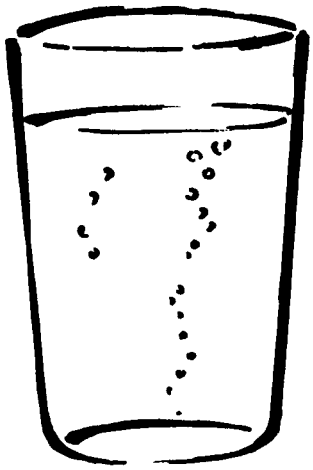
SCIENCE ACROSS EUROPE

BP Amoco



Drinking water in Europe
Trinkwasser in Europa
El agua que bebemos en Europa
L'eau potable en Europe
Acqua potabile in Europa
A água que bebemos na Europa

14-17 **English**

Drinking water

Water is vital to life. This unit reviews water the 'precious resource', how it collects impurities and what may be dissolved in it. It asks students to collect information about the quality of their water and find out if their community has concerns about it. Students may then exchange their information with students in other schools across Europe. The unit concludes by asking students to compare their findings with information they receive in return.

There are many possibilities for extending this study and for linking it with subjects such as geography and foreign languages.

Teachers will need to make prior arrangements for contacting other schools. To receive a list of schools using this unit in Europe, you should fill in and post the Registration Form supplied with this book as soon as possible. Registration is also possible using E-mail through the Science Across The World web pages - ***http://www.bp.com/saw***

This unit is in five parts

Part 1 Water, a precious resource
A short introduction to the unit.

Part 2 What is in your drinking water?
Information about water resources and the quality of water used by students in your class.

Part 3 What do other students think?
Exchanging information about water quality with students in other countries.

Part 4 Drinking water across Europe
Comparing the responses from different countries and discussing the results.

Part 5 Information section
This part includes data and information about impurities found in drinking water; the main stages in the purification of water; maps.

The aims of the unit are:

- ❒ to show that it is difficult to get pure water, and why;
- ❒ to show the variety of sources of water for drinking;
- ❒ to show that the purity of water depends on local conditions;
- ❒ to encourage critical awareness of water quality;
- ❒ to raise students' awareness of the perspectives of people from other countries;
- ❒ to improve students' confidence in using a variety of European languages;
- ❒ to give students experience, where possible, of using a range of communication technologies.

Prior knowledge and skills:

The unit is intended for use by students aged 14 to 17 years. It is assumed they have the following prior knowledge and skills.

❒ Concepts and knowledge
- physical and chemical change;
- ions;
- chemical formulas;
- concentration of solutions;
- micro-organisms.

❒ Skills
- reading and interpreting data from tables and maps;
- estimating quantities;
- measuring pH.

Instructions for teachers

Requirements

Before beginning the lesson:

- ❒ make a class set of copies of the student pages;
- ❒ make a few copies of the Exchange Form for sending the information from your class to other schools. (It may also be helpful to make a copy for overhead projection.)

When you have received the Exchange Forms from other schools:

- ❒ copy for your students to read and discuss the Exchange Forms received from other schools and the class' own Exchange Forms;
- ❒ copy the map(s) for overhead projection or for student use.

Summary of the unit

Part 1 Water, a precious resource

This is a short introduction to the unit.

Part 2 What is in your drinking water?

Some of this part should be individual work but most of it should be discussed in small groups.

Part 3 What do other students think?

When students have completed Part 2, the whole class will need to agree a set of answers for the Exchange Form in Part 3. The Exchange Form provides a quick and simple way of exchanging information between classes in different countries. You are more likely to get an answer from another school if you send your results at the same as asking for information. You might also like to send photographs of your school.

Part 4 Drinking water across Europe

This part may be used as a follow-up when you have received Exchange Forms from other countries.

Part 5 Information section

Additional information on water supply, impurities and purification that may be used with other parts of the unit.

Acknowledgements

Further activities
ITIS 'G.B. Pininfarina', Moncalieri, Torino, Italy.

For consultation on the Informations Section
'Drinking Water Directorate', UK & Water Aid, London, UK

Further activities

Here are some suggestions

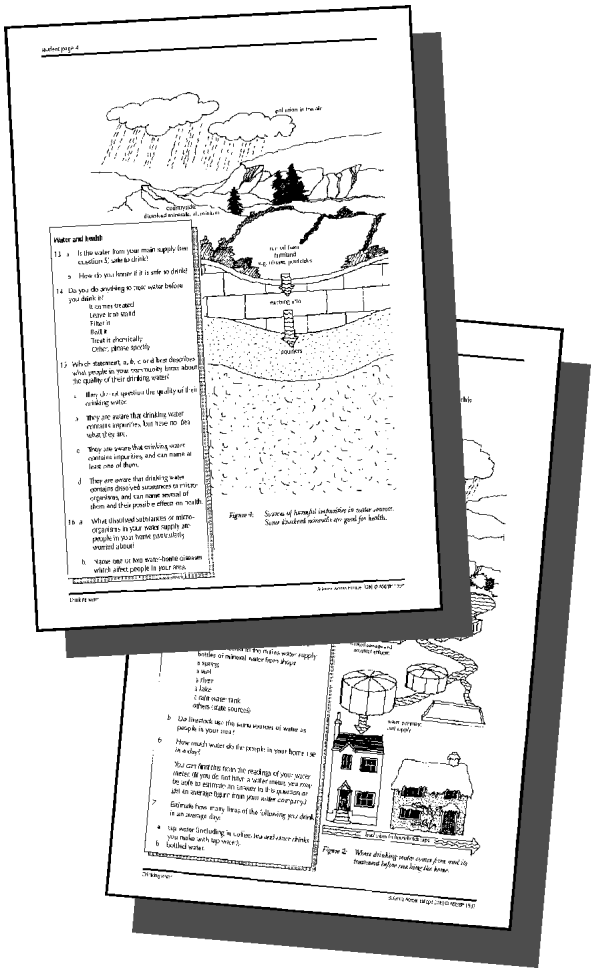
1 Looking at mineral water
Collect different brands of mineral water and look at the analyses to find the concentrations of dissolved substances. Compare these with EC guidelines.

2 Looking at hardness
Measure the hardness of different types of water, including mineral water.

3 How do water purifiers work?
Examine water purifiers of the filter type to see how they work.

4 Where does your water come from?
Find where your water was collected from before it was stored and purified. The water company should be able to help.

5 Visit the local water company



Further activities contd.

Period of gathering data from . . . . . to . . . . . .

	number
members in family	
bathrooms	
animals	

Specify type of animals: . . . . . .

. . . . . .

Table 1: Water consumption for personal hygiene

	Sunday			Monday			Tuesday			Wednesday			Thursday			Friday			Saturday		
	nº	t	l	nº	t	l	nº	t	l	nº	t	l	nº	t	l	nº	t	l	nº	t	l
Shower																					
Bath																					
Personal hygiene																					
Sewage water																					

nº = number of times in use
t = time expressed in minutes
l = litres

Flow rate shower tap	l/m
Flow rate basin tap	l/m

Further activities contd.

Table 2: Water for the home

	Sunday			Monday			Tuesday			Wednesday			Thursday			Friday			Saturday		
	nº	t	l	nº	t	l	nº	t	l	nº	t	l	nº	t	l	nº	t	l	nº	t	l
Washing machine																					
Dishwasher																					
Kitchen tap*																					
Basin Tap*																					
Garden Tap*																					

Flow rate kitchen tap	l/m
Flow rate basin tap	l/m
Flow rate garden tap	l/m

* *Take into account all consumption other than personal hygiene food washing drawing off for food use, washing floors, washing by hand, watering plants etc.*

Notes on the questions

Part 2

1 You will find useful information in the background information section. Your local water company may also supply information to schools.

2b Ask your meteorological office.

Questions 4-7 should be answered by each student about their home.

6 Where water is not metered it may be difficult to answer this question. The water company should be able to provide a figure for average water consumption per household. Sometimes this information is available from consumer associations. Alternatively, follow the procedure suggested by optional worksheets on pages 3 and 4 of these teacher's notes.

7aInclude tap water used to make other drinks such as coffee and tea, but not canned or bottled drinks such as lemonade or beer.

8aThe pH of the supply will vary according to temperature, how long the water has been standing, etc. It is best to take the pH of a fresh sample from the cold tap.

8b, 9, 10 The local water company can give answers to these questions and provide an analysis of the water. Some students may obtain their water from a well or bore hole, and they may not be able to get an analysis.

Information concerning various impurities is given in the information section.

11, 12 The EU and WHO guide levels for selected substances are given in the information section.

15, 16 The answers to these questions will be subjective. Students should be able to judge the awareness of family and community by asking a few simple questions about impurities and micro-organisms in the water supply.

Part 4

1 Rainfall is one of the many factors affecting water supply. Loss of water through evaporation and the transpiration of plants is another. In large cities, the standard of living (for example, the use of water for toilets, baths and washing machines), the use of water for irrigation and gardens, all place high demands on water supply. Water shortages in areas of high rainfall may sometimes be due to lack of investment in storage reservoirs and pipelines, or to environmental objections to the building of new ones.

Science Across the World

Drinking water

Date	
To (teacher's name)	
School	
Address	
Tel: (with international dialling code)	Fax
E-mail	
Web address of school	

From (teacher's name)	
School	
Address	
Tel: (with international dialling code)	Fax
E-mail	
Web address of school	

Water resources

1 *a* *The main water resources in our country or region are:*

b *Where we live, we use these water resources:*

2 *a* *Where we live, it rains at these times of the year:*

b *In a year our total rainfall is: ……mm*

3 *a* *In our region the situation about water shortage is:*

b *This is how often our water is rationed or limited:*

4 *Examples of the ways in which people re-use water are:*

Where drinking water comes from

5 *a* *The crosses* [X] *show where our drinking water comes from:*

- ☐ *a tap connected to the mains water supply*
- ☐ *bottles of mineral water from shops*
- ☐ *a spring*
- ☐ *a well*
- ☐ *a river*
- ☐ *a lake*
- ☐ *a rain water tank*

others ……

b *The places where livestock drink are:*

6 *a* *We estimate that the amount of water used in a home is……. litres in one day*

7 *a* *We estimate that a single student drinks …… litres a day of tap water (including in coffee, tea and other drinks made with tap water).*

b *We estimate that a single student drinks …….. litres a day of bottled water.*

Water analysis

8 *a* *The pH of our drinking water is ……..*

b *The concentrations of impurities are:*

lead ions, Pb^{2+}……μg per litre

nitrate ions, NO_3^- ……..μg per litre

pesticides …….. μg per litre

9 *The hardness of the water is* *low* ☐ *medium* ☐ *high* ☐

10 *The number of coliform bacteria is …… per 100 ml in our local water supply.*

11 *Impurities that exceed the EU guide level for drinking water are:*

12 *In our country the drinking water guide levels*

are the same as EU ☐ *are the same as the WHO* ☐

Differ from EU or WHO levels in these ways:

Water and health

13 *Our main water supply is* *safe to drink* ☐ *not safe to drink* ☐

We know this because:

14 *Before we drink water from our main water supply we:*

☐ *do not treat it*
☐ *filter it*
☐ *leave it to stand*
☐ *boil it*
☐ *treat it chemically*
☐ *it comes treated*

other……..

15 *The statement which best describes what people in our community know about the quality of their drinking water is:*

a *They do not question the quality of their drinking water* ☐

b *They are aware that drinking water contains impurities, but have no idea what they are* ☐

c *They are aware that drinking water contains impurities, and can name at least one of them* ☐

d *They are aware that drinking water contains dissolved substances, and can name several of them and their possible effects on health* ☐

16 *a* *People are particularly worried about these dissolved substances or micro-organisms in drinking water:*

b *Examples of water-borne diseases which affect people in our area are:*

Drinking Water

Part 1 A precious resource

Water is essential to life. In many parts of the world water is a limited resource. Many people do not have a good source of water and this causes many problems.

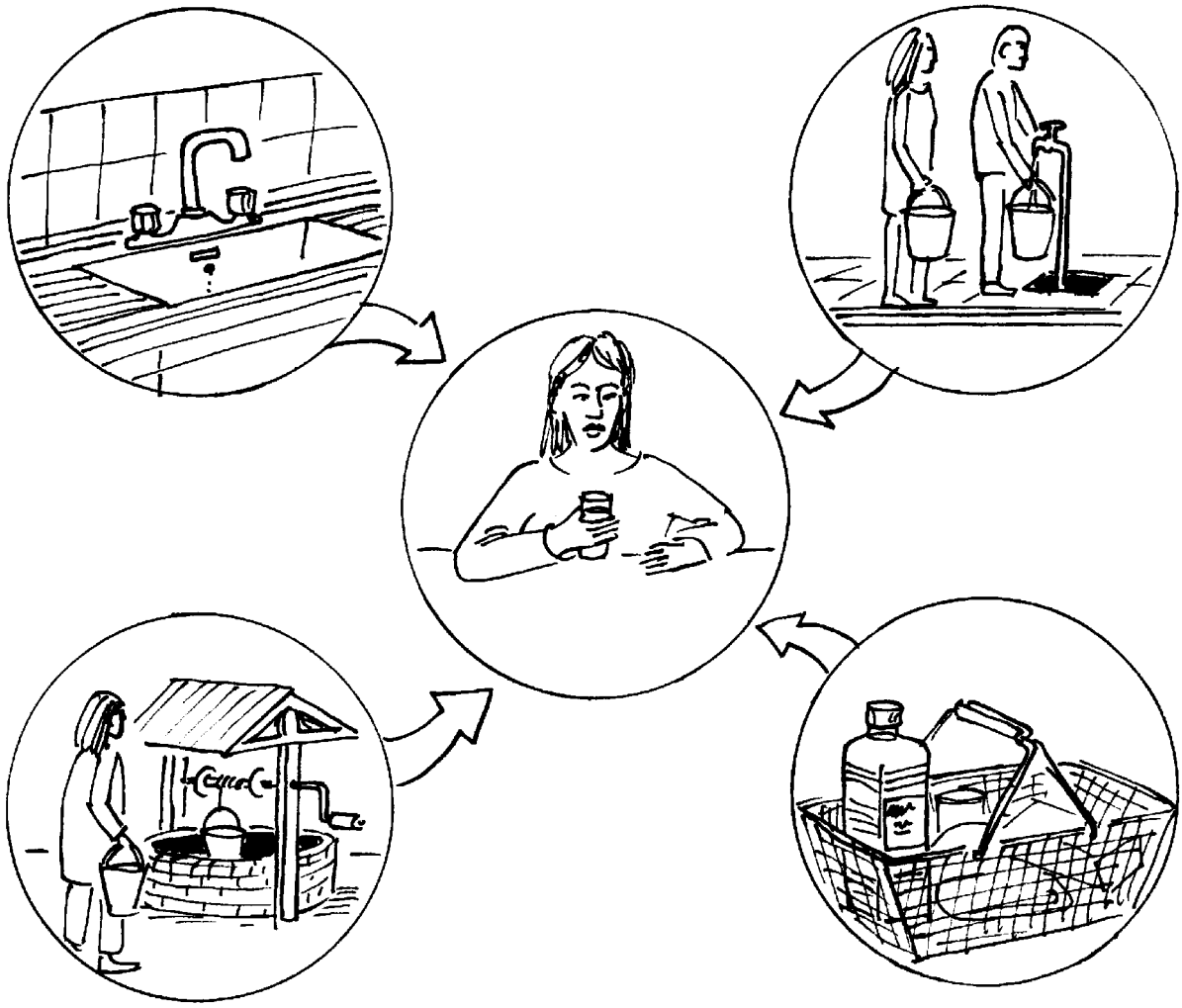


Figure 1: *Possible sources of drinking water*

Even though water may look clear, it does not mean that it is clean.

There are many diseases which people get from water. Some come directly from drinking dirty water, others, such as Encephalitis and Malaria, come from organisms which live or breed in water.

WATER IS PRECIOUS - DO NOT WASTE IT

Safe water for all is the target for people all over the world. In this unit you will collect information about drinking water and compare it with information from students in other regions and other countries.

Part 2 What is in your drinking water?

In this part of the unit you will collect information about the water you drink; where it comes from, how much you have and how safe it is. In Part 3 you will exchange some of this information with students in other regions or countries.

Water Resources

1 a What are the main water resources in your country or region?

Lakes and reservoirs
Rivers and springs
Boreholes (drilled wells)
Dug wells
Rainfall (collected in tanks)
Other

b Which of these water resources do you use where you live?

2 a At what times of year does it rain where you live?

b How many millimetres of rain fall in a year where you live?

3 Does the community suffer from water shortages? Why? Is the water supply sometimes rationed?

4 Do you re-use water in your home? If so how? (for example, using washing water to water your garden)

Where drinking water comes from

5 a Where does your drinking water come from?

a tap connected to the mains water supply
bottles of mineral water from shops
a spring
a well
a river
a lake
a rain water tank
others (state sources)

b Do livestock use the same sources of water as people in your area?

6 How much water do the people in your home use in a day?

You can find this from the readings of your water meter. (If you do not have a water meter, you may be able to estimate an answer to this question or get an average figure from your water company.)

7 Estimate how many litres of the following you drink in an average day:

a tap water (including in coffee, tea and other drinks you make with tap water),
b bottled water.

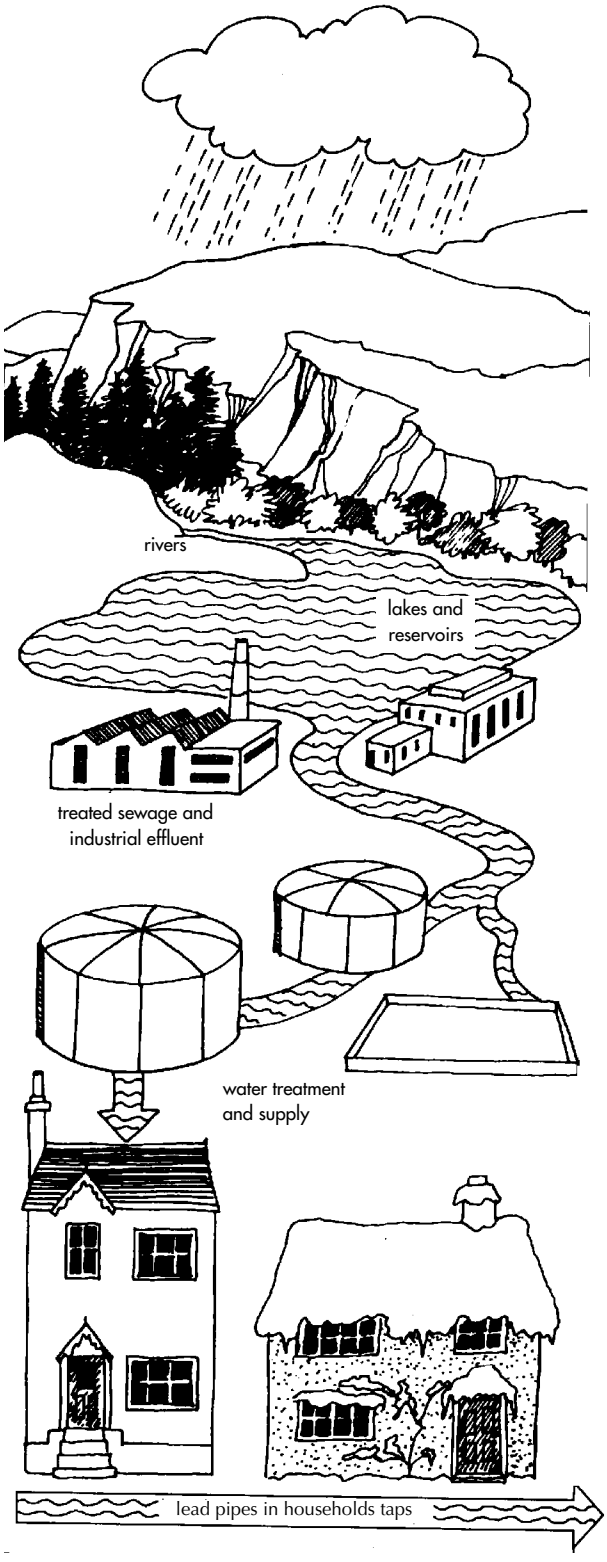


Figure 2: *Where drinking water comes from and its treatment before reaching the home*

Water analysis

Water is an excellent solvent - but this property can be both an advantage and a disadvantage. Some of the substances dissolved in water are beneficial such as calcium ions, iodide ions and other minerals too. Others are harmful to the body. It is not usually possible to see dissolved substances, so without some chemical analysis we do not know if they are there or not. In addition we have other substances in water which we may or may not be able to see. Such things as leaves and mud we can see, but micro-organisms (germs) which may be dangerous to us are invisible.

To find the answer to this part, you will need to obtain the analysis for the water you use. You will probably be able to get this from your local water company. See also the information section of this unit.

8 a What is the pH of your water supply?

b What is the concentration in your local water of each of the following?

- Lead, Pb^{2+}
- Nitrate, NO_3^-
- Pesticides

9 What is the hardness of your water?

- Low
- Medium
- High

10 How many coliform bacteria per litre are there in your water supply?

11 Are any substances in higher concentrations than the EU guide level? (See table 2 on page 6.)

12 Does your country have its own guide levels? If so, how do they differ from the EU or WHO guide levels?

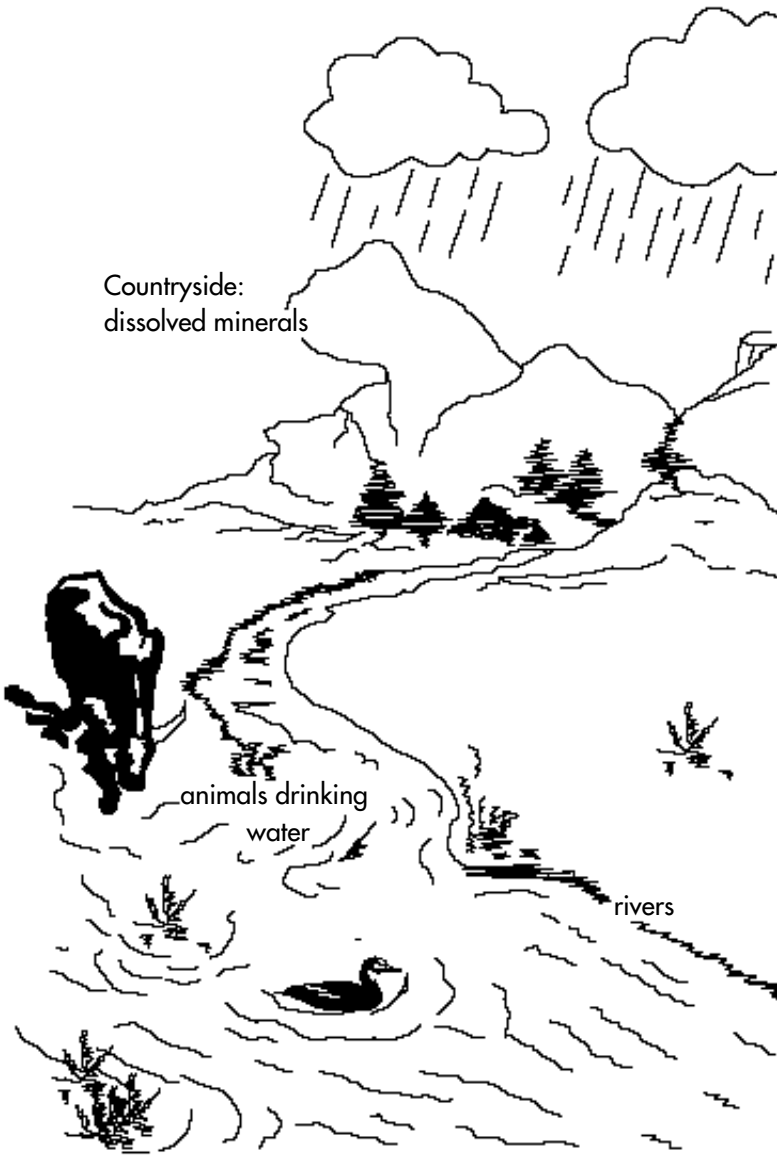


Figure 3: *Water is an excellent solvent. Some dissolved substances are beneficial and others harmful to the body*

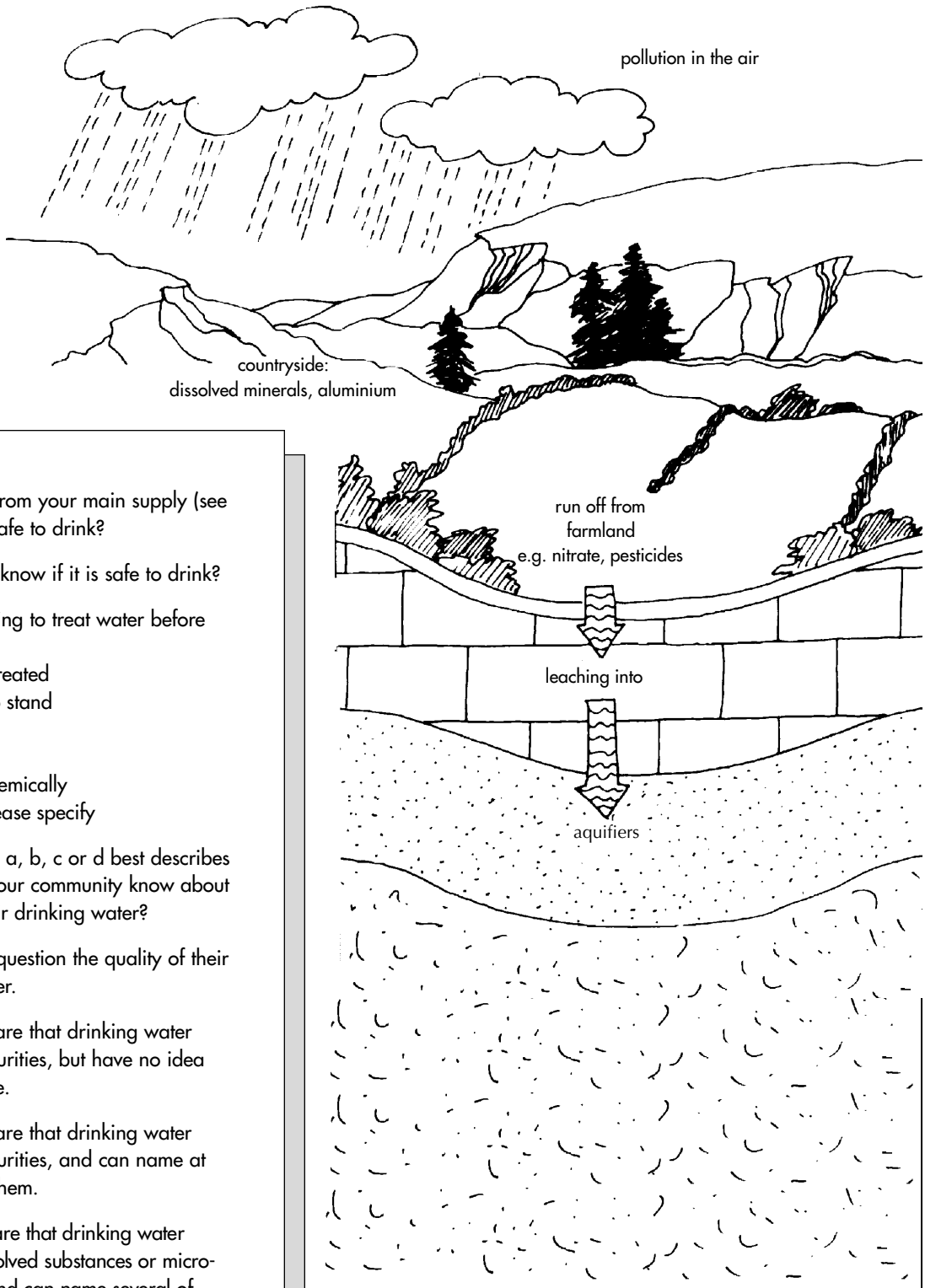


Figure 4: *Sources of harmful impurities in water sources. Some dissolved minerals are good for health.*

Water and health

13 a Is the water from your main supply (see question 5) safe to drink?

b How do you know if it is safe to drink?

14 Do you do anything to treat water before you drink it?

It comes treated
Leave it to stand
Filter it
Boil it
Treat it chemically
Other, please specify

15 Which statement, a, b, c or d best describes what people in your community know about the quality of their drinking water?

a They do not question the quality of their drinking water.

b They are aware that drinking water contains impurities, but have no idea what they are.

c They are aware that drinking water contains impurities, and can name at least one of them.

d They are aware that drinking water contains dissolved substances or micro-organisms, and can name several of them and their possible effects on health.

16 a What dissolved substances or micro-organisms in your water supply are people in your home particularly worried about?

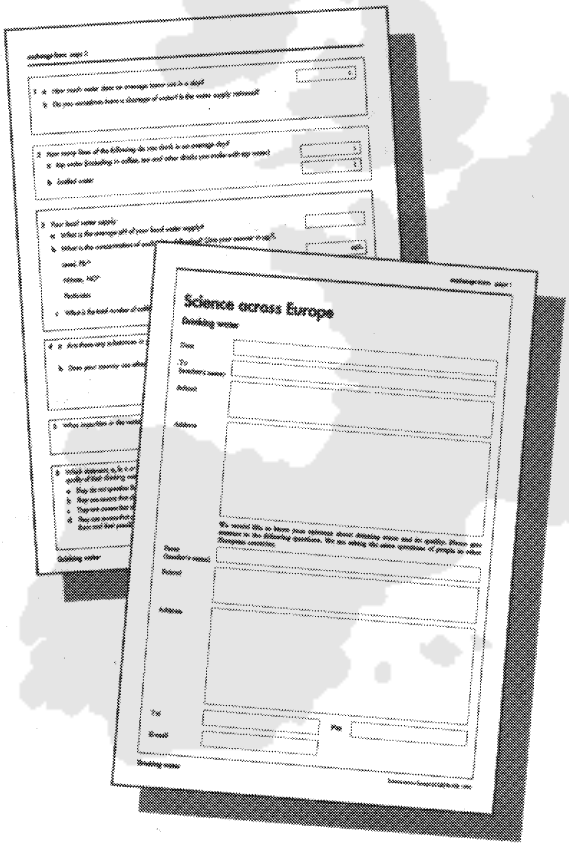
b Name one or two water-borne diseases which affect people in your area.

Part 3 What do other students think?

In this part of the unit, you will exchange information with students in different European countries and other regions of the world.

Your teacher has an Exchange Form with spaces for answers to the questions you answered in Part 2. As a class, decide what information to provide on it.

Send the form to students in other schools across Europe and other parts of the world. Your teacher has a list of classes in other countries that are studying the same unit of work. Your class will receive Exchange Forms from other schools in return. Exchange Forms may also be sent via the Science Across The World web pages - **http://www.bp.com/saw**



Part 4 Drinking water across Europe

When you have received replies, discuss the following:

1 Did any classes say they had a shortage of water? Why do you think they have a shortage? Where do they get their water from? The information section may help you.

2 Discuss the different sources of drinking water and how the need to get drinking water affects peoples' lives.

3 Are people in other countries worried about different impurities or micro-organisms in the drinking water, or are their concerns similar?

4 Did any of the schools tell you they had a noticeable impurity or micro-organism? Are either of these above the WHO's standards?

5 Are people in other countries well informed or not concerned about the quality of their water supply?

Part 5 Information section

Impurities which may be harmful	How it may get in the water	Bad effects
Lead Pb^{2+}	From lead pipes, sometimes from industrial waste.	Affects brain and nervous system, inhibits intellectual development and causes behavioural problems.
Copper Cu^{2+}	From copper pipes, sometimes from industrial waste.	Causes nausea.
Aluminium Al^{3+} From aluminium cooking pots	From water treatment.	Massive doses causes brain lesions.
Mercury, Hg (organic compounds)	Waste disposal.	Affects nervous system.
Nitrate, NO_3 (in fertilisers)	From fertilisers, detergents.	Causes increased growth of algae in waterways and 'Blue Baby' syndrome.
Pesticides (in fertilisers)	From agricultural pest control.	May cause cancer.
Coliform bacteria (of type found in human gut)	From sewage.	May indicate, through upset stomachs, that other harmful bacteria are present.

Table 1 *Information on some impurities found in drinking water which can be harmful*

Impurity	EU standards for 1980 in μg/litre	World Health Organisation (WHO) guidelines, 1993 μg/litre
Lead Pb^{2+}	50	10
Copper Cu^{2+}	3,000	2,000
Aluminium Al^{3+}	200	200
Mercury, Hg (organic compounds)	1	1
Zinc, Zn^{2+}	5,000	3,000
Cadmium, Cd^{2+}	5	3
Iron, Fe^{3+}	200	300
Sodium, Na^{+}	150,000	200,000
Potassium, K^{+}	12,000	none
Nitrate, NO_3	50,000	10,000
Phosphorous, P (normally as Phosphate, PO_4^{3-})	5,000	none
Fluoride, F^{-}	1,500	1,500
Chloride, Cl^{-}	25,000	250,000
Pesticides (total)	0.5	1 - 100
Coliform bacteria	0 per 100 millilitres (ml)	0 per 100 ml
pH	6.5 - 8.5	none
Dissolved solids (dry residue)	1,500	1000

Table 2 *Levels for water impurities*
Source: *EU standards for 1980 and WHO guidelines for 1993.*

How is water purified?

It is not possible - or necessary - to remove all the impurities from drinking water. At the waterworks, they reduce the concentration of impurities to make the water safe to drink. The normal purification process is shown in Figure 5.

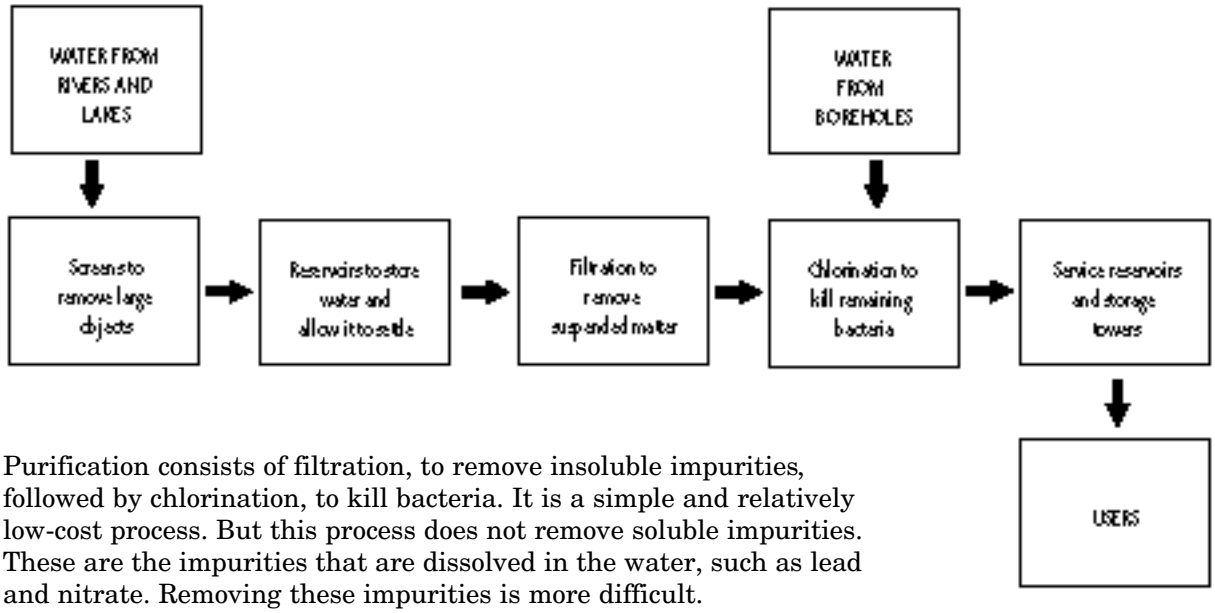


Figure 5:
The main stages in the purification of water

Purification consists of filtration, to remove insoluble impurities, followed by chlorination, to kill bacteria. It is a simple and relatively low-cost process. But this process does not remove soluble impurities. These are the impurities that are dissolved in the water, such as lead and nitrate. Removing these impurities is more difficult.

How can soluble impurities be removed?

If the concentration of the impurity is not too high, diluting the impurity is the easiest way to deal with the problem. The water company blends the water. It mixes the water with high levels of nitrate with water from places with a lower level of the impurity.

Soluble impurities can also be removed by chemical methods. Two important examples are:

- **Nitrates**

  The nitrate ion, NO_3^-, can be removed by ion-exchange. The water is passed through a special resin which exchanges NO_3^- ions for harmless chloride, Cl^-, ions.

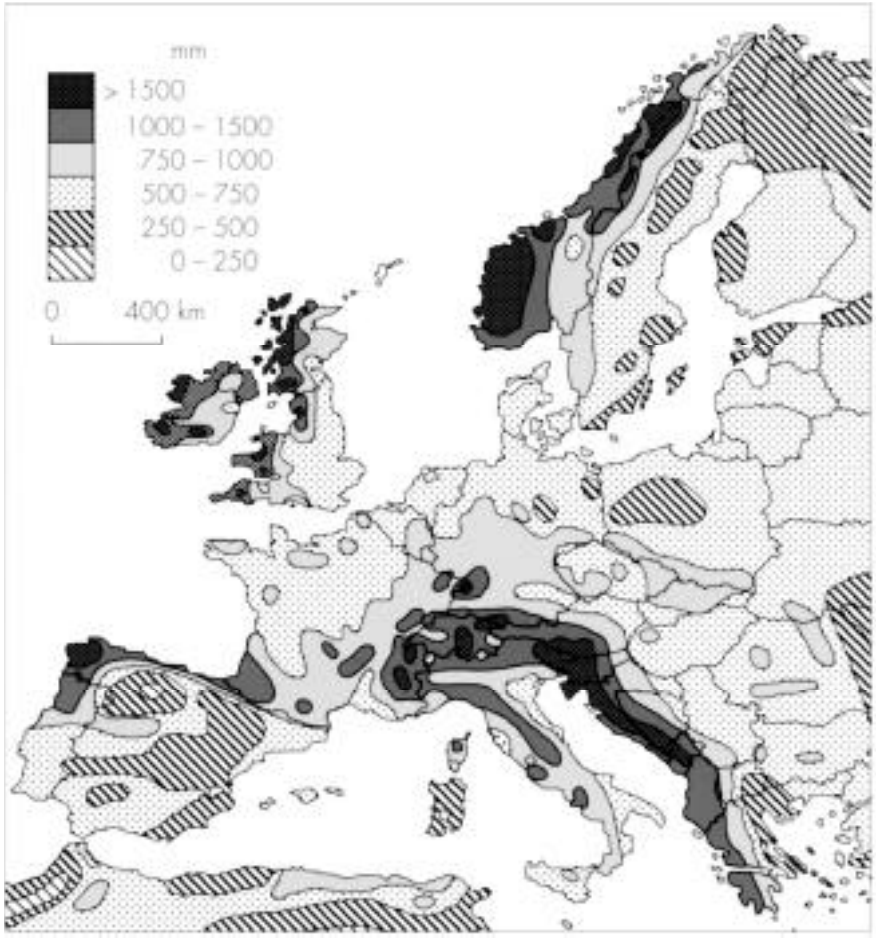
- **Pesticides**

  Pesticides are organic compounds. They can be oxidised to turn them into harmless compounds using ozone, O_3, as the oxidising agent. Pesticides can also be absorbed from the water, using activated charcoal.

What is a coliform count?

A coliform count is an indicator of soil, human and animal waste, and other organic contamination. The bacteria used in the count are themselves not disease causing. Coliform counts are expressed as a count of bacteria, Escherichia coli (E. coli) per 100 ml of water. The level considered safe by the WHO's standards for drinking is 0 per 100 ml.

Map 1 *Precipitation in Europe (rain, snow etc.)*



Map 2 *Water Balance*
In warmer countries, much of the rain that falls in summer evaporates before it can flow into rivers or be taken up by plants. The water balance map shows the annual precipitation minus the water lost through transpiration by plants.