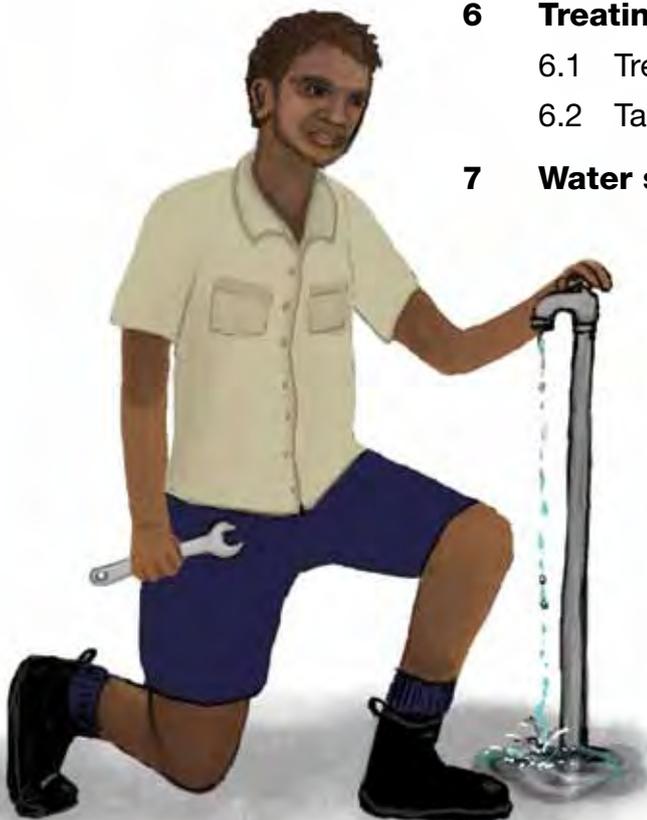


# 6

## WATER SUPPLY

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# 1 Water – its importance and sources

## 1.1 THE IMPORTANCE OF WATER

Water is one of the most important substances on earth. All plants and animals must have water to survive. If there was no water there would be no life on earth.



*Fig. 6.1: Plants and animals need water.*

Apart from drinking it to survive, people have many other uses for water. These include:

- cooking
- washing their bodies
- washing clothes
- washing cooking and eating utensils; such as billies, saucepans, crockery and cutlery
- keeping houses and communities clean
- recreation; such as swimming pools
- keeping plants alive in gardens and parks.

Water is also essential for the healthy growth of farm crops and farm stock and is used in the manufacture of many products.



Drinking



Cooking



Washing ourselves



Washing clothes



Washing cooking utensils

*Fig. 6.2: Some domestic uses of water.*

It is most important that the water which people drink and use for other purposes is **clean water**. This means that the water must be free of germs and chemicals and be clear (not cloudy).

Water that is safe for drinking is called **potable water**.

Disease-causing germs and chemicals can find their way into water supplies. When this happens the water becomes polluted or contaminated and when people drink it or come in contact with it in other ways they can become very sick.

Water that is not safe to drink is said to be non-potable. Throughout history there have been many occasions when hundreds of thousands of people have died because disease-causing germs have been spread through a community by a polluted water supply.

One of the reasons this happens less frequently now is that people in many countries make sure drinking water supplies are potable. Water supplies are routinely checked for germs and chemicals which can pollute water. If the water is not safe to drink it is treated. All the action taken to make sure that drinking water is potable is called **water treatment**.

## 1.2 SOURCES OF WATER

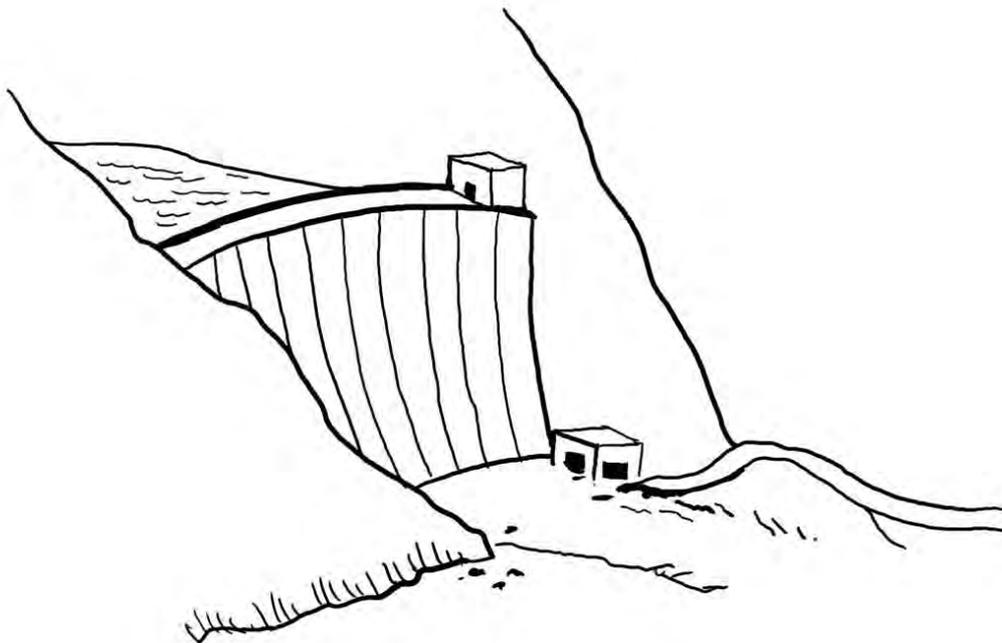
There are many ways in which we can collect water. The main sources are discussed below.

### Surface water

This is water which falls to the ground as rain or hail.

This water is collected from a special area called a **catchment**. The catchment feeds water into a holding area via rivers, streams and creeks. The water is then stored in a natural or artificial (manmade) barrier called a **dam or reservoir**. Dams are usually placed at the lower end of a valley.

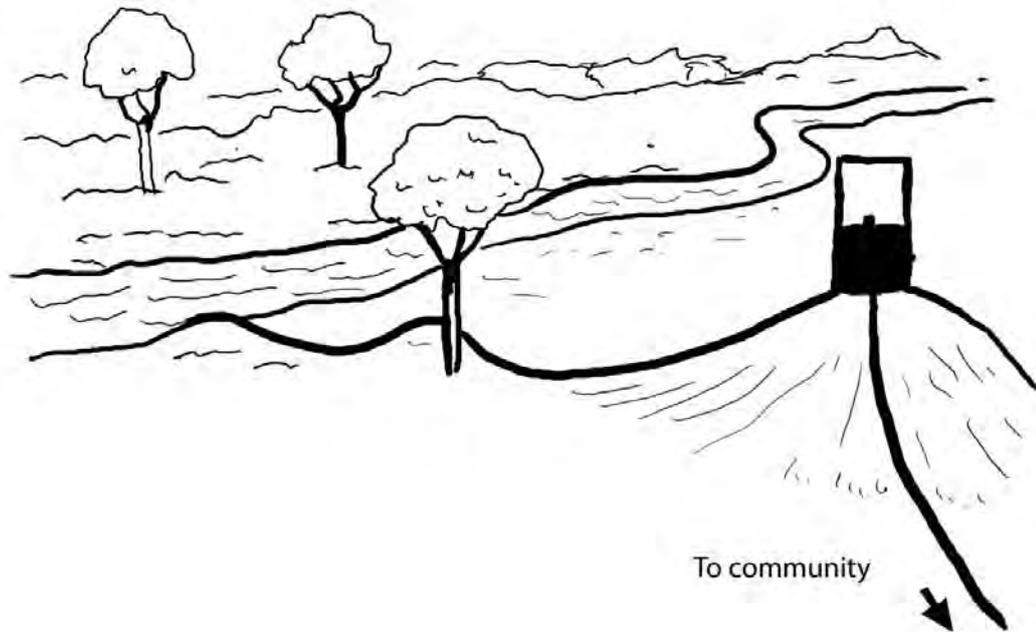
Catchment areas are usually far away from towns or cities to lessen the chance of the water being polluted. There are laws which control human activities, such as farming and recreation in catchment areas and on dams to make sure that water supplies are kept potable.



*Fig. 6.3: A surface water dam.*

## Rivers or lakes

Town or community water supplies are sometimes drawn directly from nearby rivers or lakes.



*Fig. 6.4: Rivers and lakes can supply water.*

## Springs

These are found where underground water flows out of the ground naturally without the use of bores, wells or pumps.

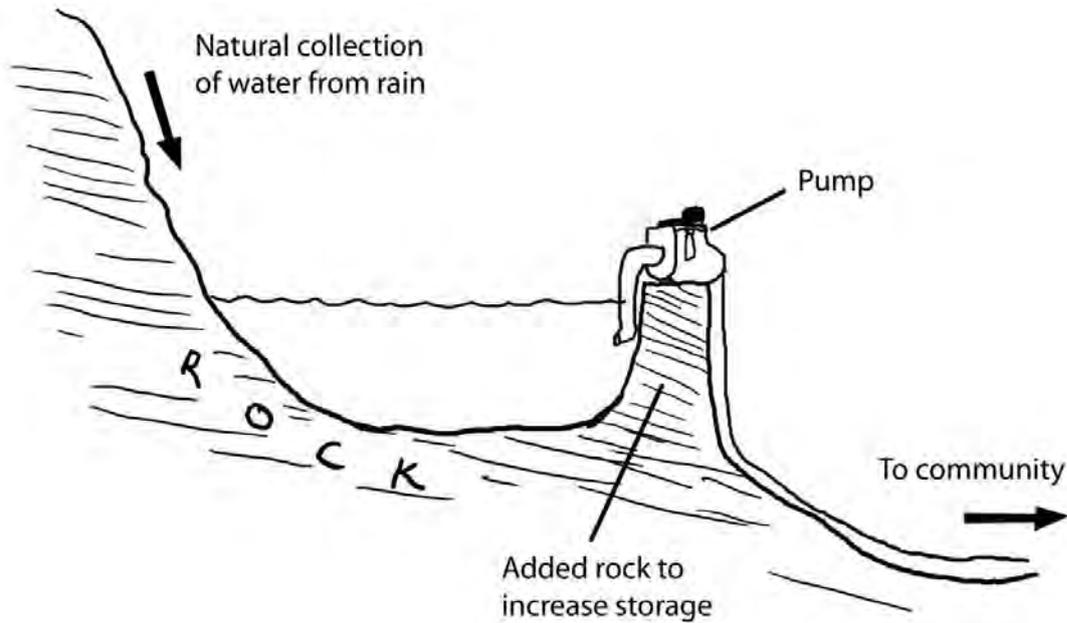
Springs often occur towards the bottom of a hill or on sloping ground.



*Fig. 6.5: A spring.*

## Rock catchment areas and rockholes

Sometimes large rocky outcrops contain low areas in which water is trapped. These low areas make good natural dams. Often a wall can be built to increase the amount of trapped water.



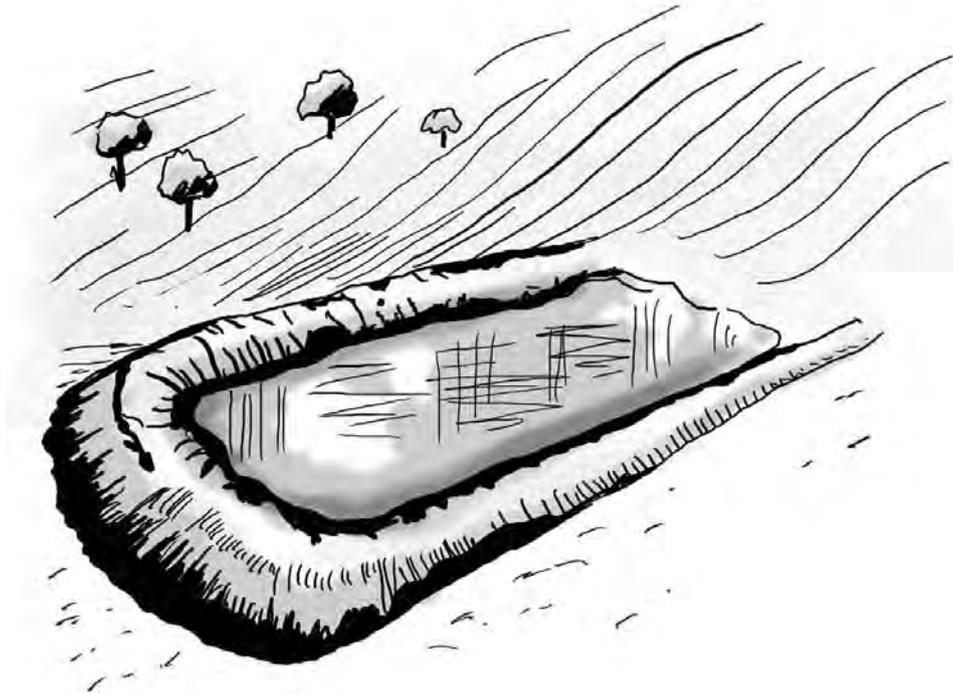
*Fig. 6.6: A rockhole.*

## Excavated dams

Excavated dams are made by scooping out soil to make a large shallow hole. These dams are sometimes placed at the bottom of a slope to aid water collection. However, this can only be done in areas where the soil will not allow the water to drain away very easily through the ground. For example, in clay soils.

Soils which do not allow water to drain away are called **impervious**.

If a community wants a dam in an area where the soil is not impervious this can still be done by digging the hole and lining it with clay or an impervious liner, such as concrete or heavy plastic. Excavated dams are often used by farmers to supply water to stock.

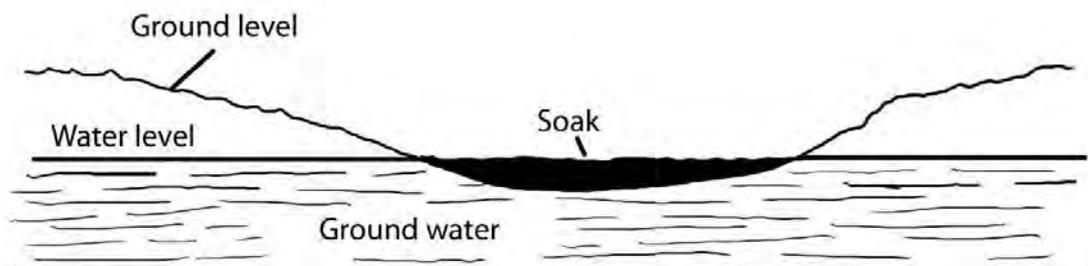


*Fig. 6.7: An excavated dam.*

There is often a layer of water lying beneath the ground surface, trapped by an impervious layer of rock which will not allow it to drain away. The water may be close to ground level or it may be deep in the ground. This layer of water is called the **water table**.

When this water table is close to ground level the water may actually come to the surface and create a permanent wet area called a **soak**. This usually occurs in low lying areas or hollows.

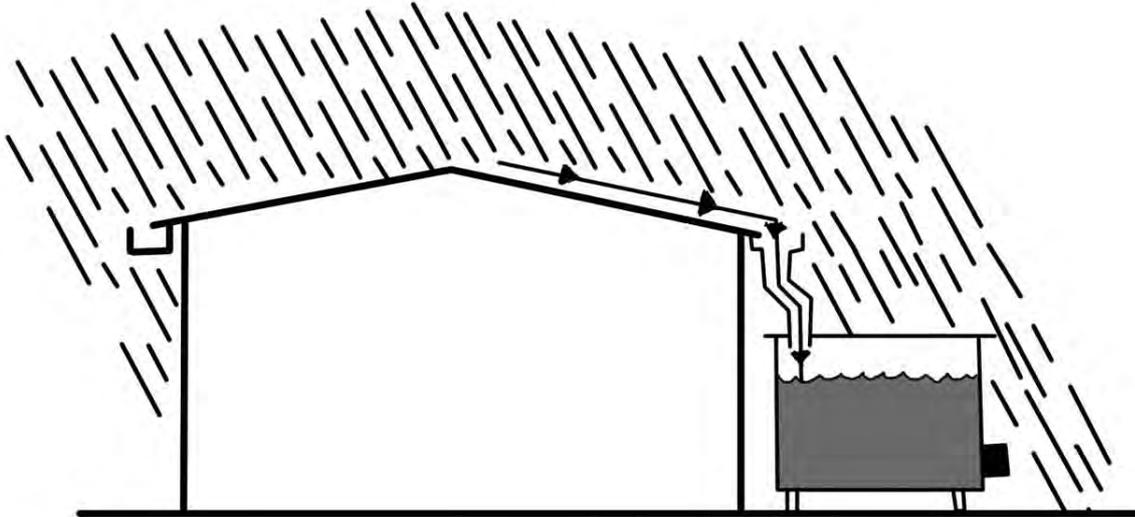
Soaks are affected by changes in the depth of the water table. That is, if the water table drops then soaks may dry up. Some causes of this can be drought or overuse of ground water by people.



*Fig. 6.8: A soak.*

## Rainwater tanks

The rainwater which falls on the roofs of houses is often collected using roof guttering leading through a pipe to a storage tank.



*Fig. 6.9: A rainwater tank.*

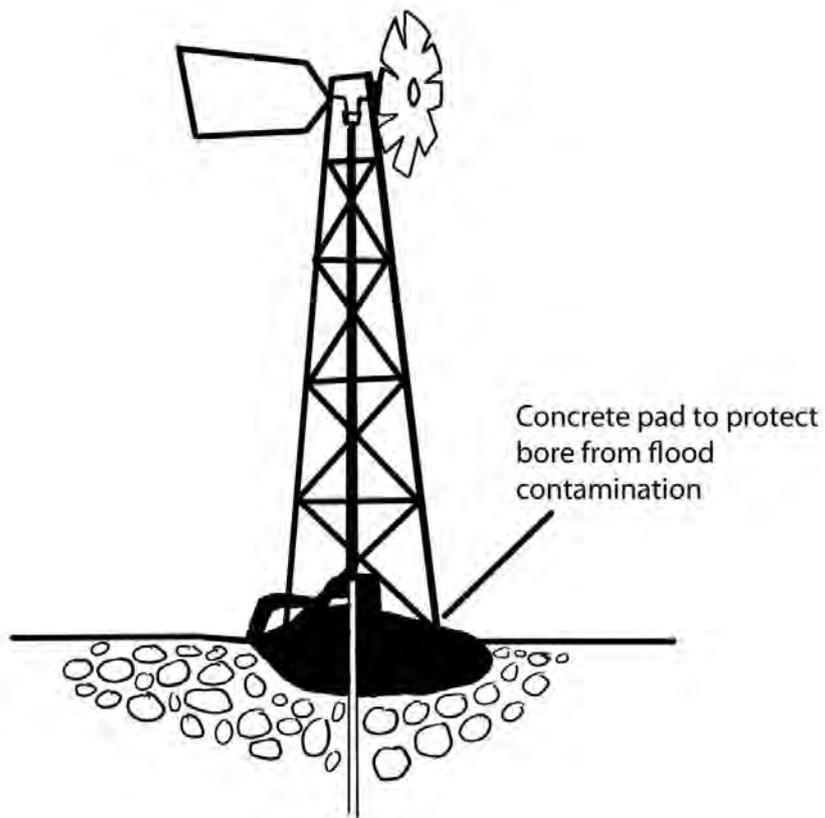
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**Note:** enHealth's monograph '*Guidance on use of Rainwater Tanks*' provides the most up-to-date information and advice on the range of potential hazards that can threaten rain water tank water quality. Environmental Health Practitioners are encouraged to use the guide when planning how to prevent these hazards from contaminating rainwater, straightforward monitoring and maintenance activities and, where necessary, corrective actions. The monograph can be found on the enHealth website or by using a search engine with the title of the monograph.

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## Bores and wells

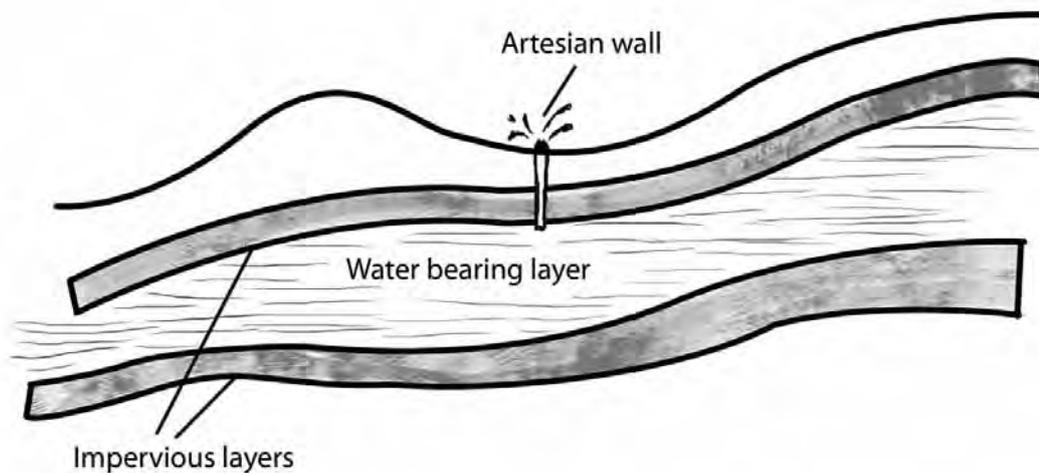
These are holes drilled into the ground deep enough to find a permanent (long-lasting) body of water. A pipe runs down the hole into the water and a pump is used to get the water up to ground level. The water is then pumped to the community.



*Fig. 6.10: A bore.*

### **Artesian bores**

Sometimes when a bore is sunk into a low lying area the water gushes out of the hole under its own pressure. This water is under pressure because it is part of an underground body of water much of which is at a higher level than the bore opening. This kind of bore is called an artesian bore.



*Fig. 6.11: An artesian bore.*

A water supply taken directly from a bore or well is often called **groundwater**.

The water which comes from any of these sources may be salty, cloudy, smell unpleasant or have germs in it. Water of this kind would require special treatment to make it potable.

## 2 Water contamination and disease

It is very important that the community water supply be kept clean and free of germs and chemicals.

### 2.1 DISEASES WHICH CAN COME FROM POLLUTED DRINKING WATER

#### Diseases in Indigenous communities caused by germs from polluted water

Bacterial diseases:

- salmonellosis
- shigellosis
- acute diarrhoea (caused by E. coli).

Viral diseases:

- gastroenteritis
- hepatitis A.

Parasitic:

- giardiasis
- hookworm infection (there is some evidence that hookworm larvae can live in drinking water).



**Fig. 6.12: Stomach upsets can be caused by contaminated drinking water.**

In most parts of Australia and many other countries, proper water treatment methods have almost eliminated the germs that cause many of these diseases from water supplies. However, water treatment and hygiene standards in Indigenous communities, especially small communities or camps, are often inadequate and this is why many of these diseases still occur in Indigenous communities.

The germs may get into the water:

**Directly by:**

- a lagoon overflow effluent pipe discharging into a river or stream supplying drinking water
- the presence of dead animals in the water
- people or other animals swimming, washing or going to the toilet in a drinking water supply.

**Indirectly by:**

- contamination from an effluent system, such as a leach drain too close to a bore or the overflow from a lagoon flowing into a water supply
- people washing themselves or going to the toilet in or near a water source.

## **2.2 WATER CONTAMINATION AND HOW IT CAN BE PREVENTED**

Anything which contaminates water is called a contaminant or pollutant. Water can be contaminated or polluted by:

- **Organic materials** such as:
  - » animal carcasses
  - » animal and human faeces and sewage
  - » food waste
  - » plant matter (grass, leaves, wood)
  - » oil, petrol and grease.
- **Inorganic materials** such as:
  - » scrap metal and junk
  - » sand
  - » chemicals.

Many of these materials can carry disease-causing germs into water supplies. Chemicals in the water supply can poison people and other animals.

Water can be contaminated at:

- the source, such as the river or bore
- in storage, such as in elevated tanks
- in the pipe system which delivers water to the user.



***Fig. 6.13: Drinking or swimming in contaminated water can be dangerous to health.***

Different types of water supplies can become contaminated in a number of ways. Some of these, and their methods of prevention are described below.

### **Domestic rainwater tanks**

#### **Contamination**

The rain which falls onto the roof of a house is usually clean, and should not normally contain germs. However, there may be a lot of dirt and rubbish on the roof, especially if it has not rained for a long time.

This dirt might include the faeces from birds and small animals. Also, the wind can carry germs in dust blown onto the roof. When it rains the dirt and rubbish will be washed into the storage tank, along with the germs. Some of these germs may cause disease.

Dirt, animals and bird faeces can get into a storage tank if it does not have a lid. All these things can carry disease-causing germs. Often animals are trapped in water tanks and drown. As dead bodies rot, germs will grow and contaminate the water.

The inside of the tank walls and floor may also become dirty after a period of time. This dirt can contaminate the water.

### **Prevention**

If a house has a rainwater tank as its water supply, these are the things which should be done to keep the water clean:

- (a) Install a first flush diverter. This prevents the first flush of water, which may have contaminants from the roof, from entering the tank.
- (b) Keep the roof and gutters clean.
- (c) Keep a lid on the water tank.
- (d) Check for and repair any leaks.
- (e) Regularly look into the tank. If the water or walls or floor are dirty the tank will need to be cleaned.

### **Rivers and billabongs**

#### **Contamination**

There are several ways in which rivers and billabongs can become contaminated with germs or chemicals:

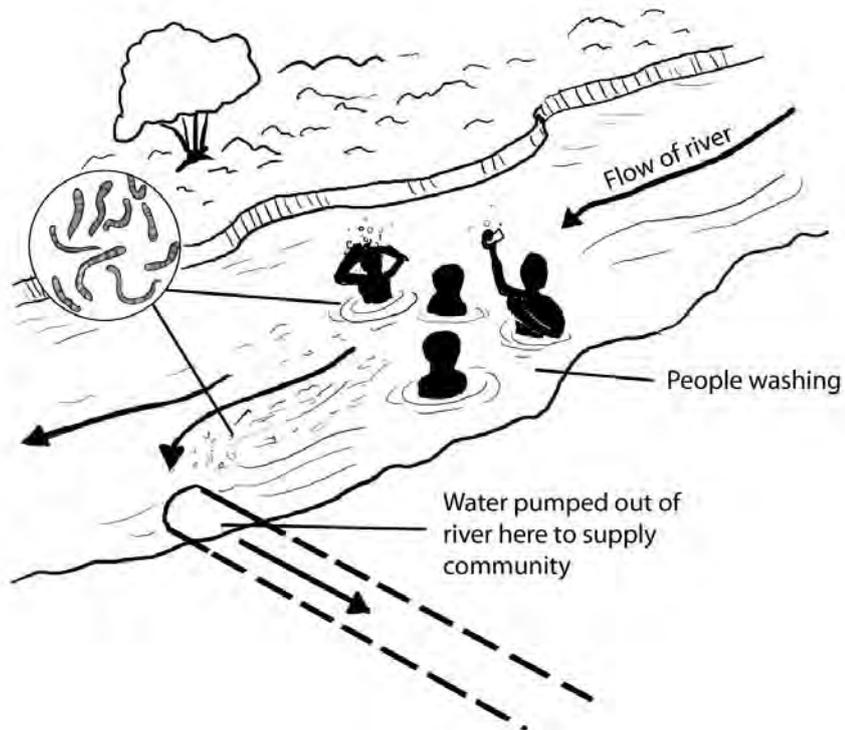
- Rubbish may fall into or be washed into the river or billabong, for example, from a nearby dump.
- Sewage may seep into the river or billabong from nearby septic tanks and leach drains.
- Faeces may be deposited directly into the river by people or other animals.
- Faeces deposited near the river may be washed into it by rain.
- Chemicals or poisons sprayed onto land near the river or billabong may be washed into the water.
- People or animals may wash themselves in the river or billabong.

There is a risk that the water supply will be contaminated if the community pumps its water from a place:

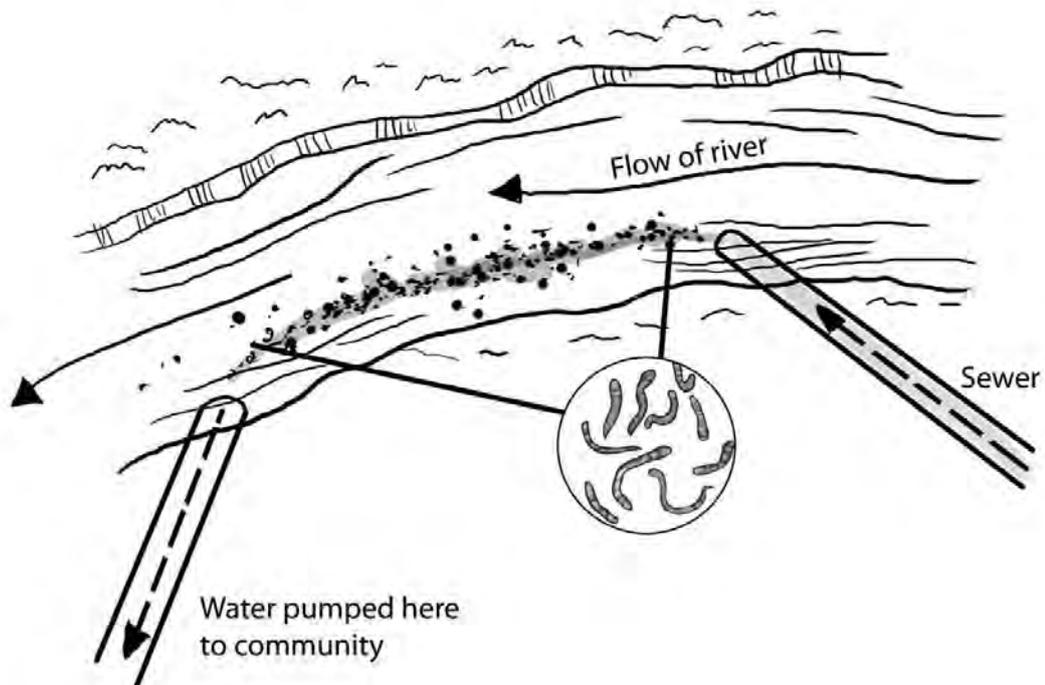
- near where a contaminant enters the water such as an effluent discharge point
- where contamination is occurring, such as a swimming area.



**Fig. 6.14: Faeces contaminate drinking water.**



**Fig. 6.15: People washing or swimming in a water source can pollute it.**



**Fig. 6.16: Water supply contaminated by effluent discharge.**

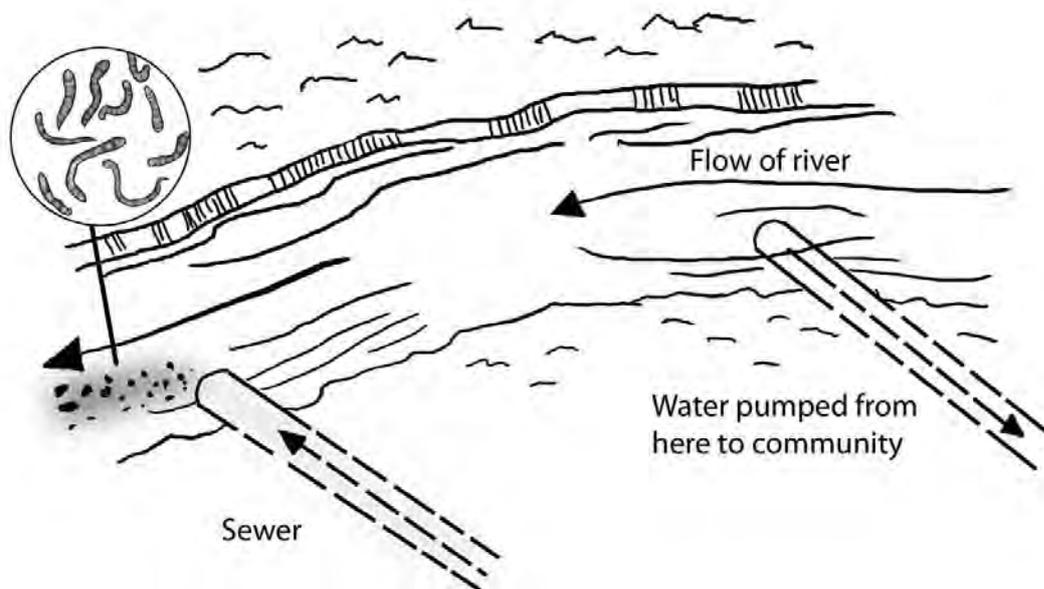
### Prevention

It is important to try and stop the river or billabong from being contaminated, particularly in the area from which the community takes its water supply. Discharging effluent into rivers and streams should always be avoided.

Sometimes it is not possible to stop the contamination of a river or billabong. This is because the contamination source is not known, or cannot be controlled, like if the contamination is occurring upstream or is because of not being able to keep cattle out of a billabong.

The following prevention methods can be adopted:

- (a) If the community water supply comes from a river make sure:
  - » it is obtained upstream from any possible contamination sources, for example, swimming holes or effluent runoff points
  - » it is taken from the deepest possible point in the body of water.
- (b) Make sure that there is little or no building development near the water supply source. There are laws which control where people can put septic tanks/leach drains, effluent ponds, and rubbish tips in relation to water supplies.
- (c) Make sure people do not use the area around the water supply source for recreational purposes, such as playing sport and having picnics.
- (d) In the case of a billabong, it may be possible to fence the water source to prevent contamination by people and other animals.



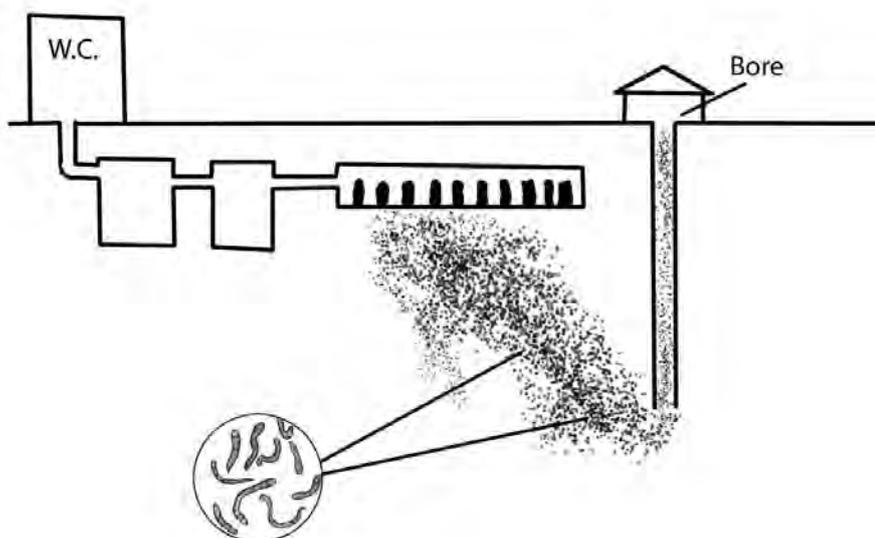
*Fig. 6.17: Take drinking water upstream from effluent discharge.*

## **Bores**

### Contamination

Bores can become contaminated:

- underground. (This can happen if a contaminant is able to get to the water body, for example, if a leach drain is built too close to the water source, or a faulty effluent disposal system allows disease-causing germs to soak down into the groundwater)
- while bringing it to the surface.



*Fig. 6.18: Leach drain too close to water supply.*

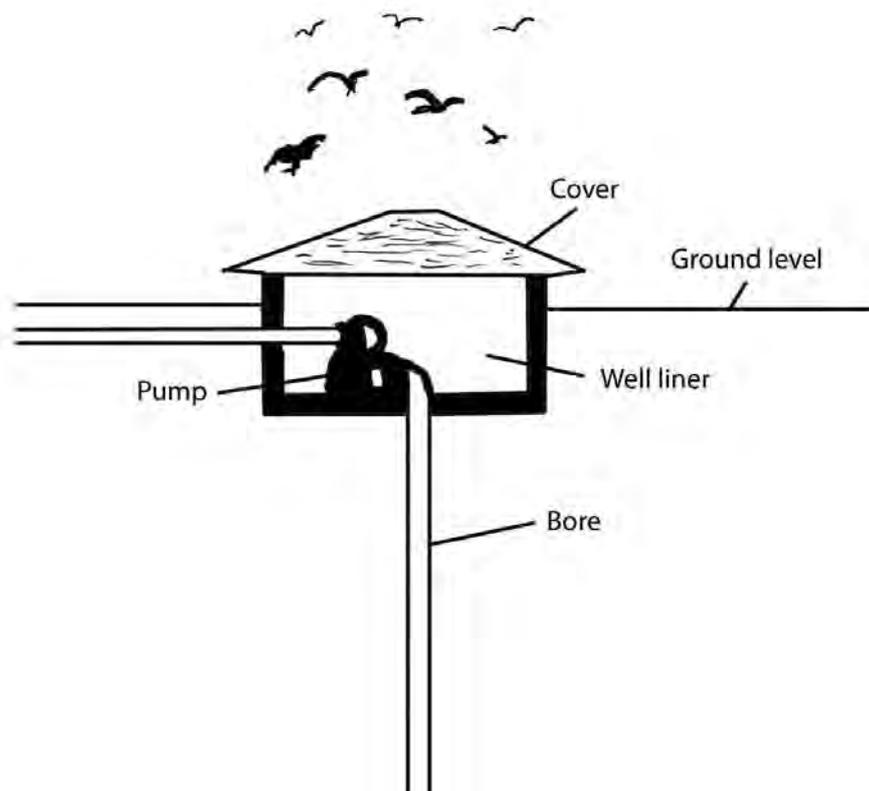
This could occur in the bore itself or at the place where the bore pipe comes out of the ground. This is called the **bore head**.

If the bore head is unprotected then animals can spread disease causing germs and parasites to the water via the equipment. For example, if the equipment leaks and allows water to pool, animals will be attracted (especially stock and birds) and their faeces may enter the water at the bore head.

### Prevention

It is important that:

- (a) covers be placed over bore heads
- (b) there are fences around bore heads to keep animals away
- (c) the bore head area is protected from flooding as this can carry disease-causing germs into the bore. The bore head is usually protected by raising it above ground level
- (d) septic tanks/leach drains and effluent disposal sites are well away from the bore.



*Fig. 6.19: Protective cover for bore.*

**Laws control the distances these facilities must be away from a bore or water source.**

## Community water tanks

### Contamination

If a large community tank does not have a proper fitting lid, then people, especially children, birds or other animals may find their way into it and contaminate the water with disease-causing germs.

Occasionally, the inside of the community water tank will get dirty and can contaminate the water.

### Prevention

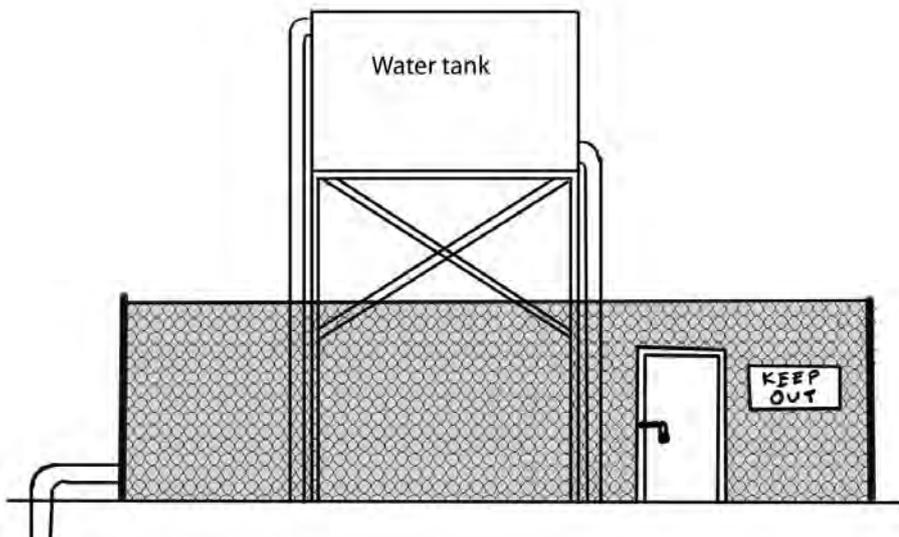
To make sure that the water in the community tank is always clean:

- The tank should have a proper fitting lid.
- There should be a high fence, with a locked gate, around the tank.
- The tank should be regularly inspected to make sure that it is not leaking and that the water is clean and free of animals, such as frogs.
- If the inside of the tank is dirty it must be cleaned. The proper way to clean a tank is described in Section 6.2.

## Community water pipes and household plumbing

### Contamination

A water supply can become contaminated between the source and the community water tank or the user. The pipes that carry the water can be below or on the surface of the ground. They can be above the ground also, such as in the case of pipes carrying water from an elevated tank to the ground. An elevated tank is one that is raised above the user's water outlets either on a stand or on a hill.



*Fig. 6.20:  
Community  
elevated water  
tank.*

If a pipe is leaking around a joint or has been broken, disease-causing germs and parasites can get into the water and contaminate it. These germs and parasites can come from:

- the surrounding soil
- the wind
- animals, including people, attracted to leak or the pools of water.

### **Prevention**

Contamination of water in pipes can be avoided by ensuring that:

- all joints are maintained free of leaks
- pipes are placed below ground whenever possible to protect them from damage
- any above ground pipes are held secure and are protected from damage, especially from vehicles
- any leaks or broken pipes are repaired as soon as possible
- connections to tanks, pumps and bores are well maintained and kept free of leaks.

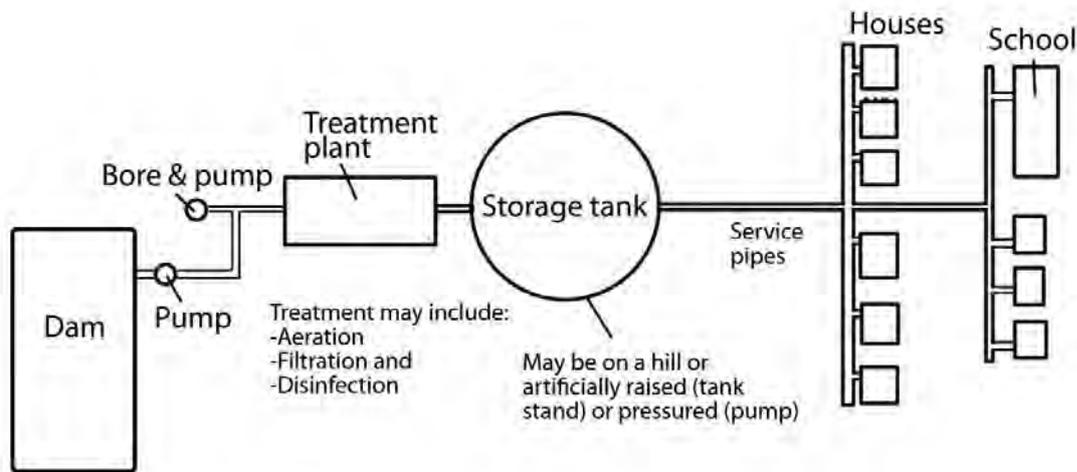
## **3 Community water supplies**

### **3.1 TOWN COMMUNITIES**

The supplier of water to most cities and towns is the state or territory water authority. Communities which are situated near towns usually get their water from the town water supply.

In these communities, the water is pumped from its source which is usually a dam or bore. The water is treated for possible contamination and is then stored in large tanks or reservoirs.

From these tanks or reservoirs a complex system of underground pipes takes the water to the community's houses, schools, hospitals and other users.



**Fig. 6.21: Plan of large community water supply.**

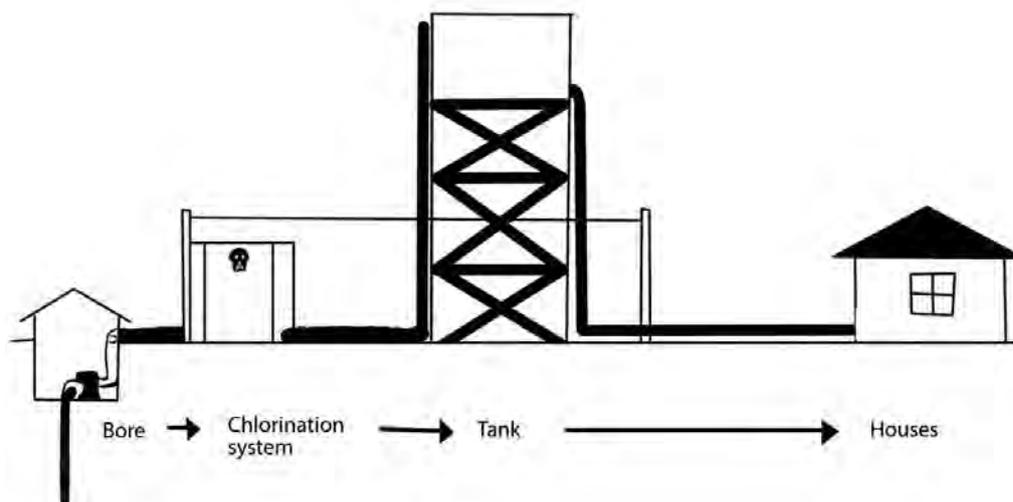
It is the supplier's responsibility to maintain the water supply equipment. Normally, this will be the water authority. The supplier usually looks after all pipelines to houses and other buildings. Maintenance and repair of water plumbing in the yard or house is the responsibility of the owner of the house.

### 3.2 BUSH COMMUNITIES

Most communities that are situated away from towns get their water supply from a bore. The bore is sunk in an area where the water is cleanest and most plentiful. Sometimes, water for a bush community is pumped from a river, pool or billabong.

The bush community's water supply is a smaller version of a town water supply. When the water is pumped from the bore it is first treated to make it clean and free of germs. It is then pumped into a storage tank.

From the storage tank a network of pipes carries the water to the houses, the school, the clinic, the shop and any other buildings.

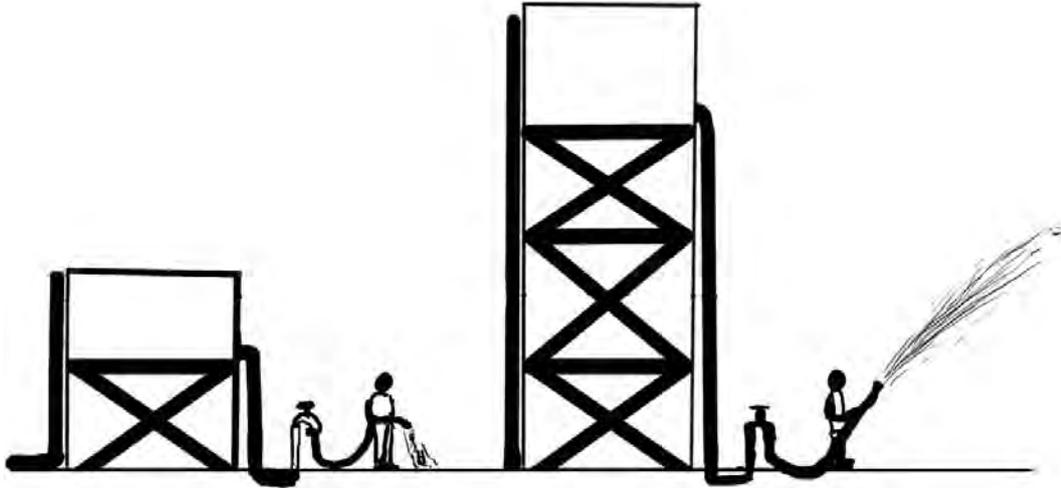


**Fig. 6.22: Small community water supply.**

### 3.3 THE ELEVATED TANK

Community water tanks can be set on high stands or placed on a nearby hill. The reason is that the elevation (height) of the tank creates the water pressure at the tap.

The higher the tank above the taps in the community, the greater is the water pressure at the taps. The maximum (greatest) height for a community water tank is usually 12 metres.



*Fig. 6.23: The higher the tank the greater the pressure.*

If water pressure at the taps was not created by elevating the tank, the water from the taps and hoses would dribble out very slowly or no water would come out at all, for example, it might take an hour to fill the toilet cistern or it might be impossible to have a proper shower.

### 3.4 PIPE LAYOUTS IN THE COMMUNITY

Water pipes come in different **widths**. The width of a pipe is the measurement of its **diameter**. The diameter is the distance across the centre of the pipe. Some measurements are taken across the inside of the pipe, and others from the outside.

House plumbing is usually copper or sometimes PVC. Copper is always used to carry hot water. Other water supply pipes around a community are usually PVC.

The water pipes around houses are usually 12 mm pipes, although 18 mm or 25 mm pipes are sometimes used. Pipes of these sizes would be too small to bring the water from the storage tank to all the houses and other water users, such as the clinic and the shop. These pipes are much larger and are strong enough for the high water pressure. They are called **main water pipes**.

For a small community the main water pipe from the supply tank to the houses is usually a 50 mm PVC pipe. For larger communities a 100 mm PVC pipe is used and

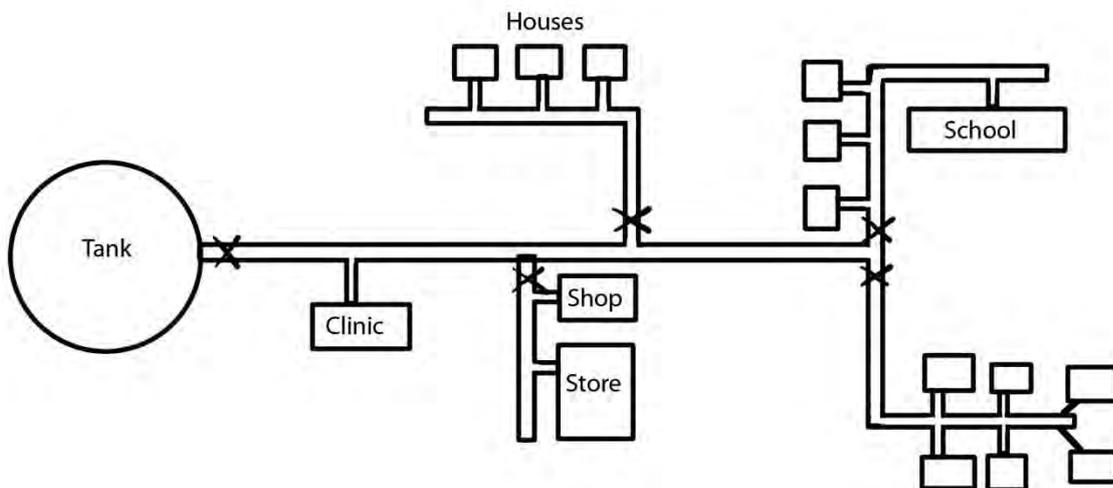
very occasionally, a 150 mm PVC pipe. The larger pipe is used when there are lots of houses to be serviced or when the water has to be transported over a long distance. This larger pipe gives a better flow so that the pressure is not lost at the tap.

To get water from the main pipe to houses and other places, smaller branch pipes are taken from the main pipe. The main pipe will get smaller in size as the branch pipes are taken from it. This maintains the pressure to the water users regardless of their distance from the tank.

Depending on the community layout, individual water users will obtain their water service from the branch pipes or sometimes in small communities, directly from the main pipe. Pipes used to take the water from the main into the houses and other buildings are usually 18 mm PVC.

At several points along main pipes there are taps (or valves) which allow the water to be turned off. One of these taps is at the tank so that the whole community's water supply can be shut off if necessary.

Other taps are usually placed where branch pipes go off from the main. This is done so that only one branch needs to be shut off if a break occurs or if some maintenance work needs to be done.

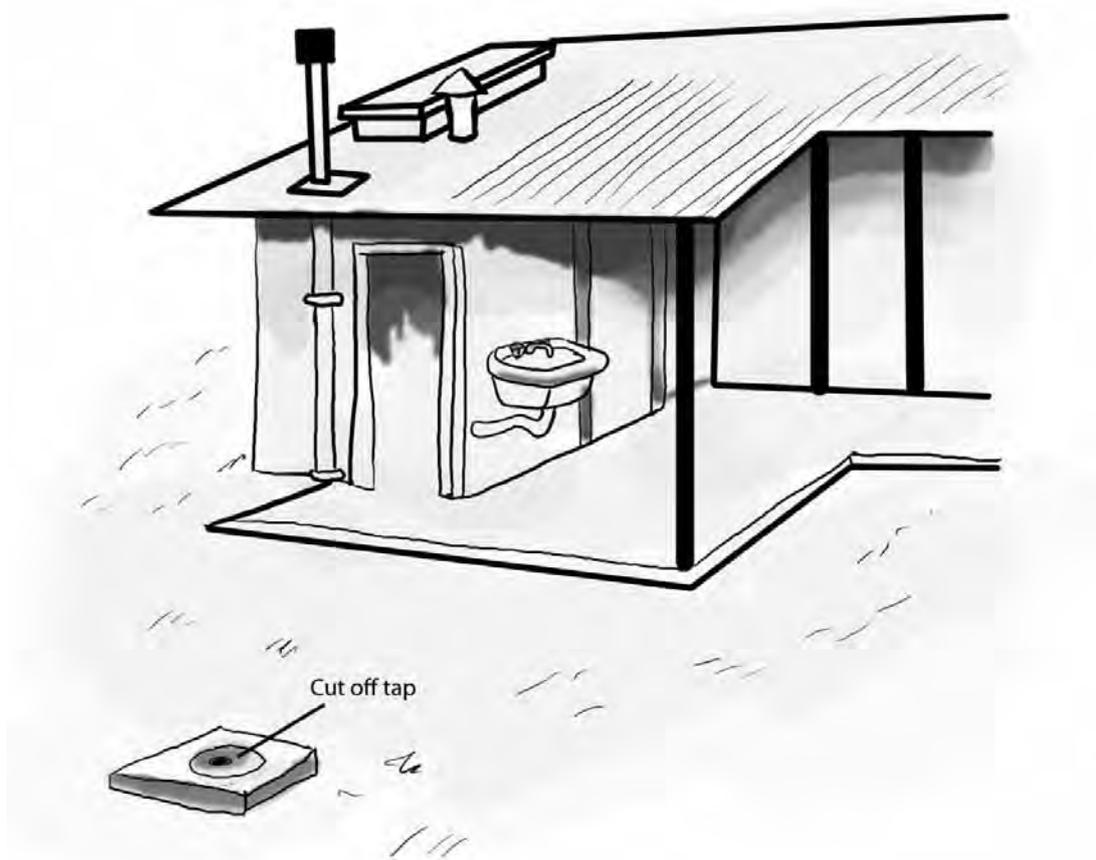


**Fig 6.24: Plan of community water supply showing cut-off taps.**

The government water authority has plans of the water supply system for most communities. These plans can be obtained through the community office.

It is wise for each community to try and get a copy of the plan of its own water supply system. This will help the EHP and/or other people to find all the underground pipes and the cut-off taps in the system.

Each house or building supplied with water has its own **main cut-off tap**. This tap is set in the pipe coming into the house from the main or branch water pipe. It is normally located in the ground not far in from the fence line of the house. If this tap is turned off, all the water to the house is stopped. Each householder should know where to find the main cut-off tap.



*Fig. 6.25: House cut-off tap.*

## 4 Water supply contaminants and disinfection

### 4.1 WATER SUPPLY CONTAMINANTS

There are four main types of contaminants that can be found in water that is taken from bores, rivers, billabongs and lakes. These are germs, suspended solids, dissolved salts and chemicals.

#### **Germs**

These deserve the greatest attention because of the health risk they present to everyone in the community.

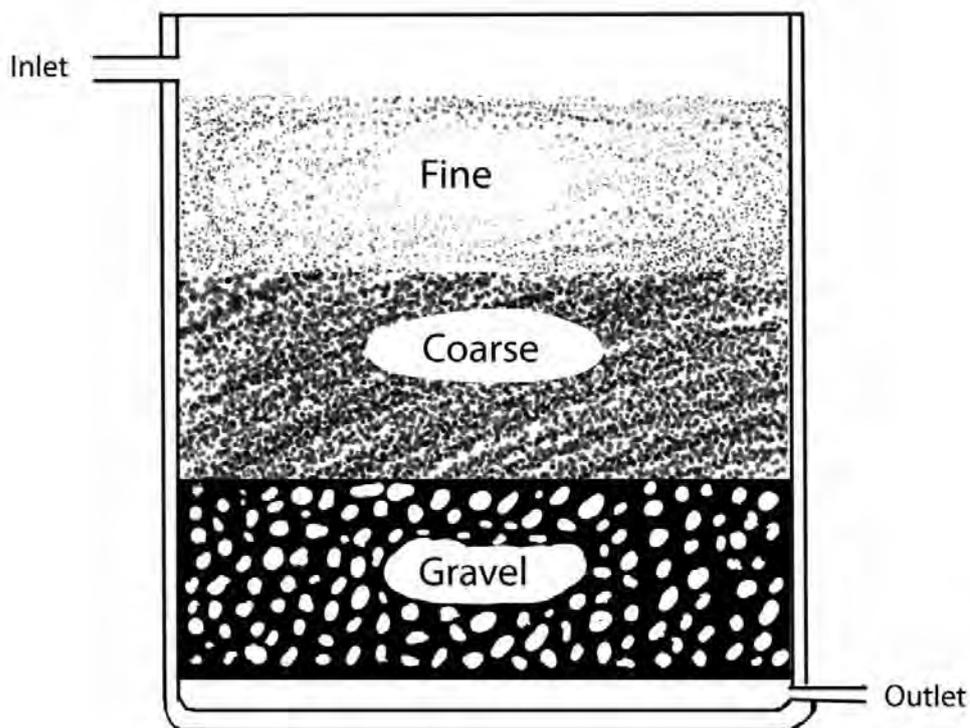
Nearly all the water collected from bores, rivers, lakes and billabongs has to be checked regularly and if necessary treated to make sure it is free of germs. Rainwater collected with equipment known to be free of germs is probably the only type of water supply that does not normally have to be treated.

When searching for the source of germ contamination of a water supply, it may be necessary to check the whole supply system to try and find the point at which the germs are entering the water. This may be at the water supply source, the tank, anywhere in the pipelines or a breakdown in the water treatment system.

### **Suspended solids**

Suspended solids include small particles of clay, iron oxide or plant matter which hang in the water and give it a murky (dirty and cloudy) appearance.

These solids can be removed by letting the water stand to allow solids to settle. Suspended solids can also be removed from water by filtration. This means running the water through very fine material which will catch the solids.



*Fig. 6.26: Water filtration through coarse and fine sand and gravel.*

## Dissolved salts

As rainwater runs over the ground and down into the soil it sometimes comes into contact with limestone and similar rocks. Small amounts of minerals from these rocks dissolve in the water, in much the same way as sugar is dissolved in cups of tea. These minerals are the salts of sodium, calcium and magnesium. For example, sodium chloride (common salt), calcium carbonate (limestone) and magnesium sulphate.

The dissolved salts make the water **hard**. Hard water is what causes the white crust to form on the elements of electric kettles and on the inside parts of toilet cisterns. Soap will not lather easily in hard water. People may get an upset stomach from drinking hard water.

Hard water can be made **soft** by treatment with chemicals. However, this is not often done. Provided the mineral content is not too great and a danger to health, most people can put up with hard water.

## 4.2 DISINFECTION

Treating a water supply to kill germs is called disinfection. Communities get their water from sources such as bores, rivers, lakes and dams. The water from these sources is often contaminated; sometimes only slightly, sometimes badly. This is why the water supplier makes provision for water treatment (usually chlorination) between the water source and the storage tank or in the tank. This treatment should keep the water free of live germs and parasites.

These are some methods of disinfection:

### Chlorination

Chlorination uses chlorine chemicals to kill the germs and should leave sufficient **free residual chlorine** in the water. This is a little extra chemical in the water which acts as a safety buffer against further contamination. That is, if all the germs in the water at the storage point are killed, there is still some chlorine left to attack any other germs which might get into the water system in the tank or the pipes which take the water to the community, for example, via a cracked or leaking pipe or tank.

**The recommended level of free residual chlorine in drinking water is between 0.2 and 0.6 ppm (parts per million) or mg/L (milligrams per litre).**

This means that there is between 0.2 and 0.6 parts of chlorine per million parts of water, or 0.2 and 0.6 milligrams of chlorine per litre of water. These units of measure are basically the same and either can be used in detailing the measured level of chlorine.

Swimming pool free residual chlorine levels are much higher than the level in drinking water.

The length of time which the chlorine needs to kill the germs depends upon the level of water contamination. It is important to note that at times the water supply, especially at the source, may be so badly contaminated that normal levels of chlorination will not be enough.

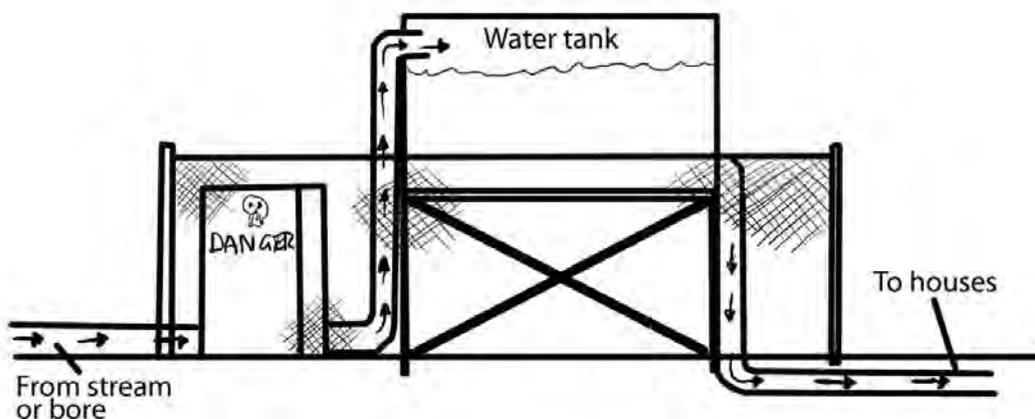
**For example:**

- a rotting carcass of an animal such as a cow or dog may have contaminated the water source
- a sewage leak or sewage dumped near the water source
- rubbish dumped near the water source
- water has high levels of iron

There are three main chemicals used to chlorinate water:

**Chlorine gas**

Many communities have a gas chlorination system for their water supply. Cylinders of chlorine gas are connected to the water supply line. The gas is automatically fed into the water at the correct dosage to make sure that all germs are killed.



***Fig 6.27: Gas chlorination of a small community water supply.***

Chlorine gas is yellow-green in colour and has an irritating, sharp smell. It is an extremely poisonous gas and breathing even small quantities can be fatal.

If the gas chlorination system breaks down and causes chlorine gas to leak into the air, the EHP should make sure that no-one goes anywhere near the area and that the water supplier, is notified (told) immediately. People who enter areas into which chlorine gas has leaked must wear full breathing equipment (air tanks).

### **Sodium hypochlorite**

The chlorine can also be combined with other substances. These can be in solid form or as a solution (liquid).

Sodium hypochlorite is one of these substances. This comes in a liquid form. Sodium hypochlorite is used where the chemical has to be added to the water on a regular basis. For example, in swimming pools or water tanks where the chlorine level needs to be checked every few days and sodium hypochlorite added as necessary.

Particular steps need to be taken in checking the chlorine level in drinking water and in adding more chlorine to the water. These are dealt with in Section 6.1.

### **Calcium hypochlorite**

This is another chemical in which chlorine is combined with other substances.

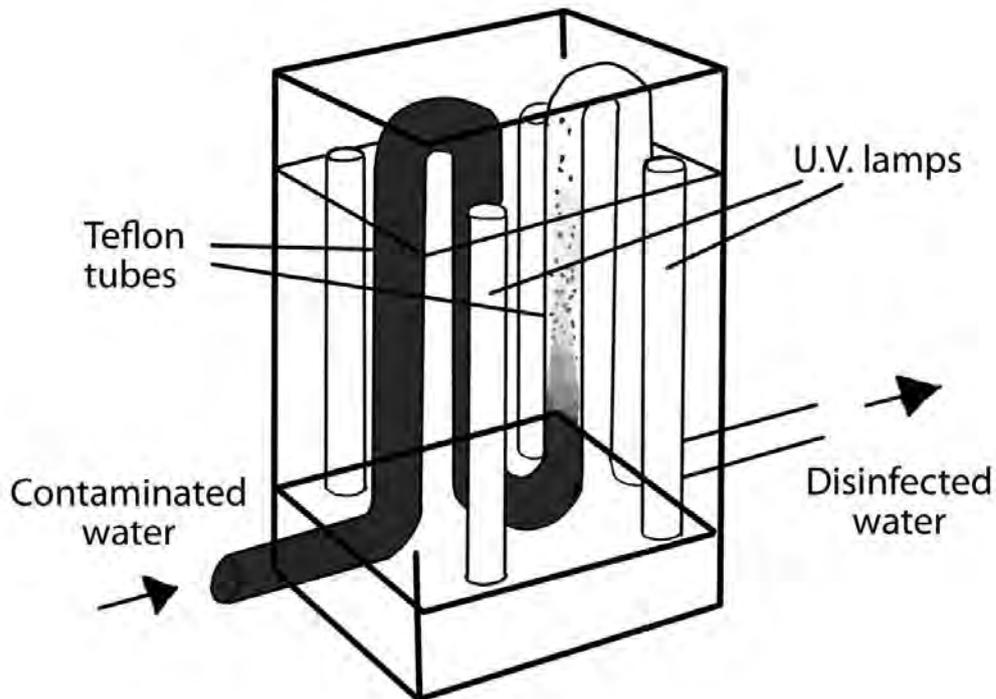
Calcium hypochlorite comes as a white powder. It is often referred to as 'A chlorine'. It is used for the same purpose and in the same way as sodium hypochlorite. It is also discussed in Section 6.1.

Calcium hypochlorite is not as strong as sodium hypochlorite in its germ killing action. However, it is cheaper to buy and is used more often.

### **Ultraviolet (UV) light**

Ultraviolet light cannot be seen by the human eye. However, when it is produced in a lamp (tube) other types of light are also produced which can be seen.

When the ultraviolet light is strong enough it is able to kill germs. The water flows through a container in which ultraviolet light producing tubes are set. The water pipes are placed between the ultraviolet light tubes. These pipes are made of Teflon which allows the UV light to pass through into the water and kill any germs present.



**Fig 6.28: Ultraviolet light unit for water disinfection.**

One disadvantage of ultraviolet light disinfection of water is that there is no residual effect. Germs are killed only at the point of contact with the ultraviolet light. Germs will not be killed if contamination occurs after the water has left the disinfection plant. Chlorine may still have to be added to provide the residual effect.

### **Filtration**

When water is run through fine sand, the filtration process removes suspended solids.

Water supplies for large towns often have their disinfection systems assisted by filtering the water through large sand beds before chlorination. This will reduce the chemicals required for disinfection. However, this is rarely used in smaller water supplies.

### **Boiling**

If none of the above methods is possible then boiling water for 5 minutes is an effective way of killing germs. Obviously this method would be only useful for small quantities of water. However, it is a good way of getting safe drinking water in an emergency or in a temporary bush camp.

## 5 Contaminated water supplies

### 5.1 SIGNS OF CONTAMINATED WATER

It is important for the EHP, or whoever is in charge of the water supply within the community, to constantly monitor the quality of the water.

One sign that the water supply might be contaminated is when several people from different families in the community become sick at the same time. A contaminated community water supply can make lots of people sick at the same time.

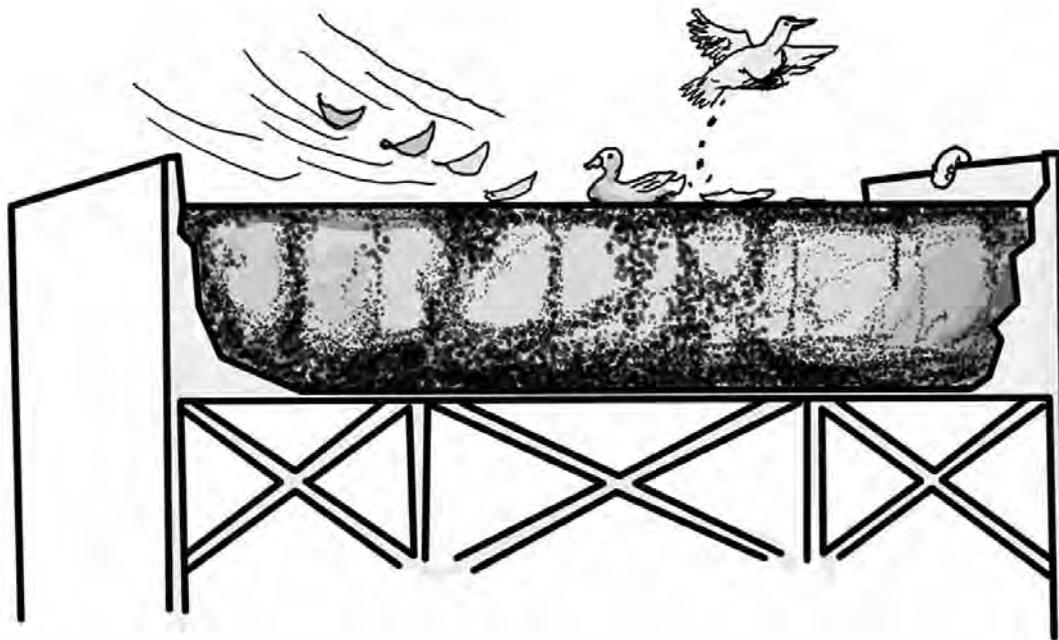
Remember, however, such sickness may also be caused by contaminated food or vectors carrying disease-causing germs.

It is, therefore, a good idea to occasionally check the complete water supply system for any problems. If any are found they must be fixed. It might be necessary to call the water supplier for help in locating and fixing the problem. Where contamination by germs is suspected, sampling of the entire water supply system is recommended to find the contamination source. This is done by working through the water supply system and sampling at different places.

The results of these samples will show which parts of the system are contaminated and where the contamination may be happening.

It is important that every water tank is inspected regularly for signs of water contamination. These are signs that the water in the tank is contaminated:

- The water is a green or brown in colour.
- Green slime is growing on the sides or bottom of the tank.
- Faeces, rotting leaves or dead animals are in the water.
- Live animals, such as frogs, are in the water.
- There is no lid on the tank.
- The lid of the tank is not on tightly or is rusty and has holes in it.



*Fig. 6.29: Contaminated water tank.*

If any of these problems are found, steps must be taken immediately to correct the fault so that water quality is maintained. This usually means making repairs to or cleaning out the tank. The procedure for cleaning a water tank is covered in Section 6.2.

## **5.2 TESTING FOR CONTAMINATED WATER**

Water sampling and testing drinking water supplies in communities is undertaken by either the water supplier or the EHO from the local authority. Who does this job depends upon which of the two agencies has responsibility for providing the water supply. EHPs should make themselves known to these agencies so that they can assist in sampling programs. However, some communities may not have a regular sampling program.

If the results of the tests show there are germs in the water supply, steps will have to be taken to remove the germs and their source. For example, if the water bore is found to contain germs, the source of the germs will have to be found and fixed if possible. Where this cannot be done, the water in the tank will have to be more strongly chlorinated.

The EHO can make sure that EHPs follow the correct sampling procedure.

**The EHP must talk with the EHO or the water supplier before doing any water sampling.**

They will authorise any water sampling so that the community will not be charged for the cost of the test/s. If the EHP is to assist in water sampling programs, he/she

should check with the EHO or water supplier before taking samples to make sure that all the necessary procedures are being followed, such as the correct way to send the sample/s to the laboratory for testing.

### **Routine water tests**

There are two kinds of tests which may be routinely carried out on a community water supply:

#### **The test for germs**

Coliform bacteria is one of the most important germs that is looked for in water, in particular one type of coliform called E. coli (Escherichia coli).

Coliforms indicate faecal pollution. Faecal coliforms, including E. coli, indicate human faecal pollution.

This test is complicated and is done at professional laboratories.

#### **The test for the chlorine level in the tank**

This test is done to make sure there is enough chlorine in the water to produce sufficient free residual chlorine. If testing shows the correct free residual chlorine level, the water should be free of germs.

### **Other water tests**

Another test can be done to find out what chemicals there are in the water. This can include testing for salt and hardness or other chemical contaminants.

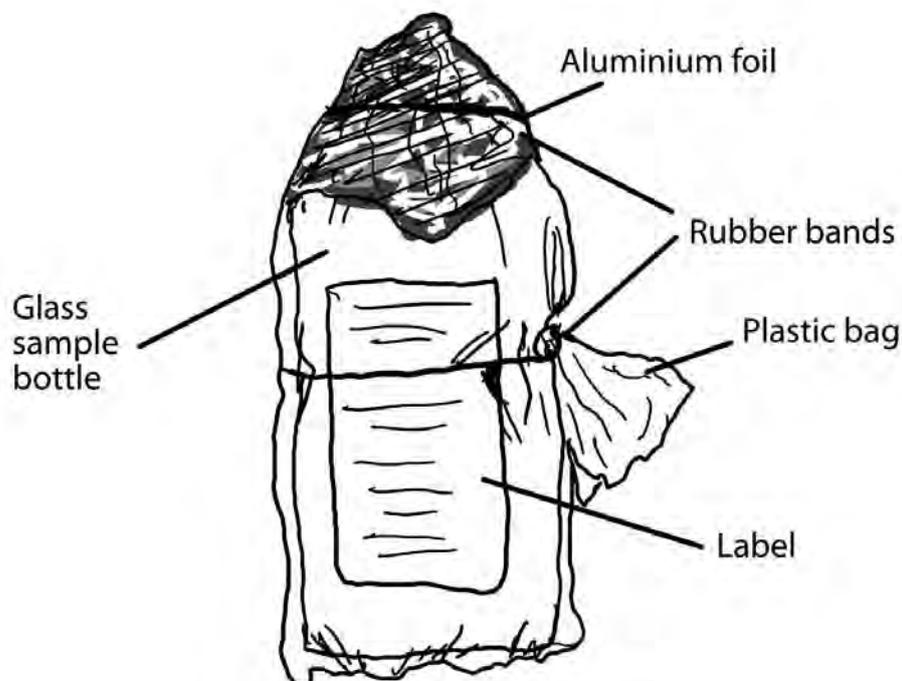
Tests for some parasites in a water supply can also be done. Special samples of the water similar to those taken for germs must be submitted to a laboratory where the water will be examined. If such tests are required the EHP must contact the local EHO or the EHP supervisor before sampling.

### **Taking a water sample**

To test the water supply for germs the water sample is taken in a special water **sample bottle**. Each bottle has its own label and comes in a sealed plastic bag. Make sure the cap is screwed on properly to protect the sample from contamination.

Any chlorine in the water is **neutralised** as soon as it enters the bottle. Neutralising means using a chemical action to combine the chlorine with another substance so that the chlorine is no longer free to act on germs while it is being transported to the laboratory. The substance in the bottle which neutralises the chlorine in the water is sodium thiosulphate.

Neutralising the chlorine in this way gives a true indication of the drinking quality of the water at the moment of sampling. If the chlorine is not neutralised it will continue to kill the germs in the sample before it gets to the laboratory. The test would then show a water supply that is potable even though the sample may have contained germs when it was taken.



**Fig. 6.30: A water sample bottle.**

Several things must be remembered when taking water samples to test for germs:

- The water samples will have to be sent to an approved laboratory for testing.
- The water samples must be kept on ice while they are transported.
- The water samples should be at the testing laboratories within 6 hours of being collected. However, water samples can be accepted for up to 24 hours after the time of collection. EHPs or others collecting samples should contact their testing laboratories for guidelines on transit times for samples.

Before the EHP takes any water samples he/she must be properly prepared to do the job. This means:

- (a) obtaining the necessary equipment. These include:
  - » bottles, forms, eskies and freezer bricks. These can be obtained from the professional laboratories

- » a gas or methylated spirit burner if sampling from a tap. A methylated spirit burner can be a piece of cottonwool attached to the end of a length of wire and soaked in methylated spirits.
- (b) contacting a professional laboratory for sampling kits
- (c) organising the quickest possible transport of samples to the laboratory. There may be a charge for transporting samples
- (d) remembering to **label the bottles** prior to taking the water sample. Once the bottle is wet it is difficult to write on the label. Also remember to fill **out the sample submission form** and have the correct address put on the esky.

When the water sample is taken from the water body, it is essential that **no germs from any other source get into the bottle**. The main outside source of germs will be the EHP's hands. When handling the bottle **do not touch the lip of the bottle or the inside of the cap**. Always try and hold the cap so that the inside faces the ground but never place it on the ground.

Water samples may need to be taken from any one of three different situations:

- Running water from a tap.
- Flowing water such as a river or stream.
- Still water such as a tank, dam or billabong.

Each of these situations requires a different sampling technique.

#### Water sampling from a tap

- (a) Run water from the tap for one minute.
- (b) Turn off the tap and sterilise it by flaming it for 30 seconds with a flame from a gas burner or methylated spirits burner.
- (c) Run the water again for 20-30 seconds.
- (d) Hold the bottle by the base, remove the cap and then take the water sample.
- (e) Immediately recap the bottle and place the bottle in its plastic bag.
- (f) Place the sample in the esky with a freezer brick. The completed sample submission form can be placed in an envelope in the esky.

Water sampling from flowing water

- (a) Remove the bottle from its plastic bag, holding the bottle near the bottom.
- (b) Remove the cap from the bottle.

- (c) Hold the bottle upside down and lower it into the water to about elbow depth.
- (d) Turn the bottle so that the top is slightly higher than the bottom and the lip of the bottle is facing into the flow of water. By facing into the flow of water, germs from the person's hand or arm are taken away from the sampling area. Fill the bottle with water.
- (e) Remove the bottle from the water and complete the procedure as for water from a tap.



*Fig. 6.31: Water sample from tap.*



*Fig. 6.32: Sampling flowing water.*

### Sampling still water

The procedure is basically the same as for running water. The only difference is when the bottle is turned ready to fill, the bottle should be gently pushed forwards to create an artificial flow while it is being filled. The flow of water takes any germs from the person's hand and arm away from the sampling area.



*Fig. 6.33: Sampling still water.*

There may be a time when an EHP finds it necessary to submit water samples from a swimming pool for testing. This type of water sampling requires a special number of samples to be taken and special transport arrangements. If this type of sampling needs to be done it is important to contact the local EHO to find out the correct procedure.

### Sampling water for chemicals

Sometimes the community water supply is tested for chemicals or minerals, such as salts and metals which may have dissolved in it. In this case, it is not necessary to be so careful about not getting germs into the sample bottle. Get the sampling bottles from the laboratories and sample according to these procedures:

- (a) Mark the bottle with source, identification, number and date.
- (b) Run water for one minute.
- (c) Take the sample.
- (d) Seal the bottle and fill in the form giving sample details. Sometimes there is no form to fill in and when this happens a letter explaining the sample must be provided.
- (e) Send off the sample and letter or completed form. This sample undergoes different tests to those for germs and, therefore, goes to a different laboratory. As there are several laboratories which do these tests, arrangements will need to be made with the laboratory before sampling.

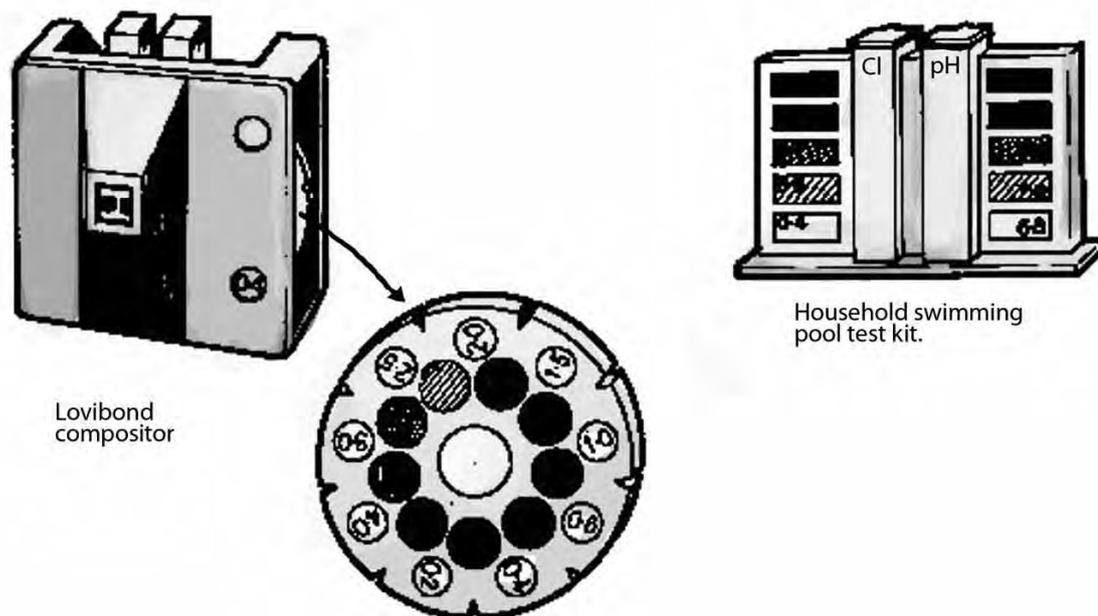
Contact your local EHO or EHP supervisor for information regarding:

- the laboratory to which such samples should be sent
- the transport method
- any costs for testing and transport.

### **Testing for chlorine**

The water in a community tank should be regularly tested for the amount of **free residual chlorine**. If it is not high enough germs in the water may not be killed and the water may not have its chlorine safety buffer against further contamination.

The chlorine level in water is usually tested with a **chlorine test kit**. The most common is a Lovibond Comparitor or a photometer although sometimes a less accurate swimming pool water test kit can be used. Both kits can also be used to test pH (the acidity or alkalinity level) of the water.



**Fig. 6.34: Chlorine level testing kits.**

The Lovibond Comparitor has two chambers in the centre for placing the samples of water. However, the swimming pool kit provides results for both chlorine and pH at the same time while the Lovibond requires two steps and a change in test disc. The Lovibond is the more accurate of the two kits.

With either kit, drops of solution or tablets are added to the water samples in the test chambers in accordance with the instructions provided.

Always remember to rinse the sampling chambers with some of the water to be tested before taking the water sample.

The chlorine level in the water can be found by matching the colour in the chlorine chamber to the standard colours alongside it for the swimming pool kit, or on the colour disc for the Lovibond Comparitor. The Comparitor has more chlorine levels but the discs must be changed to read the pH.

The photometer is different from the Lovibond Comparitor. Instead of comparing the colours manually, the photometer tells you how much residual chlorine is in the water. Drops of solution or tablets are added to the water samples in a small tube. The tube is then shaken and inserted into the photometer for a reading.

The recommended concentration of free residual chlorine in drinking water is 0.2 to 0.6 parts of chlorine per million parts of water (0.2 to 0.6 ppm or mg/L). On the Lovibond Comparitor the result will be shown as 0.2, 0.4, or 0.6. This test kit will also have readings of 1.0, 1.5, 2.0, 2.5, 3.0 and 4.0.

## 6 Treating contaminated water

Chlorine is normally added to the water tank:

- when the germ test shows that germs are present
- as a routine task to maintain the free residual chlorine level.

### 6.1 TREATING WATER WITH CHLORINE

#### Safety with chlorine

If a water supply requires chlorination and the system does not have an automatic chlorination plant, chlorine chemical will need to be added regularly to the water in the tank. The chemical, usually a form of hypochlorite, normally comes as a solid. When it is dissolved in water it produces chlorine which kills any germs in the water and provides the safety buffer.

Because chlorine comes in different forms there are different instructions for their use. Also, the dose will depend on the amount of water in the tank and the amount of chlorine already in the water. Chlorine powders usually come in plastic buckets or bottles. Instructions for use are always written on the container. **Always read and follow these instructions.**

Sometimes the instructions for using chlorine are difficult to follow. **Always check with the EHO, the EHP supervisor, Program education staff or the water supplier before using chlorine in a water tank for the first time.**

**Chlorine powders are dangerous chemicals and must be used carefully.**

There are two dangers associated with chlorine powder:

- The powder and its solution give off chlorine gas. Chlorine gas is very poisonous.
- If the powder gets onto the skin or into the eyes it can cause painful and damaging burns.

The wet powder will also bleach (take out the colour) in clothing.

The following safety precautions should always be taken with chlorine powder:

- (a) When working with the chlorine concentrate avoid breathing in the fumes.

**Always open the concentrate packet and mix the solution outside in the open air. Never lean close to the open part of the packet or the top of the bucket when mixing the concentrate. Always put the lid back on the concentrate container once the required amount has been removed.**

- (b) Keep chlorine powder away from children and food.
- (c) Do not let the chlorine powder get wet before you mix it with water in a bucket.
- (d) Do not add the chlorine powder straight into the water tank. The correct amount of powder should first be dissolved in water in a bucket.
- (e) Always add the chlorine powder to the water, never the other way around.
- (f) When adding chlorine powder to water in a bucket, add it slowly and stir the water all the time. Avoid splashing.
- (g) Keep stirring the solution in the bucket until all the chlorine has dissolved.
- (h) If any chlorine does get onto the skin or clothes, wash it off quickly with lots of water.
- (i) The container used for measuring out the chlorine powder should be used only for that purpose.

### **Working out how much chlorine to use**

Before starting to chlorinate the water in a tank, the **volume of water** in it must be measured. This is the amount of water in the tank measured in litres or cubic metres.

**If the EHP finds these calculations difficult, he/she should check with the EHO, EHP supervisor, Community Nurse or the local school teacher.**

It must be remembered that the amount of water in the tank will differ from time-to-time and because of this, the volume of water must be worked out each time the water is chlorinated.

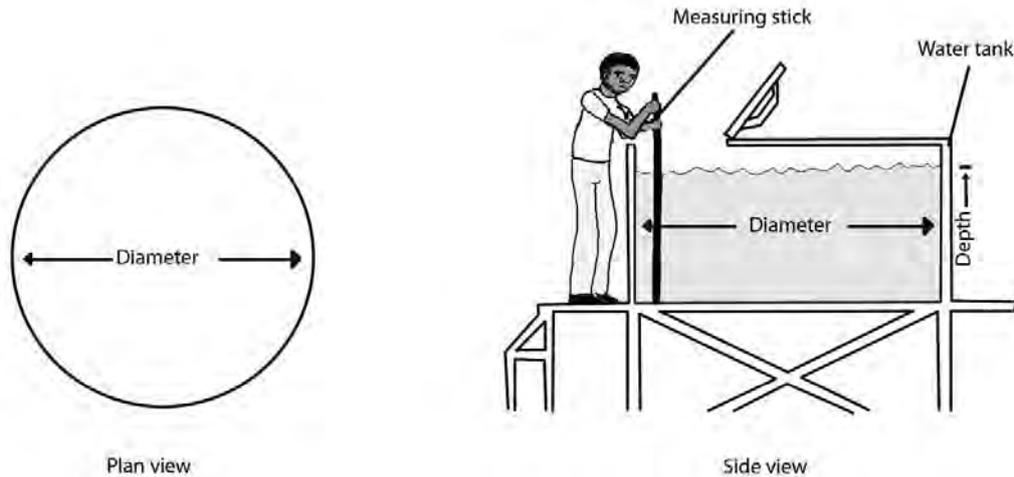
It may also be necessary to allow for any chlorine left in the water from a previous treatment. Before adding any more chlorine, the chlorine level should be measured and taken into account when calculating how much more is needed. For example, if the chlorine level is 0.2 ppm, the amount to be added will be less than if there was no chlorine.

The volume in litres can be worked out in the following way:

- (a) Using a stick marked in metres and centimetres measure the depth of the water. Write this measurement down.
- (b) With a measuring tape also marked in metres and centimetres, measure and write down the diameter of the tank. The **diameter** of the tank is the distance from one side of the tank to the other side

measured straight across the middle. Measure the depth of the water and the diameter of the tank in metres. As the diameter of the tank is not going to change, this measurement can be recorded in the office for future use.

(c) Using these measurements do this sum for a round tank:



**Fig. 6.35: Depth and diameter of tank.**

Volume in litres = 785 x depth x diameter x diameter

*Example:* Depth of water in the tank = 3.5 metres

Diameter of the tank = 3.0 metres

$$\begin{aligned} \text{Volume} &= 785 \times 3.5 \times 3.0 \times 3.0 \\ &= 24\,727 \text{ litres} \end{aligned}$$

---

**Note:** The factor of 785 used in this calculation is a simplified approximation of usual formula for calculating volume. The result is sufficiently accurate for a round tank chlorination.

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The volume of a square or rectangular tank is easier to work out. Measure the depth of water in the tank as before, and then measure two of the sides. In the case of a square tank which sides are measured is not important. However, in a rectangular tank measure a long side and a short side.

*Using these measurements do this sum for a square tank:*

$$\text{Volume} = \text{Depth} \times \text{length of one side} \times \text{length of the same side.}$$

*For a rectangular tank the sum will be:*

Volume = Depth x length of a long side x length of a short side

*Example for a rectangular tank:*

Depth of water in the tank = 2.75 metres

Length of a long side = 3.0 metres

Length of a short side = 2.5 metres

Volume in cubic metres =  $2.75 \times 3.0 \times 2.5 = 20.625$

There are 1,000 litres in a cubic metre.

Therefore: Volume =  $20.625 \times 1\ 000 = 20,625$  litres

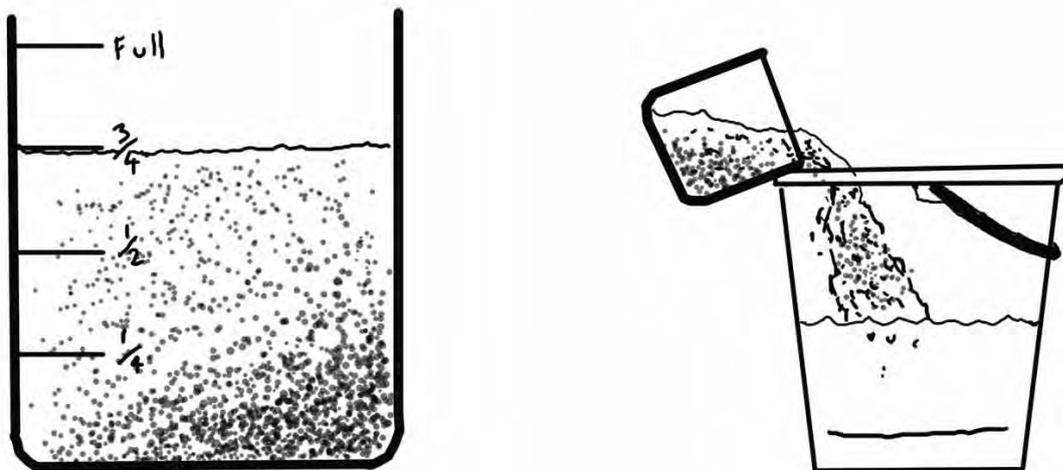
After the volume of water in the tank has been worked out, the instructions on the chlorine container will tell how much chlorine powder will need to be added to the water in the tank.

### **Adding the chlorine**

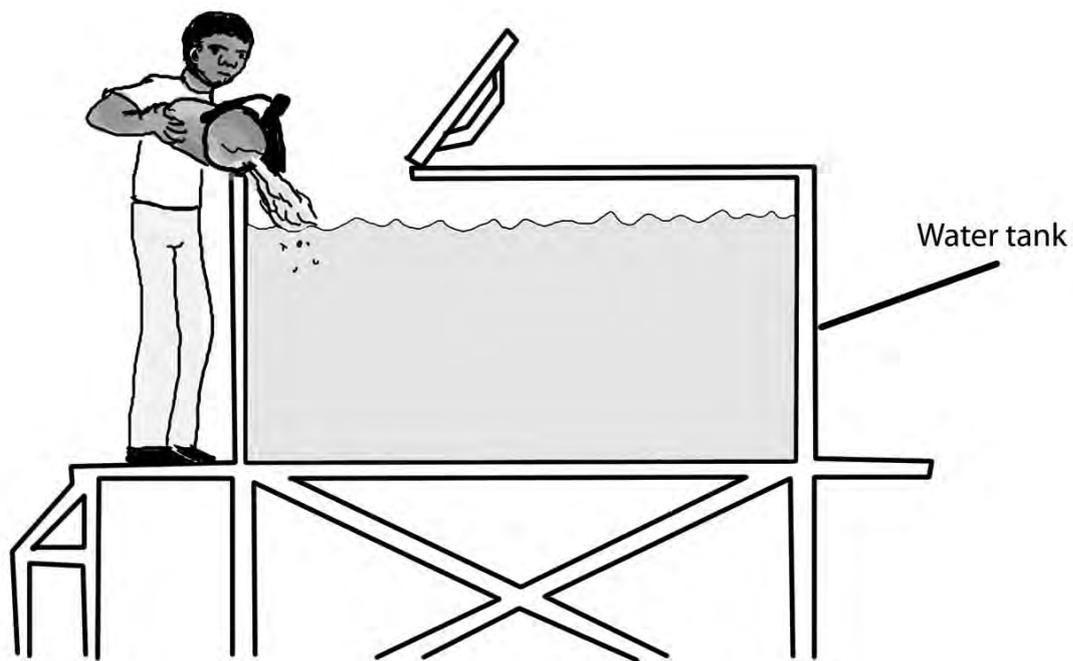
**Always** add the chlorine to the bucket holding the water ready for mixing. Never add the chlorine before the water.

- (a) Check the level of water in the tank and work out the volume of water, to find how much chlorine powder will be needed.
- (b) Measure out this amount of chlorine in the special container.
- (c) Partly fill a plastic bucket with water and get a flat paddle to use as a stirrer.
- (d) Slowly add the chlorine powder to the water and stir until it has all dissolved. **Do this out in the open air.**
- (e) Take the bucket of chlorine solution to the water tank and slowly pour it into the tank. If possible add small amounts of the solution to different parts of the tank.  

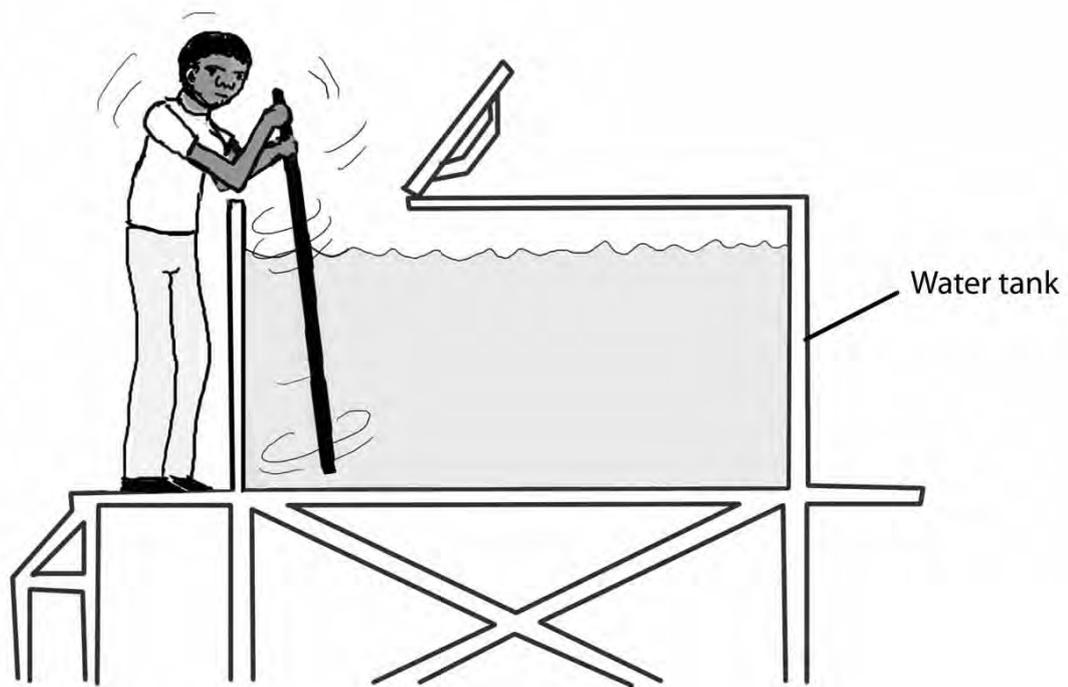
It may be necessary to climb a ladder to get to the opening of the tank. If this is the case, the EHP will need a ladder.
- (f) If possible stir the water in the tank.
- (g) Wait for 2 hours and then test the chlorine level in the tank water to make sure it is near the 0.2–0.6 level.



*Fig. 6.36: Measuring chlorine powder.*



*Fig. 6.37: Adding chlorine solution to tank.*



**Fig. 6.38: Mixing in the tank.**

If the chlorine level is less than the range of 0.2–0.6 ppm more chlorine will need to be added.

Should the chlorine level be above the 0.6 ppm level, it does not present a health problem. The high level of chlorine may make the water taste of chlorine and some people in the community may not like this. If the water is needed for drinking, let it stand in an open container or boil it. This will allow the chlorine to escape. However, if it is going to stand in the open the water must be protected from contamination.

The community may wish to take steps to correct a high chlorine level by topping-up the storage tank if there is room. Another solution to the problem is to allow some of the water to run to waste and then top-up the tank. Check the chlorine level after each of these actions.

Always remember that there should be a free residual chlorine level of 0.2–0.6 ppm after chlorination has been finished. Sometimes however, because of the level of contamination in the water, it may be necessary to add extra chlorine to kill all the germs and to get the required free residual chlorine level.

## 6.2 TANK CLEANING

Occasionally the inside of the community water tank will need to be cleaned out. This would be necessary if anything happened in the tank to contaminate the water supply. For example, a dead animal may be found in the tank, dust and dirt might be washed into it or slime may have built up on the sides.

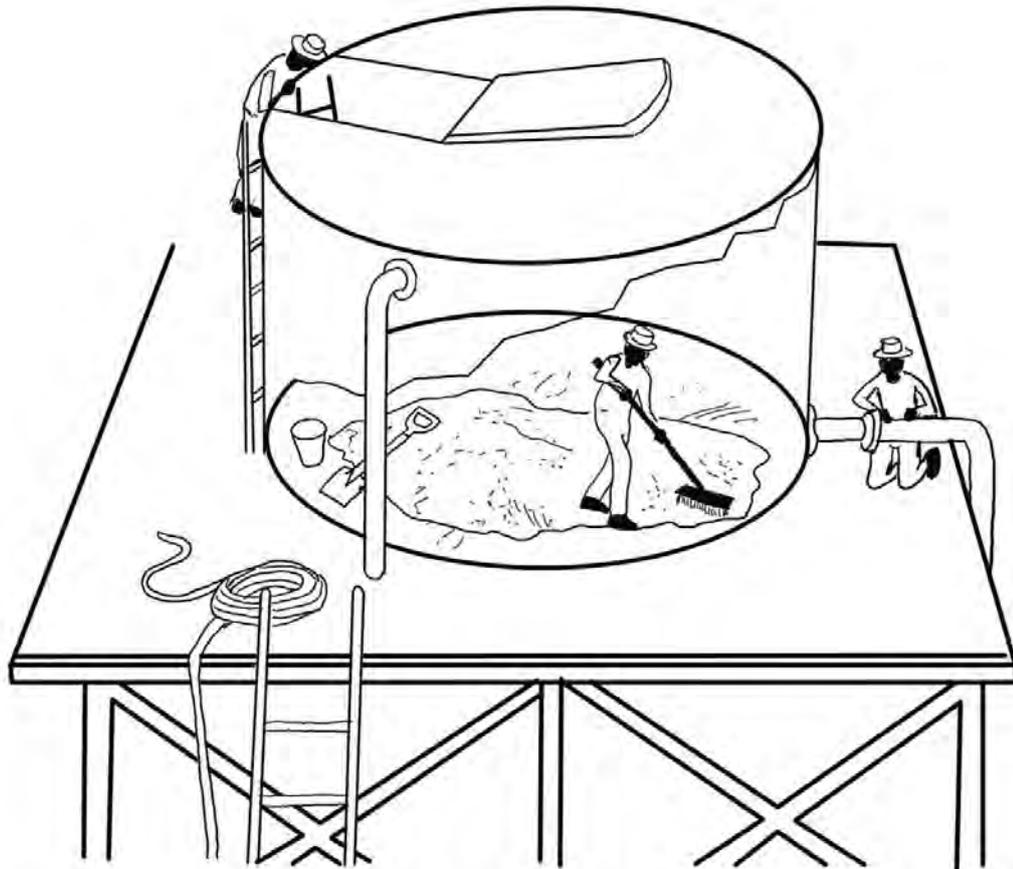
These are the steps involved in cleaning out a water tank:

### **Before the cleaning day**

- (a) Let the community people know well beforehand that the tank is to be cleaned and that the water will have to be turned off for a few hours. This will allow them to collect enough water to keep them going whilst the water is turned off.
- (b) Discuss the tank cleaning job with the water supply agency before commencing the job. The agency can provide any technical assistance especially if the system has an automatic chlorinator. There may be special precautions which need to be taken when the pump is switched off.

**If you have any problems contacting the water supply agency, the EHO or the EHP supervisor can help.**

- (c) Try and plan the tank cleaning job when the tank is nearly empty so that a lot of water will not be wasted.
- (d) Organise at least 2 people for the cleaning job. One person to get inside the tank and do the cleaning, the other to watch from the outside as a safety precaution and to assist with the cleaning job.
- (e) Make sure all the necessary equipment will be on hand to do the job. For example, a broom with hard bristles, a scrubbing brush, bleach powder, and a shovel. A bucket on a rope may be needed to lift the dirt out of the tank.
- (f) Make sure there will be enough water available to rinse and refill the tank after it has been cleaned.



*Fig. 6.39: Tank cleaning.*

### **On the cleaning day**

- (a) Turn off the pump which fills the tank.
- (b) There should be no need to turn off an automatic chlorinator. However, follow any instructions given by the water supplier.
- (c) Turn off the main tap to cut off water supply to the houses.
- (d) Disconnect the pipe which takes the water to the houses. This will allow the water in the tank to run out.
- (e) It may not be necessary to disconnect any pipes if the tank has a draining pipe and a valve which can be used to let the water out of the tank.
- (f) Empty the tank.
- (g) Make sure that the second person is outside the tank all the time the cleaner is inside.
- (h) Thoroughly clean all of the inside of the tank. It may be necessary to use a scrubbing brush. Bleach powder may help get rid of dirt and slime which has built up inside the tank.
- (i) Thoroughly rinse out the tank with fresh water and allow this water to go to waste.

- (j) Reconnect any disconnected pipes and turn on the pump to refill the tank. Turn on the main tap supplying water to the houses.
- (k) Make sure the automatic chlorinator is working properly as the tank fills or add the correct amount of chlorine when the tank is full.

## 7 Water supply plumbing

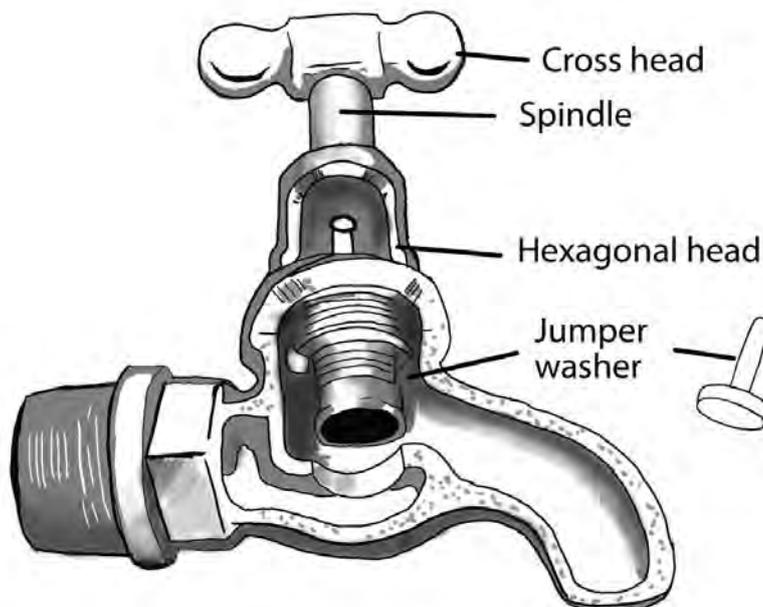
Before undertaking domestic plumbing repairs, the mains tap must be turned off to cut the water to the house. Every building supplied with water in the community will have a mains tap.

This will need to be done when fixing taps, including replacing washers, repairing split pipes or broken pipe joints.

### Taps

One of the most common water supply maintenance tasks is the repair of leaking or broken taps. A tap may require:

- a new jumper washer because the tap leaks from its outlet
- the washer seat to be smoothed because it has become pitted from use
- a new O-ring because the tap leaks around the spindle (handle). However, some new types of taps do not have this O-ring and the tap will have to be replaced.



*Fig. 6.40: Common domestic tap*

The repair of split or broken pipes is another common area of water supply maintenance. This usually requires soldering or welding and/or the replacement of a piece of the pipe.

Leaks in toilet cisterns can be very wasteful of water. However, the repair of these items is covered in Chapter 2—Sewage systems (Section 5).

For further information refer to:

- enHealth  
(<http://www.health.gov.au/internet/main/publishing.nsf/content/ohp-environ-enhealth-committee.htm>)
- Community Water Planner  
(<http://www.nhmrc.gov.au/publications/synopses/eh39.htm>).

Environmental Health Practitioners are encouraged to refer to the *Community Water Planner Field Guide* developed by the Centre for Appropriate Technologies (CAT) under guidance from Water Quality Research Australia. This guide is available online at <http://www.wqra.com.au/cwplanner/CWPlanner.htm>

EHPs should also be aware of the National Health and Medical Research Council (NHMRC)'s Australian Drinking Water Guidelines which provide advice on what is good quality drinking water. The Australian Drinking Water Guidelines can be found at the NHMRC website (at <http://www.nhmrc.gov.au/publications/synopses/eh19syn.htm>).