Curriculum Visions

The Water Book

SECOND EDITION

Key to interactive features

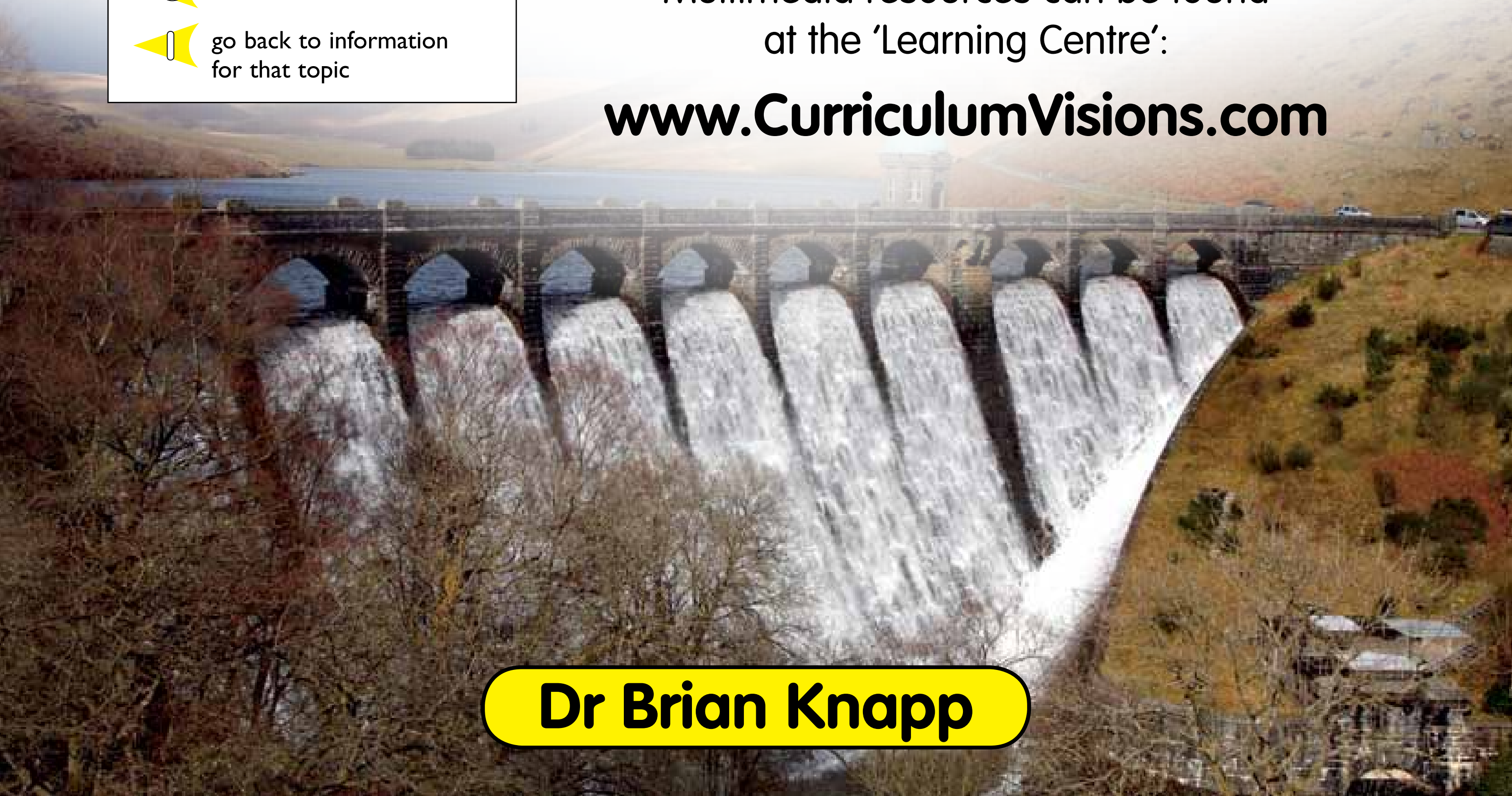
Press Teacher's Resources box right to go straight to Contents page.
Click on any item in the Contents to go to that page.
You will also find yellow arrows throughout that allow you to:

- 1A go to worksheet
- go back to previous page
- go forward to next page
- C go back to contents
- I go back to information for that topic

Teacher's Resources Interactive PDF

Multimedia resources can be found at the 'Learning Centre':

www.CurriculumVisions.com



Dr Brian Knapp

Curriculum Visions

A CVP Teacher's Resources
Interactive PDF

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Author
Brian Knapp, BSc, PhD

Senior Designer
Adele Humphries, BA, PGCE

Editors
Lisa Magloff, MA, and Gillian Gatehouse

Illustrations
David Woodroffe

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Contents

Note: The Curriculum Visions web site has pictures of a drinking water treatment works and a sewage works that could be used as an alternative to a visit.

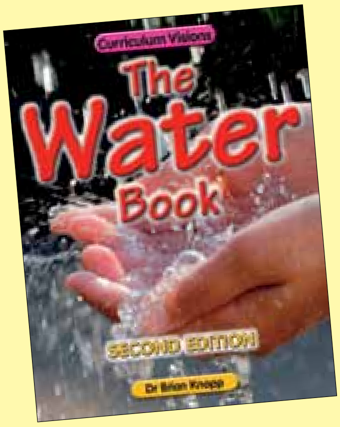
Section 1: Resources

Welcome to the Teacher's Resources for 'The Water Book' Second Edition.

The Water resources we provide are in a number of media:

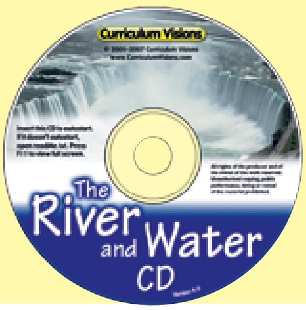
1

You can buy 'The Water Book' Second Edition. This is 48 pages long and covers the geographical principles of water supply.



2

The River and Water Mini-Movies CD contains information and examples that enhance the topics covered in The River and Water Books and provides a virtual field trip experience for a variety of rivers and river features. Each mini movie is accompanied by pop-up field notes and a gallery of pictures to copy and paste.



3

You can buy the Water PosterCard Portfolio – four posters and a total of 28 A4-sized key diagrams/photographs on two folded, double-sided and laminated sheets.

4

You can buy the supersaver pack that contains the student book, poster, PosterCard, and the Teacher's resources (what you are reading).

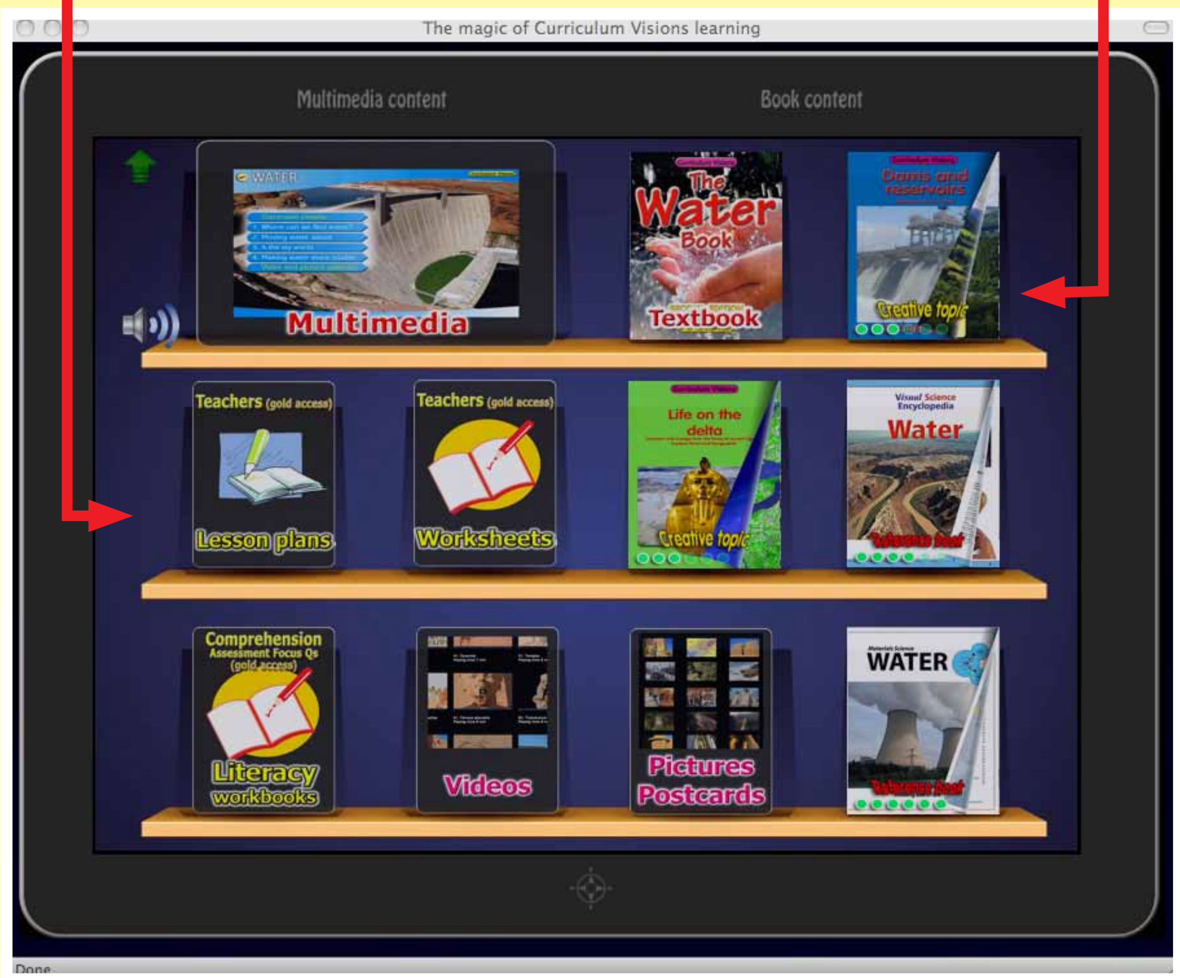
5

Our Learning Centre at
www.curriculumvisions.com
has almost everything you need to teach your primary curriculum in one convenient Virtual Learning Environment.

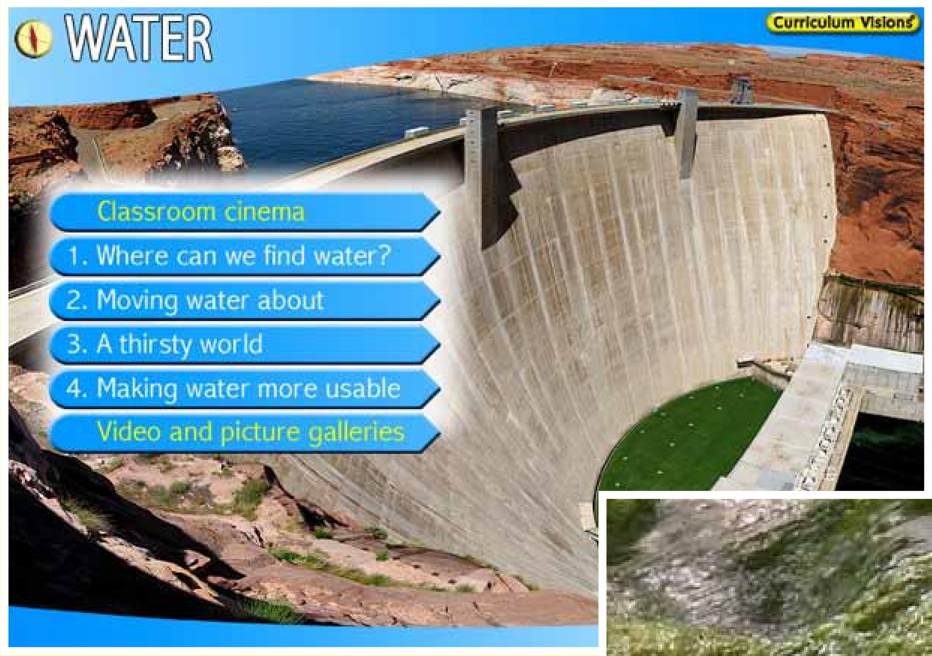
You can use support videos, e-books, picture and video galleries, plus additional Creative Topic books, graphic books called Storyboards, and workbooks. Together they cover all major curriculum areas.

All topics are easily accessible, and there is a built-in context search across all media.

You can also use our printed student books online as part of your subscription to the Learning Centre. There page-turning versions of every printed Curriculum Visions book for use on your whiteboard.



▼ The Water home screen



▲ Web site page

▶ Web site caption

Learning objectives

These following learning objectives have been addressed:

Where can we find water locally?

How does water get to where it is needed?

Who uses water? What do they use it for ?

Is all water usable? How can water be made more usable?

Links with science

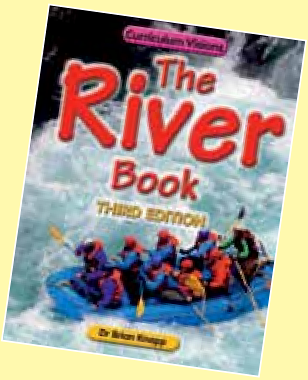
There are many opportunities to link this material with science, for example, life sciences can be studied through microbes.

These and other ideas are introduced, as appropriate, on the worksheets.

Links with history

There are many opportunities to link this material with history, especially through the way that water has been delivered to people by aqueduct (Romans), and also the major study of water supply and disease through the ages (see pages 36–41 of the student book).

Linked resources

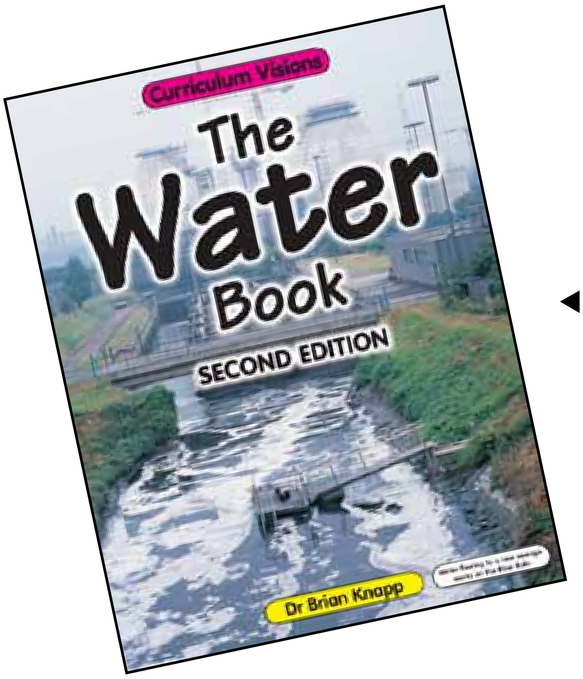


Section 2: The Water Book explained

Although the student book – *The Water Book* – is clear and simple, a great deal of care and thought has been given to the structure and the content of each double-page spread. The worksheets in section 3 of this *Teacher's Resources* also directly link to the pages in *The Water Book*.

It is possible to use *The Water Book* and section 3 of the *Teacher's Resources* without reading this section, but we would strongly recommend that you take a short time to familiarise yourself with the construction of the student book.

The Water Book begins with a quick visual introduction to the nature of water supply. This is followed by sections on the water cycle and how we adapt it for our needs. We then look at how water is used, and by whom, where water can be found and how it can be exploited. Finally, we look at the need to clean up water and also how water is likely to be an important resource and a potential source of conflict in the future.



◀ **The Water Book title page.**

⚠ Take care by reservoirs, rivers and lakes!

Safety

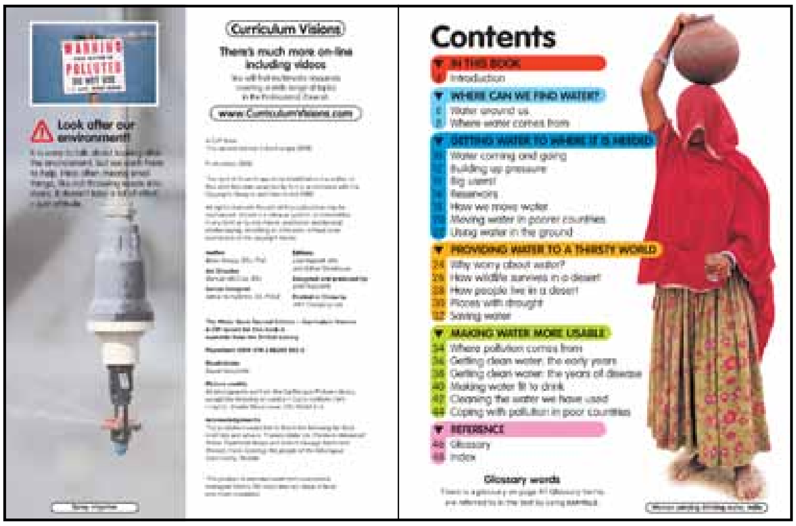
Please note that there are minor safety issues when dealing with this topic. Children should never handle water that may be contaminated with microbes.

Any work they do should use tap water. River or drainpipe water is not necessarily safe. Water from the foul drainage system should never be used.

Children should also be made aware of the dangers of playing near outlets to sewage systems and other water supply facilities.

Finally, children should be taught the rules of safety when going near rivers, reservoirs and lakes as specified by your Local Education Authority or other authorised body.

Contents



The book is organised into chapters and subdivided into double-page spreads. Chapters are shown on the contents page and are colour coded. Matching coloured headers run across each spread. The concept is paralleled by the pages on the web site.

Each spread has a heading, below which is a sentence that sets the scene and draws out the most important theme of the spread. The main text of the page then follows in straightforward, easy-to-follow, double column format.

Words highlighted in **BOLD CAPITALS** in the student book are defined in the glossary on pages 46–47. The majority are technical words important to the subject, but some are simply difficult words.

The glossary definitions help to reinforce the meaning of a word that may be slightly ambiguous if taken out of context. Many technical words used by geographers are also used in everyday situations where they may have a different meaning.

The glossary words are highlighted on the first page where they are encountered. They may be highlighted again on subsequent pages if they are regarded as particularly important to that page or spread.

Please note that case studies have been especially chosen from various parts of the world. Thus, one spread may have examples from the UK, the next may be from Australia and the next from Kenya. In this way, students will automatically be exposed to a number of contrasting environments, both at home and abroad. However, it will be especially helpful to remind students to look carefully at the way the pictures and their captions are related to, and often extend, the theme of the spread.

A word on getting the right balance

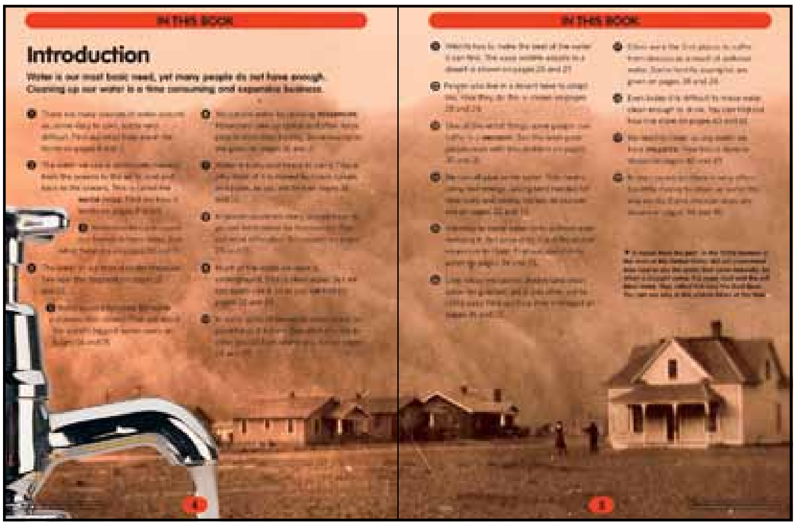
In this book, considerable efforts have been made to show pictures of different types of water supply. This is to provide points for class discussion. Because of the limited space available, and because of the requirements of the curriculum, students – who are likely not to be familiar with living in the developing world – may get the impression that the developing world is all slums and countryside, as shown in some pictures. Please take the time to explain that these pictures are shown for a particular purpose and that students should realise that perfectly clean water supplies are available to many people in the developing world. At present it is estimated that two-thirds of the people in the developing world have access to safe drinking water. This is a great improvement on just a few years ago and continual progress is being made towards the goal of safe water for all. Nevertheless, a third still do not get clean water.

In trying to raise student's awareness to the plight of such people and the problems they face, this is the sector of the society that has been addressed in most of the pictures. It will be especially helpful if teachers can use the opportunity to deal with the whole issue of development sensitively and positively.

In this book

Spread 1 (pages 4–5)

Introduction



This spread provides a summary of water supply.

Points 1 to 20 discuss the main features of the water cycle, water supply and water cleaning.

Some of the words shown on pages 4 and 5 are highlighted as glossary entries. (The meaning of each word will become more apparent when it is encountered on the relevant page later, in the context of the supporting explanation and information.)

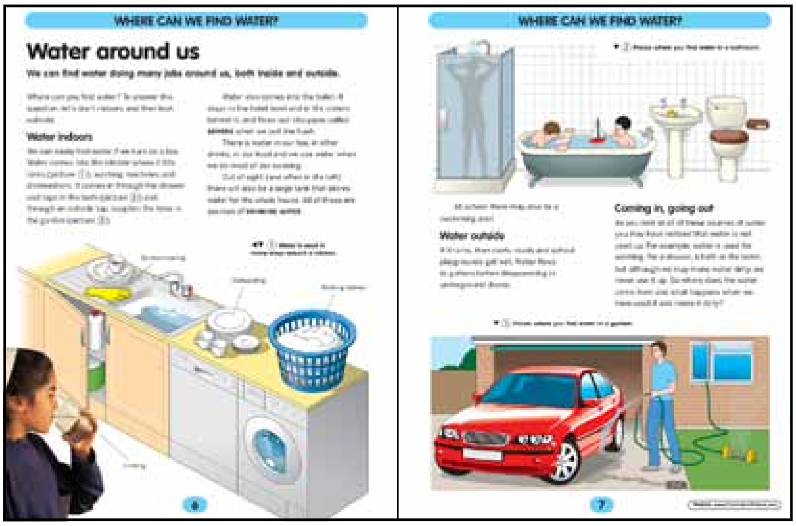
The picture on pages 4 and 5 is of great historic significance. It is taken at the time of the Dust Bowl crisis in western America, during the 1930s. You may feel you can use it to highlight the many aspects of water supply. Water supply is not just about providing drinking water, important though that is. Drinking water is vital, but the majority of the world's water is supplied to farms and factories. The fact that the land just to the east of the Rocky Mountains experiences a highly variable rainfall was not appreciated by those that came to farm there in the late 19th century, for they had migrated from the east and saw the land at a time of plentiful rain. But this might not have mattered, if it were not for the fact that the people who farmed were poor and so could not afford to put in place water conservation or water supply measures. (Also, they were 'mono-cropping' – so did not replace the nitrogen in the soil – causing the top soil to be used up and leaving mostly non-living dirt which did not hold water in and so blew away.) Today the same land is used for productive crops because deep wells have been sunk and aquifers tapped. However, this required finance unavailable to small, poor farms.

Chapter 1: Where can we find water?

This chapter begins to raise student's awareness of water around them by starting with the home environment and then looking further afield.

Spread 2 (pages 6–7)

Water around us



2

This spread begins to show students not only that water is important for many of the things we do, but that it is present in a surprisingly large number of places around the home.

As the sources of water are surveyed, it becomes apparent that there are at least two different kinds of water: clean water of the kind that comes in to the taps, and contaminated water that carries our waste away.

Some interesting points can be raised at this stage. For example, students can be asked to think about whether it is important that all the water entering the house needs to be clean. For example, do we really need drinking water quality water in the toilet cistern? This could lead on to a discussion of the fact that each kind of water needs a separate set of pipes, and so the cost of installing pipes may be higher than people want to pay.

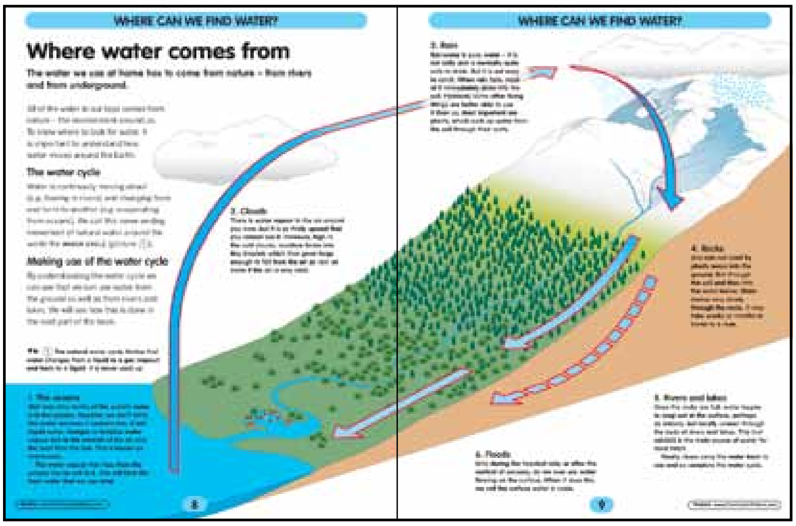
It might also be important to notice that some water is not very contaminated. For example, bath water is perfectly suitable for flushing toilets, or even for use in the garden for irrigation.

Water that cannot be drunk, but can still be used for other purposes is called grey water. Grey water may be used water, or it may be water stored in water butts and collected after rainfall.

Many people around the world do make use of their grey water. Using washing machine water on gardens can, however, cause problems because of the detergents and other chemicals in the water. Students can be introduced to this idea so they see that water, and its contents, make a more complicated (as well as interesting and challenging) task than they might initially have supposed.

Spread 3 (pages 8–9)

Where water comes from



3A

3B

This spread focuses on one of the most important features of water supply – the idea that the water we use is part of a natural cycle.

You may have already introduced the water cycle as part of rivers or weather studies, but it is worth noticing that the way the water cycle is used depends on its context. Thus, from a water supply context, more emphasis needs to be placed on such features as underground water and how water gets underground, than would be the case when dealing with rivers. Similarly less emphasis would be placed on evaporation and clouds. Springs are important from a historical perspective, but are a minor part of water supply.

It is often difficult for students to focus on the way that water moves underground, how long it takes, and how effective the ground is at filtering out contaminants. These ideas are all built on later, but at this stage it is very often helpful for students if the pattern of underground water movement is demonstrated by using a sponge. Begin with a dry sponge and then add water at the top. Students will often be surprised at how much water can be held by the sponge before any comes out of the bottom. They may also be surprised by how long it takes water to flow through.

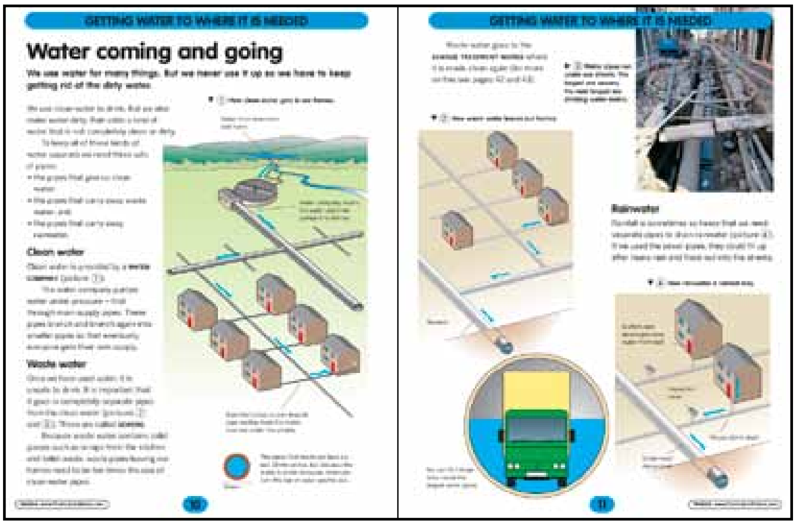
Similarly, when you stop adding water, the water continues to flow from the bottom of the sponge for a long time. This can be explained as equivalent to how water seeps from banks to keep rivers flowing between rainstorms. It is a key idea in water supply. The appropriate worksheet takes this further.

Chapter 2: Getting water to where it is needed

This chapter focuses on the transport of water from sources of supply to places of demand.

Spread 4 (pages 10–11)

Water coming and going



By now, students will know that there are many sources of water in the home. They will know that this is also true in nature, with water coming and going to make the water cycle. This is therefore the moment to see how home water supplies fit in to the overall pattern of water transfer.

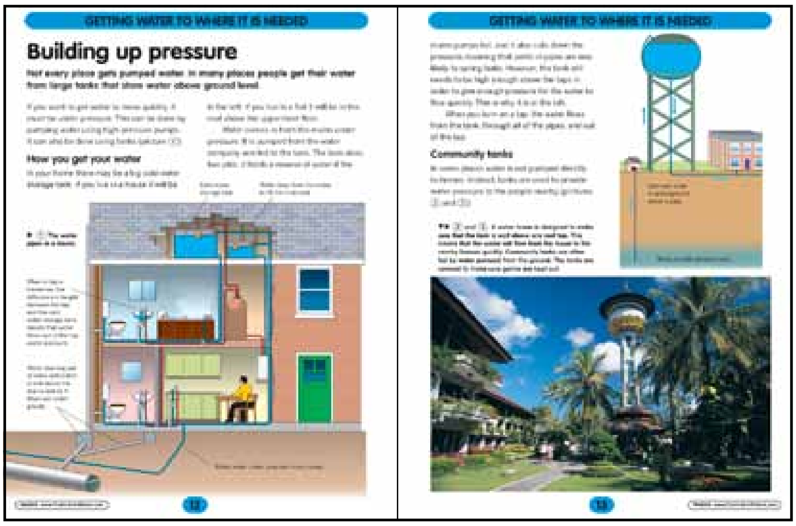
The spread reminds students that there are three kinds of water to be dealt with: clean water from treatment works, water that has been used, and rainwater flowing from roofs and roads and which, while not 'used', is certainly not safe to drink after it has travelled over the ground. It is an example of 'grey water'.

In each case, the water coming to or leaving a home is just a tiny part of an overall network. To help students see this, you can compare the way water leaves homes as being like a number of tributaries which all feed into bigger 'rivers' (the trunk sewers, for example). In effect, the water company creates an artificial river system, with small pipes leading to ever bigger pipes.

This system is used for both waste water and for rainwater in drains (stormwater). These systems all work just like rivers, using gravity to allow the water to drain away.

The water supplied to our homes is the same kind of network, but in reverse, with the water being pumped from a treatment works to homes. This water is clean, and under pressure, so it can flow in small-diameter pipes. As the water does not rely on gravity, supply pipes can also go up and down over the landscape, cross between valleys, etc.

Spread 5 (pages 12–13)
Building up pressure



5A

5B

5C

One feature that is noticeable in many rural areas is the water tower. In this spread, we look at the geographical range of water towers. Students might be encouraged to find out if there is a tower in their neighbourhood.

Water towers are like large cisterns. They lift water above the surroundings and so make it possible to use gravity to feed taps in a district, rather than have the supply constantly under pump pressure.

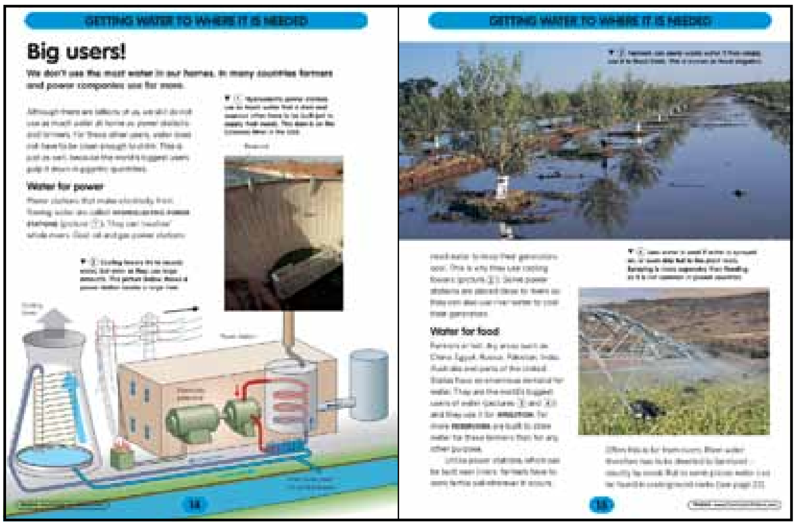
Water towers are frequently used in areas that receive their water from aquifers. This water does not have to receive much, if any, treatment apart perhaps from disinfectant. As a result, water towers and their surrounding district can be a self-contained unit.

Not all water towers are fed by pumping from wells. Some towers which were once fed from wells are now supplied from water treatment works through pumps. However, for the purposes of providing links between geography and science, and giving a chance for practical work on piping, there is nothing better than a water tower.

Students should notice from the diagram that water towers supply a radial area around them. If the water is pumped, then the pump will be housed over the well and kept in a small building to protect it from vandalism and the weather.

Water towers can be prominent features in parts of towns and cities, but are more easily seen in rural areas that lie over aquifers. They are an almost ubiquitous feature of rural landscapes in North America and Australia, the Paris Basin, etc.

Spread 6 (pages 14–15)
Big users!



6A

6B

Students may feel, with so many people in the world, that homes are the biggest users of water. This, however, is almost never the case. This mistaken impression comes about because it is much easier to see water use in the home than elsewhere.

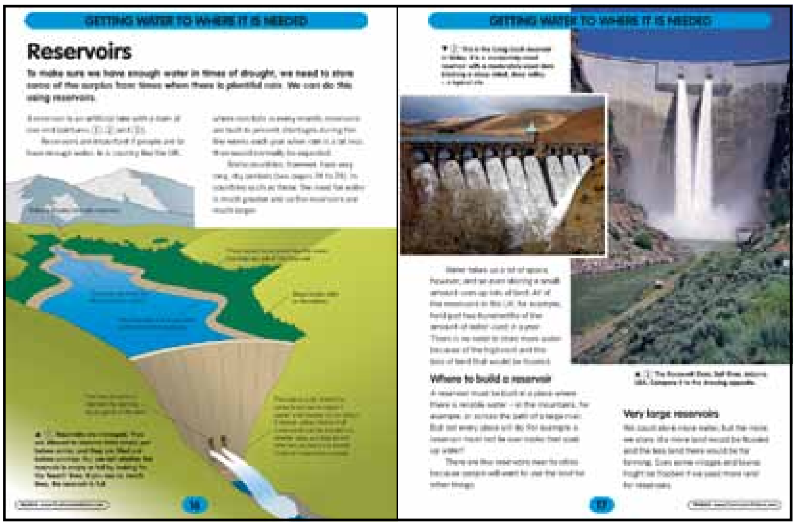
Industry is a larger user of water than homes. Power stations use water for cooling. They use so much water that many of them are built close to rivers. However, because the pipes are all buried, or inside a site to which the public has no access, it is not easy to see just how much water is used.

Hydroelectric power stations use so much water that special reservoirs often have to be created for their needs. Some farmers are also big water users. Arable farms in particular make large scale use of water for irrigation. However, unless you happen to be in an arable countryside location, you may be unaware of such use.

When discussing who uses water, it might also be appropriate for teachers to nudge students in the direction of recognising that the way water is used in the UK is not necessarily representative of how it is used in other parts of the world. We shall come back to this idea towards the end of the book, but for now students might like to imagine how water use might change if they lived in a hot, dry country. And in such a country, what would the flow of water to rivers be like?

Spread 7 (pages 16–17)

Reservoirs



7A

7B

If people want a reliable supply of water, then in general they will need to build reservoirs. The reason for this is that natural river flow is very variable, and there is a need to store some water to guard against drought.

We are looking at reservoirs from the point of view of water supply. It may not be necessary to add complexity by saying that reservoirs are normally built for a variety of purposes, including flood control. Water supply in this context includes water for drinking, for industry, for power stations and for irrigation.

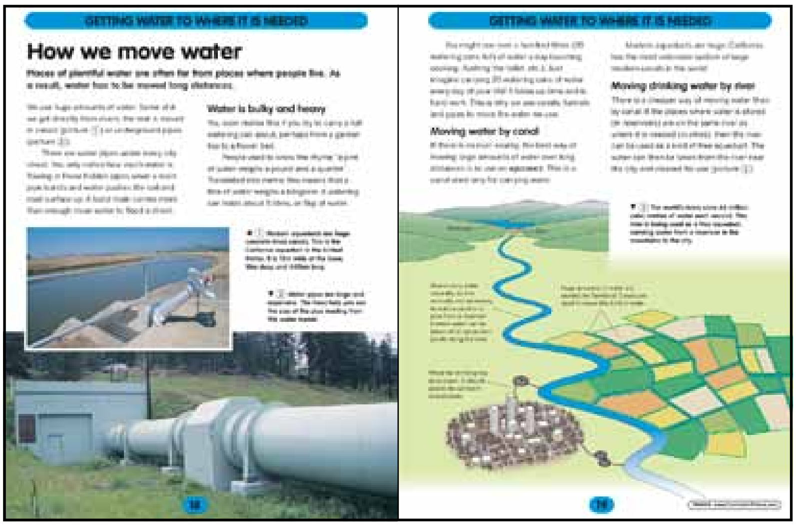
Reservoirs have very specific site requirements and these may present a conflict with other land use needs. For example, reservoirs need to be in valleys to be cost-effective but this may also be a place where people live, or where some endangered wildlife lives. Students may be able to think up additional conflicts.

In general, the bigger the dam, the bigger the reservoir and the greater the area of land used up. Many water supply professionals feel that most very large dams have been built for prestige rather than economic reasons and the costs of many outweigh the benefits. The current controversy over the huge dams in India and China – including the huge numbers of people displaced – make the point.

For more able students it may be worth mentioning that reservoirs are like lakes. That is, they stop the flow of water. As a result, the rivers flowing into them drop their sediment and, in time, the reservoirs will silt up. Some large reservoirs have a projected lifespan of no more than half a century. Students may have thought that reservoirs, once built, would be used for ever.

Spread 8 (pages 18–19)

How we move water



8

Safety first!

Please ensure that all children try this under supervision and that LEA guidelines concerning lifting heavy objects are complied with.

It is all too easy to see reservoirs but not connect them to the pipes that enter our houses. This spread tries to explain that moving water is often a monumental task, all too easily taken for granted and yet a major part of the work of any water company.

Water is both bulky and heavy. To get some idea of its weight, get children to try lifting some buckets of water. They may also have garden rollers at home that are filled with water to give them weight.

Despite the arrival of the metric system, the rhyme 'a pint of water weighs a pound and a quarter' still runs off the tongue. Of course, decimalisation makes the calculation easier – a litre weighs a kilo. But it is not as memorable.

Weight tends to restrict the way that water can be carried. If it is carried in bottles and by truck, it becomes very expensive. You might ask children to visit a supermarket and write down the price of mineral water (look for the cheapest to be fair). From this they can calculate how much it would cost to have a bath. The price is extraordinary.

From this it can be seen that water is a bulk commodity that needs to be handled by bulk transport if it is to be at all economical. This really means using canals and pipes.

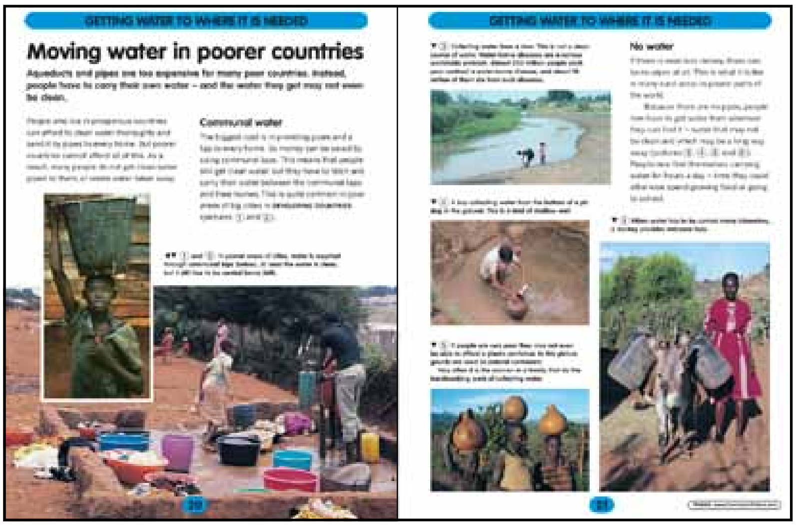
Pipes cannot be built as large as canals and they are much dearer. Nevertheless, they do have their uses, especially after water has been cleaned.

For a long time people were prohibited from using some reservoirs in the UK because water was taken by pipe directly from the reservoir to taps, on the supposition that this was the best way of keeping it clean. While this might have been true at the end of the 19th century, it is no longer true and pipes are a costly way of transferring water from a reservoir to the tap.

The radical rethink of how to move water happened in the 1960s and 70s. Then, it became clear that water could be moved most easily by simply allowing it, as far as possible, to move as part of the normal water cycle in rivers, abstracting it at a point as near as possible to where it would be needed. This change of tack has resulted in many a grand pipe or canal scheme being scrapped (although not all). By using better methods of transport, people have also been able to avoid interbasin transfers (although some were built before it was realised there were cheaper ways of dealing with the problem).

Spread 9 (pages 20–21)

Moving water in poorer countries



9A

9B

Any method of controlling or moving water costs money. Developed countries such as the UK raise the money for water resource projects through their water charges.

These water charges can be quite high because people can afford to pay such amounts. However, in developing countries, the amount of money people have is much lower and so they cannot afford to pay high water charges.

But even if people in developing countries could afford to pay more, the distribution in their countries may very well be different to ours. Students should be encouraged to see that, whereas most of us live in cities, despite the existence of many huge cities in the developing world, most people there still live in the countryside. It is far more expensive to provide pipes to scattered communities than to concentrated communities (as water supply companies will tell you if asked about their costs of supply or sewage to rural areas). So developing countries not only have little money for providing a network of water pipes, but their network will, invariably, be high cost because of the dispersed nature of its population.

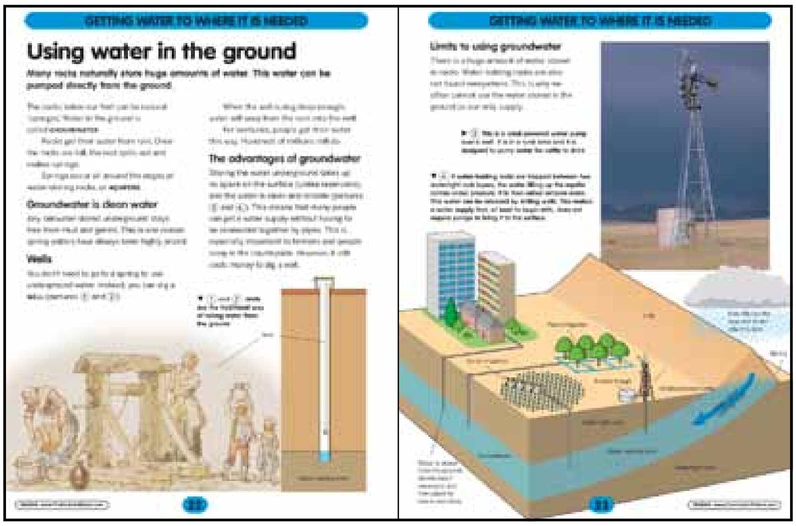
There are many practical ways in which the difficulties of water movement can be demonstrated. One of them is to get students to carry buckets of water about. They should realise not only that the buckets are heavy and the work is tiring, but also that the work wastes time and is boring.

But whereas it is all very well for them to complain, people who depend on getting water this way simply have to grin and bear it. Students should therefore comment on how much time (mostly of women, boys and girls, not men!) would be freed up for other productive things if hundreds of millions of people did not have to spend large parts of the day carrying water.

⚠ Safety first!

Please ensure that all children try this under supervision and that LEA guidelines concerning lifting heavy objects are complied with.

Spread 10 (pages 22–23)
Using water in the ground



The majority of the world's usable fresh water is in soils and rocks, and only a little in rivers (although the majority of fresh water is locked up as ice sheets). It therefore makes sense to exploit these underground reserves wherever possible.

The advantages of underground water include its freedom from microbes and therefore the need for very little treatment before it can be used as drinking water, and the fact that aquifers often occur over large areas and so can be used to serve rural communities without the need for expensive networks of water pipes. Farms in particular can make use of water in rocks.

When students looked at the water cycle earlier in the book, they were encouraged to look at the way water travels through a sponge. They should be reminded of that here, and possibly the demonstration should be repeated. Its importance concerns the fact that water travels slowly in rock and so if it is pumped out too fast, then the rock will be sucked dry. A delicate balance between recharge and use has to be struck. If this is achieved then underground water can be an immensely important resource. Very large aquifers underly many cities, as well as country areas. London, for example, overlies a chalk aquifer. So both cities and countryside can benefit from using underground supplies.

Links can be made to history and the way that people established settlements at springs (which are on the edge of aquifers) and how they dug deep wells. Links can also be made to how aquifers can be important in the rural areas of the developing world. You might also note that we shall be returning to the theme of wells in a later spread on disease, because wells need to be kept clear of sewage disposal so the water supply does not become polluted.

Another side effect worth noting is that if water is 'mined' from aquifers, the ground above subsides. This has happened, for example, in California, where the ground level in places has sunk several tens of metres.

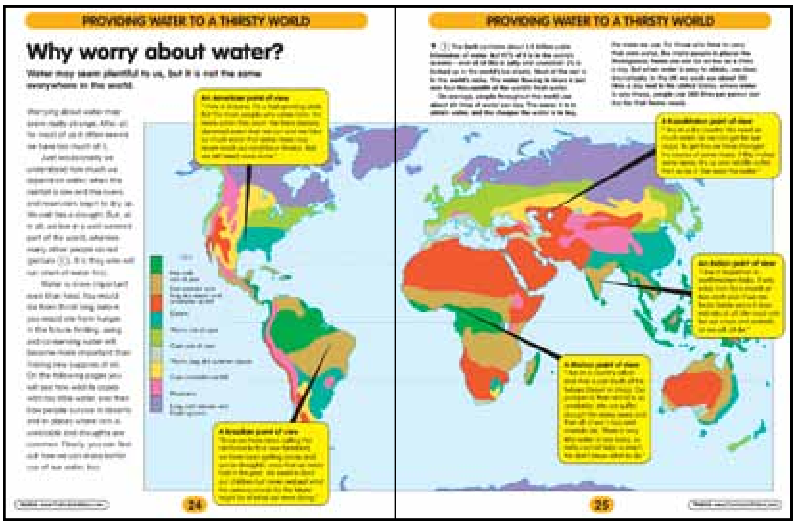
Chapter 3: Providing water to a thirsty world

This chapter concentrates on places where water supply is demonstrably difficult.

The first part looks at the natural world and strategies employed by plants and animals. It then considers how people use deserts and semi-arid parts of the world and the problems they face. The chapter concludes by thinking about how we could save water, too.

Spread 11 (pages 24-25)

Why worry about water?



So far we have concentrated on the way in which water is brought to us, without any regard for whether the source of water might or might not be in short supply. This spread widens the perspective by getting children to look at a world map and consider reactions that people might have elsewhere.

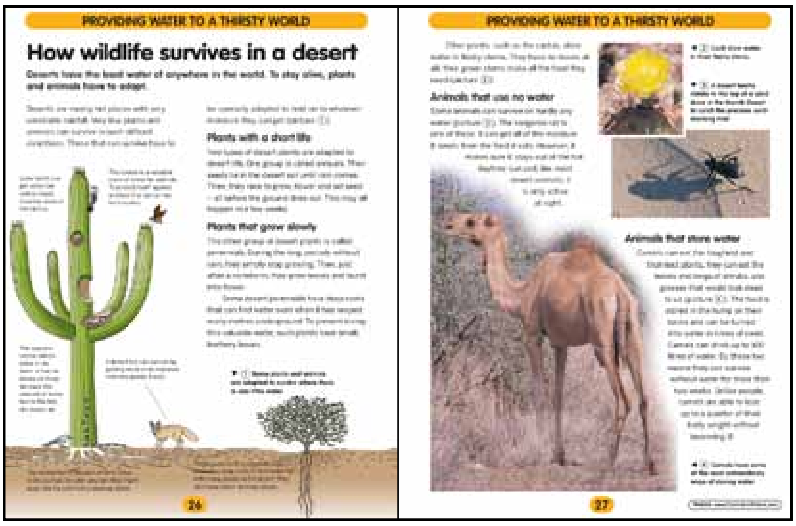
This spread could be used as a starting point for considering world weather and climate. More information on this theme is given in the Curriculum Visions book, *The Weather Book*.

The entire range of problems can only be introduced here. But you could widen the scope with such devices as 'Where in the world is Barnaby Bear?'

At the outset, children need to see that the quotes in the textbook tell of both the economic circumstances as well as the climatic ones. They should see that water shortages are not just about differences between rich and poor, but much more than that. The quotes discuss the need to make something of the resources you have, and hint at the disasters that might arise if we try to exploit more than is sustainable in the long term, both in rich and poor countries.

Spread ⓬ (pages 26–27)

How wildlife survives in a desert



This spread pauses from looking at people in order to give children some familiarity with water resources in dry countries.

This spread deals with deserts, in part because this is where the water supply problem is most obvious, but also because it provides a chance to see how it is possible to make evolutionary adaptations for coping with water supply problems.

Children can be shown desert plants because these are readily available at a garden centre. They should look at the two forms of adaptation: a rapid life cycle; and storing water in stems or sending roots down to reach water supplies at great depth.

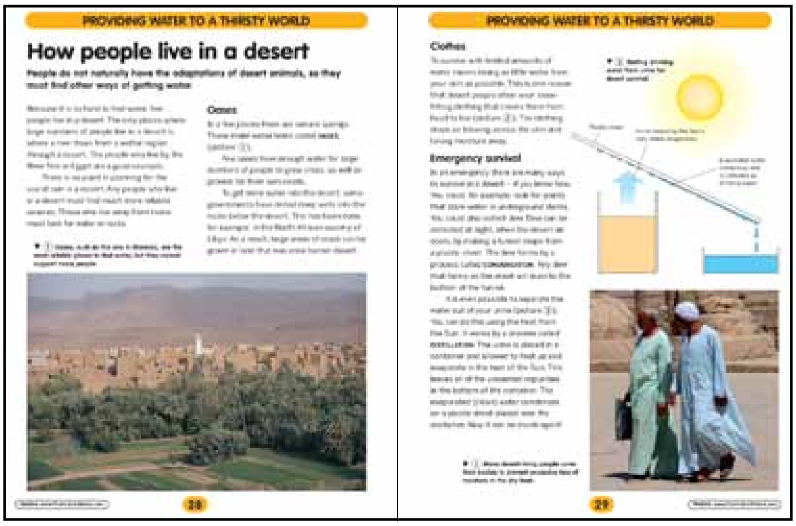
They should notice how desert plants either have small leaves or no leaves, or that they shed their leaves to reduce losses.

The section on animals focuses on the familiar camel because camels can be seen in zoos. The extraordinary features of a camel are adaptations to survival in a waterless area. It is especially noteworthy how much a camel's body weight can fall before it becomes ill.

This is all in preparation for thinking about how people might survive in similar circumstances – a theme tackled on the next spread.

Spread 13 (pages 28–29)

How people live in a desert


PROVIDING WATER TO A THIRSTY WORLD

How people live in a desert

People do not naturally have the adaptations of desert animals, so they must find other ways of getting water

Oases

28

PROVIDING WATER TO A THIRSTY WORLD

Clothes

Emergency survival

29

From the previous spread, children gained some idea that adaptations are needed if living things are to survive in areas with little rainfall. They can now begin to think about whether or not people can adapt.

In general, the answer is yes and no. The traditional clothing worn by desert people is an adaptation to the dryness of the air and the need to conserve water. By wearing clothing that covers the body, not only are people protected from heat, sand and so on, but their skin is not exposed to the air and so less water is lost in evaporation from the skin.

In many areas people drink relatively little. This is a sensible adaptation because if you drink a lot you immediately break out in a sweat. This encourages you to remove your clothing to allow the air to evaporate the sweat. Of course, the loss of water through sweating leads to the danger of dehydration.

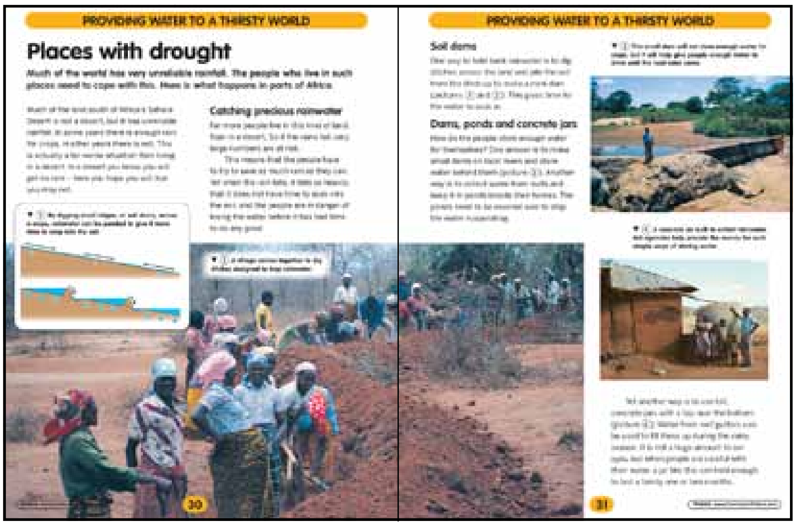
It is a curious fact to note that in the desert areas of the United States, where many tourists visit and go hiking, the National Parks Service recommends to people that they take large amounts of water with them instead of covering up their bodies and drinking small amounts. This is a response to the fact that water can be brought into the area and that tourists are unlikely to understand the best way of adapting. The park staff, however, mostly wear long trousers, long-sleeved shirts and wide brimmed hats and drink less water.

You can discuss with children whether they would be prepared to adapt, or whether they would rather face the risk of dehydration.

In a desert, rainfall is known to be a remote possibility and so in a way things are more certain. People have to find a reliable groundwater supply (an oasis) or they will die. They know that plants will also need water and so this limits what they can grow.

Life in a desert is by no means as chancy for the experienced as in some other places. We will introduce children to one such region in the next spread.

Spread 14 (pages 30–31)
Places with drought



A desert may have little water – and everyone who lives there is very clear on this fact. But there are other areas which are far more hazardous to people than deserts, notably those areas that lie on the margins of deserts, for example, the area to the south of the Sahara Desert, or northeast Brazil, or in northwestern India. All of these areas typically have very unreliable rain that is cyclic in nature. Rainfall may be good for a few years, but then start to ease off until years of severe drought follow. Then the rainfall improves again and the cycle is repeated.

This pattern of rainfall is potentially dangerous. The high rainfall part of the cycle encourages people to think things will be alright – only to face disaster as the downturn in rainfall occurs.

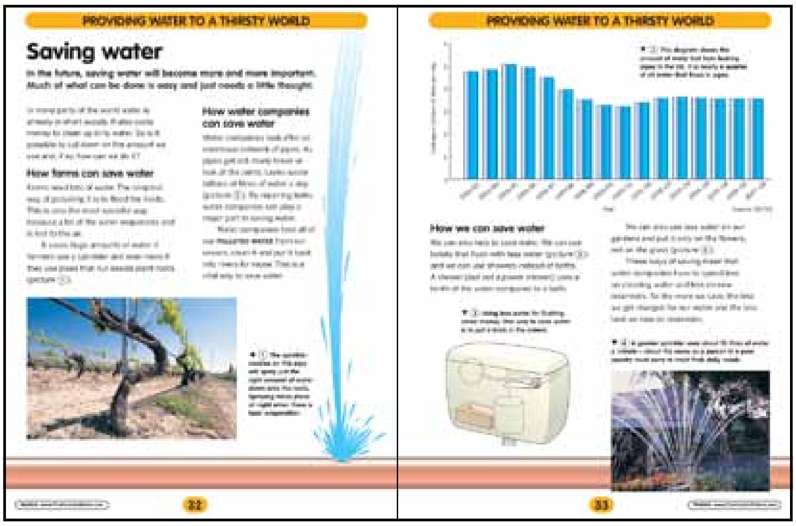
Students should understand that in the developing world, problems of drought are compounded by a rapidly increasing population. Here it is not the case that people were unaware of the unreliability of their climate – in the past some people coped with it by being nomadic. In times of drought they simply moved on, knowing that there was land to spare elsewhere. There were also relatively fewer people, and so a year with poor rainfall in the wet season did not spell disaster. But as populations have grown, the situation has become more and more critical. Where once a year of poor rainfall was a problem, now the population is so large that the people depend on good rainfall just to survive, and years of good rainfall do not occur all of the time.

Furthermore, rainfall in these areas is not like rainfall here. Students could experience some conditions of a tropical storm in the wet season by standing not under an ordinary shower, but under a power shower. The difference to our experience of rainfall could not be greater. This kind of rain cannot soak into exposed soil, but mainly runs off, eroding the soil as it does so. So people farming bare land can often experience drought even though it has rained heavily.

The Sahel and similar areas have suffered terribly because of population pressure on fragile land coupled with unreliable rainfall. But it is important that students should not be depressed by this, but rather that they should see how positive some people can be about improving their situation even when they have almost no money. This page therefore concentrates on how people are using basic understanding of the water cycle to cure erosion, allow the rain to soak in and also to store water for their own use. But this alone will not give a much better life. Only population control and increased wealth can do that.

Spread 15 (pages 32–33)

Saving water



15

Saving water is important. Because we get water easily, we tend not to think of it as a valuable resource. Yet here is an opportunity for students to see just how much can be lost, and who are the biggest water wasters in society.

In the world as a whole, farmers are the biggest users of water and 'waste' the most. That is, plants can only make use of a small amount of the water that is applied to fields. Enough water has to be applied, for example, to flush salts from the soil otherwise salts will build up and make the soil sterile. Furthermore, a lot of the water used in irrigation is lost as evaporation. Britain is uncommon in not having a farming community that uses far more water than any other sector. This is because of our fortunate climatic circumstances.

What students could research, however, is the amount of water wasted by leakage in the water company's pipelines. The table gives a total for England and Wales – you could get regional data from Ofwat (www.ofwat.gov.uk) or from your local water company.

Students could try to calculate how many baths or swimming pools could be filled by the billions of litres of water leaked each day. This way they can see the scale of the possible savings.

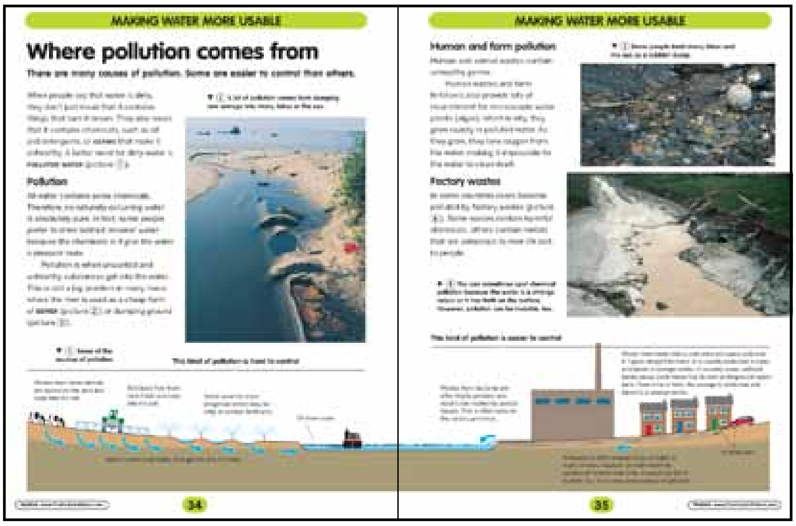
Water companies clearly have a responsibility to prevent leaks. We also have a responsibility to conserve water and students could discuss how they might save it. Suppose everyone in the country (59 million people) saved a bath full a day. How would this, for example, compare to the savings the water companies could make by getting rid of their leaks?

Chapter 3: Making water more usable

This section considers the nature of water treatment to remove any possible harmful substances in the water.

Spread 16 (pages 34–35)

Where pollution comes from



This spread begins the topic of pollution and how to clear it up.

We have already talked about keeping drinking water separate from waste water, but did not at that stage discuss why. Now is the time to go into more detail about how water becomes contaminated and what to do about it. In this section there are many links to science, including topics such as dissolving and microbes, as well as history links to the development of water supplies. There are also many local study opportunities.

This spread aims to identify the main sources of pollution as domestic, farms and industrial. Each source tends to produce a different kind of pollution.

Domestic sources are essentially water polluted from use in washing together with toilet waste. Some of this waste contains detergents and other chemicals. It also contains microbes and fats.

Agricultural water can include slurry from farm animals, but major pollution sources are pesticides and herbicides and the nitrates and phosphates that leach from the soil after fertiliser applications.

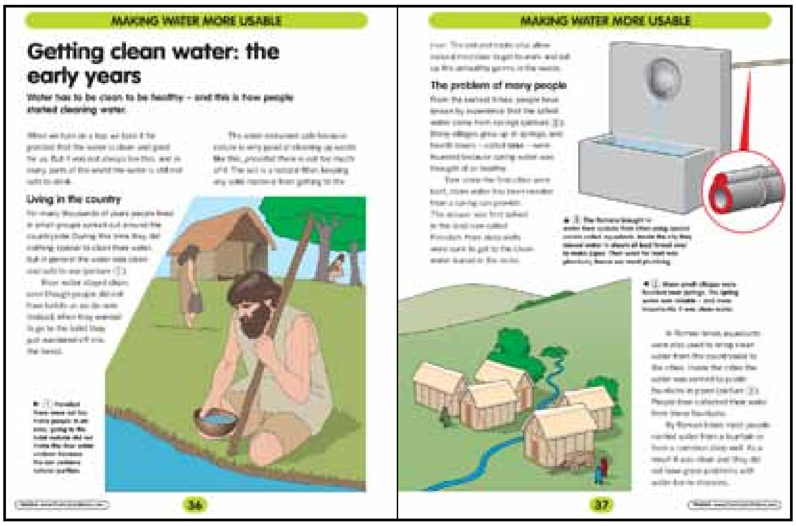
Industrial waste often contains more heavy metals than any other kind of waste. It may also contain a variety of chemicals.

Students should note which sources are localised (and so easy to control – at least in theory) and which are dispersed and so very difficult to control.

In the diagram, the pollutants are shown all discharging to the river. Students should note that such discharges would be highly detrimental to the wildlife and this is why water is treated both before use (for drinking water) and after use wherever possible.

Spread 17 (pages 36–37)

Getting clean water: the early years



17A

17B

17C

This spread begins a three part section on the changes in water pollution over time, along with their causes and cures.

There are significant links with history here, from discussing both early settler groups, such as the Vikings, and later groups such as Tudors, Victorians and the 20th century.

The first point to be made is that the environment is essentially self-cleansing unless it is overloaded. Thus, people living in rural communities and with no toilet facilities and no way of cleaning water whatsoever, may still lead healthy lives if the toilet and other waste is kept separate from the water used for drinking. In this way, any wastes can be biodegraded naturally before any seepage from them arrives at the river.

Small groups of settlers can simply tip their rubbish out around them, and possibly use pit latrines, but until the numbers of people grow substantially, the environment can still cope.

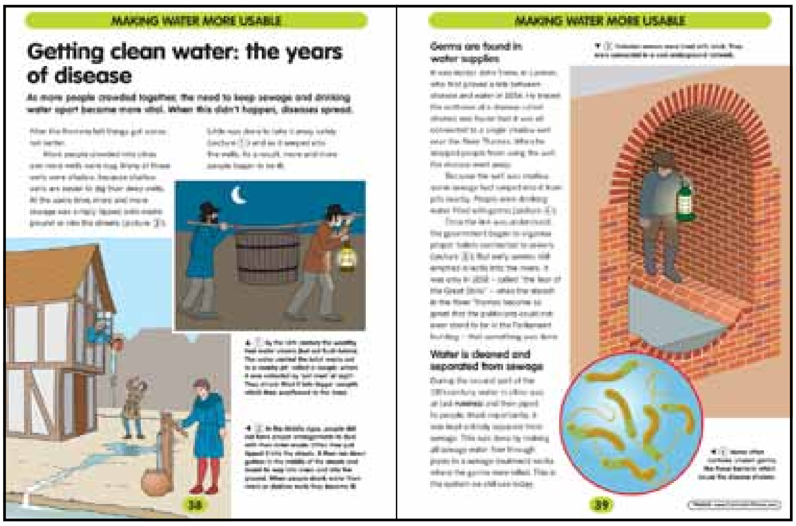
The end of the spread addresses the problem that is faced by a city – even the first cities. Here the concentration of waste can be too much for natural biodegradable activity.

Cities also need to bring in water, and for many early cities, which were sited in dry climates in the Middle East, this meant either locating beside a river or natural spring (and therefore using clean groundwater, e.g. Mecca) or bringing the water in some form of aqueduct (e.g. Jericho). The Romans brought aqueduct water to public fountains, for example in Rome and elsewhere. In this way waste and clean water were kept apart and health was not too bad.

The problems start when there is a chance of waste and clean water mixing, which happened as cities grew but administration to provide water was poor. This is dealt with on the next spread.

Spread 18 (pages 38–39)

Getting clean water: the years of disease



This spread follows on from the previous page and focuses on the way that sanitation and disease were linked in a downward spiral of ill health. The end of the spread then leads on to the discovery of the causes of much ill health and the construction of the first modern sewers.

It is helpful if students are aware of the fact that changes in health took place in part because of severe crowding and poor nourishment, but in large measure because of poor sanitation.

After the Roman period the quality of public services drastically changed for the worse. At the same time, more and more people crowded into cities, and with many cities being on the banks of rivers, it was ever more likely that waste would seep into the groundwater and hence into the rivers.

As more people lived in cities, so it also became common for water to be drawn from wells. The water table stands quite high in the ground close to rivers and so the wells only needed to be shallow. It was, however, a fundamental mistake to use such water, because most of the waste dissolved in water also travels at shallow levels. As a result, the incidence of water-borne disease increased dramatically.

Furthermore, even where the waste was disposed of in open pits, these pits either overflowed or they were cleaned by people called night-soil men who then tipped the waste into larger pits that often overflowed into the river. Much waste was simply tipped straight into the river.

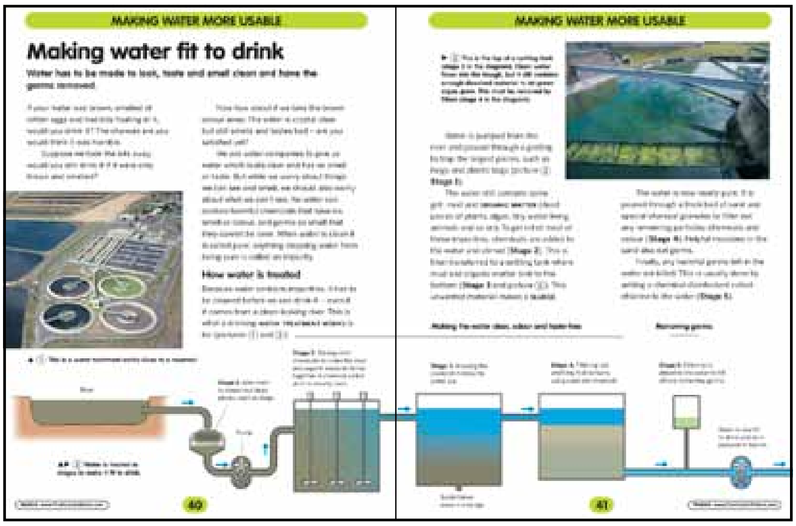
Students might like to imagine what the streets and rivers must have smelled like at this time, especially on a warm summer's day when the water level was low and the amount of water able to dilute the effluent was at a minimum.

The Great Stink and other manifestations of pollution and disease did not provoke a rapid response from government because the cost of any kind of cleanup was high. The first step was therefore simply to divert all drains to a large sewer which fed straight into the river. This helped the quality of water in shallow wells, but did nothing for the river. Sending sewage to a sewage works was a further expensive step that could only be taken as the growing wealth of the country made it possible.

As soon as the first steps were taken, however, civic pride meant that many towns and cities felt obliged to follow suit and so the change in waste disposal was rapidly accomplished in the latter part of the 19th century.

Spread 19 (pages 40–41)

Making water fit to drink



19

Modern water treatment is a complicated and sophisticated business, involving physical, chemical and biological processes. This spread attempts to show the changes that have to be made in order to clean water and make it fit to drink.

Notice that there are physical steps, including screening and filtering out debris, chemical steps to coagulate the fine muddy and organic materials and get them to settle out, biological steps to digest as much dissolved organic material as possible, and then more chemical steps to disinfect the water and remove all germs.

Students should be helped to see that water is not necessarily safe to drink because it looks clear. Mountain stream water is often clean, but river water is unlikely to be so. As a result, students should be advised only to use tap or bottled water to avoid any risk of disease.

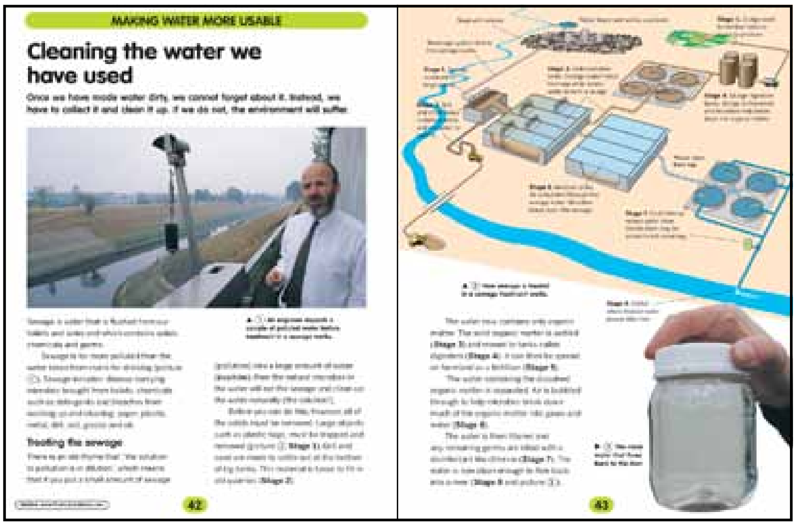
There are a number of simple science practicals that can be done in conjunction with this spread, especially connected with dissolving and filtering.

Your local water company may be able to provide the opportunity to visit either a water treatment or a sewage works. Several water companies also have useful web sites with educational information. We have further information on our web site.

Please note that specific water treatment works vary and if you visit one on a school trip it may not be identical in its facilities as the one shown here.

Spread 20 (pages 42–43)

Cleaning the water we have used



20

Sewage treatment is not essentially different from drinking water treatment, except that sewage does not have to be purified to drinking water quality. Sewage also contains far more germs and sediment than water extracted for drinking. As a result, the balance between different parts of the process changes to meet specific needs.

In particular, sewage contains a large amount of sediment which must be allowed to settle out. Not only does this waste cause the water to be coloured, but it also causes the pumps to wear out. As a result, large settling ponds or lakes are used where possible. These allow the water to stand, and then about seventy percent of solids settle out. The only use for this material is in a landfill site.

Fine material is coagulated using chemicals and biological agents. This makes it larger and heavier and so able to settle out. The mostly organic material that settles is called sludge. Suitably digested by microbes and compressed, it can be used on fields as a fertiliser.

After the removal of the heavier solids there is still organic material in the water, including harmful germs. These can be removed by spraying the sewage water over pebbles on which harmless microbes (protozoans) live. They are able to digest bacteria and so clean the water biologically. An alternative is to pass the water through a tank which contains high concentrations of these microbes. The water and microbes in these tanks are continually overturned with jets of air that bubble up from the base of the tank. Aerators of this kind use less space than filter beds and digest more waste.

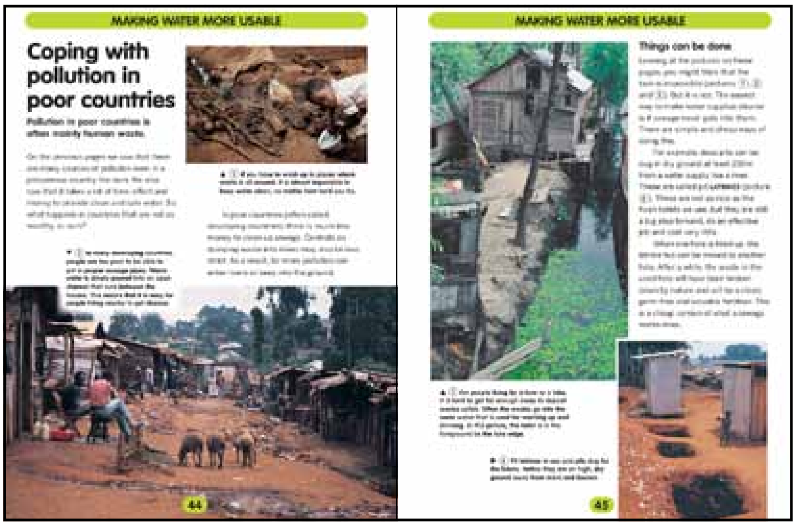
What you find in your local works will depend on the amounts and kind of sewage they have to deal with.

Once the water has been biologically treated it may be filtered even more and then disinfected before being released to the environment.

Not all of these steps are followed in every works. The simplest, and least effective, sewage works simply filter out visible debris (called primary treatment). The secondary treatment to improve the quality and remove germs is expensive, but necessary. In some cities a third stage of filtering and disinfecting, called tertiary treatment, is also used.

Spread 21 (pages 44–45)

Coping with pollution in poor countries



The students will have seen how dealing with sewage is an expensive and complex process. It is made especially so by using water as a transport agent for waste. In many developing countries, the systems in place in industrialised countries cannot be installed or maintained because of the cost. This means that other systems have to be used.

The first thing students have to appreciate is the scale of the problem. The dramatic pictures on this page are designed to shock and make students realise that there is a problem to tackle. Then they are encouraged to think about low cost solutions.

One of the simplest is to use dry latrines. Here, the waste accumulates in pits well above the local groundwater. Natural digestion takes place as a result of microbe activity. After a suitable time, the contents of the pits can be used as fertiliser.

By studying the pictures, students may be able to suggest other ways in which the risk of disease can be reduced.

Students should be reminded again that very poor conditions apply only to a sector of the population and that perfectly good sanitary conditions occur in many parts of the developing world. Situations tend to be at their worst in slums, where governments do not take responsibility and the people have no money for self-improvement.

You should try to get students to see a positive way forward for people in these difficult circumstances.

Reference

The last three pages of the book contain the glossary and the index.

Glossary (pages 46–47)

The entries in the glossary are listed in alphabetical order. The short definitions are given in simple language for the context in which they are used. They are, therefore, not necessarily the same as definitions given in an encyclopedia or dictionary.

Where necessary, more breadth is given to a definition (to make it encompass other meanings, or make the definition more general).

Index (page 48)


INDEX

Index

48

A comprehensive index allows specific subjects to be found. The index can be used to encourage research skills.

Section 3: Photocopiable worksheets for The Water Book

Introduction

The photocopiable worksheets in this *Teacher's Resources* have been designed to be a fast and efficient way of working through the study of water.

It is intended that you photocopy each worksheet and distribute the photocopies for students to complete. The questions are on all worksheets.

At the head of each worksheet are the relevant pages of *The Water Book*. So, 'See pages 8 and 9 of *The Water Book*', means that the answers to all of the questions can be found by using pages 8 and 9 of the student book, unless stated on the worksheet. Some of the worksheets also require the use of an atlas or of practical materials. This is stated where appropriate.

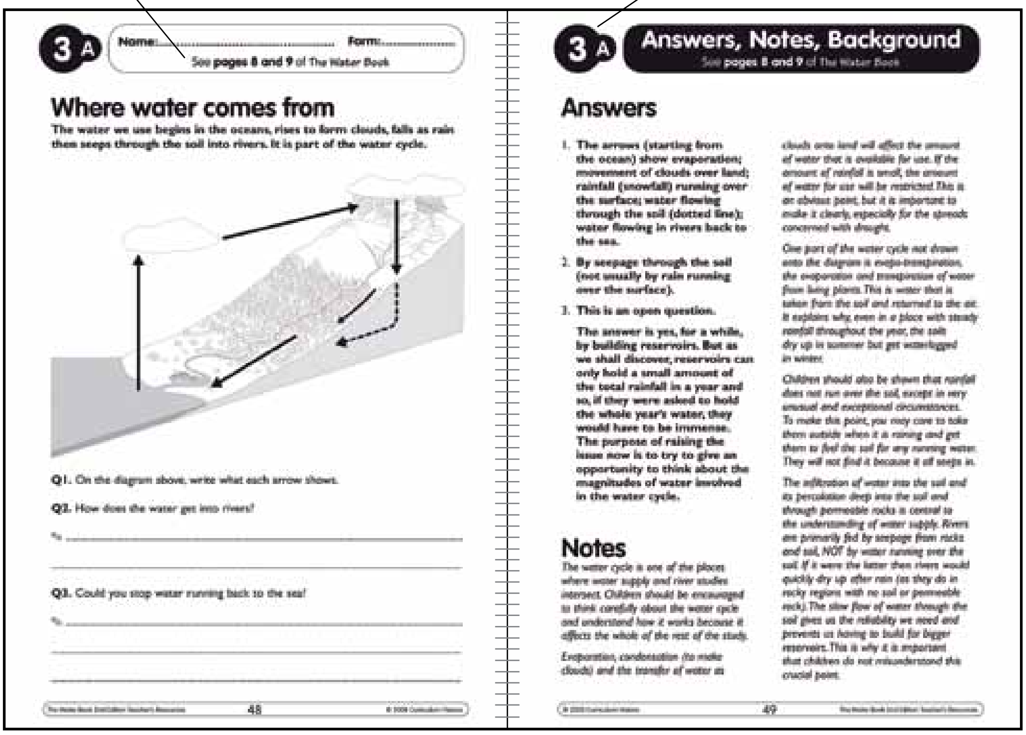
Each worksheet has been given a unique number which is in a circle at the top of the page. If there is more than one worksheet per student book spread, then they are labelled **A**, **B**, etc.

The answers face each worksheet. Here you will also find additional information that may help in class discussion.

Note: the first sheets contain simple diagrams that can be used for making up your own worksheets.

Refers to the page numbers in the student book to which the worksheet relates.

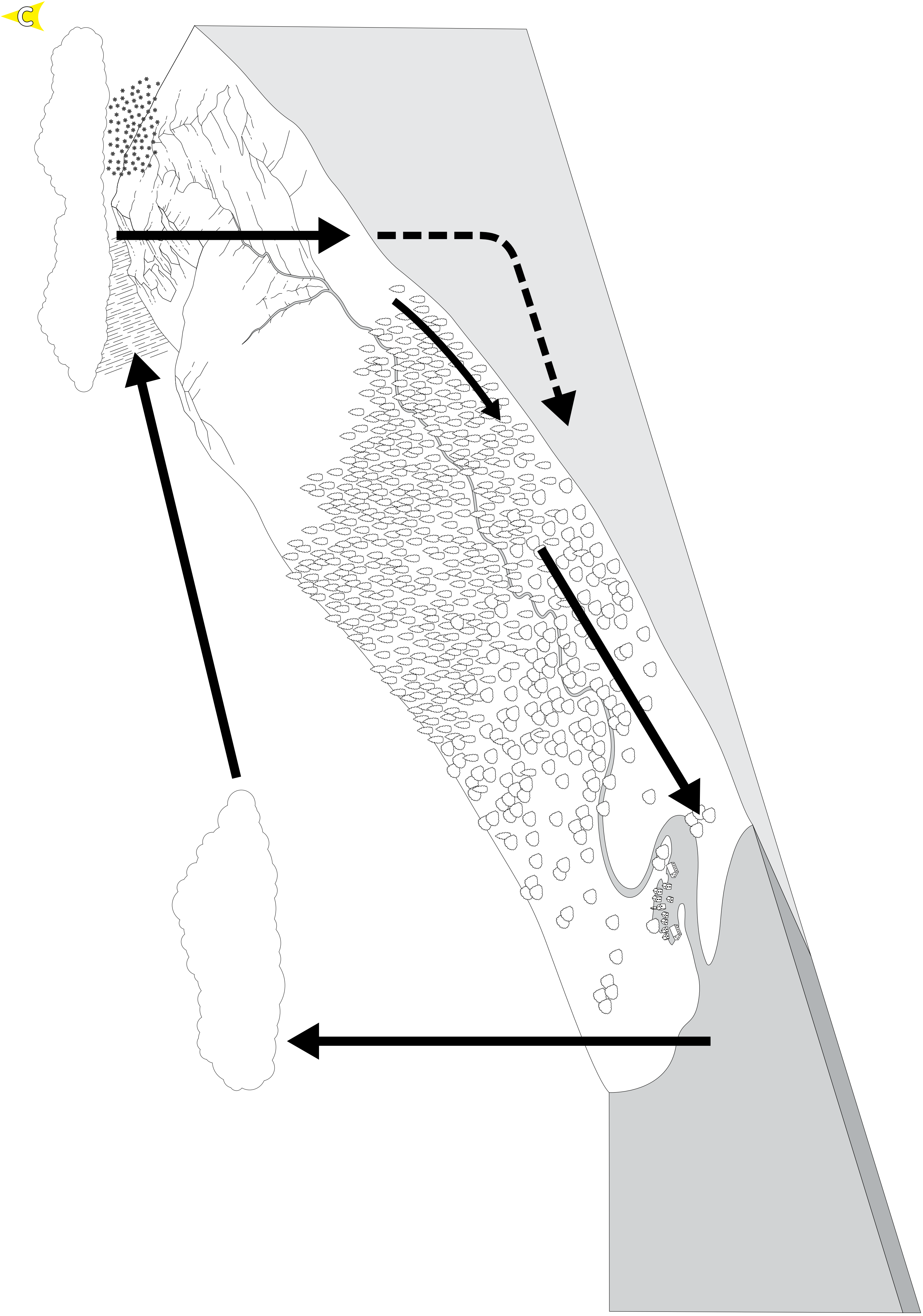
Worksheet number – may be labelled A, B, C, etc.

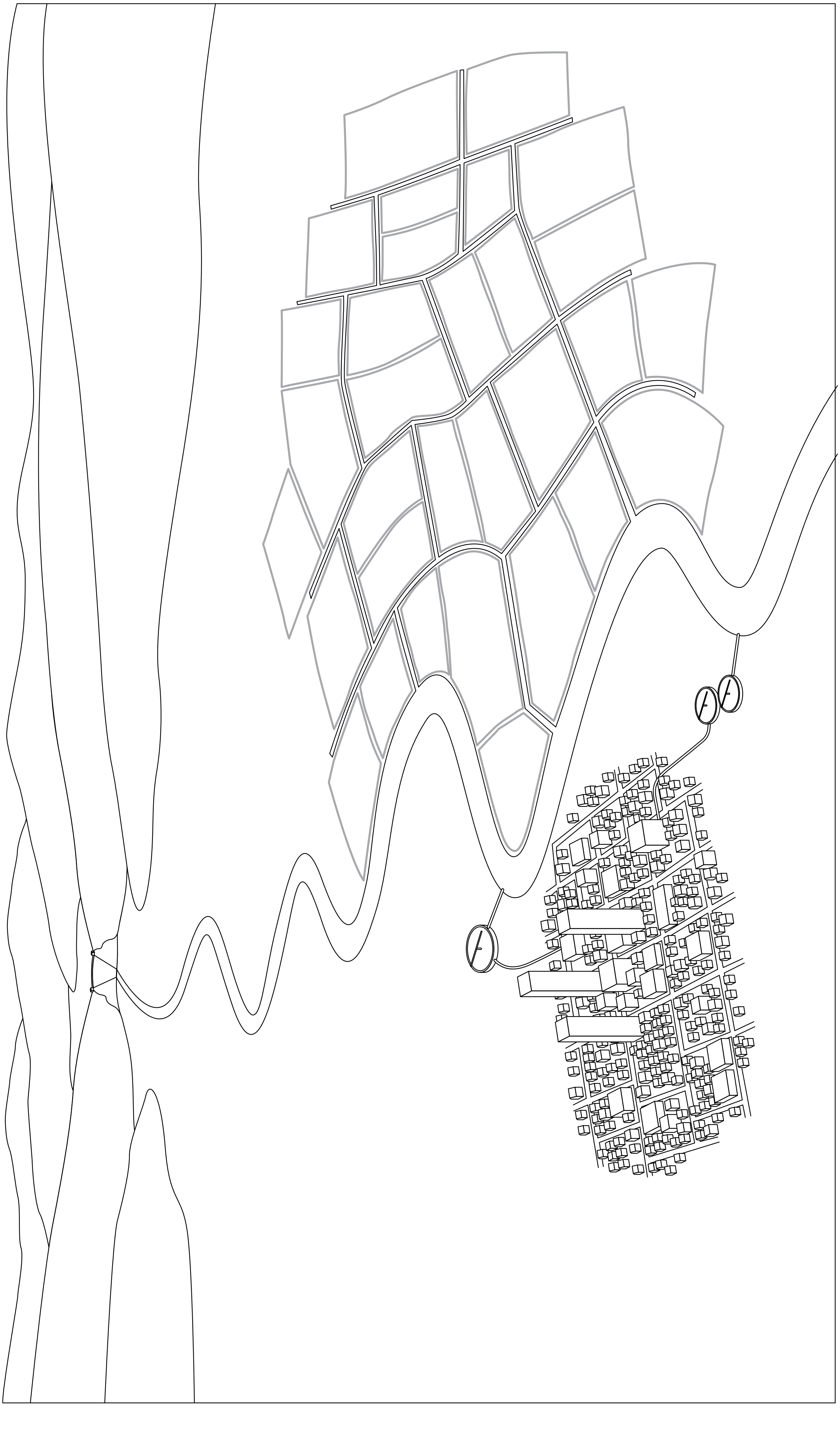


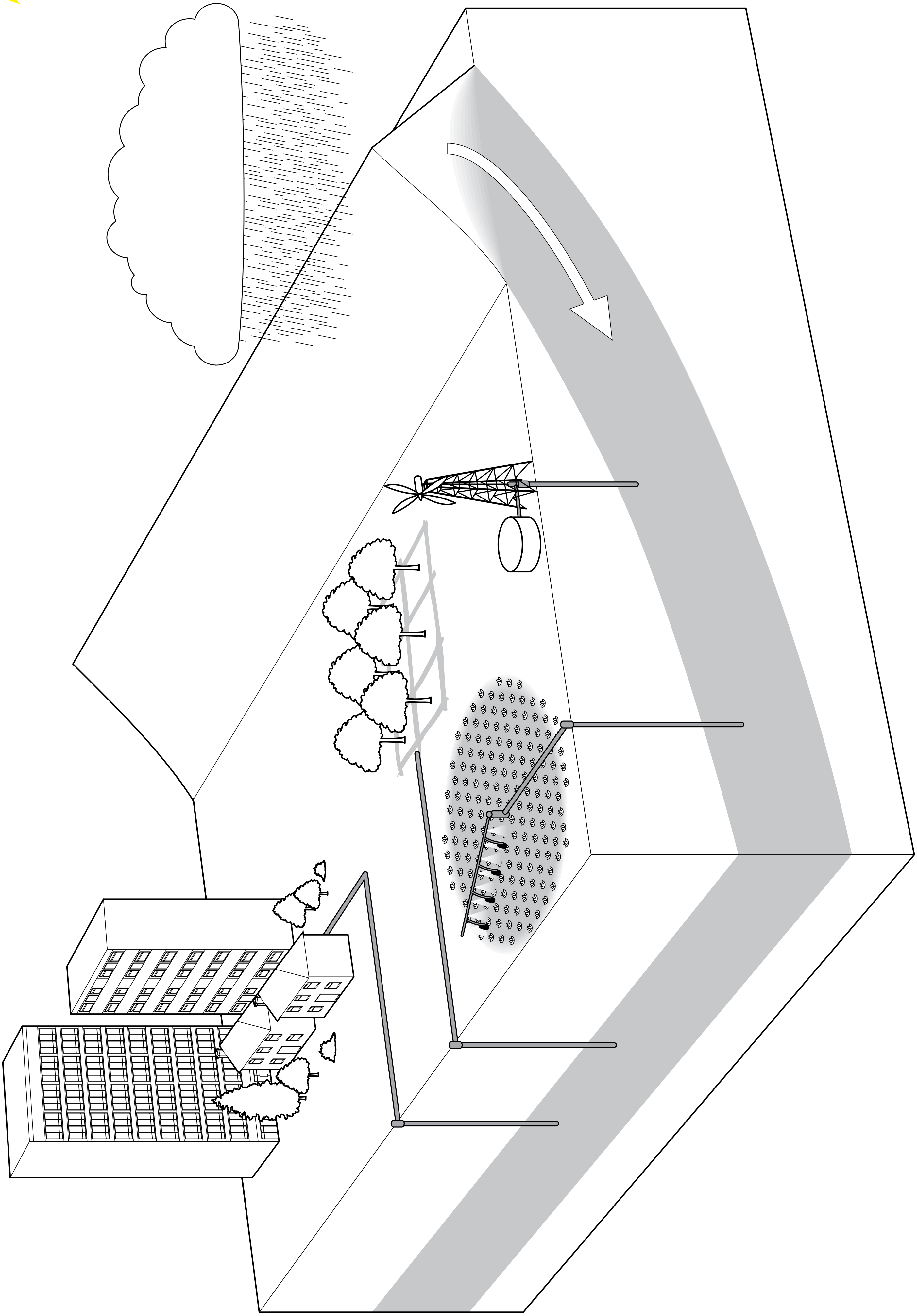
The left-hand page is to photocopy and hand out to pupils.

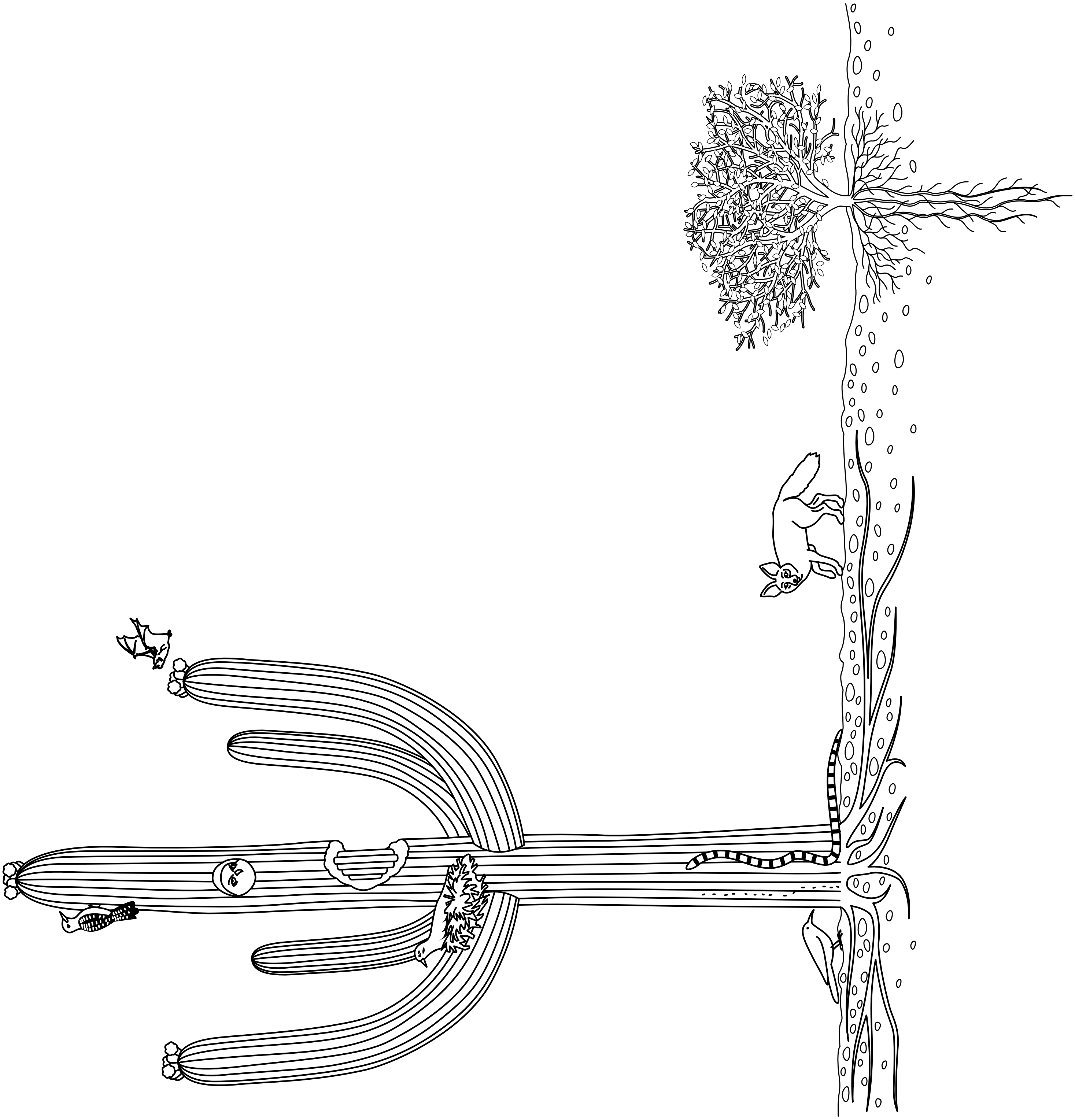
The right-hand page provides the answers and teacher's notes.

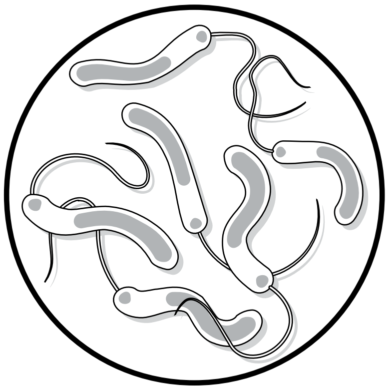
Worksheets with answers and background assistance

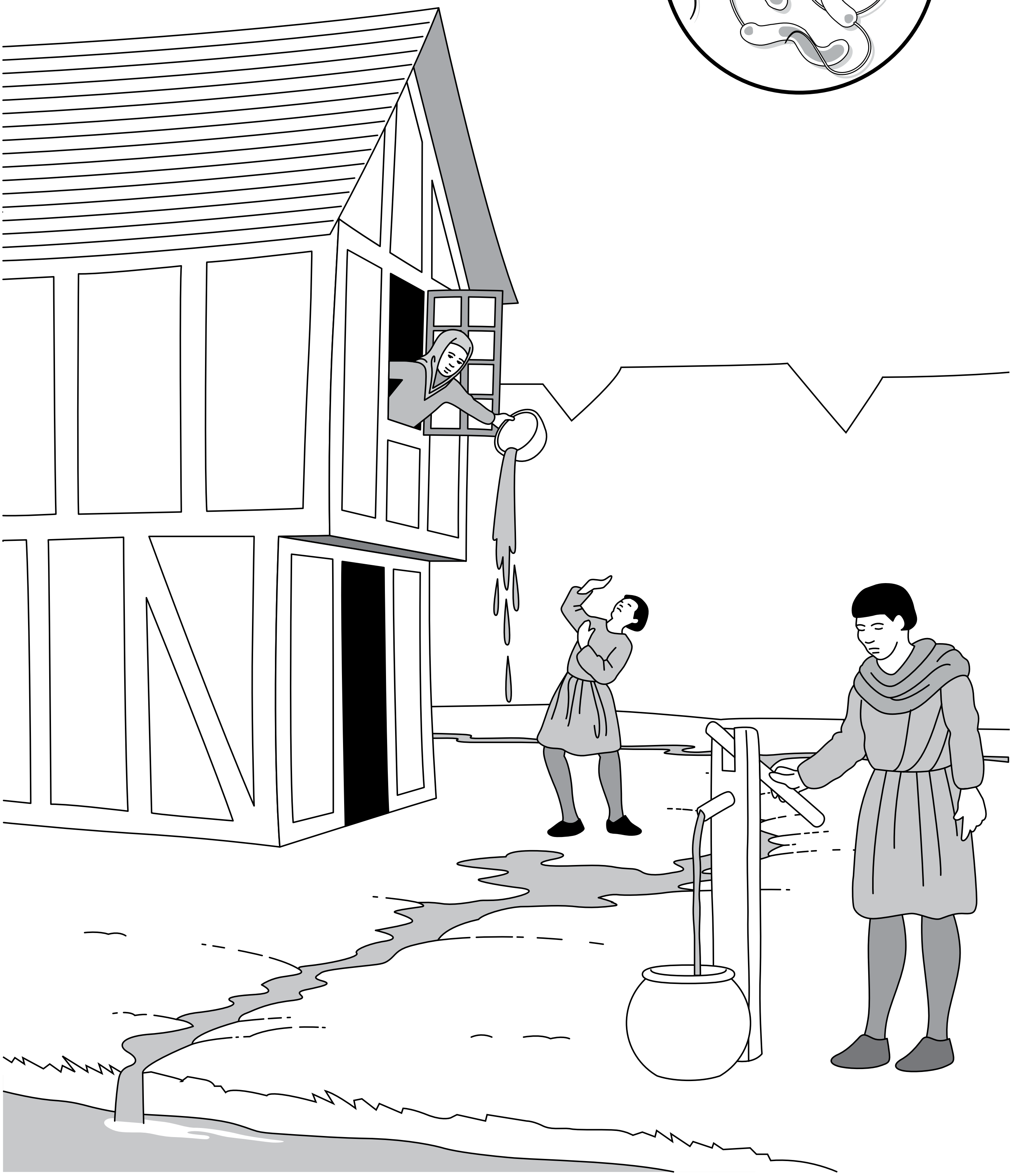


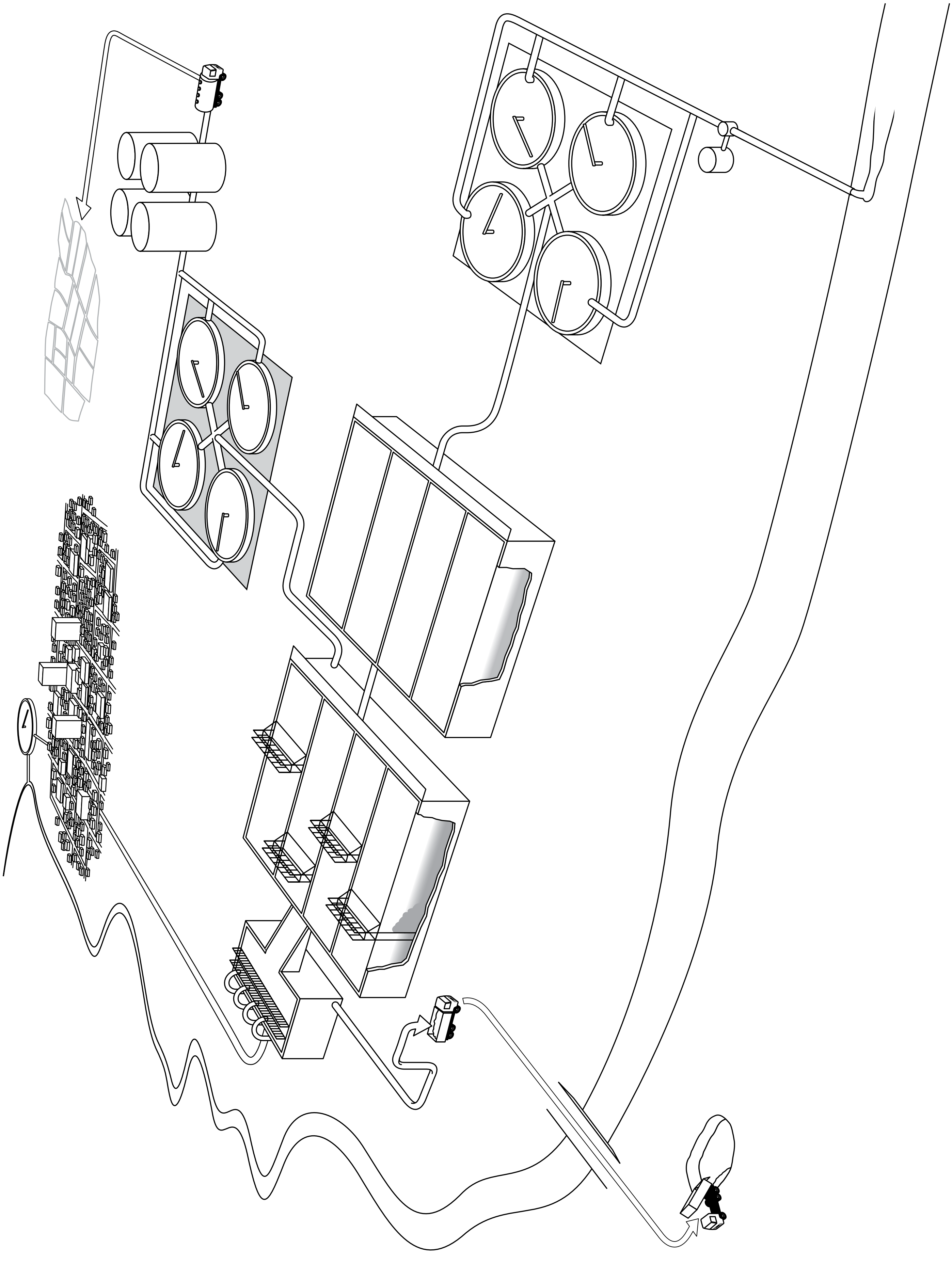












1

Name:... Form:....................

See **pages 4 and 5** of *The Water Book*

A lesson from the past

Lack of water can affect much of our environment. Here we look at the effect of dry soil being blown from the ground in America during the 1930s.

Q1. Look at the pictures on pages 4 and 5 of The Water Book. What can you see in the sky behind the houses?

✎ ....

Q2. How can you tell it is not the cloud from a thunderstorm?

✎ ....

Q3. If you were in one of those houses when the cloud arrived, what do you think might happen?

✎ ....

....

Q4. This kind of soil blow was common in the years when rain was scarce. The part of America where it happened was known as the Dust Bowl. Why do you think it got this name?

✎ ....

....

....

Q5. This kind of thing could not happen in the UK – or could it? When do we have bare fields and strong winds?

✎ ....

....

Q6. How could you hold the soil in place when the weather is dry?

✎ ....

....

1 Answers, Notes, Background

See **pages 4 and 5** of *The Water Book*

Answers

1. **A cloud of dust.**
2. **It hugs the ground.**
3. **The sky would appear to darken and dust would start seeping into the rooms even if you had the doors and windows shut.**
4. **Because the soil that was whisked up into the air had to be as fine as dust or it would not have stayed in the air. (The bowl part comes from the fact that the area was restricted to states near Oklahoma.)**
5. **Arable fields are bare in winter, and the winds are strongest from late autumn through to spring.**
6. **By keeping the soil covered with grass or some other kind of plant.**

Notes

You might like to consider when to use this worksheet. You may use it at the beginning of the course just to make sure children think of the water supply as more than just water from the taps, or you might use it at the end for the same purpose. It can also be linked to page 30 as an example of the devastation that can happen in a developed country faced with drought.

Children should be encouraged to think of the dust seeping in under the doors and then getting in their eyes, their ears and their mouths. They should imagine having to put a handkerchief over their mouths – and this lasting for days on end. It is a scary result of poor land management, and lots of imagination can be used. How would children stay clean (they wouldn't). What might it feel like to be dusty all of the time?

LINK: *This could also form an adjunct to literacy work. You may care to read out, or get children to read, photocopied versions of extracts from The Grapes of Wrath by Steinbeck. This classic story of people forced from their homes is one which is brought about by a combination of poverty, ignorance of the best conservation farming practices and a drought-prone climate where the land is flat and strong winds common.*

If the land is planted, the plant roots prevent the wind from picking up the soil. Furthermore, any plant cover also helps to retain moisture in the soil by keeping the wind from blowing over it (especially important in the winter when the plants are not growing and so not taking up moisture themselves). Plants also help to provide humus, which binds the small particles together. You can therefore also link this to science (Making plants grow well).

2

Name:.. Form:....................

See **pages 6 and 7** of *The Water Book*

Water around us

Water is used in many places around the home.

Q1. Write a list of places in the kitchen where you would find water being used.

✎ ....

....

....

Q2. What would you use water for in a bathroom ?

✎ ....

....

....

Q3. What do people use water for outside their houses or apartments?

✎ ....

....

....

Q4. What is a drain?

✎ ....

Q5. There are two kinds of drain, what is each one for?

✎ ....

....

....

....

Answers, Notes, Background

See **pages 6 and 7 of** The Water Book

Answers

1. **Dishwasher, sink, washing machine, making tea and coffee, diluting soft drinks, cooking food, dog or cat's bowl, floor washing, etc.**
2. **Washing, bathing, showering, flushing the loo, cleaning teeth (cleaning the windows), etc.**
3. **Cleaning windows, cleaning the car, cleaning the paintwork, watering pots and flower beds, etc.**
4. **A pipe used to carry away dirty water.**
5. **One drain carries away dirty house water, such as from toilets. The other carries away rainwater from roofs.**

Notes

This work can either be done as part of a homework investigation, it can be adapted for use in school, or it can be done using the pictures on the pages of the student book. Alternatively, it can be started using the book pages and continued as a home investigation by means of constructing a check list. This way, children would be encouraged to find extra uses and sources of water that we have not covered in the pictures in the book.

A check list is set out below.

The objective is to get children to become aware of the many ways that water is used and made available in the home. You can also extend the investigation to separate out cold and hot water sources.

Name: .... **Form:** ....

Sources of water in the kitchen

✎ ....

....

Sources of water in the bathroom

✎ ....

....

Sources of water outside

✎ ....

....

Uses of water in the kitchen

✎ ....

....

Uses of water in the bathroom

✎ ....

....

Uses of water outside

✎ ....

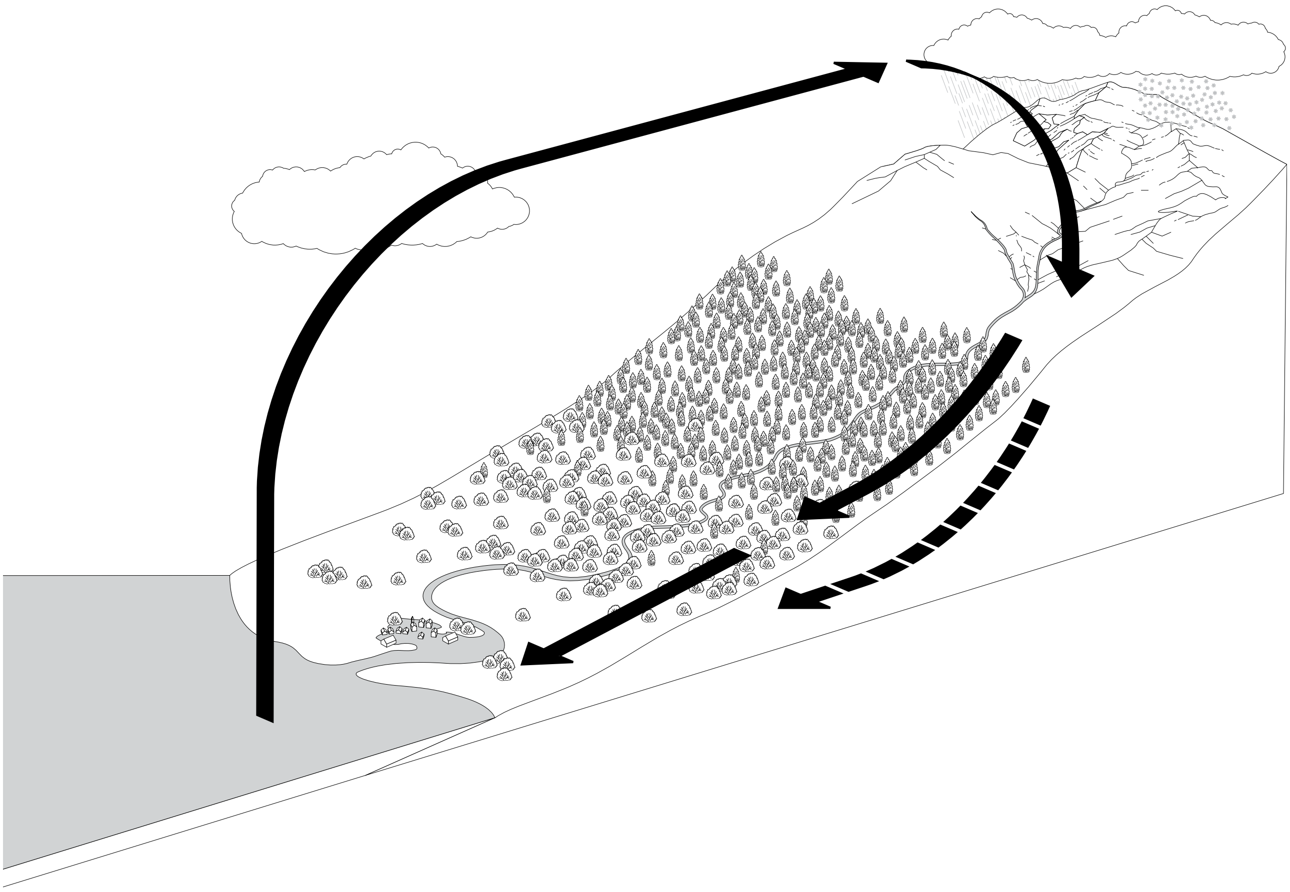
....

Name:... Form:...................

See **pages 8 and 9** of *The Water Book*

Where water comes from

The water we use begins in the oceans, rises to form clouds, falls as rain then seeps through the soil into rivers. It is part of the water cycle.



Q1. On the diagram above, write what each arrow shows.

Q2. How does the water get into rivers?

✎ ....

....

Q3. Could you stop water running back to the sea?

✎ ....

....

....

Answers

1. **The arrows (starting from the ocean) show evaporation; movement of clouds over land; rainfall (snowfall) running over the surface; water flowing through the soil (dotted line); water flowing in rivers back to the sea.**
2. **By seepage through the soil (not usually by rain running over the surface).**
3. **This is an open question.**

   The answer is yes, for a while, by building reservoirs. But as we shall discover, reservoirs can only hold a small amount of the total rainfall in a year and so, if they were asked to hold the whole year's water, they would have to be immense. The purpose of raising the issue now is to try to give an opportunity to think about the magnitudes of water involved in the water cycle.

Notes

The water cycle is one of the places where water supply and river studies intersect. Children should be encouraged to think carefully about the water cycle and understand how it works because it affects the whole of the rest of the study.

Evaporation, condensation (to make clouds) and the transfer of water as clouds onto land will affect the amount of water that is available for use. If the amount of rainfall is small, the amount of water for use will be restricted. This is an obvious point, but it is important to make it clearly, especially for the spreads concerned with drought.

One part of the water cycle not drawn onto the diagram is evapo-transpiration, the evaporation and transpiration of water from living plants. This is water that is taken from the soil and returned to the air. It explains why, even in a place with steady rainfall throughout the year, the soils dry up in summer but get waterlogged in winter.

Children should also be shown that rainfall does not run over the soil, except in very unusual and exceptional circumstances. To make this point, you may care to take them outside when it is raining and get them to feel the soil for any running water. They will not find it because it all seeps in.

The infiltration of water into the soil and its percolation deep into the soil and through permeable rocks is central to the understanding of water supply. Rivers are primarily fed by seepage from rocks and soil, NOT by water running over the soil. If it were the latter then rivers would quickly dry up after rain (as they do in rocky regions with no soil or permeable rock). The slow flow of water through the soil gives us the reliability we need and prevents us having to build far bigger reservoirs. This is why it is important that children do not misunderstand this crucial point.

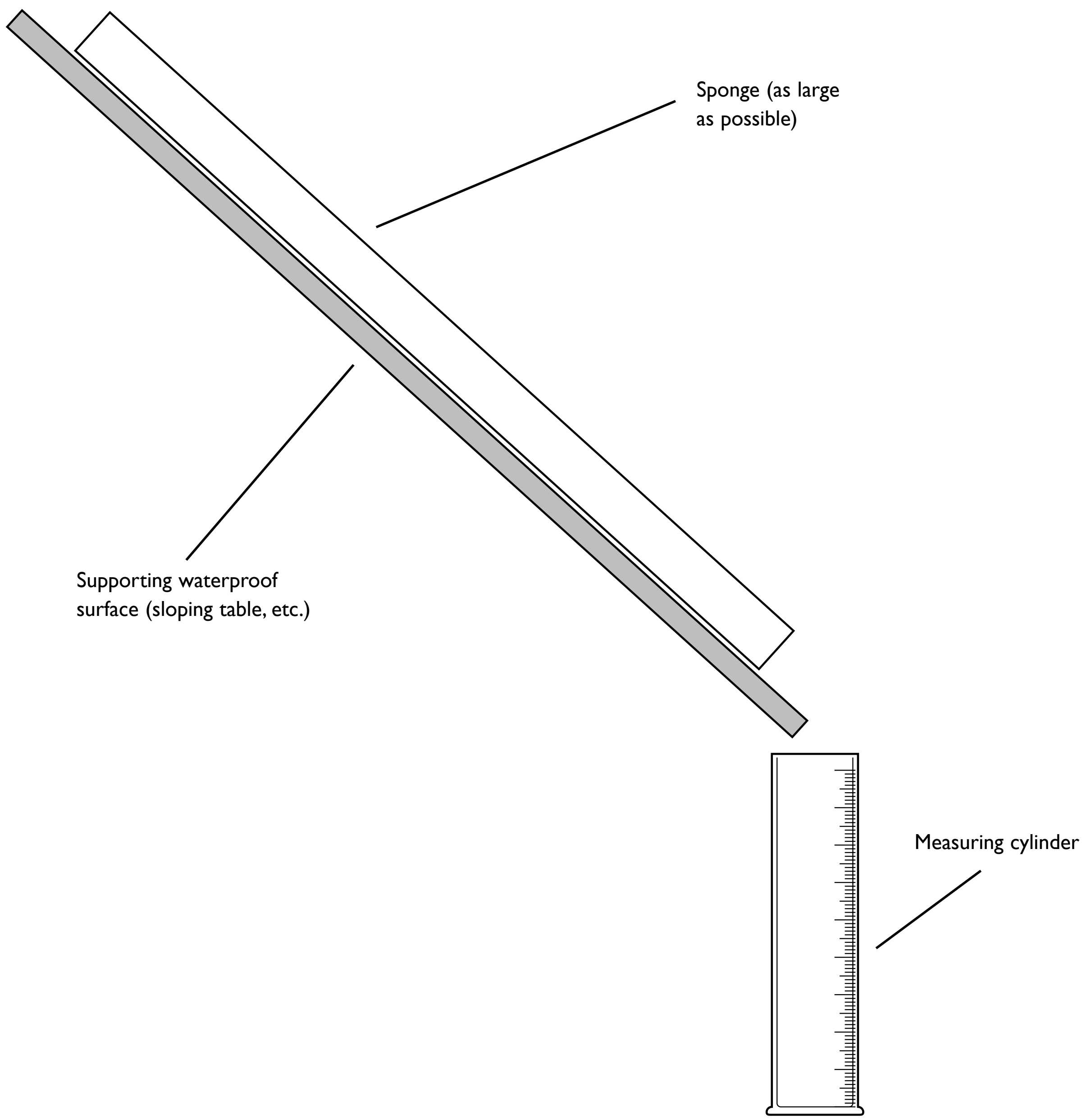
Name:.. **Form:....................**

See **pages 8 and 9** of *The Water Book*

Practical work: Where water comes from

Much of the water that falls seeps into the ground and then moves slowly to feed rivers.

Place a sponge on a sloping waterproof surface, such as a plastic tray. You are going to pour water in at one end of the sponge and measure the water that flows out of the other end. Then you are going to make a chart of what happens.



Notes

This is a fun practical to do in a classroom (provided you can get a jug of water). All you need is a sponge, a tilted surface to support it (a table with two legs propped up) and a bowl to collect the water in.

The bigger the sponge the better. It will actually work with a small car cleaning sponge, but if you can get a sponge sheet then so much the better because the practical will last longer and the results will be easier to measure.

Turn the sponge so that one corner points down to the bottom of the supporting surface. It must also hang over the end of the surface because you want children to measure the water that flows out.

You also need a measuring device (two, actually, as you are going to want to swap a full one for an empty one without losing water). A measuring cylinder would be ideal, but you will need to start with a large capacity one. Towards the end you may want to swap it for a small capacity one. If you can't get hold of two measuring cylinders from the science co-ordinator, then use a cone-shaped measuring cylinder of the type used in cooking. Make sure it is marked in metric measure.

The idea is to pour the water onto the sponge, using the sponge as surrogate soil. First, children will see the water enter the sponge. It will be very difficult to make water flow over the surface. Reinforce this point by having the children take note that there is no surface water.

Get children to measure the water that flows out over time. For this they will need to work as a team, one keeping track of time using the second hand of a watch, another measuring the water and a third getting ready to put the second measuring cylinder in place immediately after the first one is removed. Then, while the second one is filling, the water in the first cylinder can be measured and recorded.

The ideal way to show this is with glass tubes. Each volume of water is placed into a separate tube and the tubes placed side by side. The level at the top of the tubes shows the pattern of flow. Alternatively, simply make a chart and join the top of the bars with a curved line. (Scientists call this chart a hydrograph, by the way.)

Children should notice that it took time for any water to flow out of the bottom (where has all the water gone, you might ask). The flow begins and peaks and then declines. It will take many minutes for a jug full of water to drain through the sponge.

If you have measured all of the outflow, you might then add them all up and show that the total is less than the quantity of water poured in from the jug. Where is the rest? – it is soil moisture, stored for the next time it 'rains'.

If you repeat the experiment, the water will begin to flow through faster than if the sponge was dry. Also the total in and out will match more closely. This is because any new water introduced at the top pushes water out of the bottom.

There are lots of possibilities, and children can try different shapes and sizes of sponge, different thicknesses, different kinds of sponge and so on. All can be related to thick and thin soils, well draining and poorly draining soils and so on.

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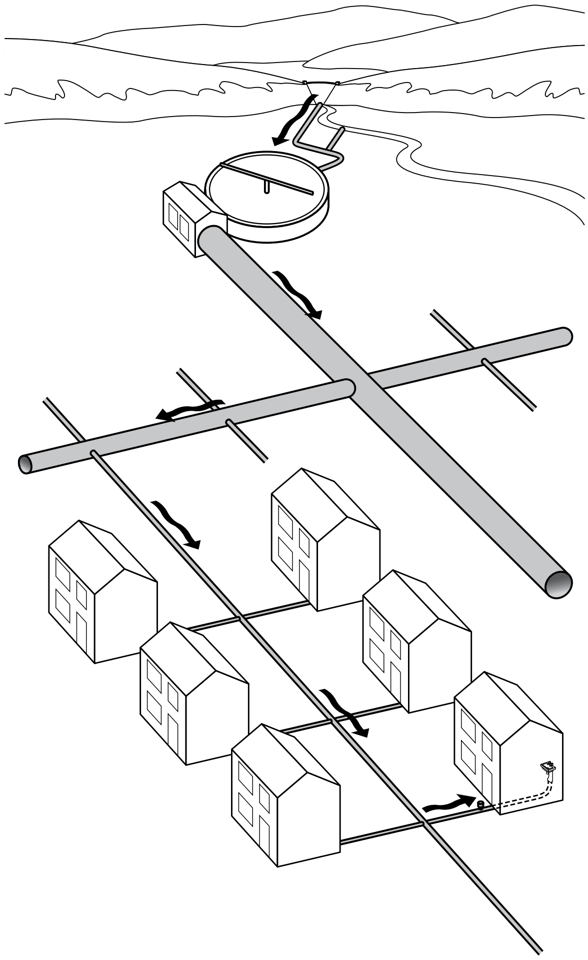
Name:... **Form:**..................

See **pages 10 and 11** of *The Water Book*

Water coming and going

Water arrives and departs through separate pipes.



Q1. Which kind of water is flowing in the pipes in the diagram above: dirty water or clean water?

✎ ....

Q2. Draw another house and connect it to the correct water pipes.

Q3. Which is larger, the water pipes going into a house or the water pipes leading from it?

✎ ....

Q4. Why is rainwater not simply fed into the sewers?

✎ ....

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4 Answers, Notes, Background

See **pages 10 and 11** of The Water Book

Answers

1. **Clean water.**

2. **The connection should be to the small bore pipe and not to the large bore (mains) pipe.**

3. **The pipes leading from it.**

4. **Because the sewers might overflow if they were overloaded by a flash flow of rainwater after a storm.**

   Sewer flow is a known quantity that can be allowed for, rainwater is not. For example, a storm of a centimetre of rain or more in an hour will flood the rainwater drains and spill onto the streets. But this does not matter because the water is not dangerous.

Notes

On this spread we show how three kinds of pipes enter and leave a home. It is very important to show that the incoming pipes can be small bore because they are under pressure, while the large bore pipes are needed when sewage contains solid matter. Large bore pipes are not under pressure – this is an additional reason the pipes have to be large.

You may care to bring into the classroom samples of each kind of pipe. Most children will never have seen them. You can get standard 15mm water pipe, drainpipe and sewer pipe (or fittings) from any builder's merchants. They can come in short lengths which are inexpensive.

The other point to make is that as pipes converge, the pipe needed to carry the combined flow must be larger.

One excellent way of showing sewers is to show a clip from the film The Third Man, which shows the sewers in Vienna. Not only do children get a marvellous view of sewer sizes in a dramatic setting, but the whole nature of the film helps them to understand what a complex network of passageways there has to be below the streets.

LINK: *The clip from the film can also be used to link this subject to literacy, using the dialogue and the way language is used to highlight drama. This can be contrasted to the kind of formal language used in a textbook such as The Water Book. It is also an excellent opportunity to get children to begin to analyse a film.*

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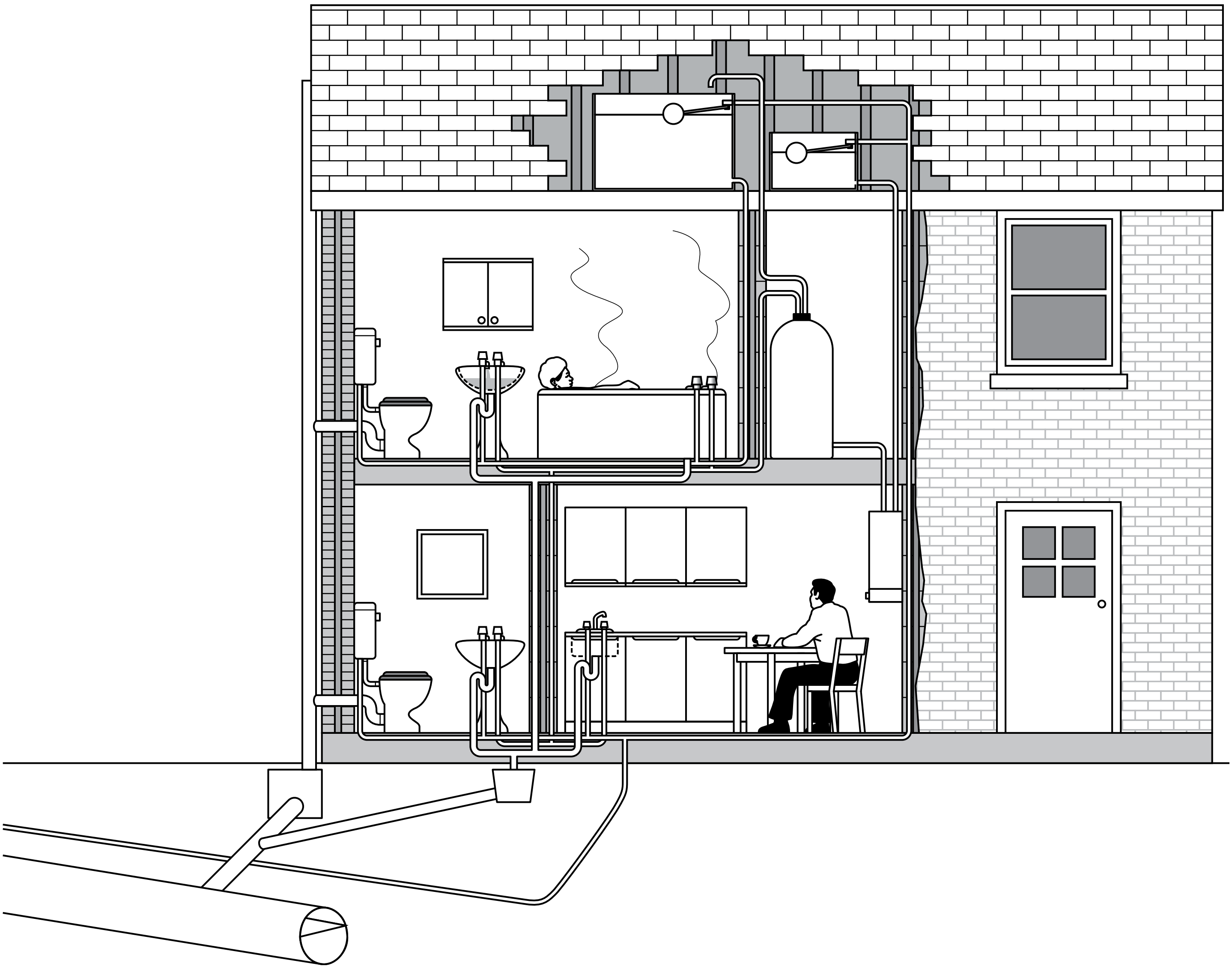
Name:... Form:....................

See **pages 12 and 13** of *The Water Book*

Building up pressure

Water can be under pressure in many places in a house. This is true of water entering and water leaving.



Q1. On the diagram above, use a coloured pencil to show which pipes are carrying water under pressure from the mains.

Q2. Use a different colour to show the other places where water is under pressure (but not mains pressure).

Answers

1. **The pipes under mains pressure on this diagram are the pipe leading from the mains in the street to the loft tank and also the pipes that branch from this to supply cold water to downstairs, such as the sink.**

2. **Water under less than mains pressure are all the pipes from the loft tank: the upstairs hot and cold (including the boiler and hot water cylinder) and also the pipes leading to the toilet.**

   For those who might be looking for smart solutions, the toilet cistern also puts water under pressure as soon as the handle is pulled. This is how the toilet is flushed. Note that the water in the drains is NOT under pressure and so the drains and sewers should not be coloured in.

Notes

This is an apparently simple task that actually takes children around all of the pipes in the house and gets them to follow connections.

The simplest connection is to the tank, but many may well miss the branch to the downstairs sink, etc.

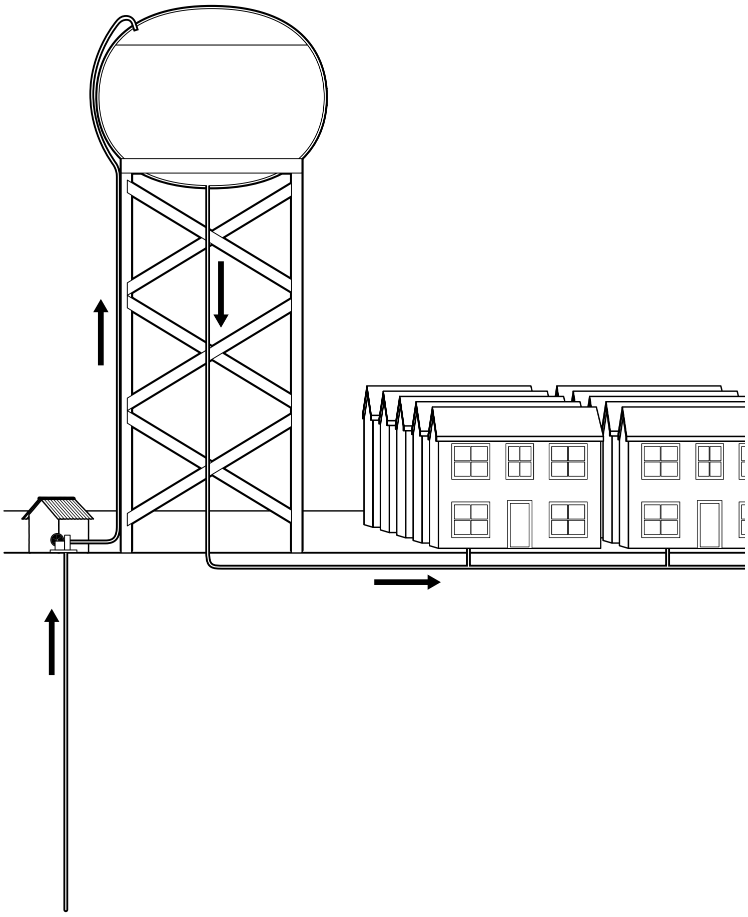
Following the path of water pipes from the loft is more complex, so some children will need help and for some it may take quite a long time.

Name:... **Form:**...................

See **pages 12 and 13** of *The Water Book*

Building up pressure

When you turn on a tap water comes gushing out. But have you ever thought how the water gets out so quickly?



Q1. The water pipes are buried in the ground, so the water comes up into your home. Your home may also be higher than the local reservoir. What makes the water come out of your taps?

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Q2. Some people have large water towers near their homes, like the one shown above. Explain what the tower does.

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Q3. Some water towers are fed with water from the mains. Where do the other towers get their water?

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Answers, Notes, Background

See **pages 12 and 13** of *The Water Book*

Answers

1. **Pumps. The water is impelled along the pipes under pressure from large pumps. This is also the reason that small bore pipes can be used.**

2. **It provides a reservoir higher than the taps in the surrounding district and so provides water pressure (water engineers call this a head of water).**

3. **From groundwater supplies pumped from wells. This is more common in rural areas.**

Notes

Water supplies get to our taps under pressure. This allows small bore pipes to be used as well as allowing water to be fed uphill.

You can demonstrate the way that an impeller pump works if you happen to have a pump that can be driven from an electric drill (the sort bought in DIY stores for pumping out waste water – it fits into the chuck of the drill).

It is an impeller pump, meaning that there is a propeller blade inside the pump. This acts like a screw, pulling water through the pipe. It is quite an exciting demonstration for children to watch. A bucket of water can be emptied in a minute or two.

Gravity feed to give a head of water is less common in cities, but still found in rural areas. A demonstration for this is on the next worksheet.

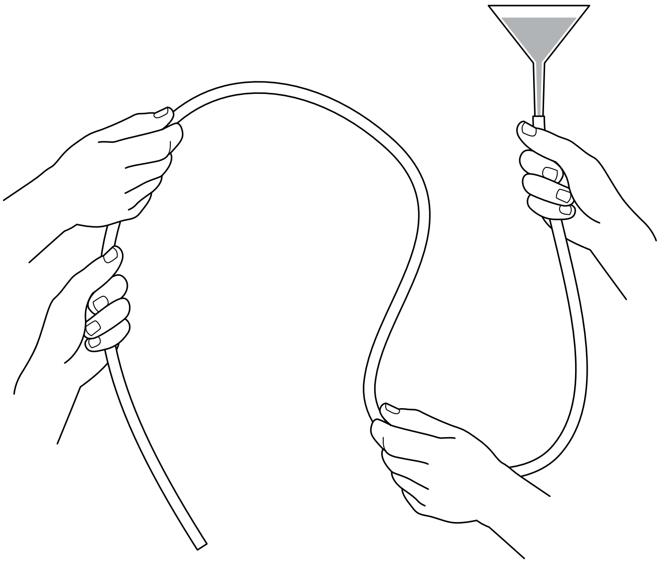
Name:... Form:...................

See **pages 12 and 13** of *The Water Book*

Practical work: Investigate water pressure

You will need a length of clear plastic tubing, a jug, a funnel, a bowl, a measuring cylinder, a watch and some coloured water for this work. It is best that three people work together on this demonstration.

You are going to find out how height of water affects pressure.



1. Use a pen to make a line around the funnel near the top. This will be the level of water you will maintain while you are doing the work.

2. Push one end of the tubing onto the funnel and then hold the other end of the tubing over the measuring cylinder. (It will prevent troublesome spills if the measuring cylinder is placed in the bowl.)

3. Hold the funnel 10cm above the open end of the tubing. Begin pouring water into the funnel so that it stays close to the pen mark. Then time how much water is collected in 15 seconds. (You can stop collecting water by moving the measuring cylinder out of the way. Now you know what the bowl is for!)

4. Repeat the task but this time hold the funnel 50cm above the open end of the tube. Then repeat again with the funnel 100cm (1m) above the pen mark.

5. What do your results show?

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See **pages 12 and 13** of *The Water Book*

Answers

The results show that as the funnel is raised above the tube outlet, the water flows through faster, meaning that an increase in height of the funnel (an increase in the head of water) gives higher pressure.

Notes

This demonstration shows how pressure is produced by moving the inlet high above the outlet of a tube completely filled with water.

By repeating the demonstration with various heights of the funnel, students can, if you wish, make a chart of the height against amount collected.

The same principle applies to the water tower used to supply district water. The height of the tower reflects the head of water the engineers want to achieve to provide customers with a good flow of water, taking into account the losses of pressure due to friction in the pipe over long distances.

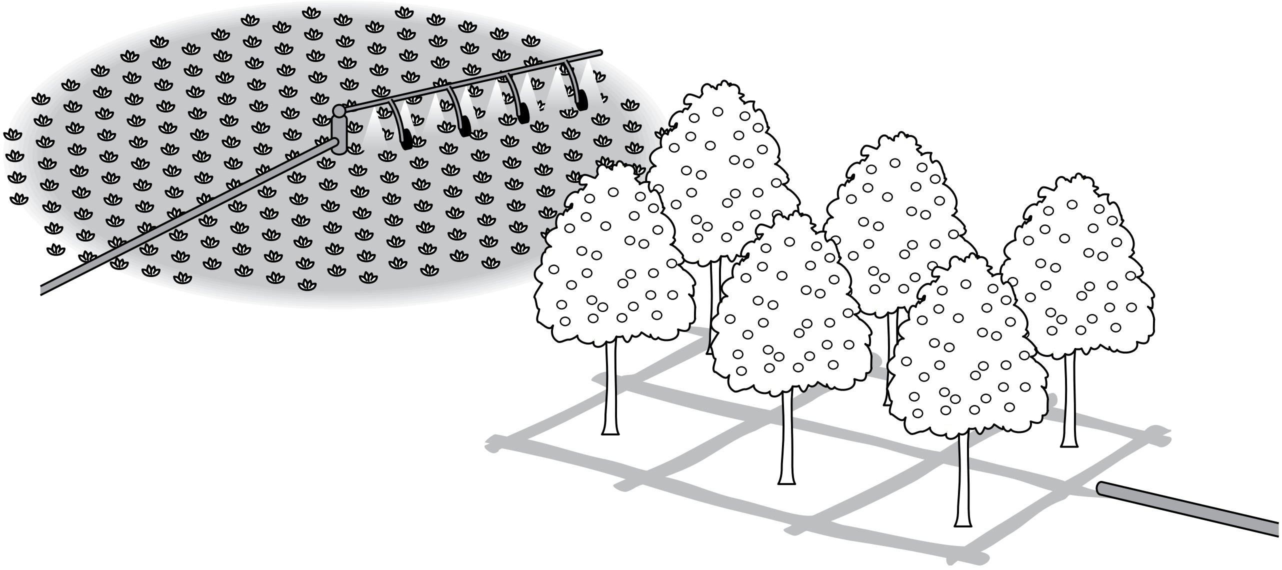
You can extend this practical by getting children to think about the toilet cistern. This is the same principle as before, with a head of water needed to flush away the contents of the bowl. In this case a wide pipe is used from the cistern because it is important to get enough water moving at high speed. There has to be enough energy in the water to move the solid waste. (Energy is proportional to mass multiplied by velocity.) You can make the comparison that boulders are moved during heavy floods by fast-flowing rivers.

Name:... Form:...................

See **pages 14 and 15** of *The Water Book*

Big users!

Farmers, power stations and factories are the biggest users of water – not homes.



Q1. What is it called when farmers use water to help their plants to grow?

✎ ....

Q2. Some ways of watering fields use large amounts of water. Name the two ways shown in the diagram above.

1 ✎ ....

2 ✎ ....

Q3. What does a gas, oil or coal power station use water for?

✎ ....

Q4. The biggest users of water need to make sure they have water when it is needed. Where do they store their water?

✎ ....

Answers

1. **Irrigation.**

2. **Flood irrigation (right) and spray irrigation (left).**

3. **Cooling the generators.**

4. **In reservoirs.**

Notes

Most children will not have given much thought to who else might use water besides themselves. So this page is designed to provide some examples of the users that consume most of the world's water.

The examples and illustrations are chosen because they are simple and easy to see. But it is important to point out to children the scale of these operations. Get them to look, for example, at the size of the dam in Picture 1 in the textbook (it is a dam on the Colorado River in the USA).

It also makes sense to think of reservoirs as huge storage tanks, and in this context it follows on from the previous spread.

The UK does not use as much water for irrigation as many other countries, and for this reason children may not be very familiar with it. But most will probably have seen the cooling towers of a power station. The cooling towers are condensers. Water is fed in at the top in the form of a hot spray. As it falls down over the slats in the tower, the water is cooled by water passing up the tower. This is an interesting example of part of the water cycle, for a little of the water evaporates as it falls. At the same time, by exchanging heat with the air, it warms the air and this causes it to rise. The rising air then pops up from the top of the towers and cools in the surroundings. The cool air then forms clouds.

Water is only added to top up that which evaporates. This is about three per cent of the total in circulation in the power station. However, some power stations do without towers and use river water. When they do this they may use nearly all of the river – although, of course, they send it out again almost at once.

Name:... Form:....................

See **pages 14 and 15** of *The Water Book*

Practical work: Big users!

Find out how much water fields of plants need.

A classroom is a kind of desert because it never rains. It is a good place to find out just how much water a growing plant uses. This will help us work out how much water is used by plants growing in fields.

You will need a good, large, leafy houseplant and a measuring cylinder. Choose a plant that has soft leaves, not leathery or shiny ones (these plants come from places where there is drought and so they do not use much water).

1. Put the plant on a windowsill in the classroom and water it until the soil is moist. Add the water with a measuring cylinder to find out how much water you added. As soon as the soil begins to dry out, record the amount of water you need to add. Keep doing this for a couple of weeks.

If you stand the pot in a saucer, you will see if any water seeps out from the bottom of the pot when you water the plant. Measure this water and take it away from the amount you added.

✎ ....

2. Once you have several measurements you can work out how much water the plant needs each day.

✎ ....

3. Let's imagine that if the plant were in a field it would be spaced a metre from its neighbours. On a piece of farmland which is one kilometre on each side there would be 1,000 plants in a row and a thousand rows – a million plants.

4. Use your measurements to find out how many litres of water such a field would need each day, assuming it did not rain. (The answer is 1 million times the amount you measured.)

✎ ....

Answers, Notes, Background

See **pages 14 and 15** of *The Water Book*

Answers

The answer will be different for each plant. Check each student's work to make sure they have multiplied correctly.

Notes

Here is a simple practical that brings home just how much water irrigation can use.

There are several important points. First, children may not have thought of their classroom as a climatic desert. You may need to explain what a desert is (we will need this information later in the book).

Second, we introduce the idea of scaling up from samples. There are lots of flaws with this experiment in terms of scaling it up to a field, but for our purposes we can ignore these.

***LINK:** Children will not necessarily have imagined how many plants you can get into a field. This is a simple exercise in maths. The ideas of transpiration is a link to science.*

If you want to get more perspective, find out how much water fills a bath tub and get children to find out how many bath tubs of water will be needed to water our field. This way they can see how farms in dry countries may need very large amounts of water indeed.

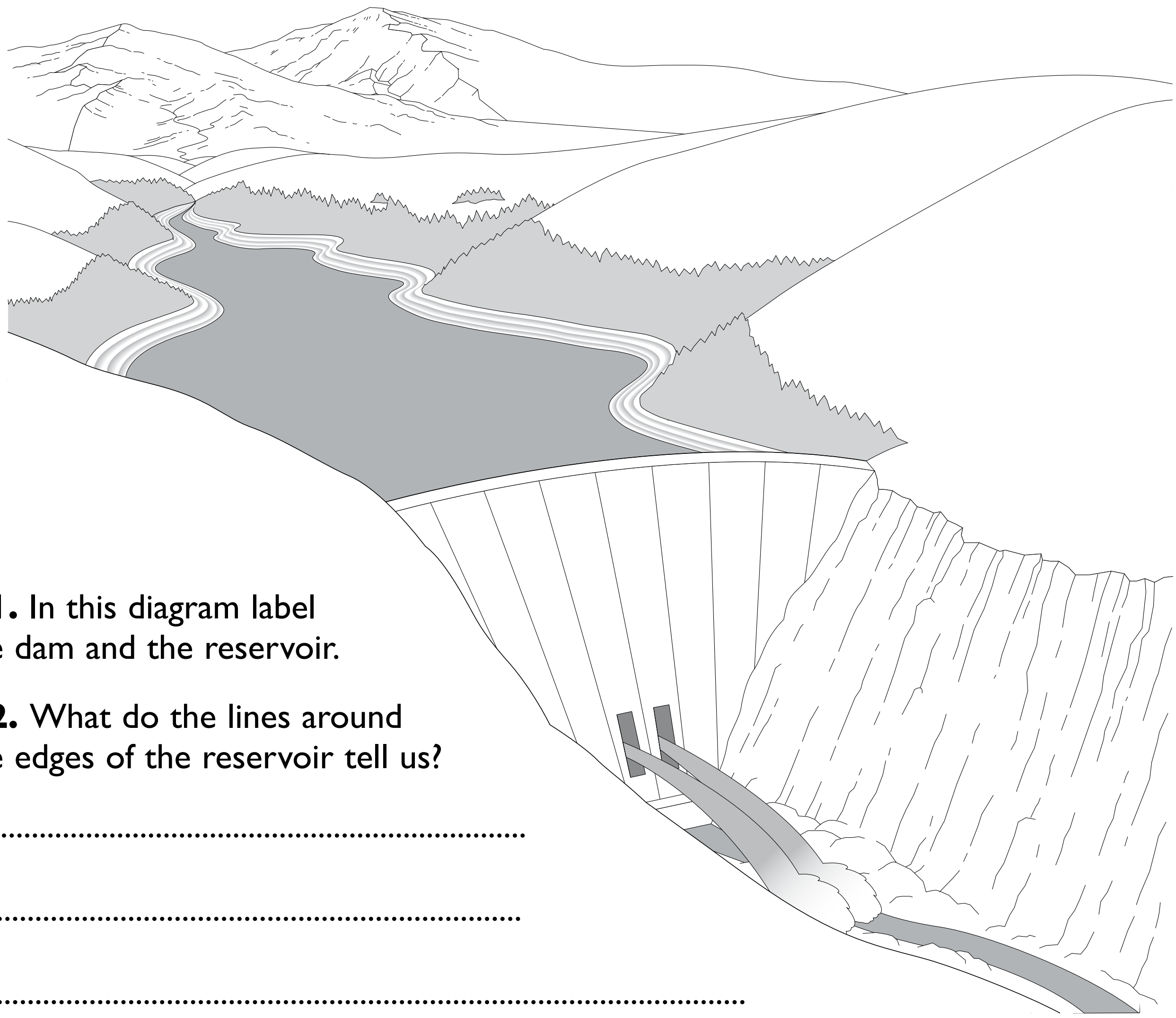
It is also the case that some plants (paddy rice, for example, which feeds half of the world) are swamp plants, so when they are grown in fields they need even more water than most other plants. These kind of plants would have to be in flooded (paddy) fields; they cannot be spray irrigated.

Name:.. Form:...................

See **pages 16 and 17** of *The Water Book*

Reservoirs

Reservoirs are a kind of water bank, holding water for times of need.



Q1. In this diagram label the dam and the reservoir.

Q2. What do the lines around the edges of the reservoir tell us?

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Q3. Find out about a large reservoir in the world.

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Answers, Notes, Background

See **pages 16 and 17** of The Water Book

Answers

1. **The dam is in the foreground. The reservoir is trapped behind it.**

2. **The lines are beach lines and show how the reservoir is managed. You will see more lines in late summer when the reservoir is partly empty and very few in late spring when it should be full. If you see lines in late spring, then the water company will have a problem on its hands come late summer.**

3. **This depends on the example chosen.**

Notes

This is a good opportunity for children to know about some of the world's biggest reservoirs and where they are. They can use encyclopedias and other reference books for this, and they can use the 'Rivers of the World' section of our ***www.curriculumvisions.com*** *web site (under Geography/River) or the River and Water CD. From either source, children can click on the World Rivers tab (top right) or, if they know a river they would like to find a reservoir on, they can click on Picture Finder and then search using the Browser Find button and the key word 'reservoir'. Under the Rivers and People tab there is also a section on reservoirs.*

If looking at world rivers, you might ask children to look at the River Colorado in North America (it's the one that has formed the Grand Canyon). They will see several dam and reservoir pictures there.

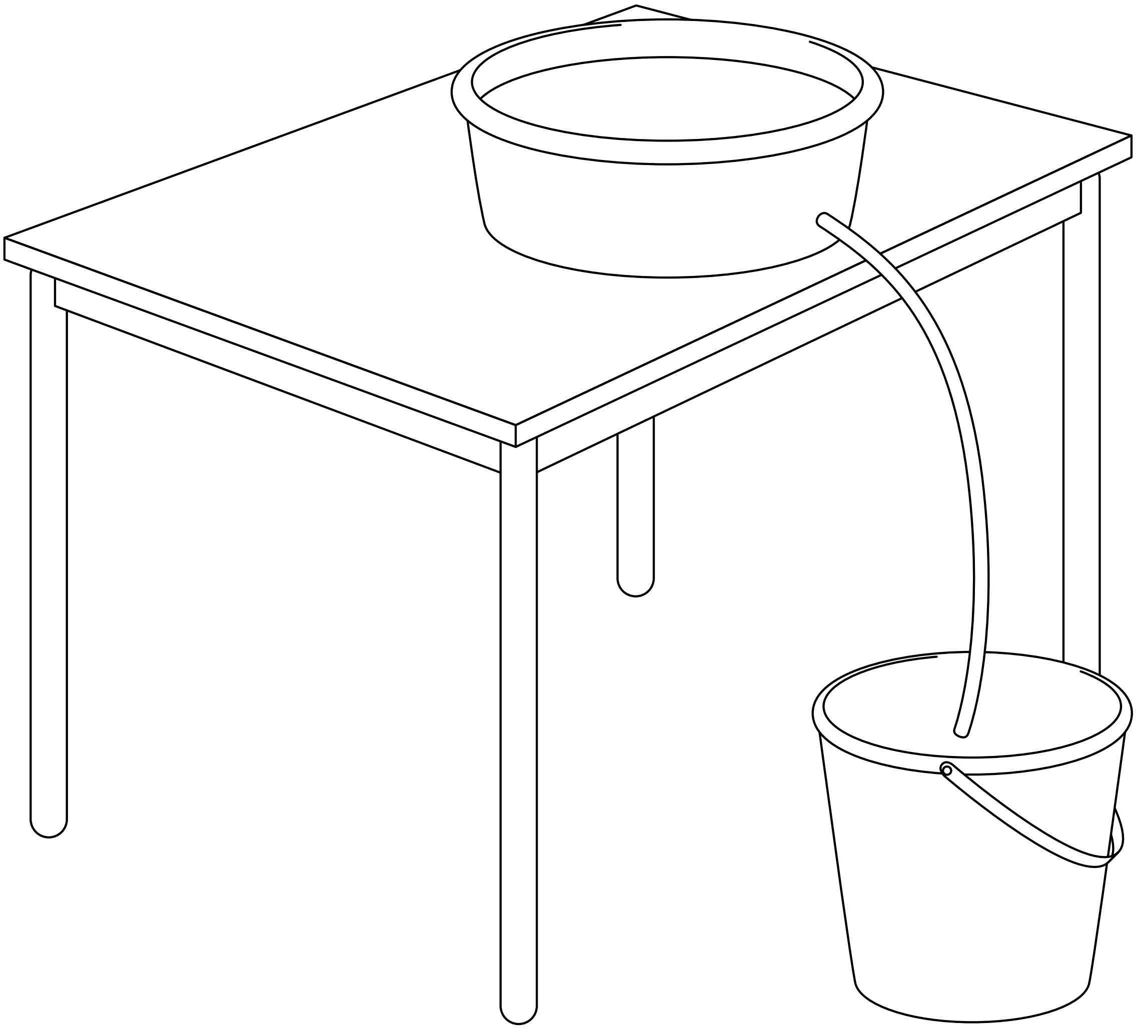
Name:.. Form:....................

See **pages 16 and 17** of *The Water Book*

Practical work: What reservoirs do

You will need a large bowl and some tubing for this practical.

You are going to try to make a reservoir using the bowl, and use the tubing to control the way water flows out.



1. Make a hole in the bowl and force the tube inside so that it makes a watertight fit in the hole.

2. Allow the tube to hang over the edge of a table and place a bucket underneath.

3. Add water to the bowl and watch the way the water flows out. You can put lots of water in the bowl and fill it to the brim, or just put water in from time to time.

Notes

A reservoir is a damping device. The outflow is controlled by the head of water in the reservoir (as we saw in practical 5B. But because the tubing is of a fixed diameter, if the amount of water entering is very large, the outflow will not be able to cope and the reservoir will spill over (as commonly happens in winter), which is why reservoirs have spillways (see page 17 Picture 2 of The Water Book).

If the water is added by the jug (representing intermittent rainfall) then it will be found that the outflow is much more even. So a reservoir (just like a lake) naturally steadies the flow of water in the river it is built on.

By putting a thumb over the outlet of the tube, it is easy to show how the flow can be stopped or reduced to allow the water to build up in the reservoir.

You might ask the children if they think the water is ever turned off to allow the reservoir to fill. This is never the case because so much depends on the river continually having a flow of water in it (for example, for fish, dilution of sewage).

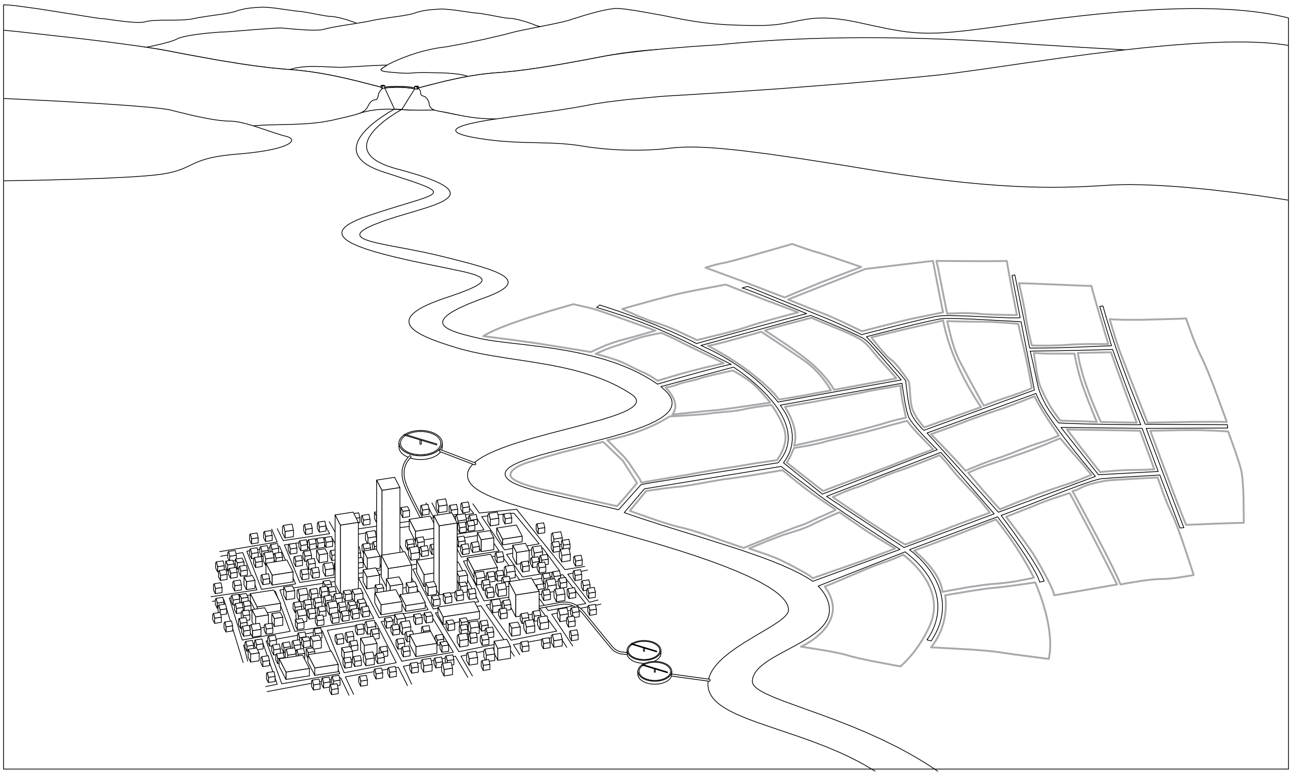
8

Name:.. Form:..................

See **pages 18 and 19** of *The Water Book*

How we move water

People often live far from the most reliable water supplies. As a result they have to move water – often over long distances.



Q1. Label these features on the diagram above: reservoir, irrigated farmland, city water pipe.

Q2. Why isn't water carried by pipe from a reservoir?

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Q3. What is a simple word for aqueduct? ✎ C.................................

Q4. Why is water sometimes moved by aqueduct and not by river?

✎ ....

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8 Answers, Notes, Background

See **pages 18 and 19** of *The Water Book*

Answers

1. **The reservoir is in the background, the irrigation to the right and the city water pipe in the foreground.**

2. **Because this would be an unnecessarily expensive thing to do. It is cheaper to let the water flow naturally in the river and then take it from the river at the point closest to where it is needed.**

3. **Canal.**

4. **In some cases the river does not go in the direction of the city where the water is needed. In these circumstances there is no alternative but to make an artificial river, or aqueduct.**

Notes

This is the first of two spreads that deal with the movement of water. The first concerns the developed world, the second the developing world.

Here, students are introduced to the problem that water is both heavy and bulky. They should also realise that they use a lot of it.

The developed world solution is to make use of rivers as a free transport system whenever possible, and then to use aqueducts and finally pipes.

Pipes are by far the most expensive means of carrying water. In general, they are buried and take a very long time to construct. In big cities there is no alternative but to use a main (often a ring main).

In the UK, aqueducts are not common because there is a high density of rivers. However, in other parts of the world, and especially in arid and semi-arid regions, aqueducts are commonplace. Los Angeles, in California, for example, lies on the coast in a virtual desert. It relies on getting all of its water by aqueduct. In this case, sources of water are hundreds of kilometres away.

Name:.. Form:....................

See **pages 20 and 21** of *The Water Book*

Moving water in poorer countries

When it is too expensive to use aqueducts and pipes to each house, more time-consuming and less reliable methods have to be used.

Q1. Look at the large picture at the bottom of page 20 in The Water Book. Explain what the people in the foreground are doing and what their problems might be.

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Q2. You might walk at about 3 km an hour when carrying a bucket of water. You can carry just 15 litres. You are part of a family of eight. Everyone uses about 15 litres of water a day. You live 4 km from a place where you can get water. How much time must you spend collecting water each day?

✎ ....

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Q3. Can you think of better ways of collecting more water to save time and effort?

✎ ....

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9 A Answers, Notes, Background

See **pages 20 and 21** of The Water Book

Answers

1. **This is an open question. The people are doing two things. The man is filling up a jerry can with water to carry away. The woman is using the same area for washing clothes. There are several practical reasons for this. Washing uses more water than cooking, so it is easier to wash at the communal tap than to carry the water back to home. This is exactly what people used to do in the UK before piping was widespread. Notice also that the concrete base is a cleaner place to wash that elsewhere, for the land behind is simply trodden earth and if clothes touched it they would become muddy.**

2. **4 km/3 km per hour = 1.3 hours each way = 2.6 hours per 15 litres of water. Eight people = 2.6 x 8 = 20.8 hours a day. This is clearly impossible, so several children would have to go. Indeed, in many developing countries one of the major activities is the fetching and carrying of water.**

3. **Using donkeys, using bicycles, building hand carts, etc.**

Notes

This spread is designed to bring home the reality of what fetching and carrying water really means. Essentially it is a waste of time for the people involved and may take up hours of the day when they could be at school, working in the fields or doing something else. Nevertheless, people have to have water and so they are forced to undergo this drudgery day in and day out.

Some children become quite inventive and build wheelbarrows and sack trolleys out of old wood and old wheels. They then fill large plastic barrels (usually old oil tubs) with water, strap them to the barrow and push them home. This can cut the time spent considerably. Even so, the answer is to find a means of increasing the wealth of a country so that it has the money to support the provision of piped water. It is also more a problem of the country than the city.

The problem brings home what an immense task it is to improve the quality of life for poor people.

Note also that the water is often not clean, so even after carrying it, the water may cause frequent illness.

Name:.. Form:...................

See **pages 20 and 21** of *The Water Book*

Practical work: Moving water

You will need a number of buckets for this. You are going to find out (in a minor way) what it is like to have limited water supplies.

1. Agree that for today your class will only use one tap. It must be an outside tap.

2. Now carry on as usual except that whenever you want water, you will need to go to the outside tap and fill up a bucket and then carry it with you.

3. When you have done this, what problems did you find? Write down here what the problems seemed to be. Use these headings:

weight

✎ ....

....

time consuming

✎ ....

....

unsure of cleanliness

✎ ....

....

4. You might like to try the same exercise at home, if your family agree. But be warned it will be far more inconvenient at home than at school because you use most of your water at home. As a result, just try it out for a few hours.

Safety first!

Please ensure that all children try this under supervision and that LEA guidelines concerning lifting heavy objects are complied with.

Notes

This practical is to give children a real feeling for what it must be like to have to fetch and carry water. The reason for the outside tap is to get children to realise that many people do not have a tap in their homes. Many do not have a tap at all.

Children should consider trying out some different ways of carrying. For example, is one bucket in each hand better than just one bucket? Is it easier to carry a bucket on your head than in your hand if you have a long way to carry it? (It is actually better for you.) Can children lift a small bucket of water on to their heads? Children of their age in the developing world can and do – every day, often several times.

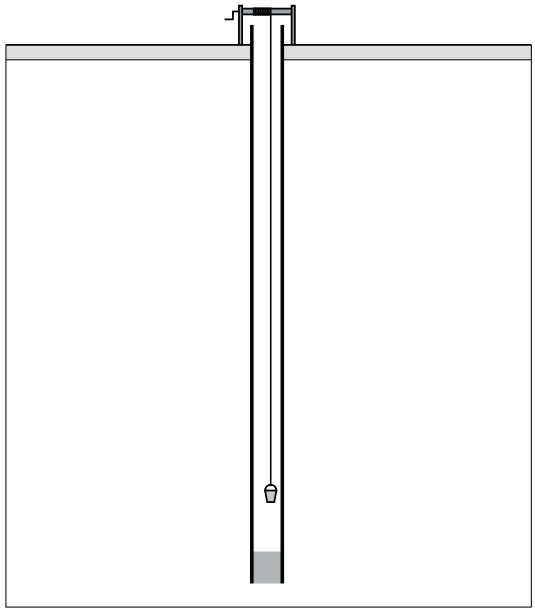
Look to see if any children would not consider drinking from an outside tap. Water from our outside taps is just as safe to drink as water inside, but some children may find this difficult psychologically. There is no need to compel them to drink from an outside tap, of course, but the class should recognise just how much we are cosseted and how much we take for granted.

Name:... **Form:**....................

See **pages 22 and 23** of *The Water Book*

Using water in the ground

Rocks can store huge amounts of water. Some flows naturally to the surface, and some has to be dug for.



Q1. This picture shows a well. Mark on the diagram where you think the water level is inside the rocks by the well.

Q2. Where does the water come from that reaches the well?

✎ ....

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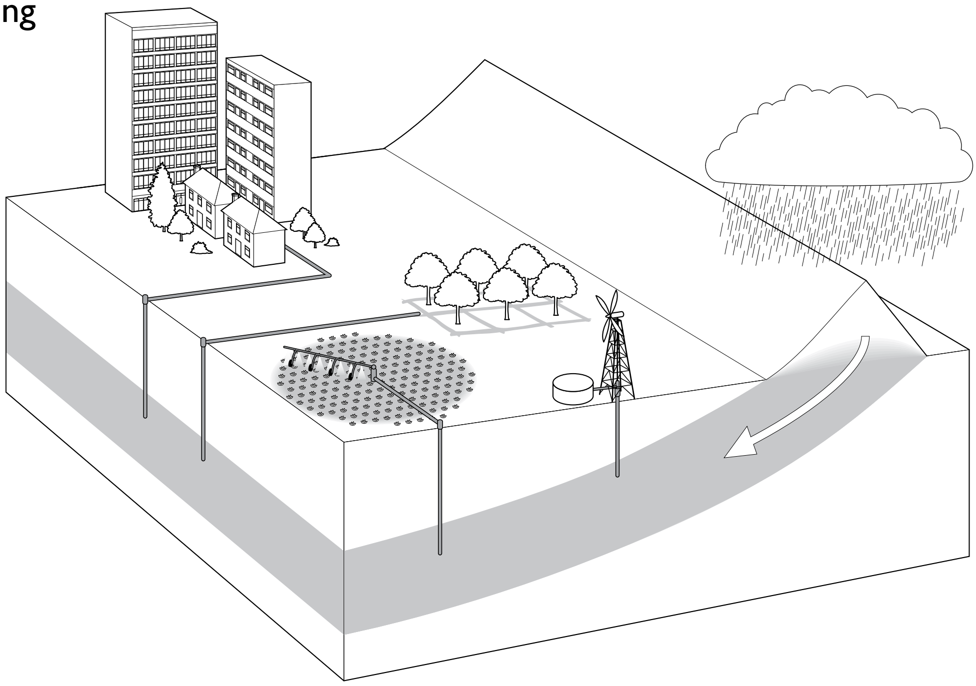
Q3. What is a spring?

✎ ....

Q4. Draw a spring on the diagram.



Q5. Why do springs only flow near the edge of the hills?

✎ ....

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10 Answers, Notes, Background

See **pages 22 and 23** of *The Water Book*

Answers

1. **The water level in the rocks should be the same as the water in the well.**

2. **The water seeps through the rocks to fill up the well. In turn, the rocks receive their water from rain that seeps into the ground.**

3. **A place where water flows from an underground aquifer (rock) across the surface.**

4. **Should be to the left or right of the hills on the surface.**

5. **Because all of the rest of the land has a capping of watertight rock.**

Notes

Groundwater may be unfamiliar to children because it cannot be seen. The place where it is most likely to make sense is in the context of a well. Springs are also the result of water flowing underground. Most springs form at the junctions of permeable and watertight (impermeable) rocks. In the diagram, this is always at the base of the line of hills.

One important point about using water from underground is that the water-bearing rocks (aquifers) have a finite storage and can be overpumped. If this happens, the water table (the top of the water in the rocks) falls and wells have to be drilled deeper. In artesian areas, water no longer flows to the surface under its own pressure and has to be pumped.

Children should also note that because the water has to seep through soils, you cannot pump a well as you might a tank of water. There are limits to the speed that a well will refill. Thus, wells suit a small, well-spaced demand rather than a large one. But very large numbers of wells can be drilled, as happens in drought-ridden parts of the world where the well water is often used for irrigation, with one well per field.

Notice that fields irrigated by many sprinkler systems are circular because the water is fed from a rotating boom.

LINK: *You may care to link this to settlement studies. Many Saxon and Viking settlements were founded along spring lines (those south of Lincoln are a classic example). Celtic peoples also settled near springs.*

Springs provide a reliable source of water and are more convenient than water drawn from a river (especially in times of flood). Floodplains are naturally marshy and do not normally make good settlement locations.

C I 11

Name:.. Form:....................

See **pages 24 and 25** of *The Water Book*

Why worry about water?

In the UK rainfall is spread evenly through the year. But other places get too little or too much rainfall.

Q1. On picture 1 in The Water Book, you can read about some water problems for a person in Mali. Find other countries in Africa that are to the east and west of Mali and write them down.

✎ ....

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Q2. Find out about the pattern of weather in these countries. Do they have long dry seasons?

✎ ....

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Q3. Now choose a place that has rain throughout the year, for example, the rainforests of the Amazon in Brazil, South America. Write down what you think the water problems might be in that place.

✎ ....

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Answers, Notes, Background

See **pages 24 and 25** of *The Water Book*

Answers

1. **These are the countries of the Sahel. You may care to tell children more about the Sahel.**

   To the west of Mali are Mauritania, Senegal and Guinea. To the east are Niger, Chad and Sudan. The northern part of all but Senegal and Guinea are deserts.

2. **They all have long dry seasons. The best way to show this is to show graphs of rainfall in each month of the year.**

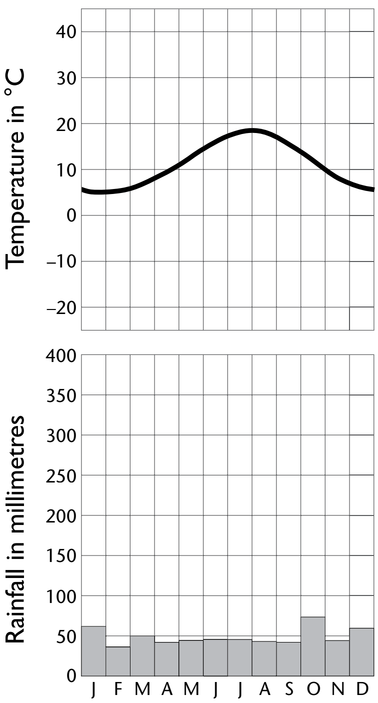
   Here are three graphs to copy if you wish. They are for the UK, for a place with a long dry season and a place with a tropical rainforest. Your students may need some help in understanding what these charts show.

3. **In a rainforest, the water supply problem is having too much water. This is an open-ended question in which you can discuss the wider aspects of excess water, such as the difficulty of finding a place for a latrine that is above the water table.**

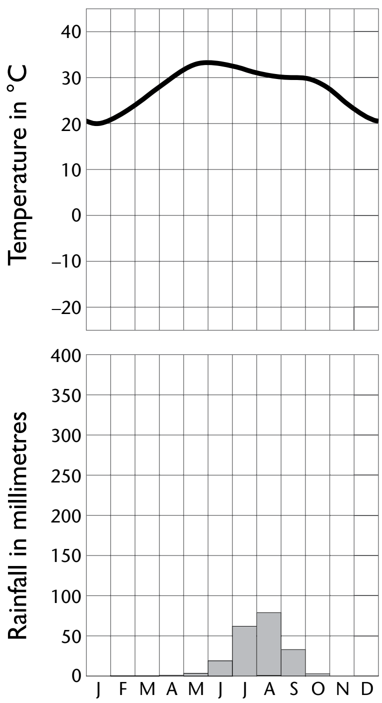
Notes

This spread gives the opportunity to develop atlas skills in finding and interpreting maps of rainfall and temperature. These can be used to supplement the map given on pages 24–25 of The Water Book. There is also considerable opportunity to develop skills in citizenship and related PSHE skills as children can be asked to put themselves in the shoes of someone in a different part of the world.

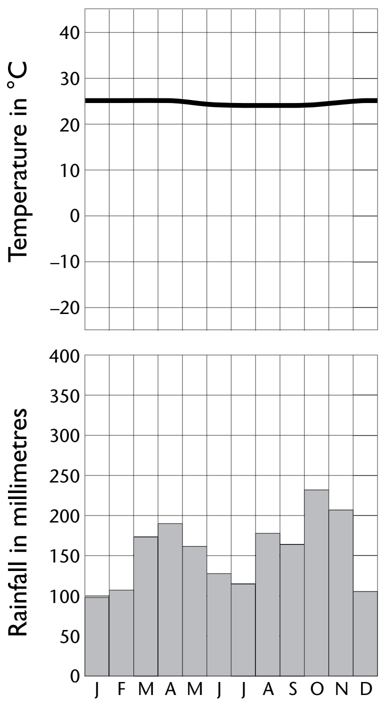
London, England



Timbuktu, Mali



Kisangani, Congo



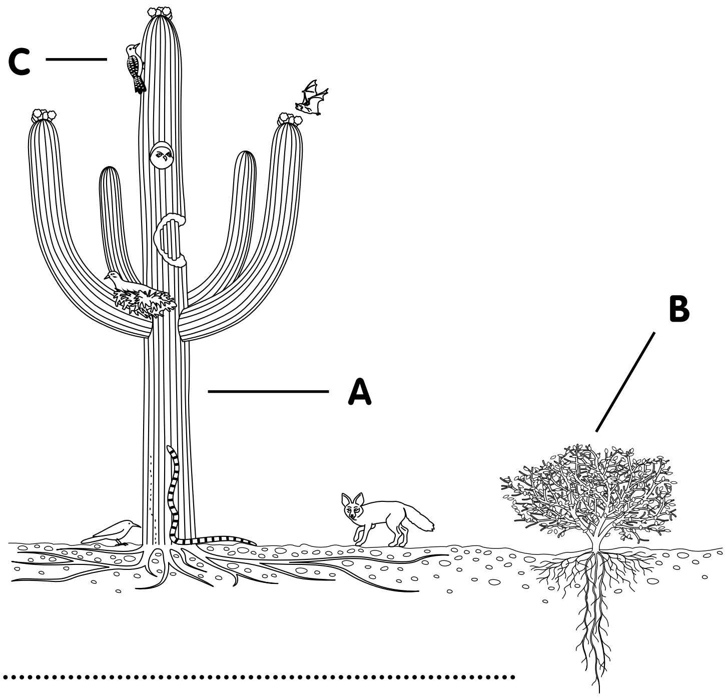
C I 12

Name:... Form:...................

See **pages 26 and 27** of *The Water Book*

How wildlife survives in a desert

Both plants and animals have adapted to live in a desert.



Q1. Name two problems that wildlife might have in a desert.

✎ ....

✎ ....

Q2. Explain how plant A manages to survive in a desert.

✎ ....

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Q3. Explain how plant B manages to survive in a desert.

✎ ....

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Q4. Why do you think birds (c) might be found near plant A.

✎ ....

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Q5. What is special about a camel that allows it to survive without water?

✎ ....

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Answers

1. **Combating lack of water, coping with high temperatures (and for animals) a lack of food.**

2. **By storing water in its stem. Having a widely-spread root network near the surface to catch any rain that does seep into the soil. Having no leaves to lose water.**

3. **By having small, leathery leaves that lose very little water. By having roots that go deep into the ground in search of water.**

4. **Birds may be attracted to the nectar or pollen. They may be attracted to the moisture in the fleshy stem. They may be attracted by the insects that suck the sap.**

5. **A camel can lose up to a quarter of its bodyweight in water before it suffers any ill effects. When they get the chance, camels can also drink vast amounts of water and store it in their body.**

Notes

This spread is concerned with the water consumption and retention of plants and animals. Its purpose is to provide pointers from the natural world as to the extreme adaptations that are needed in truly arid conditions.

Deserts are not lifeless, although the amount of life is much smaller than elsewhere. Most desert animals are nocturnal and can get the moisture they need from the plants or other animals they eat.

The cactus will be familiar to children and it is easy to get one from a garden centre. The spines are to protect the plant from too much damage from feeding animals.

The other type of plant is more widespread than the cactus. A common plant of this kind is called the creosote bush. It is wooden and leathery and its leaves have very few pores. In this way it conserves its moisture. It also remains dormant and does not grow during the long periods between rainstorms. The deep roots seek water from tens of metres below the surface. Such plants may have roots deeper than a house.

Camels are examples of animals that can make use of the hard, desert vegetation. Children should look at the thorn scrub the camel is eating. This would be inedible to most animals.

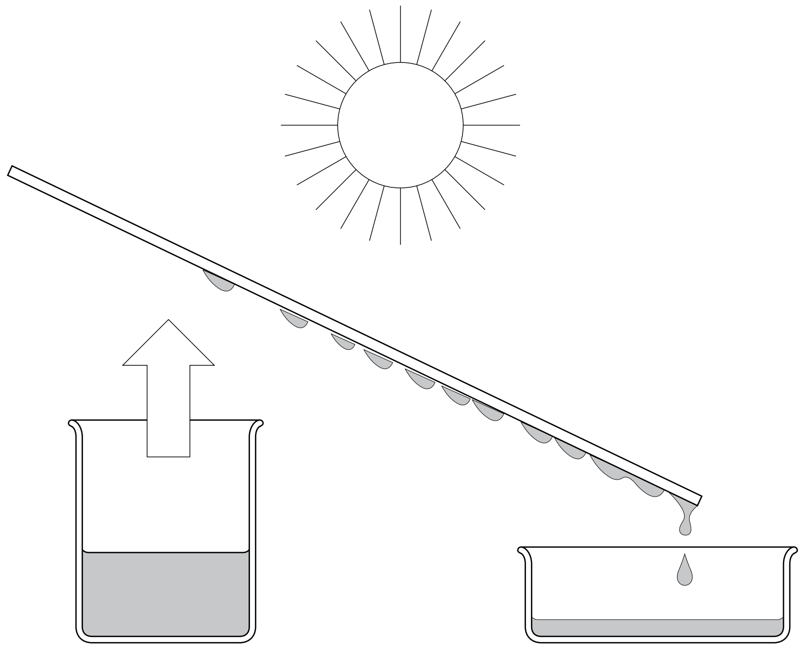
13

Name:... Form:...................

See **pages 28 and 29** of *The Water Book*

How people live in a desert

People must be inventive if they want to live in a desert.



Q1. Why is it useful to cover your skin in hot, dry areas?

✎ ....

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Q2. Where do people traditionally live if they want to farm in a desert?

✎ ....

Q3. On the diagram above, write the words evaporation and condensation in the correct places.

Q4. Explain how the heat of the Sun can be used to help re-use water that we would not normally drink.

✎ ....

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13

Answers, Notes, Background

See **pages 28 and 29** of *The Water Book*

Answers

1. **It reduces loss of body moisture and so reduces the need to drink water, making it possible to survive on limited amounts of water.**

2. **In an oasis.**

3. **Evaporation is on the left, condensation on the right.**

4. **This refers to re-use of urine in emergency situations. The heat from the Sun can be used to make the water in the urine evaporate. The evaporated water then has to be condensed and collected.**

Notes

This spread concentrates on desert living for traditional peoples because many of their adaptations have the same functions as the adaptations of plants and animals shown on the previous spread. However, more and more people are now living modern, normal lives in deserts. This is happening all over the Middle East and especially in southwest United States, where the population of such cities as Las Vegas, Nevada and Phoenix, Arizona are growing fast.

In these situations there are virtually no adaptations (concessions) to the environment. People have gone there for the Sun (in the case of the USA) and they expect a normal lifestyle with just as much water consumption as ever. As a result, power consumption on air conditioning is high and water consumption for swimming pools and even golf courses is enormous. This is all made possible by the use of aqueducts to transport water from distant rivers (mainly the Colorado).

In the oil-rich parts of the Middle East some drinking water is obtained by the use of desalination plants (burning oil to make seawater evaporate and then condensing it to recover the pure water).

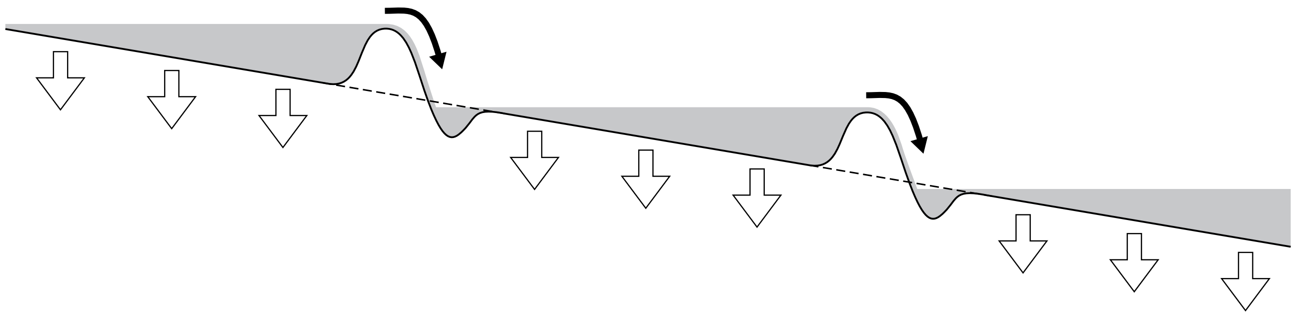
The thing both of these areas have in common is high energy consumption.

Name:.. Form:...................

See **pages 30 and 31** of *The Water Book*

Places with drought

People who live on the edge of deserts need to store all of the water they can.



Q1. Why does rain in the desert run over the soil instead of sinking in?

✎ ....

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Q2. The picture above shows one way of ponding up the rainwater for long enough for it to sink in. Explain how this works.

✎ ....

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Q3. Name three ways that people store water to carry themselves through the dry times.

1 ✎ ....

2 ✎ ....

3 ✎ ....

Q4. Explain how concrete jars are filled with water.

✎ ....

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14 Answers, Notes, Background

See **pages 30 and 31** of *The Water Book*

Answers

1. **Because it rains so hard the water never has a chance to sink in.**
2. **By digging out soil and making it into ridges so that water has time to soak in.**
3. **By building dams and storing water in small reservoirs; by keeping water in ponds beside their homes; and by keeping it in stone jars.**
4. **Concrete jars are placed next to a home and the water from the roofs is diverted along the gutters and then into the jars. Picture 4 on page 31 shows this.**

Notes

This is an extremely important topic. We hear so much in the news about drought-stricken areas, and so this spread is to try to explain something about one aspect of it: how to conserve water.

It is important to make clear to children that the main areas where water is a problem are not deserts, but the land around them. In a desert everyone knows there is no water, and no chance of any. But in the semi-arid areas around a desert, rain does fall and crops can be grown. However, the rainfall is both erratic and cyclic, usually with a cycle of something like ten years. There can be poor rainfall times and droughts. In any case, in every year there is a long dry season when people have to try to make use of every drop of water they can find. In the wet season torrential rain falls from thunderstorm clouds and the rain intensity is so high that much of the water runs off over the surface, causing flooding.

At the same time, these are some of the poorest areas of the world. They exist in a broad swathe across sub-Saharan Africa (the region called the Sahel), in north-western India and Pakistan, the Middle East, Mexico and elsewhere. Similar areas occur in developed countries, particularly the southwestern parts of America and much of western Australia.

The differences between developing and developed countries is that in developing countries the population is growing rapidly and yet the people are still predominantly farmers, while in developed countries the farming population is small and in times of distress governments have the money to support their farmers.

The result is that the drought-prone parts of the developing world are in crisis as more and more pressure is put on the water resources of a dry land. Today it is common for countries to rely on the food that can be produced in a good year in the knowledge that in drought years, people will go hungry and need food aid from the outside world.

The pictures on these pages tell of the simple ways some people have tried to be effective in storing water and getting it to soak into the ground. It should be stressed that these ways involve hard work, for these people do not have the money for mechanical assistance. It should further be stressed that by such hard work, people retain their self-respect while better managing their land.

C I **15**

Name:.. **Form:**....................

See **pages 32 and 33** of *The Water Book*

Saving water

In the future it will become more and more important to save water, especially in dry parts of the world.

Q1. Where is it most important to save water – in a hot, dry place like southern USA or a well-watered cool one like the UK?

✎ ....

Q2. In a hot, dry country who uses the most water? ✎ ....

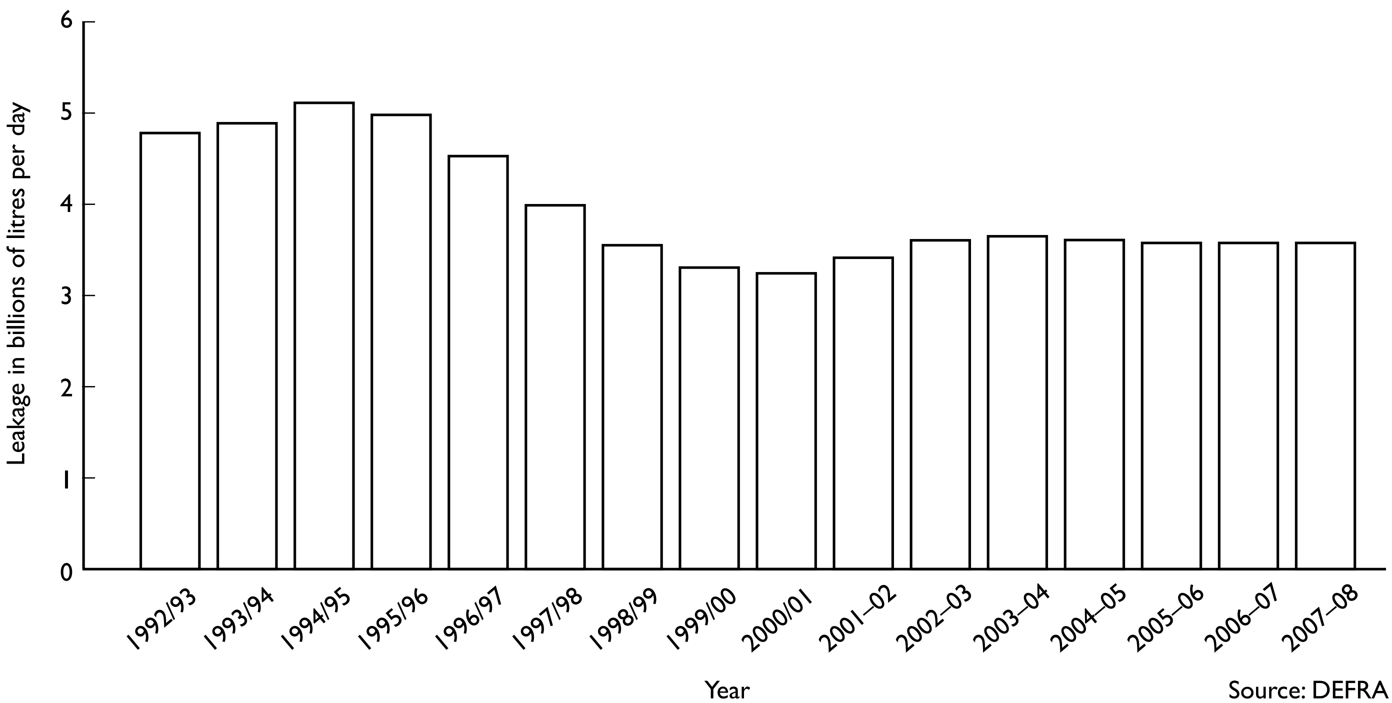
Q3. Which is the most wasteful way of watering farm crops? ✎ ....

Q4. Name two better ways of watering.

✎ .... ✎ ....

Q5. This chart shows how water companies are coping with leaky pipes. Since 2000 have they got much better, worse, or just a little better?

✎ ....



Q6. Why should we be worried about leaky pipes?

✎ ....

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See **pages 32 and 33** of *The Water Book*

Answers

1. **A dry country.**
2. **Farmers for irrigation.**
3. **To flood the fields.**
4. **Using sprinklers or drip feeders.**
5. **Since 2000 they have got no better, and even slightly worse, but they are better compared with the 1990s.**
6. **This is an open question allowing children to try to explain why we should be worried about leaks.**

   Answers can include the waste of energy in cleaning water for it only to leak away; the cost to consumers of having to clean up to a fifth of all water (would they think it reasonable to throw away a fifth of all the food they buy), etc.

Notes

Saving water is something that is frequently in the news. However, children need to be clear that there are many different situations around the world. The first questions address the idea that water is used mainly for irrigation in hot, dry countries. It is also important to know that water saving has a different priority in different countries. Saving water has a lower priority in the UK than it would have in a more arid region.

In the future it will be semi-arid or seasonally arid countries that have most to worry about. They are more likely to come into conflict with one another, as a result of trying to secure the limited water resources, than countries in better-watered areas. This will be a real concern in the years ahead.

In the UK we try to save water because we have relatively little of it stored in reservoirs and so we quickly run out during droughts. But what we can save is trivial in comparison to what the water companies allow to go to waste through leakage. Nevertheless, we all need to pull together on this issue, for example, by using more efficient loo flushing systems, using showers rather than baths, using only car washes that use recycled water, and so on. In the UK we are lucky. In some other parts of the world people are already having a very difficult time.

C I

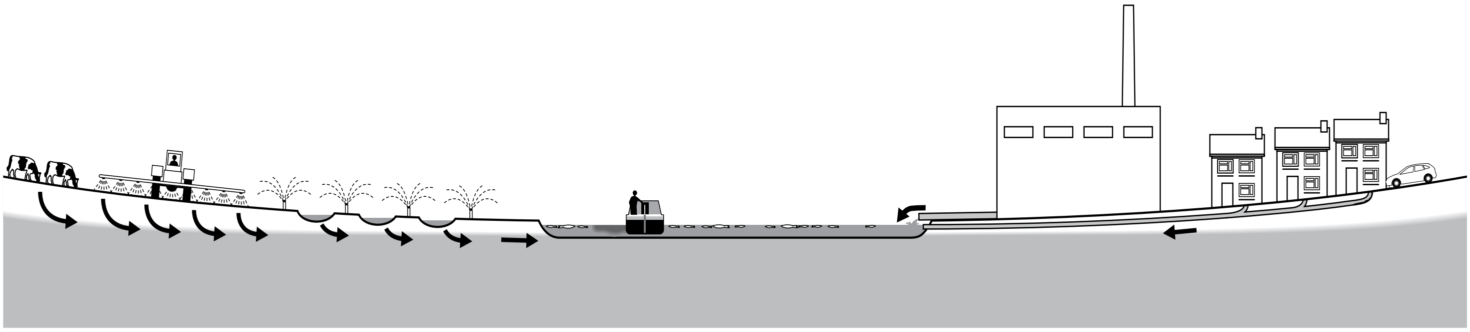
16

Name:.. Form:....................

See **pages 34 and 35** of *The Water Book*

Where pollution comes from

Water pollution may be created in homes, on farms or by factories.



Q1. This diagram shows three different sources of pollution. Write the name of each source in its proper place on the diagram.

Q2. Which kind of pollution is the most difficult to control?

✎ ....

Q3. Which kind of pollution is the easiest to control?

✎ ....

Q4. If you saw a river that was bright green, would you think that it was caused by (a) A St Patrick's Day festival; (b) chemical pollution; (c) algae feeding on human wastes and fertilisers?

✎ ....

Q5. Can you think up a slogan to try to persuade people not to throw their waste into rivers and lakes. You should mention the effect on wildlife as well as unsightliness.

✎ ....

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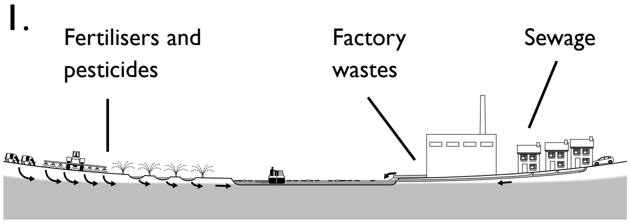
Answers

1.



2. **Farm wastes, because they are spread over the land and so seep into rivers over a wide area.**
3. **Sewage in developed countries, because each house comes with a sewer that is controlled with regulations.**
4. **(a) If the answer is also accompanied by the knowledge that this is what they do in Chicago; (b) is a possibility, but (c) is the most likely answer and given in the book.**
5. **This is an open-ended question to get children to compare ideas and agree on how to help prevent people adding to environmental pollution.**

Notes

Pollution is a problem that affects all communities. It is important to notice that there are three quite different kinds of pollution and that these require different measures. Human sewage will be the one that children can easily identify with.

Allowing raw sewage to go into rivers and lakes is like looking at a very large toilet. Children might be asked to consider how they would like this.

Chemical waste from factories is often much more hazardous and toxic because it contains heavy metals, corrosive liquids, sediment, etc. There are strict regulations concerning disposal of effluent from factories, and many factories have their own on-site treatment facilities. The problem comes when unscrupulous owners dump waste to save money.

Farm slurry (animal waste) is the easiest to deal with if it is created in pens. The scale of it, however, is daunting. Given that there are tens of millions of farm animals in the UK, the treatment works needed to deal with this problem are on the same scale. However, farms could not possibly afford to do this. Waste disposal is therefore often by containment and then spreading on the fields as a fertiliser. Waste that has partly decomposed and is spread on the fields is better than slurry that is undiluted and allowed to reach rivers.

Fertiliser waste is the most difficult of all to deal with because the fertiliser is spread uniformly over large areas.

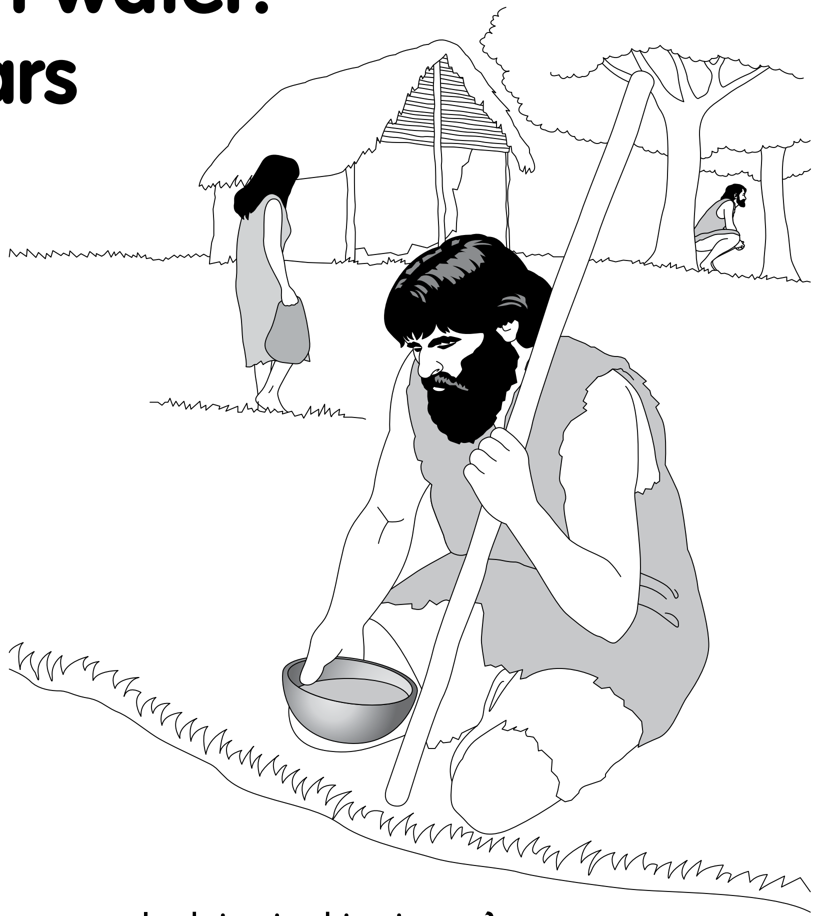
When children consider their slogan, they should consider whether to make the slogan authoritative (Do not ......) or coercive (Please don't kill me ......). They can then consider the psychology of the two approaches.

Name:... **Form:**...................

See **pages 36 and 37** of *The Water Book*

Getting clean water: the early years

Water was reasonably clean in ancient times – until people started to live in larger groups.



Q1. What are each of the three people doing in this picture?

1 ✎ ....

2 ✎ ....

3 ✎ ....

Q2. Why was it still reasonably safe to drink the water in ancient times?

✎ ....

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....

Q3. What is it in human (and animal) waste that makes it unhealthy?

✎ ....

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Answers

1. **Drinking from the stream, carrying water back to the home, going to the toilet.**

2. **Because there were relatively few people and they did not live in large groups. As a result, natural processes were able to clear up human wastes.**

3. **Human and animal wastes contain germs which, when taken in through untreated drinking water, can cause illness.**

Notes

This is the first of three spreads dealing with the history of water supply.

This spread begins in the times up to the development of large cities. It is important to notice that, in general, the landscape is not polluted because nature contains many mechanisms for breaking down potentially harmful waste materials into useful and harmless substances.

LINK: *You may wish to link to the different kinds of living things here with links to Science@School book 6B Microbes and book 4F Keeping healthy, among other topics. Many children do not know that life cycles involve decomposers (sometimes large animals such as carrion, more often microscopic ones) that break down waste into simple soluble substances that can be returned to the soil as nourishment for continued growth. For those living in rural areas, cesspits are a common, part-natural way of disposing of sewage. Compost heaps are a way of decomposing plant waste.*

The problem is that natural processes have a certain rate of action. This rate of action can cope with low population densities, but not with large numbers of people.

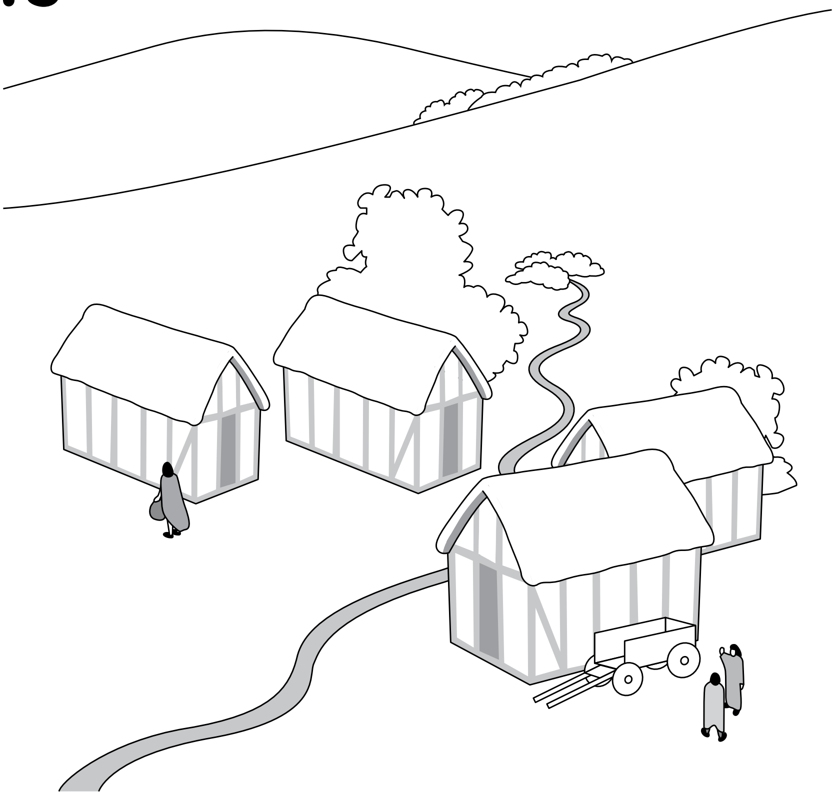
It is still the case that, in rural areas, natural decomposition works well. As a rule of thumb, when people are backpacking in wilderness areas and camp well away from any toilet facilities, the wilderness rules ask them to make sure they dig a pit and go to the toilet at least a quarter of a mile from a surface water course. The problem is that trudging backwards and forwards a quarter of a mile to go to the toilet or to fetch water is inconvenient, and hence there is the temptation not to do it.

Name:... Form:....................

See **pages 36 and 37** of *The Water Book*

Getting clean water: the early years

Water was reasonably clean in ancient times – until people started to live in larger groups.



Q1. The diagram shows a small settlement in the landscape. What do you think has made them choose this spot?

✎ ....

Q2. Why would spring water be safe to drink?

✎ ....

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Q3. If you lived in this village, would you think it mattered whether you got your water from the spring or from the stream that flowed between the houses?

✎ ....

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Answers, Notes, Background

See **pages 36 and 37** of *The Water Book*

Answers

1. **It is close to a stream/ spring.**

2. **Because it comes from the ground and the ground is a natural filter. Until the water reaches the surface it cannot become contaminated.**

3. **As soon as the water flows past habitation, the chances are that waste can get into the stream. So it is safest to get it from the spring.**

   (In general, however, springs are very small supplies of water and may not be big enough for village needs. In this case a well would be better.)

Notes

Springs have been major factors in influencing the location of settlements.

The spring is to be regarded as pure water because any pollution will have been filtered out by a long passage underground.

One very clear example is the two lines of villages either side of the chalk escarpment south of Lincoln. They are clear enough to be seen on a road map if an ordnance survey map is not available.

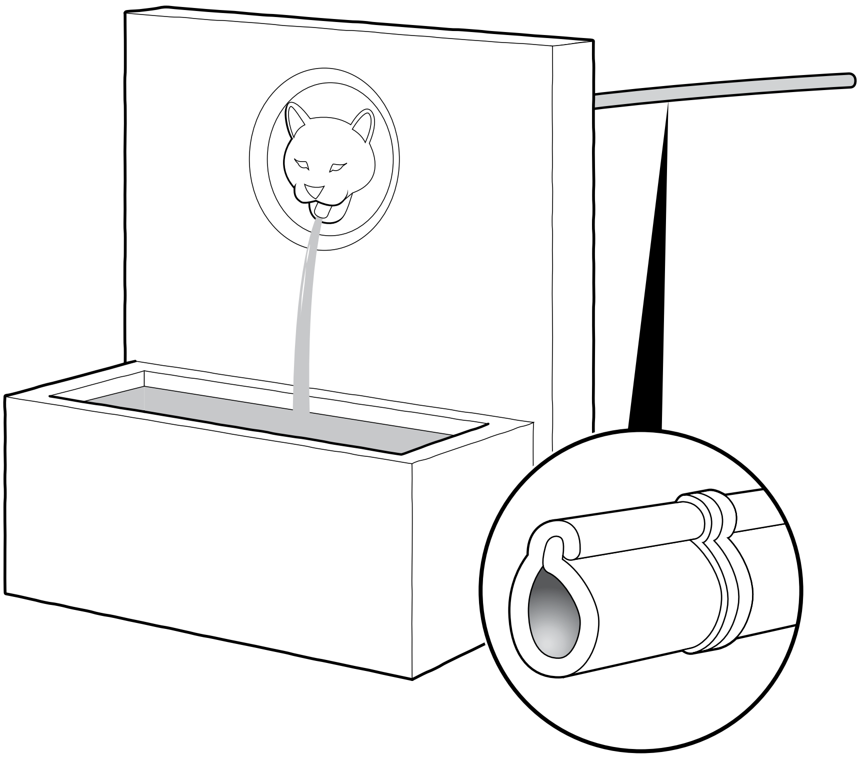
***LINK:** This can be linked to invaders and settlers in History.*

Name:... **Form:**....................

See **pages 36 and 37** of *The Water Book*

Getting clean water: the early years

The Romans were very good at providing clean water, and could even flush away wastes.



Q1. The Romans brought water by pipe to their cities. Why did they do this rather than just use stream water?

✎ ....

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Q2. Why is there a tank below the pipe in the diagram above?

✎ ....

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Q3. The Romans used lead sheet to make pipes. They folded the sheet over a rod and then overlapped the ends to make it reasonably watertight. Try making Roman pipes using a sheet of aluminium foil. You will need three of four layers of foil to make the foil strong enough. Wrap it over a rod and then tuck in the edges. You may have to wrap the edges over a number of times to make the pipe waterproof. Then pour some water into your pipe to test it out.

Answers

1. **Because they understood that stream water can cause illness (although they had no idea it was caused by germs).**

2. **To provide a convenient place for people to collect a bucketful of water, rather than having to wait while water flowed from the pipe.**

3. **By doing this practical, children will notice that a pipe can be made from a sheet. The main problems are how to connect the ends and how to make a lapped joint that is waterproof.**

Notes

The Romans were very advanced at water supply in part because they were a practical people and in part because they had an organised society in which taxes could be raised for public works.

LINK: *This could be linked to the Romans in History.*

Without a settled and unified society, the complicated piping system needed for good clean water to be brought from the nearby unpolluted streams could not have been developed.

When the Roman empire collapsed, so did the water supply system. Nothing comparable was developed in the UK for 1,500 years.

Notice that the Romans used lead for their pipes, as did the UK until the middle of the 20th century. Before this time it was not known that lead can have harmful effects on the brain.

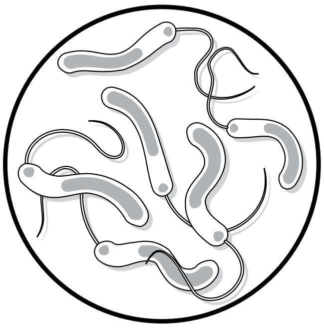
Name:.. Form:...................

See **pages 38 and 39** of *The Water Book*

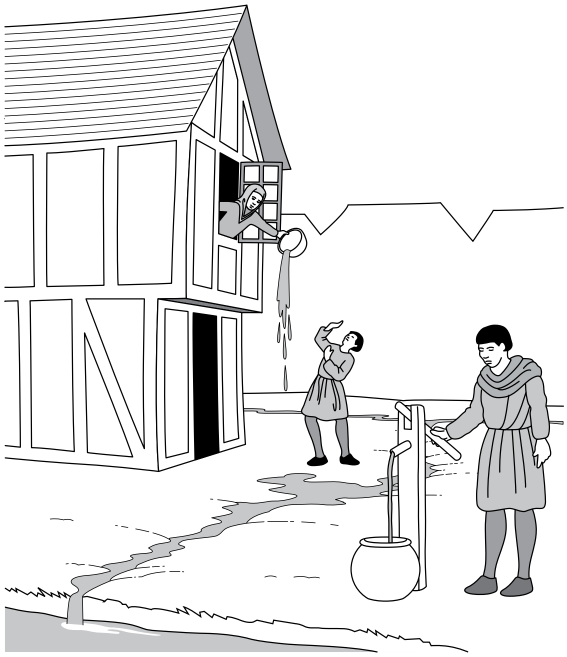
Getting clean water: the years of disease

Allowing sewage to get into drinking water supplies is a guarantee of illness and short life.

A



B



Q1. What is shown in diagram A?

✎ ....

Q2. Explain what is happening that can cause water-borne disease in diagram B?

✎ ....

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Q3. Why were 'night-soil men' no help in preventing disease?

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Q4. What did the government finally do to make sure drinking water was clean?

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18 Answers, Notes, Background

See **pages 38 and 39** of *The Water Book*

Answers

1. **Cholera (bacteria) germs.**

2. **Human waste is being tipped out onto the street. It can then flow to rivers and get into the groundwater next to the river. People using water from shallow wells near to rivers can get water-born diseases by drinking the water.**

3. **Because they only carried human waste from houses to large pits. These large pits then leaked or spilled into the river and contaminated the groundwater supplies.**

4. **It organised the distribution of water to be quite separate from sewage, piping water to homes and collecting the sewage for separate treatment.**

Notes

Children may need some more detailed help with the idea of microbes (microbes that cause human illness are called germs). In particular, it needs to be stressed that the microbes are tiny, often less than a millionth of a metre long and invisible except with a high-powered microscope.

LINK: *Science. Curriculum Visions Science@School '6B Microbes' deals with this topic thoroughly. On the pages in the student book the word shallow is underlined. This is because water from wells is easily contaminated if it is drawn from water that is close to the surface. This is most likely to occur when people live on a floodplain (as they do in most cities). In this situation the water table is close to the surface.*

There is a constant interchange between water in the soil and water in the river. If germs get into one, they readily get into the other.

Children should understand that microbes cannot be filtered out with a fine mesh sieve. Nor do they settle out like sediment. They can only be removed with disinfectant.

LINK: *History. Water supply is also part of the QCA Tudors topic and so can be crosslinked to that, or you can bring in this topic (especially including human waste disposal, when you are doing Tudors (and using Curriculum Visions 'Rich and Poor in Tudor Times', pages 14–15 and 38–39).*

Further, you can crooslink it to our book 'How life changed in Victorian times' pages 16–17: Why did children become healthier? when you are doing Victorian studies.

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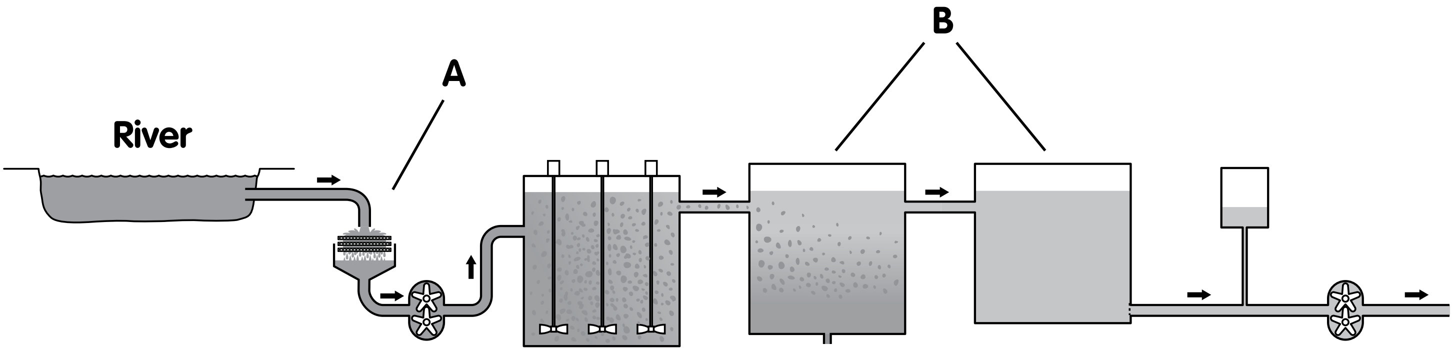
Name:.. Form:...................

See **pages 40 and 41** of *The Water Book*

Making water fit to drink

Today water is treated in many ways to make it clean and attractive to drink.



Q1. On the diagram, label the place where the disinfectant is added.

Q2. What is the purpose of A?

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Q3. What happens at B?

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Q4. What do water companies have to do besides get rid of germs?

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Answers

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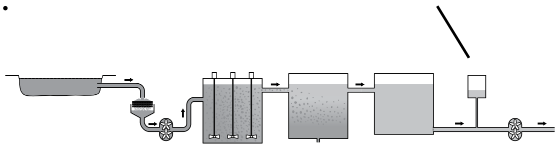


2. **To filter out large pieces of debris from the water.**

3. **The tanks at B are designed to make the water clear and odour free. They are settling and filtering tanks.**

4. **They have to remove colour and smell. A lot of effort therefore goes into making it <u>look</u> clean as well as being clean.**

Notes

Water treatment is an essential and useful job that is normally kept out of sight and out of mind.

Water treatment and sewage treatment (next spread) are essentially similar processes in so far as they have to remove suspended debris and take out any harmful, dissolved substances as well as disinfect for germs.

Because water treatment sends water directly into pipes, much more effort goes into ensuring that the water is absolutely safe. Disinfecting, is therefore a priority. Because people like to see their water clean and they do not like odours, treatment to deal with these problems is also required.

It may be worth noting that many people who draw their water from natural groundwater sources, especially those in mountain areas, often have water that is coloured or has a sulphurous smell. While not at all harmful, these features of water may be distressing to people used to entirely clarified water.

It is also worth commenting that all water coming through pipes is drinking water quality – even the water we don't use for drinking, such as that used to wash cars and water gardens.

Name:... Form:...................

See **pages 42 and 43** of *The Water Book*

Cleaning the water we have used

In order to keep our environment healthy, we need to clean up any wastes we make.

Q1. Write these words on the correct places on the diagram:

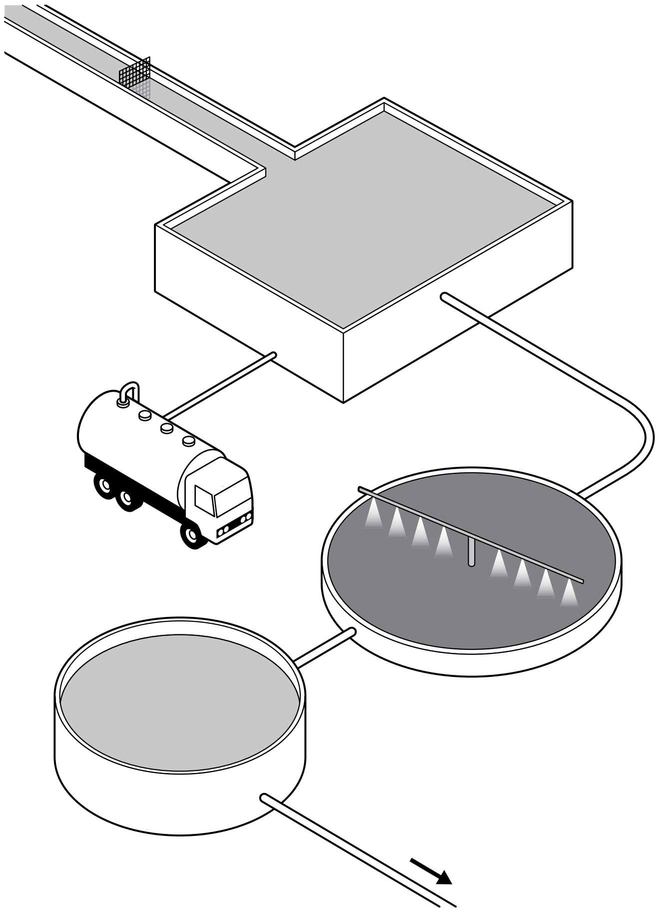
(a) Filter bed

(b) Disinfected water returns to river

(c) Lorry takes sludge to landfill

(d) Screens to trap large pieces of waste

(e) Sedimentation tank



Q2. What is sewage?

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Q3. Why is sewage harmful?

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Q4. Sludge is often spread over fields. Is this a safe thing to do?

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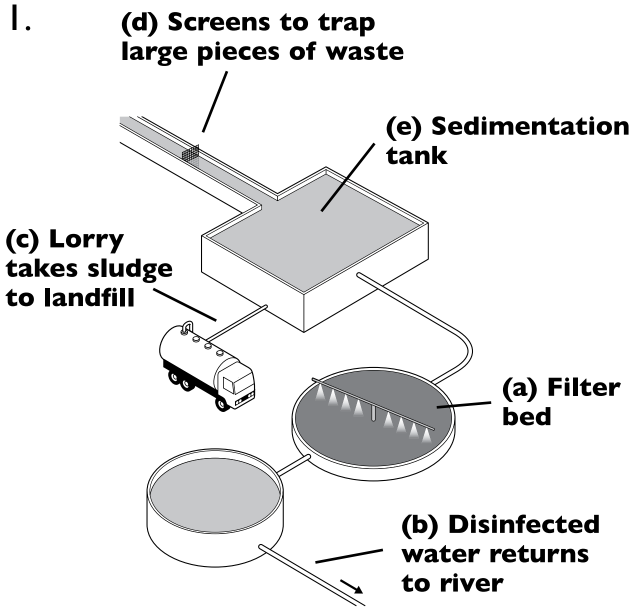
Answers

1.



2. **Sewage is water that is flushed from our toilets and sinks and which contains solids, chemicals and germs.**

3. **Because it contains germs that could make us ill.**

4. **Once sludge has been treated it is not a danger to health. Sludge is in fact a fertiliser and so it is not only safe, it is a good way of recycling nourishment back into the fields. It can smell pretty awful, however.**

Notes

This worksheet considers waste from homes. We have not considered materials such as heavy metals, that might be pollutants from factories, because these will not be familiar to children.

***LINK:** Curriculum Visions book, 'The Coast Book' which deals with the problem of sewage disposal at sea.*

Sewage contains a high proportion of excrement. Such material contains bacteria from our guts which, if digested, can cause severe illness. Children might ask why they are harmless while inside us, but dangerous when we eat them. They need to be told about germs, and this might form a link with science unit 6B Microbes and you may care to refer to the Curriculum Visions Science@School book '6B Microbes'.

In brief, the answer is that bacteria develop in specific parts of the gut and are helpful as part of digestion. They are not, however, present in the upper digestive tract, and large concentrations of bacteria from the lower gut can cause severe reactions when introduced to places where the natural bacteria cannot easily cope.

Children should realise that sewage is not just a local problem, because untreated sewage dumped in a river can travel far. The same applies to sewage dumped into the sea. It is far more difficult to cope with dispersed pollution than concentrated pollution, so collecting all of our waste and then sterilising it is the cheapest and healthiest thing we can do.

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Name:... Form:....................

See **pages 44 and 45** of *The Water Book*

Coping with pollution in poor countries

Many people are not fortunate enough to have mains sewers, so what are they to do?

Q1. Why is it so important to deal with human sewage properly?

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Q2. Why must we keep drinking water and sewage separate?

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Q3. Look at the diagram below. What are the advantages of pit latrines used on hills rather than by rivers?

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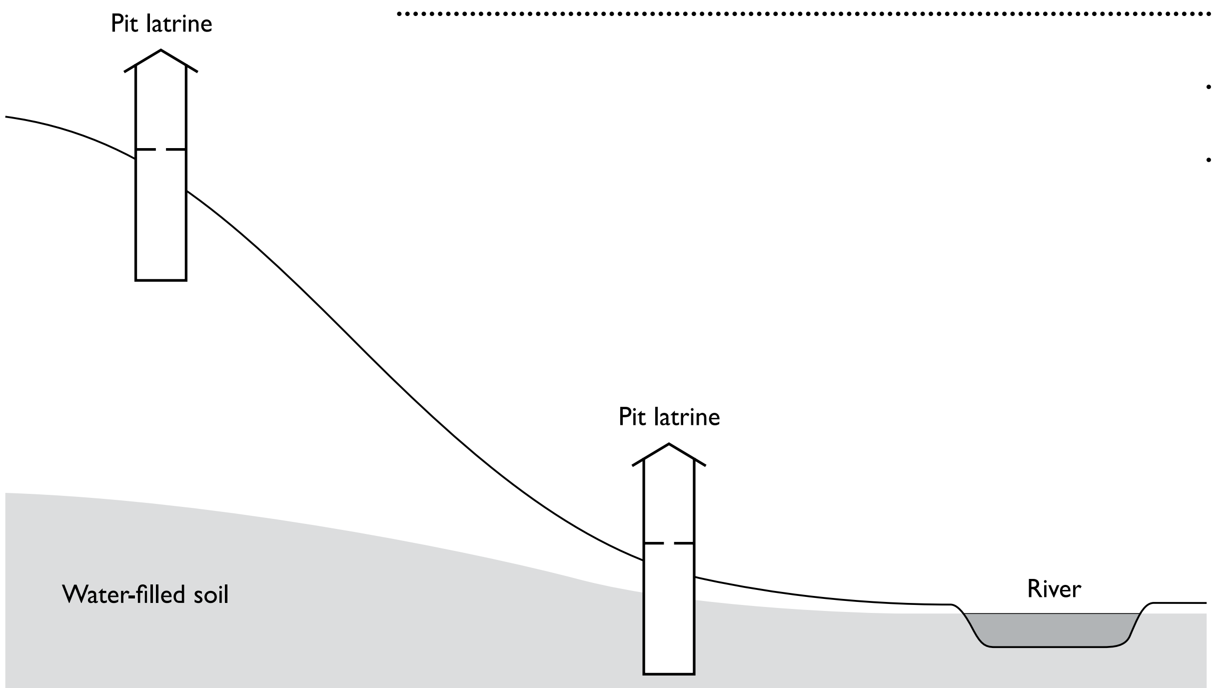


Answers

1. **Because it contains germs that can make us ill.**

2. **Because many of the germs in sewage can be carried by the water and so be drunk by people, making them ill.**

3. **Pit latrines are deep pits dug in dry ground at least 250m from a water supply like a river. After a while, the waste in the used hole will have been broken down by nature and will be a clean, germ-free and valuable fertiliser. This is a cheap version of what a sewage works does. So the advantages are that it keeps germs from water supplies and provides useful fertiliser.**

   However, if the pit latrine is dug down close to the water table then the sewage will get into the water and contaminate the river.

Notes

In this topic we deal with a sensitive issue that needs to be addressed with compassion and understanding. It is a hard fact that in poorer countries there may not be enough money for the type of sanitation that we are used to here. As a result, people are often left to their own devices.

In the past in the UK, people would go out of the house to do their toilet in a pit enclosed by a hut. There was no mains sanitation. In places around the world where sanitation is still not available, this is the best that can be done. However, there are good and bad places for individual disposal of sewage. It is important (see the page on cholera) not to allow sewage to get into water that might be used for drinking.

In general, people in slum or country areas tip their waste water into the gutters that run down the middle of most alleyways. This water, which contains the remains from washing up, is not as harmful as faeces. Faeces need to be kept from all possible contact with water, food, hands and so on.

The pictures thus give an opportunity for considering how the difficult circumstances that many people face can be dealt with in as economical way as possible.

In picture 3, attention can be drawn to the toilet hut in the foreground, and the obvious trail of faeces (yellow) into the lake. This is the worst possible situation, for it is almost certain that the lake will be used as a source of drinking water. This should be contrasted with the simple pits and huts built on high ground (look into the distance to see the houses on lower ground). These are well above the water table and so completely isolated from any drinking water supplies.

Name:... Form:...................

See **pages 6 to 13** of *The Water Book*

Water crossword 1

① (down) Water we can drink (2 words) (page 6)

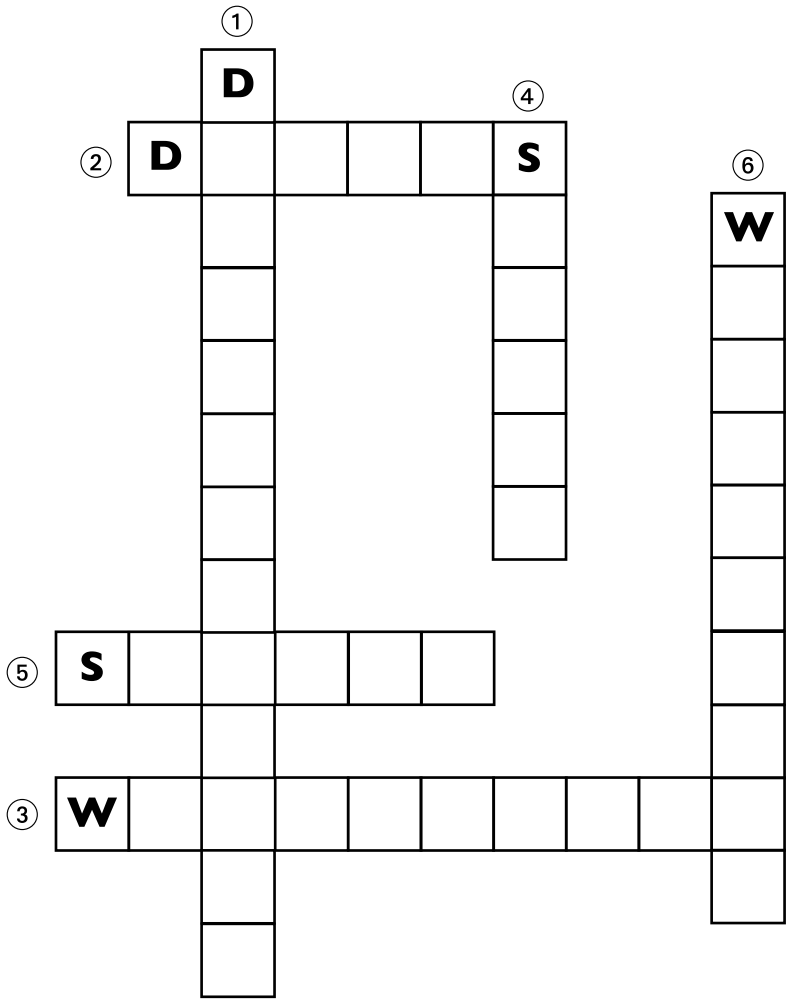
② (across) Pipes that carry used water away (page 7)

③ (across) Water moving between sea, air, land and sea (2 words) (page 8)

④ (down) Water running quickly out of rocks (page 9)

⑤ (across) Human waste in pipes (page 10)

⑥ (down) A place where water is stored (2 words) (page 13)



Crossword answers

See **pages 6 to 13** of *The Water Book*

Answers to crossword 1

Name:.. **Form:**...................

See **pages 14 to 23** of *The Water Book*

Water crossword 2

① (down) Electricity made using water (page 14)

② (across) Water for fields (page 15)

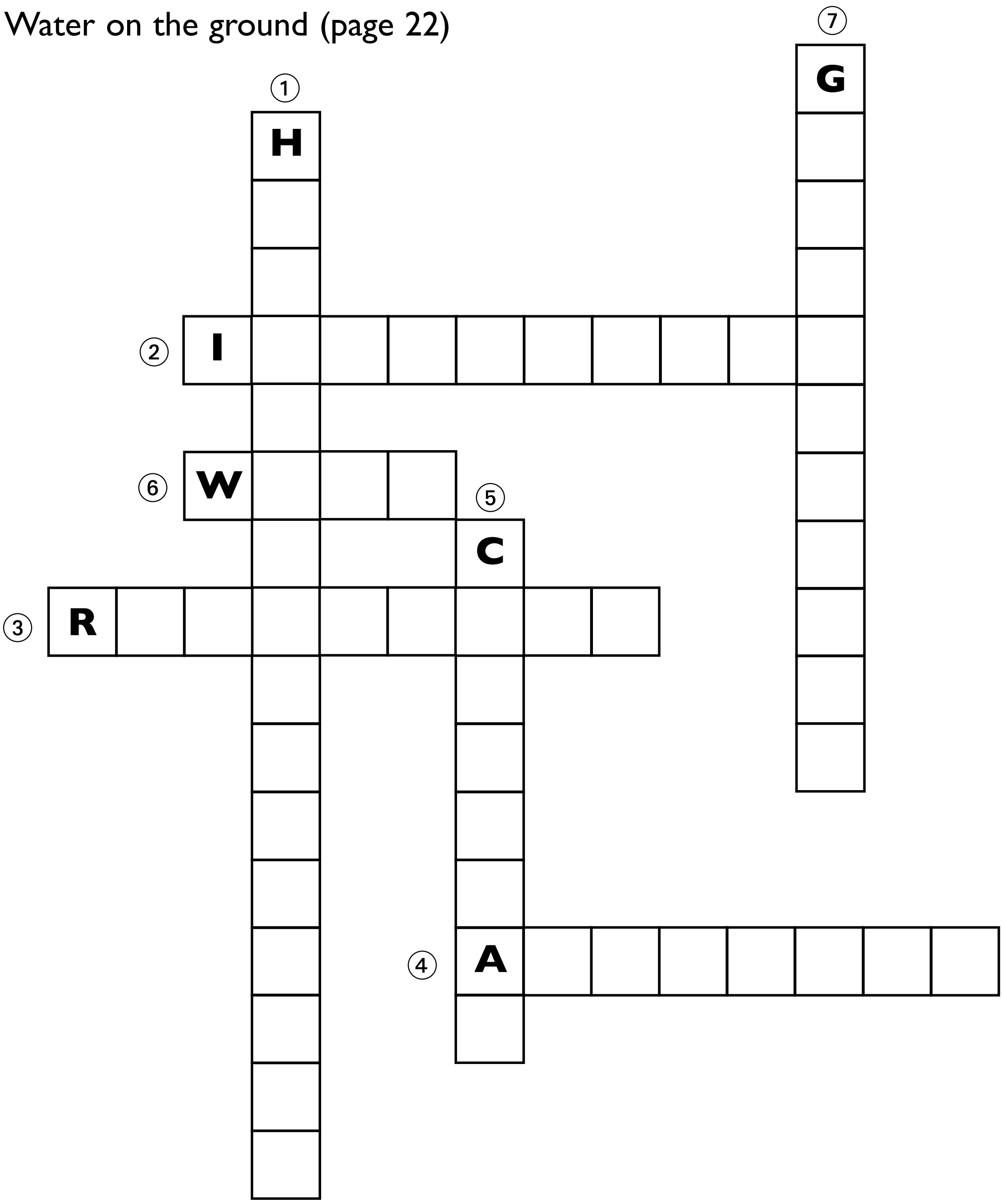
③ (across) An artificial lake (page 16)

④ (across) Canal for drinking water (page 18)

⑤ (down) A tap used by many people (page 20)

⑥ (across) A deep watery shaft (page 22)

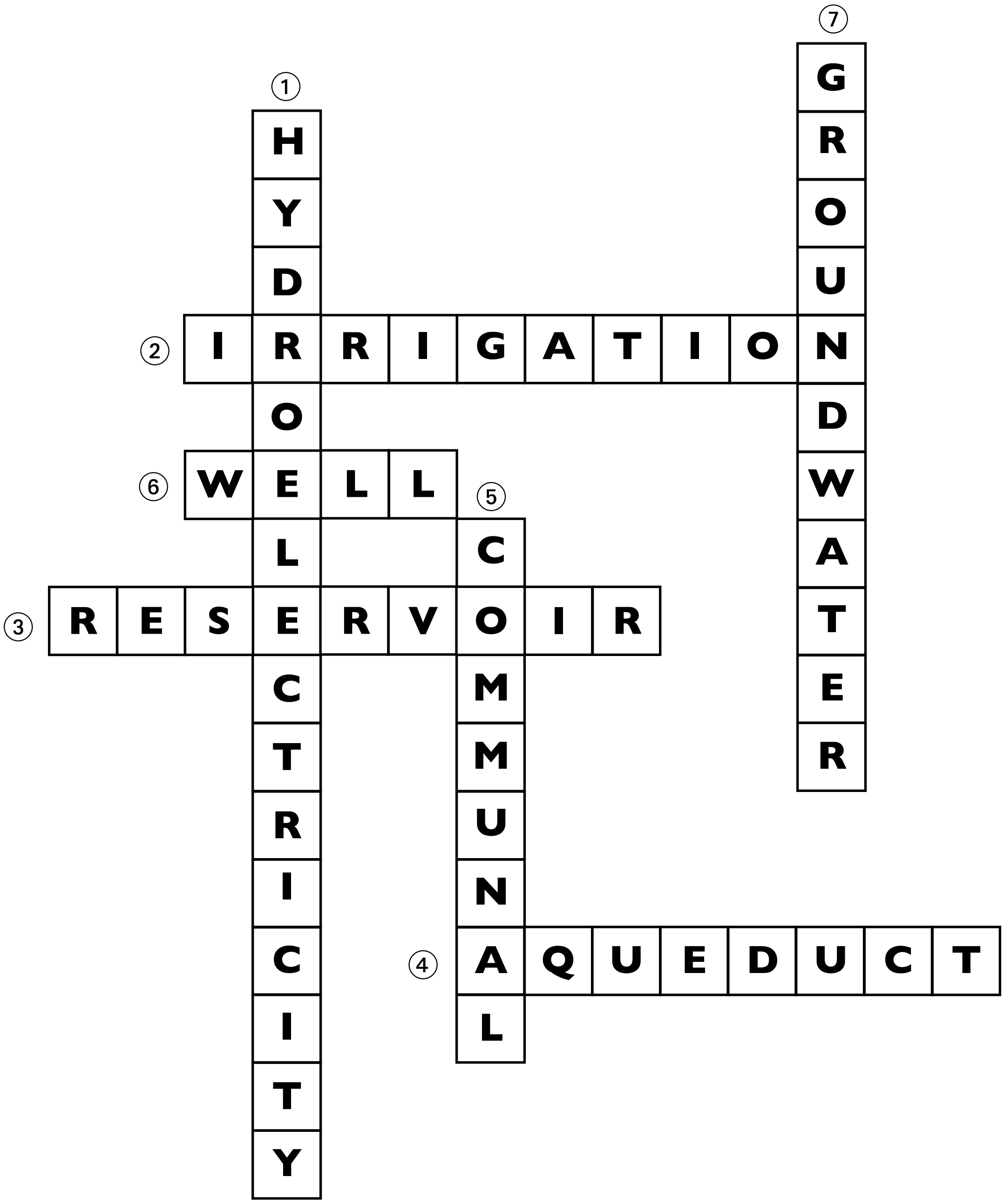
⑦ (down) Water on the ground (page 22)



Crossword answers

See **pages 14 to 23** of *The Water Book*

Answers to crossword 2



Name:.. Form:..................

See **pages 24 to 33** of *The Water Book*

Water crossword 3

① (across) A time of water shortage (page 24)

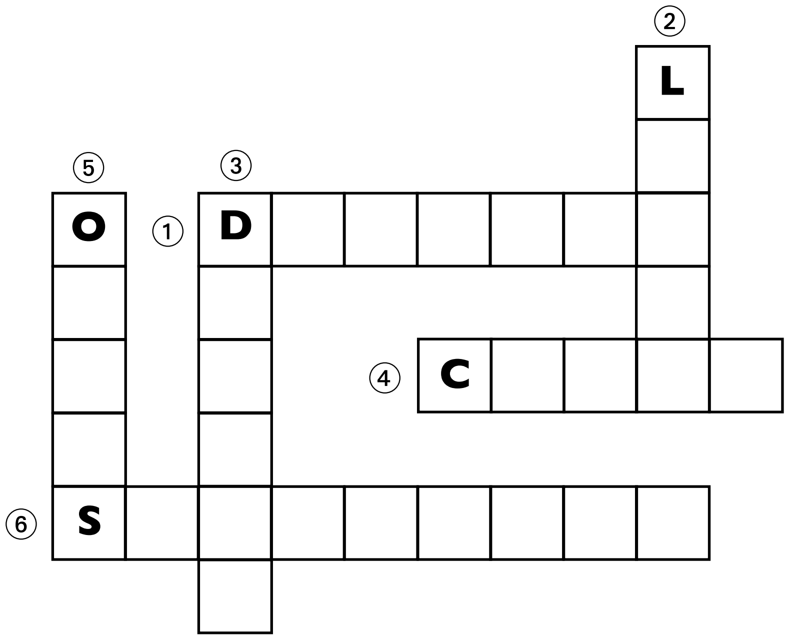
② (down) A unit for measuring water (page 25)

③ (down) A place with very little rain (page 26)

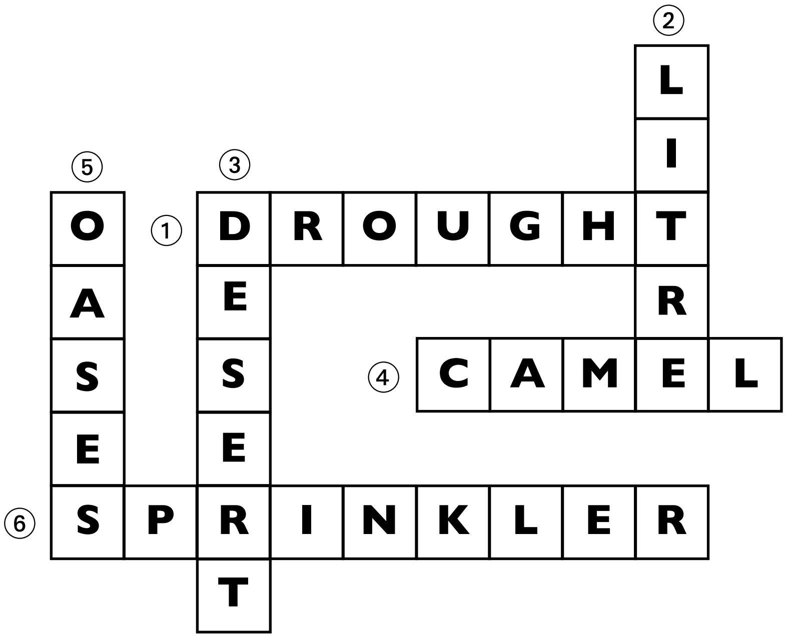
④ (across) An animal that can store water (page 27)

⑤ (down) Watering places in a desert (page 28)

⑥ (across) A device for spraying water (page 32)



Answers to crossword 3



Name:... **Form:**...................

See **pages 34 to 45** of *The Water Book*

Water crossword 4

① (down) Unclean water (page 34)

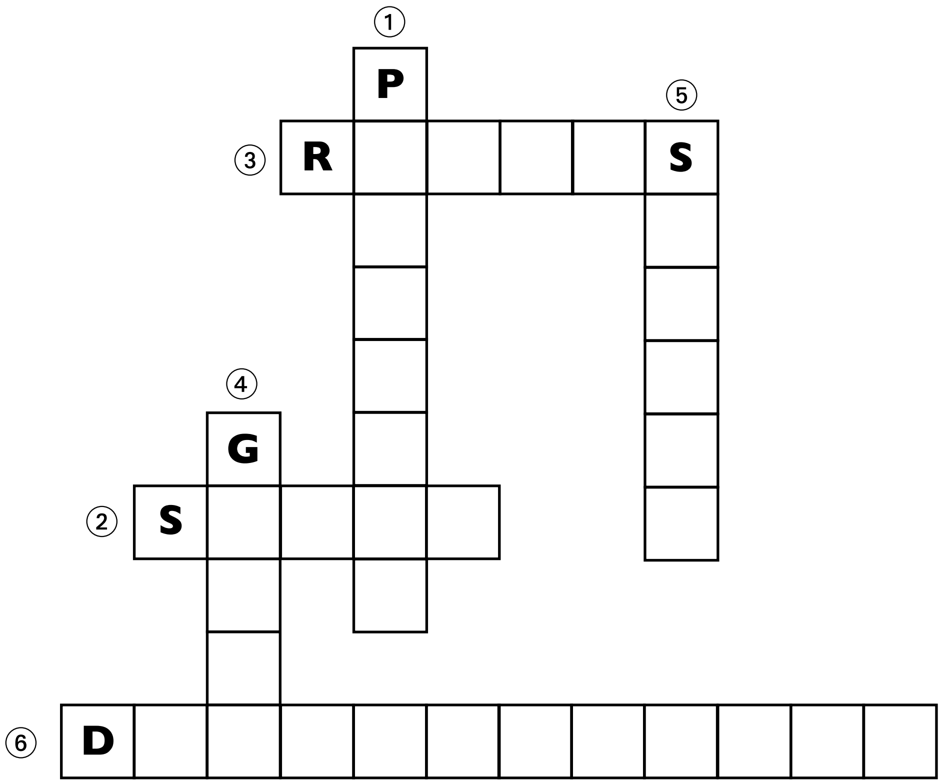
② (across) A main pipe for carrying waste water (page 34)

③ (across) The first people to use lead pipes (page 37)

④ (down) Tiny bugs that cause harm (page 39)

⑤ (down) Solid waste from a sewage works (page 41)

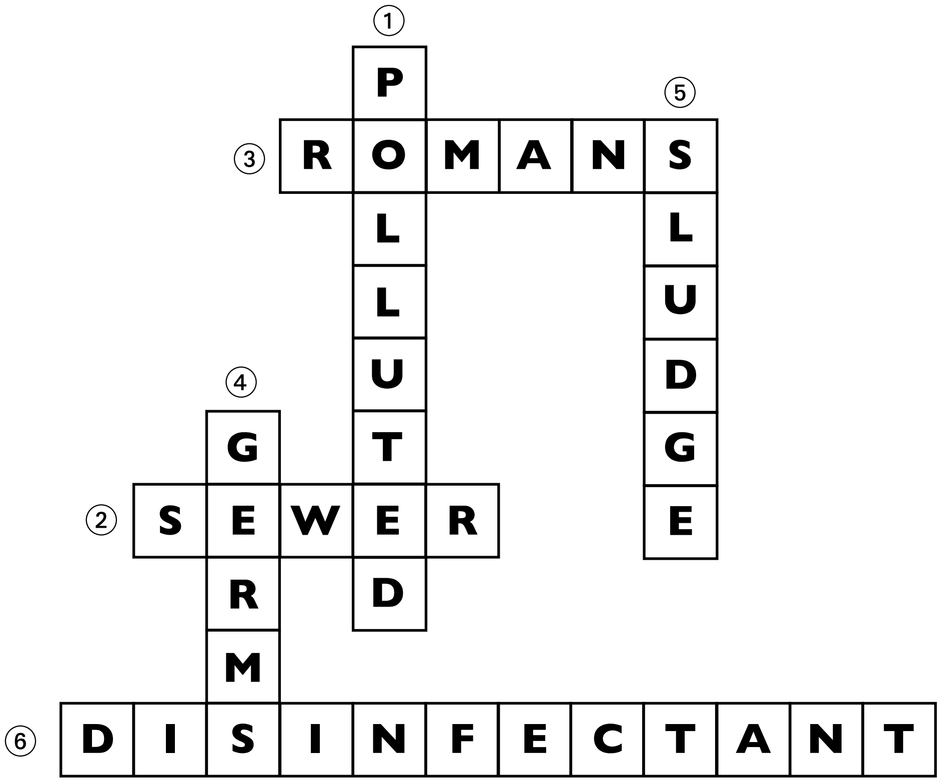
⑥ (across) A liquid used to kill germs (page 41)



Crossword answers

See **pages 34 to 45** of *The Water Book*

Answers to crossword 4



Section 5: Visit a drinking water treatment works

Notes for teachers

The following sheets can be used in class or prior to, during and after a visit to a drinking water treatment works. It can also be used with material on-line.

Every water treatment works is slightly different, and so the main thrust of this fieldwork sheet is to get children to go armed with information and some knowledge.

Once at the drinking water treatment works they can ask questions like :

Are we at stage 1 on my diagram?

On my sheet it says "....." Is that what happens here?

They can then write down what happens and also change the diagram to match the one they are visiting, or draw a new diagram.

In either event they will have notes to take with them, and a structured basis for their visit.

Many water companies also give out information, so the information they give for their specific sites can be compared with the information given here.

Children can also compare presentations: do they like the presentation here (which is rather formal) or would they prefer a presentation that is more relaxed?

Differences between works

The water treatment works shown in *The Water Book* and this *Teacher's Resources* represents works commonly found in uurban areas.

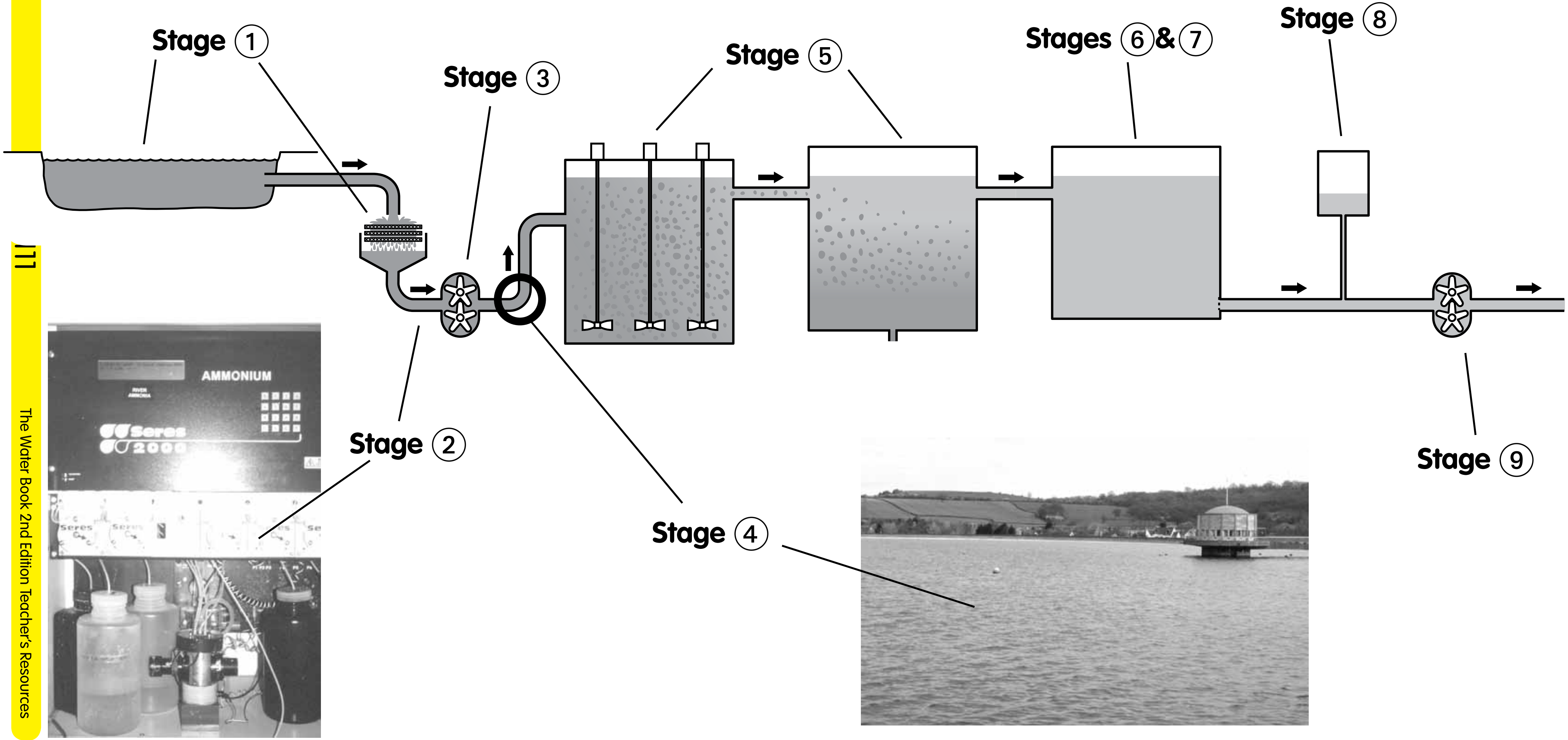
However treatment works vary depending on many factors including the history of the site, their size and the nature of the water being treated. Moreover, water treatment works are constantly being updated and modernised to give us a more reliable source of safe drinking water with a good taste and smell. Although we cannot cover all of the technological differences between works we have listed a few important variations below:

Stage 5 in the diagram opposite: Alum has traditionally been used to clump particles for removal but modern works have started to use ferric sulphate and small amounts of ozone (a form of oxygen). Froth flotation is often used to remove these clumped particles. By pumping air and the chemical additives through the mixture, the clumped particles rise to the surface forming a frothy scum that can be floated off.

Between **Stages 6 and 7** in the diagram opposite: After filtering water can be treated with ozone to help break down synthetic organic substances such as pesticide residues. Treatment with ozone also means less chlorine need be used. This reduces the taste of chlorine which is distinctive and rather unpleasant.

Name: .... Form: ....

Drinking water treatment works



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Visit a drinking water treatment works

You can use these sheets before, during and after you have made a visit to a drinking water treatment works. Alternatively, you can visit a water purification works online at

www.curriculumvisions.com under Geography/Water/4. Making water more usable/4. Water treatment

Here are some steps to show you how DRINKING water is treated. The numbers refer to the diagram. Make sure you read everything before you visit a drinking water treatment works and then find out how the works you visit is similar to, or different from, the one shown here.

Under each step there is a space for you to write in what actually happens at the works you have visited. Alternatively, if you are visiting an on-line works, write down information from this.

Remember that the water taken in by a treatment works is fairly clean already, and contains little grit or wastes (compare this to a sewage works). Here the idea is to make the water sparklingly clean and pure.

The works

Stage (1) Getting the water

The water may come from underground rocks or from a river. If it comes from a river, you can often see the water flowing in to the works. River water can contain floating debris such as logs, dead animals and plastic bags. These are trapped on screens as the water enters the works.

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Stage ② Monitoring

It is important to know about any impurities in the water. The water coming in to the works is continuously monitored and analysed using electronic equipment.

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Stage ③ Pumping

Water will need to be pumped from a river or from the ground. Large pumps are needed for this.

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Stage ④ Reservoir

Water is often stored in a small reservoir before being taken for purification. This means that there is always enough water available in case of extra demand (such as in a summer drought). Water coming from the ground will not be stored this way, however, because the rocks are natural reservoirs.

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Treating the water

Stage (5) Separating and grabbing the impurities

By adding chemicals to the water, and with some stirring, the clay, silt and most organic matter in the water will clump together. The clumps settle out and form a sludge that is collected.

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Stage (6) Filtering the water

The water still contains germs and some solid material. This is removed by passing it through a filter made of layers of sand. This traps the remaining solids and most germs.

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Stage ⑦ Carbon filter

New works also have carbon filters (large versions of the water filters you may use in your water purifier at home). These remove the last traces of unwanted chemicals. The filters are made of granules of a special carbon called activated charcoal.

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Stage ⑧ Disinfecting

Before it goes to homes the water is disinfected by adding very small amounts of the disinfectant called chlorine. Because the water is already clean, only tiny amounts of chlorine are added and so it is tasteless.

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Stage ⑨ Pumping to homes

Finally the clean water is pumped to homes, schools, etc. From now on it will be kept in pipes and away from the air so that new germs do not contaminate it.

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Section 6: Visit a sewage works

Notes for teachers

The following sheets can be used in class or prior to, during and after a visit to a sewage works. It can also be used with material on-line.

Every sewage works is slightly different and so the main thrust of this fieldwork sheet is to get children to go armed with information and some knowledge.

Once at the sewage works they can ask questions like:

Are we at stage 1 on my diagram?

On my sheet it says "....." Is that what happens here?

They can then write down what happens and also change the diagram to match the one they are visiting or draw a new diagram.

In either event they will have notes to take with them and a structured basis for their visit.

Many water companies also give out information, so the information they give can be compared with the information given here.

Children can also compare presentations: do they like the presentation here (which is rather formal) or would they prefer a presentation that is more relaxed?

(The information presented here is based on material from Thames Water and the USGS.)

Differences between works

As with the water treatment works, the sewage treatment works shown in *The Water Book* and this *Teacher's Resources* represents works commonly found in uurban areas.

Once again, although we cannot cover all of the technological differences between works we have listed a few important variations below:

Stage 4 in the diagram:
(i) Aeration tanks. The microbes break down the organic materials in solution and precipitate a sludge. Because it is biologically active with microbes this sludge is called 'activated sludge'.

During aeration the microbial action is so effective in the plentiful oxygen supply that comes in the bubbles of air, that it takes them just eight hours to convert the impurities into less harmful products.

(ii) Clinker or gravel beds. Instead of aeration tanks, another method of treatment is to spray the effluent onto a bed of clinker or gravel in circular tanks. A layer of microbes forms on the gravel bed and feeds on the effluent. In this case the microbes get their oxygen as the water is jetted on to the surface and from the holes on the gravel.

Stage 5 in the diagram: You may see a final stage of sedimentation. Some of the activated sludge is returned to the aeration tanks so that microbes can carry on with the valuable work of breaking down more nasties in the effluent.

Stage 7 in the diagram: The microbes in the digesters thrive in an environment which is warm (35°C) and without oxygen. Amongst the other by-products of their work, methane gas is released that can be captured and used to power the plant. Digesting sludge takes approximately 21 days.

Disposal at sea of the waste products from the sludge digestion is no longer allowed.

Stage 8 in the diagram: A sewage works may not need to use disinfectant if the microbes have done all the necessary work.

Visit a sewage works

You can use these sheets before, during and after you have made a visit to a sewage works. Alternatively, you can visit a sewage works online at

www.curriculumvisions.com under River/Rivers of the world/ Water supply/Sewage works

Here are some steps to show you how WASTE water is treated in a sewage, or waste water treatment works. The numbers refer to the diagram. Make sure you read everything before you visit a sewage works and then find out how the sewage works you visit is similar to, or different from, the one shown here.

Under each step there is a space for you to write in what actually happens at the sewage works you have visited. Alternatively, if you are visiting an on-line sewage works, write down information from this.

The works

Preliminary treatment

Stage (1) Screening

Waste water entering the treatment works includes items like wood, plastic bags, and even dead animals. Unless they are removed, they could cause problems later in the treatment process. Most of these materials are sent to a landfill.

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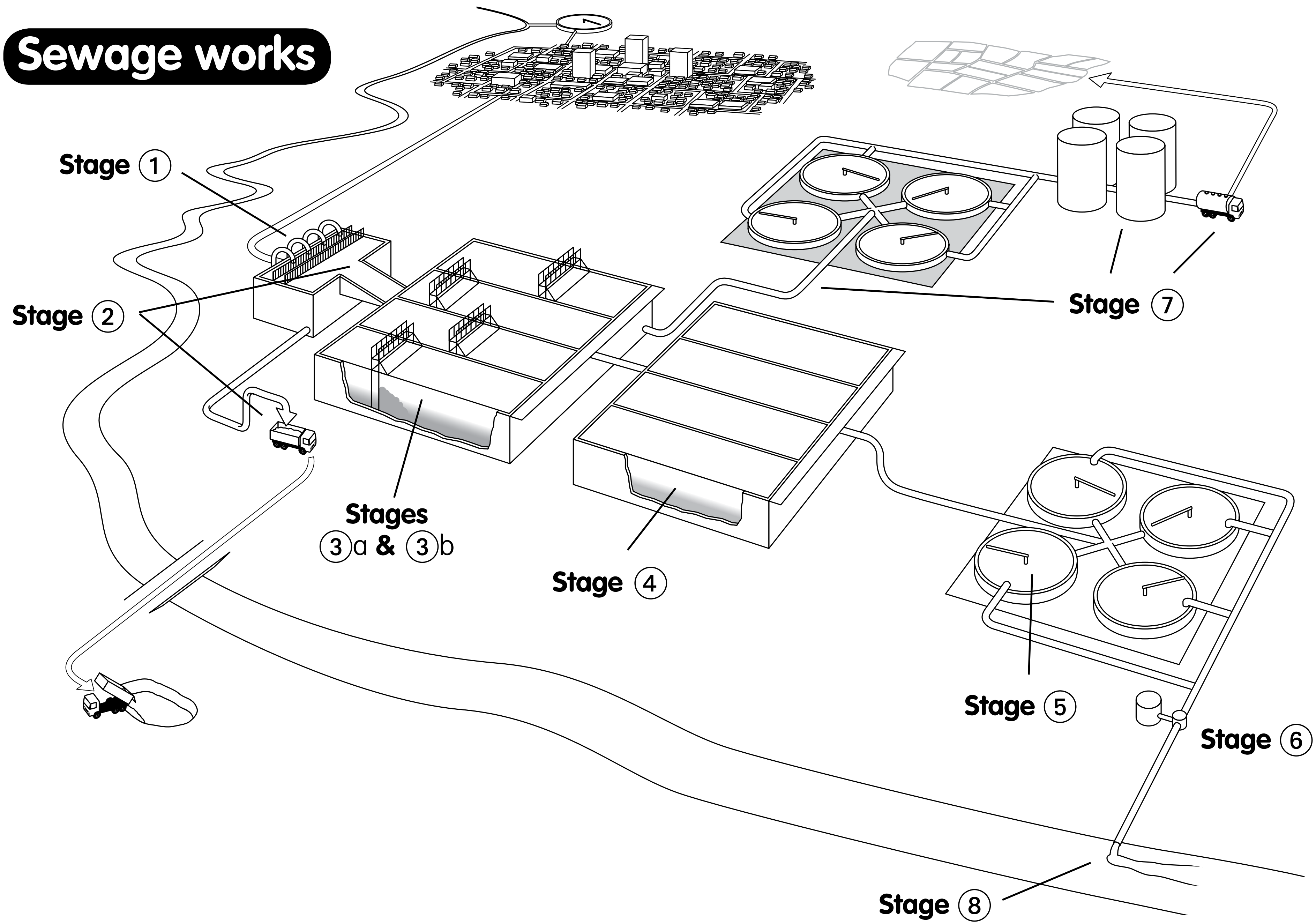
Name: .... Form: ....

Sewage works



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PRIMARY TREATMENT

Stage ② Removing grit

Waste water first passes through channels and small tanks where the 'grit' (road grit, coffee grounds, sand and other small, dense particles) settles out. Grit is pumped out of the tanks and taken to landfill sites. Some is washed and then used as building material.

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Stage ③a Removing sludge

Waste water then enters the primary sedimentation tanks. Here, most of the sludge (the solid organic portion of the sewage) settles out of the waste water and is then transferred to large tanks called sludge digesters.

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Stage ③b Removing scum

As sludge settles to the bottom of the sedimentation tanks, lighter materials float to the surface. This 'scum' includes grease, oils, plastics, and soap. Slow-moving rakes skim the scum off the surface of the waste water. Scum is thickened and pumped to the digesters along with the sludge.

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SECONDARY TREATMENT

Stage ④ Aerating

The remaining waste water is now shaken up and exposed to air. This causes some of the dissolved gases that taste and smell bad (such as hydrogen sulphide, which smells like rotten eggs) to be released from the water.

Waste water then enters a series of long, parallel concrete tanks where air is pumped through the water (aeration).

Here microbes digest the organic matter, turning it into gases and other materials that are harmless. As organic matter decays, it uses up lots of oxygen. Aeration (using jets of air) replenishes the oxygen.

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Stage ⑤ Filtration

Many cities use filter beds. After the solids are removed, the liquid sewage is filtered through a substance, usually sand, by the action of gravity. This method gets rid of almost all harmful bacteria, makes the water look clean, removes odours and removes most of the solid particles that remained in the water. Water is sometimes filtered through carbon particles, which removes other chemicals. This method is used in some homes, too. It is even used in a home water purifier.

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Stage ⑥ Disinfecting

Finally, the waste water flows into a 'chlorine contact' tank, where the chemical chlorine is added to kill the remaining harmful bacteria, just as is done in swimming pools. The chlorine is mostly used up as the bacteria are destroyed, but sometimes it must be neutralized by adding other chemicals. This protects fish and other marine organisms, which can be harmed by the smallest amounts of chlorine.

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Stage ⑦ Sludge cleaning

The sludge can be useful if it is treated. It is kept for up to a month in large, heated, enclosed tanks called digesters. Here bacteria break down (digest) the material, reducing its volume, removing most odours and killing germs. Once most of the mositure has been removed it can be compacted and then spread on farmland as a fertiliser or burnt as a fuel.

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Stage ⑧ Returning the water to the environment

The treated water is discharged to a local river or the sea.

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