUT WHAT'S KILLING THE FISH IN THE SOETRIVIER!
FAST FACT
The miniSASS test determines the health of a water source based on the presence, or lack of, pollution-sensitive aquatic insects. The bigger the variety of insects you find, the healthier the river!

FAST FACT

The miniSASS tests are very useful in determining whether a river is healthy, but it can't indicate whether there are bacteria and viruses present which would require the water to be treated before you drink it.

Put your own miniSASS kit together!

The most important piece of equipment in your miniSASS kit is your net, which you can build with materials found around the house or purchased at a hardware store.

Make your own net:

What you need:

1 x Wire coat hanger

1 x Screwdriver

Mosquito net or nylon netting with a 1 mm pore size

2 x Pipe clamps

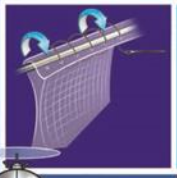
1 x Piece of string

1 x Broom handle or stick

Instructions:

1. Fold the coat hanger so that it forms a square of roughly 30 x 30 cm. Leave the ends of the wire sticking out from the middle of one side of the square. You will use this to attach your net to the broom handle or stick.

2. Ask a parent or teacher to sow the net into a bag large enough to fit over the 30 cm x 30 cm frame.



3. Secure the net to the frame with a piece of string.

4. Attach the frame and net to the stick or broom handle with clamps, using a screwdriver.

What else do I need?

1 x Copy of the miniSASS test

1 x Magnifying glass
(for looking at small insects)

5 x Small plastic bottles
(for taking unidentifiable insects home for further study)

1 x Forceps
(for picking up small insects)

1 x Ice cream tub or flowerpot base
(for putting your samples in)

1 x Bulb syringe
(for sucking up small insects)


DIFFERENT INSECTS PREFER TO LIVE IN *DIFFERENT* PARTS OF THE RIVERS. THESE HABITATS ARE CALLED BIOTOPES AND TO GET AN *ACCURATE* PICTURE OF A RIVER'S HEALTH WE NEED TO SAMPLE *AS MANY* DIFFERENT BIOTOPES AS POSSIBLE.
VEGETATION HABITATS, FOR EXAMPLE REEDS ALONG THE RIVERBANKS, ARE A POPULAR PLACE TO FIND DAMSELFLIES.
Vegetation habitat
Try and sample about 2 m of vegetation habitat in total, but divide the distance up along several sections so you don't do the entire 2 m in one place. To get a good sample in this habitat you should keep the net just below the surface of the water and push it into the reeds and grass to dislodge any insects attached to the vegetation.
Stone habitat
Keep your net downstream while overturning rocks upstream with your feet. This will cause the insects to wash off and into your net. If the water is shallow enough you can also use your hands to dislodge any insects from rocks. Keep moving around so that you can sample different parts of this habitat from both deep and shallow parts of the river. Try to spend at least two minutes in the stone habitat.
STONE HABITATS ARE CHARACTERISED BY FAST FLOWING WATER AND ROCKY PATCHES IN THE RIVER. IT IS IMPORTANT TO INCLUDE THIS HABITAT, AS THIS IS WHERE YOU WILL FIND THE WIDEST VARIETY OF AQUATIC INSECTS, FOR EXAMPLE MAY- AND CADDISFLIES.
GRAVEL, SAND AND MUD BIOTOPES ARE THE BEST PLACES TO FIND INSECTS LIKE DRAGONFLIES.
Gravel, sand and mud habitat
Look for a calm section of the river and find a spot that has a lot of muddy sediment. Start churning up the mud by moving your feet around vigorously. Drag your net through the muddy water to collect all the insects which you have disturbed. You should try to spend about a minute moving between several different patches.

GET TO KNOW YOUR INSECTS!

Empty all the invertebrates into a container after collecting your samples and remember to pour some water through the net to dislodge all the insects. Before we have a closer look, it's time to familiarise yourself with some of the most common insects you might find.

Flat worms:

Flat worms are soft-bodied and have a flat, worm-like form. They have an arrow-shaped head with two dorsal eyespots and are mostly mottled or dark grey in colour.

Bugs and beetles:

Bugs have piercing and sucking beaks for mouths and two pairs of membranous wings. They can be distinguished from beetles that have 'jaws' and outer wings that are hardened to protect the inner wings.

Dragonfly nymphs:

Dragonflies are tough creatures with a large head and protruding eyes. They don't have tails, but swim using 'jet propulsion' when they forcefully eject water from their abdomen.

Damselfly nymphs:

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 which they use to catch their prey.

Crabs and shrimp:

Crabs and shrimp have hardened bodies and legs that form a tough shell. They have four or five pairs of legs and eyes that are carried on movable stalks. Crabs are scavengers that feed mainly on leaf litter or other animals if given the chance. Shrimp are mostly scavengers or deposit feeders.

Caddisfly larvae:

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 can be seen with the naked eye. Some caddisflies construct portable cases from sand grains, bits of vegetation and/or silk that are glued together to form a shelter.

The miniSASS guide to insect identification

Identifying invertebrates isn't always easy. That's why it's a good idea to use this dichotomous key guide. It's basically an invertebrate road map that will guide you to the identity of any aquatic insect.

DICHOTOMOUS KEY (two variables or categories)

Start!

No shell

Shell

Snails

Legs

No legs

Unsegmented body

Flatworms

Segmented body

Long, thin body

Worms

Suckers on both ends

Leeches

Short, stubby legs (prolegs)

True flies

Clearly defined legs

4 plus pairs of legs

Pincer-like front legs

YES

Crabs

NO

Shrimp

3 pairs of legs

Wings

Hard, leathery front wings (NB wings may be folded)

Bugs and beetles

Beetle larvae

No Wings

Tail

Tufted Tail

Uncased caddisflies

Elongated Tail

Stoneflies

Generally 3 Tails

2 Tails

No Tail

Portable shelter/covering (made of sand, leaves, sticks)

Cased caddisflies

Bulging eyes

Dragonflies

Feathery or plate on abdomen

No feathery gills on abdomen

Other Mayflies

Side view

Humped back, fish-like way of swimming

Minnow Mayflies

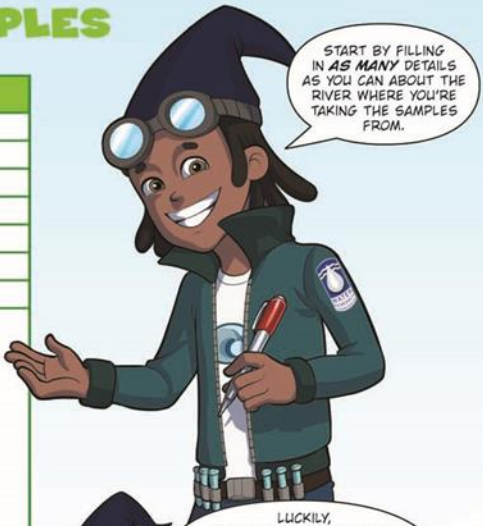
Side view

Long body

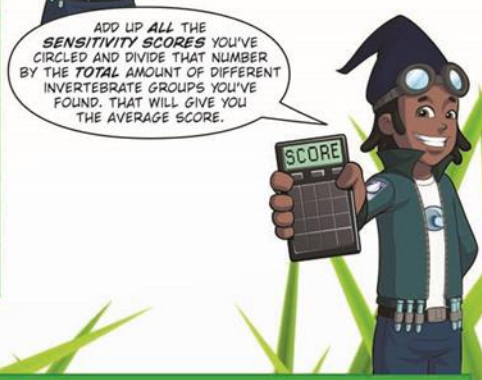
Damselflies

SCORING YOUR SAMPLES

SITE INFORMATION TABLE	
Date (dd/mm/yy):	
Collector's name:	
School/organisation:	
Site name:	
River name:	
Site description:	
GPS co-ordinate:	
Comments / Observations	



GROUPS	SENSITIVITY SCORE
Flat worms	3
Worms	2
Leeches	2
Crabs or shrimp	6
Stoneflies	17
Minnow mayflies	5
Other mayflies	11
Damselflies	4
Dragonflies	6
Bugs or beetles	5
Caddisflies (cased & uncased)	9
True flies	2
Snails	4
TOTAL SCORE	
NUMBER OF GROUPS	
AVERAGE SCORE	
Average score = Total score ÷ Number of groups	



INTERPRETATION

0 - 2 Highly impacted stream (poor condition)

2 - 4 Impacted stream (fair condition)

4 - 6 Slightly impacted stream (good condition)

> 6 Good quality stream (probably approaching natural condition)


WHOA! LOOK AT ALL THESE DAMSELFLIES FROM THE VEGETATION HABITAT. THEY'RE AMAZING!
AND I FOUND SOME MAYFLY NYMPHS IN THE STONE HABITAT!
I FOUND A WORM IN MY APPLE!
STEYN!
KIDDING! I'VE BEEN DOING THE MINISASS TEST JUST LIKE LARA SHOWED US. MY SCORE'S FIVE, THAT'S PRETTY GOOD, RIGHT?
I GOT A FIVE TOO!
THAT'S NOT A BAD SCORE, GUYS! IT MEANS THE QUALITY OF THE STREAM HERE IS MUCH BETTER THAN FURTHER DOWNSTREAM.
THE POLLUTION MUST BE COMING FROM SOMEWHERE BETWEEN HERE AND WHERE JACOB WAS FISHING. IT'S GETTING LATE, SO I'LL HAVE TO INVESTIGATE MORE TOMORROW.
HEY GUYS, I THINK I KNOW WHERE THE PROBLEM IS. BUT TO FIND OUT IF I'M RIGHT WE'RE GOING TO HAVE USE STEALTH AND SPEED. MEET ME LATER TONIGHT...
FAST FACT
You can upload your miniSASS results to www.minisass.org which allows you to share and compare your findings with a whole community of water-conscious people. This information is also crucial to the WRC's research.


LATER THAT NIGHT...
STEYN, WHY ARE YOU DRESSED SO FUNNY?
I'M A NINJA! YOU GUYS SAID YOU NEEDED STEALTH AND SPEED!


ROYSTON LEADS THE THIRSTY THREE TO THEIR DESTINATION...
WE'RE HERE! ARE YOU SURE THIS IS A GOOD IDEA, MPHO?
KEEP OUT!
TONY'S TANNERY
I CHECKED AND THE RIVER ISN'T PRIVATE PROPERTY. SO AS LONG AS WE KEEP TO THE WATER, WE'RE NOT TRESPASSING.


WHOA, SOMETHING SMELLS HORRIBLE. STEYN, DID YOU...?
I SWEAR IT WASN'T ME!
I THINK STEYN'S TELLING THE TRUTH. THAT SMELL'S COMING FROM THE RIVER. HERE, PUT ON SOME GLOVES TO BE SAFE. WHO KNOWS WHAT'S GOING ON HERE?


THE GANG CONDUCT THEIR MINISASS TESTS BY SOLAR LIGHT.
I CAN HARDLY SEE ANYTHING EITHER.
THIS IS BAD. I CAN HARDLY SEE ANY INVERTEBRATES IN HERE!
I THINK WE'VE FOUND THE ORIGIN OF THE POLLUTION. BUT WE'LL NEED TO COME BACK TOMORROW WITH JACOB AND LARA TO SEE IF I AM RIGHT.


THE NEXT MORNING...
...AND THERE WERE ALMOST NO INVERTEBRATES IN OUR SAMPLES!
SOUNDS LIKE YOU FOUND THE SOURCE OF THE POLLUTION. GOOD WORK, GANG!
LET'S GO CHECK IT OUT.

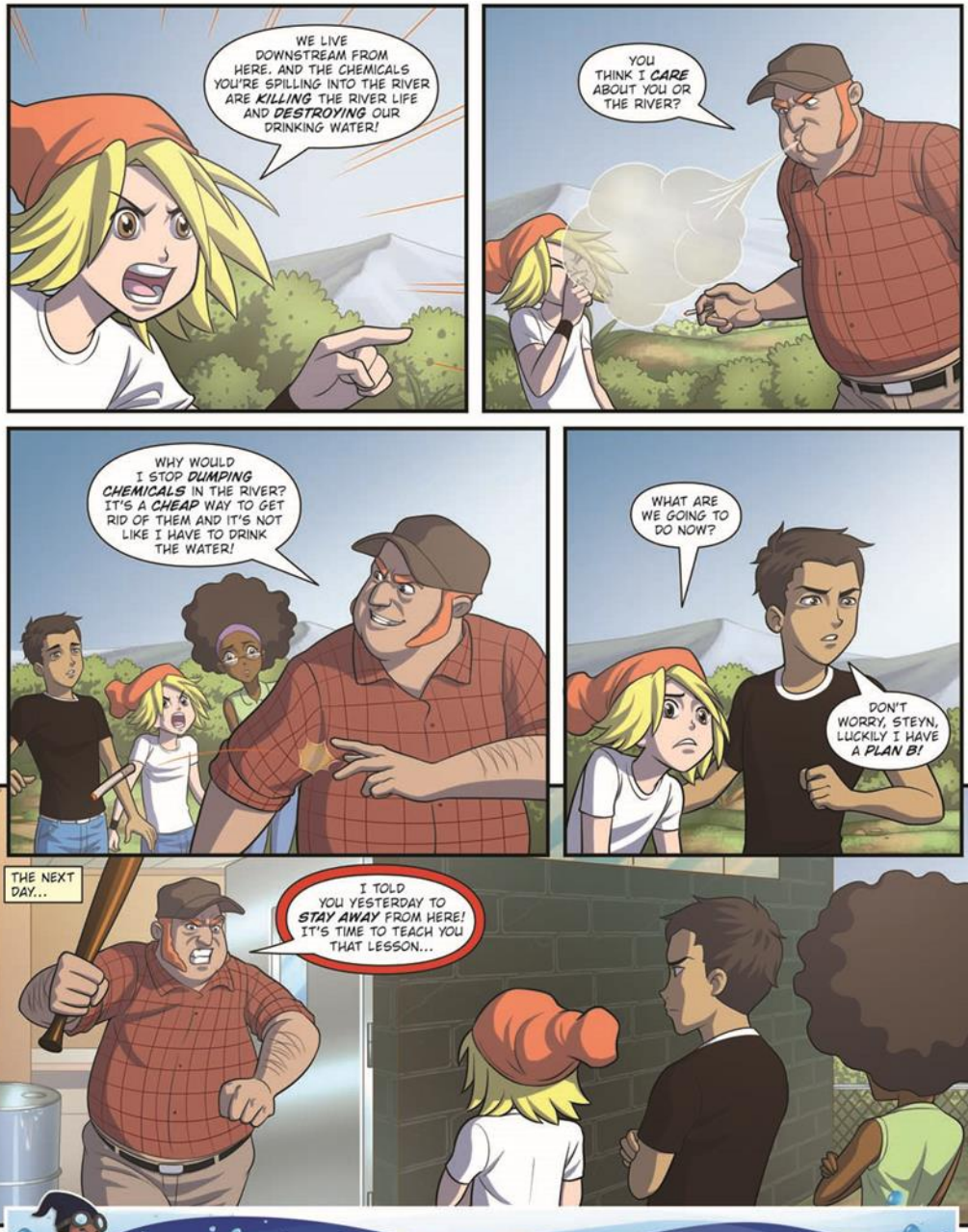

SOON...
OH NO!
I WAS RIGHT! THIS IS THE SOURCE OF THE POLLUTION!
THIS IS A LOT WORSE THAN I THOUGHT....


FAST FACT
Always wash your hands when you're done with doing a miniSASS test to avoid possible viruses and bacteria from spreading.


SPOT THE POLLUTION!
THERE ARE MANY WAYS THAT A RIVER CAN GET CONTAMINATED. SOME CAUSES ARE MORE OBVIOUS THAN OTHERS. CAN YOU SEE FOUR THINGS THAT MIGHT BE CAUSING POLLUTION IN THE RIVER?
Answers: Toxic waste spilling from drainpipes; workers dumping rubbish along riverbanks; fertiliser seeping into the river due to incorrect ploughing methods; cattle grazing next to the river, resulting in manure falling into the river.

FAST FACT

Nutrients in water are a good thing, but if fertilisers spill into the river the nutrient levels spike, causing an algae bloom. This bloom sucks all the oxygen from the water, blocks sunlight from reaching underwater plants and in some cases even releases toxins which are deadly to other lifeforms.



FAST FACT

Every day, about two million tons of waste is dumped into the world's fresh water sources. One litre of wastewater is enough to pollute up to eight litres of fresh water.

FAST FACT

If you want to help protect our precious resources, you should find out more about a career as one of the Department of Water and Sanitation's Blue Scorpions. You will be responsible for public health and will check for signs of contamination in the water or soil. This includes inspecting facilities to make sure that businesses are following health regulations. Your job will be to investigate, issue warnings and put controls in place to ensure the health and safety of the public.

What are your thoughts?

Why do you think water is so important? Have you ever encountered pollution in your area? Was there anything you could do to help solve the problem? These are the kind of questions we would like you to discuss during the creative writing exercise. Take some time to think about it and write about the role of water in your own life.

How big is your family's eco-foot print?

An ecological footprint refers to the impact each person has on the environment. The bigger your footprint, the more harmful you are to the environment. Ask your parents to help you answer these questions to find out how big or small your family's eco-footprint is.

1. WATER USE AT HOME

The harder you have to work to get your water, the more valuable it becomes to you. That's why easily accessible tap water at home is sometimes wasted!

When you wash, do you use:

a. A bucket

b. A shower

2. RE-USING WATER

South Africa is a water-scarce country. Some scientists predict that by the year 2025 we will have insufficient water for everyone's use.

When you have finished washing at home:

a. Do you discard your water or let it run down the drain

b. Do you re-use the water, for example to water plants

3. ENERGY USE AT HOME

Energy-saving bulbs or solar powered lamps are one of several ways you can reduce you electricity consumption at home, which means less coal is burned resulting in less pollution released into the air.

In your home do you have at least one energy-saving method?

a. Yes

b. No

4. ANIMAL-BASED PRODUCTS

Cow or chicken farms put a lot more pressure on the environment than vegetable farms, which means people who eat a lot of meat have more impact on the environment than those who eat less meat or only vegetables.

How often do you eat animal products?

a. Never

b. A few times a week

c. Once a day

d. Small amounts at every meal

e. A large part of every meal

5. POISONS

Many of the ingredients in household poisons cause allergies, trigger cancer growth and cause genetic defects. Most of the time, there is no need to kill that spider or weed with poison!

How do you get rid of pests? Do you:

a. Use the strongest insecticide or weed killer

b. Buy special environmentally friendly products

c. First attempt to solve the problem with a less destructive alternative

6. RECYCLING AND RE-USING

Recycling your waste helps to reduce the impact on the environment, reduces the amount of waste that goes into landfill sites (rubbish dumps), and reduces the amount of raw materials required to produce new material.

Do you recycle at home?

a. Never

b. Sometimes

c. Often

7. INDIGENOUS PLANTS

Growing indigenous plants in your garden is a great way to contribute to biodiversity. They attract indigenous insects, birds and other animals and are suited to the South African climate, which means they require less water.

How many of the plants in your garden, excluding homegrown fruit and vegetables, are indigenous?

a. Most

b. Half

c. Less than half

d. None of the plants

8. LIVING SPACE

A large home isn't necessarily a good thing, because they require more building and maintenance materials which put strain on the earth's resources.

In your home, do you have:

a. More people than bedrooms

b. The same number of people and bedrooms

c. More bedrooms than people

9. SHOPPING

You can reduce your eco-footprint by buying in bulk to reduce packaging. The less you have to throw away, the less impact you have on the environment.

How often do you think about the packaging when you buy groceries?

a. Always

b. Often

c. Sometimes

d. Never

10. CONSUMER CHOICES

You need to be informed about the choices you make when you buy something. A roll-on deodorant for example is much better for the environment because, unlike spray deodorants, they don't contain CFCs which break down the ozone layer.

When you shop do you choose the least polluting product?

a. Always

b. Often – depending on price, brand or what you have seen on TV

c. Sometimes – depending on price, brand or what you have seen on TV

d. Never think about such things

11. TRAVEL

Cars and other vehicles release poisonous gases and substances like lead into the air which cause acid rain, smog, health problems and global warming.

How do you get to work/school/college?

a. On foot

b. By bicycle

c. By taxi

d. By car

12. LOCALLY GROWN FOOD

Growing food yourself or buying locally grown, in-season and unprocessed food reduces energy consumption, because there is little or no energy spent on transporting, processing, packaging or storing food.

How much of the food that you eat is locally grown, unprocessed and in-season?

a. Most

b. About three quarters

c. About half

d. About a quarter

e. Very little

How did you score?

	A	B	C	D	E
1.	0 points	5 points			
2.	20 points	-10 points			
3.	-10 points	20 points			
4.	-10 points	0 points	5 points	10 points	20 points
5.	20 points	0 points	-10 points		
6.	20 points	-5 points	-10 points		
7	-10 points	0 points	10 points	20 points	
8.	-10 points	5 points	20 points		
9.	-10 points	0 points	5 points	20 points	
10.	-10 points	0 points	5 points	20 points	
11.	-10 points	0 points	5 points	20 points	
12.	-10 points	0 points	5 points	10 points	20 points

Eco-Footprint Calculator

Score less than 50: Green Footprint
Well done! You and your family have a really ecological footprint. You guys can be really proud of yourself for putting so little strain on the environment.

Score from 50-150: Blue Footprint
Not too bad! You have a medium eco-footprint. There are some areas that you could improve on and reduce your footprint, but the good news is you're halfway there! Keep up the good work!

Score from 150-250: Red Footprint
Whoa! You guys need to start looking at how you can seriously reduce your eco-footprint. Remember, you need to carefully consider the choices you make, since they not only have an effect on your environment, but everyone you share the earth with.

Find the word!

Can you find the following words in the word search grid below? The words run horizontally, vertically, diagonally and even backwards.

Biotopes
Invertebrates
Soetrivier
Dragonfly
Pollution
miniSASS
Steyn
Royston
Mpho

B	O	E	N	S	O	E	T	R	I	V	I	E	R
Z	I	F	O	Y	D	R	A	G	O	N	F	L	Y
Q	P	O	I	S	E	O	I	A	R	P	I	S	A
U	A	R	T	K	X	T	T	E	T	O	H	P	M
R	S	O	U	O	E	C	S	B	A	U	F	E	I
T	D	Y	L	Q	P	V	N	W	R	O	E	G	Y
Y	F	S	L	I	A	E	O	Q	Y	A	I	L	E
U	G	T	O	Z	E	B	S	N	M	E	T	B	A
I	H	O	P	M	I	N	I	S	A	S	S	R	O
O	I	N	V	E	R	T	E	B	R	A	T	E	S