Chapter 5

Domestic water supply

Domestic water supply means the source and infrastructure that provides water to households. A domestic water supply can take different forms: a stream, a spring, a hand-dug well, a borehole with handpump, a rainwater collection system, a piped water supply with tapstand or house connection, or water vendors.

Households use water for many purposes: drinking, cooking, washing hands and body, washing clothes, cleaning cooking utensils, cleaning the house, watering animals, irrigating the garden, and often for commercial activities. Different sources of water may be used for different activities, and the water sources available may change with the seasons.

There is always some kind of water source present where people live, as they could not survive without one. The source may be inadequate, however; it may be far away, difficult to reach, unsafe, or give little water, making it inaccessible or unavailable. It may give water of poor quality.

Although both problems play an important role in people's health and well-being, the availability of water is often more important than quality.

5.1 Water availability

Whether water is available or accessible to people depends on the time, energy, and/or money they have to invest to obtain it. Water from a handpump that is 25m from the but always has a long queue may be as inaccessible as water from a river 1.5km away or water that has to be bought. In addition, safety problems, such as mines or a hostile population near the water may also limit accessibility.

Issues on water availability other than health

If water availability is poor, people will lose time, energy, or money that could have been invested elsewhere. If the supply is limited, people will have to be

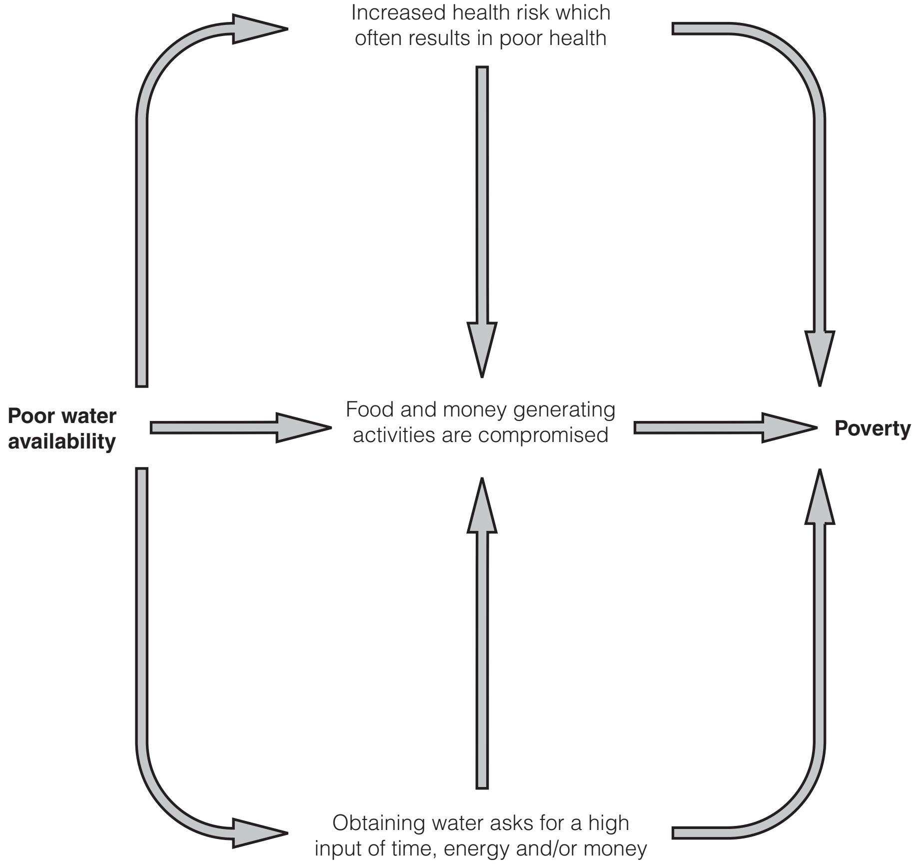

Figure 5.1. The implications of poor water availability

selective about what they use the water for. Figure 5.1 shows the implications of poor water availability to people.

Where water availability is insufficient, an effort should be made to improve the supply. It is important to ensure that making more water available to some does not take it away from others.

If a limited number of water sources are available, the areas around the sources may become degraded if too many people or animals use them. If unsustainable amounts of water are extracted, the environment may become degraded through falling groundwater levels or surface water sources such as rivers or streams may dry up. Be careful to ensure that short-term gain does not result in long-term loss.

5.1.1 Water availability and disease transmission

Poor personal hygiene favours disease transmission. The transmission of many infections can be prevented both by washing hands and by washing body and clothes. These infections are called the water-washed diseases.

People need access to enough water to be able to maintain good personal hygiene. Although good access to water does not automatically result in good personal hygiene, poor water availability will usually result in poor personal hygiene. Once there is enough water, health and hygiene promotion will often be needed to improve personal hygiene practises.

5.1.1.1 Handwashing

Contaminated hands can carry pathogens to where these can enter the body. Hands contaminated with faecal matter can transmit faecal-oral pathogens to food, water, or directly to the mouth. The soil-transmitted helminths that cause roundworm infection and trichuriasis can be transmitted if hands are contaminated with soil containing their eggs. Hands contaminated with the discharge from the eyes of people suffering from conjunctivitis or trachoma, or the contagious liquid from papules of people with yaws, can transmit these infections to other people through direct contact.

Washing hands after every contact that could potentially pick up the pathogen, and before doing anything that could transmit the pathogen onward, can prevent transmission. Faecal-oral infections can largely be prevented if hands are washed after defecation, after coming in contact with animals, and after contact with anything that could be contaminated with faeces. In addition, hands should be washed before preparing or handling food, and before eating.

Washing hands after contact with soil or anything contaminated with soil and before handling food can reduce the risk of transmitting helminths.

The transmission of trachoma and conjunctivitis can often be prevented by washing hands after touching a person's face or after handling material used to wipe somebody's eyes or face, and before coming into contact with another person's face or eyes. The risk of transmitting yaws can be reduced by washing hands after contact with contaminated skin or material.

Washing hands removes the pathogens as well as the dirt containing and protecting the pathogens (7). How effective handwashing is depends mainly on how thoroughly the hands are rubbed, and for how long. Water alone is not as effective as water with a handwashing agent such as soap or ash, which are both effective in removing pathogens from hands.

The number of pathogens will be reduced significantly if the hands are rubbed with a handwashing agent for at least 10 seconds and then rinsed with water [33]. Table 5.1 shows the groups of infections associated with poor handwashing.

5.1.1.2 Hygiene of body and clothes

Several pathogens can be transmitted through infectious skin or contaminated clothes. Certain vectors of disease live on clothes, or prefer people with a poor personal hygiene. All infections that spread by direct contact can be transmitted via direct person-to-person contact through contaminated skin or clothes.

Conjunctivitis and trachoma can be transmitted through infected skin, clothes, or other contaminated material that came in contact with infectious eye discharges. Several other infections transmitted through direct contact affect the skin, and the pathogens can be spread simply through direct skin contact, including yaws, scabies, and tinea.

Body lice, the vector of louse-borne typhus, louse-borne relapsing fever, and trench fever live on people's unwashed clothes [61]. Fleas, which transmit plague and murine typhus fever prefer people with poor personal hygiene [73]. Keeping body and clothes clean will reduce the transmission risk of all these infections.

The disease groups linked to poor hygiene of body and clothes are shown in Table 5.1.

Table 5.1. Disease categories associated with poor personal health

Risk-factors related to poor personal hygiene	Faecal-oral infections	Schistosomiasis	Water-based with two intermediate hosts	Soil-transmitted helminths	Beef and pork tapeworm	Leptospirosis	Guinea-worm infection	Spread by direct contact	Vector-borne infections
Poor handwashing	■			■ (a)	■ (b)			■	
Poor hygiene of body and clothes								■	■ (c)

(a) : the ingested soil-transmitted helminths: roundworm infection and trichuriasis
(b) : only cysticercosis
(c) : louse-borne and flea-borne infections

5.1.2 The health impact of improved water availability

Table 5.2 shows how improving the water availability and personal hygiene of people will reduce transmission of some infections.

Table 5.2. Reduction in infections associated with improved water availability and personal hygiene

Disease (group)	*Reduction in occurrence*	*Remarks*
Diarrhoea	20% [26]	increase water availability (handwashing)
Infant diarrhoea	30% [32]	wash hands with soap after defecation and before eating
Roundworm	12-37% [26]	increase water availability (handwashing)
Trachoma	30% [26]	increase water availability (washing of hands and face) [3]
Yaws	70% [29]	increase water availability (washing of body)
Louse-borne typhus/ relapsing fever	40% [29]	increase water availability (washing of clothes and body)

5.1.3 Practical issues concerning water availability

Ideally, all users should have a convenient, culturally acceptable source that provides an unlimited amount of water at an affordable price and without degrading the environment. In practise, it will rarely be possible to provide this, and a compromise will have to be made which takes into account the local social, cultural, physical, financial, and environmental constraints.

The amount of water that people need, or use, will depend on its availability and what it is used for. Factors that influence water use include the socio-economic status of the users, whether and how people have to pay for the water, whether water is easy to get, and whether water is used for special activities (e.g. irrigation of vegetable gardens, watering of animals). Table 5.3 presents figures on water needs and demands and shows the amount of water people need and how development will change water demand. Future changes in population and development level will have to be considered. Water is lost during distribution, and this will have to be taken into account when looking at how much water must be provided to a population.

In the initial phase of an emergency internally displaced people and refugees will need a minimum of three to five litres per person per day to survive, and as soon as possible this will have to be increased to 15 to 20 l/p/d to allow for water for personal hygiene [21]. In a stable situation, the minimum amount of water available to people should be 25 l/p/d[68].

Table 5.3. Water needs, demands, and losses

People (in litres/person/day (l/p/d)) [21,68]		**Institutions** (in l/p/d) [21,66,68]	
Minimum survival	3-5	Health centre, out-patients	5
Drinking and cooking needs	8-10	Health centre, in-patients (without laundry)	40-60
Minimum supply required	15-20	Cholera treatment centre	60
		Therapeutic feeding centre	15-30
Livestock (in litres/animal/day) [21]		School	25
Cattle	20-40		
Donkeys, horses	10-40	**Other** [21]	
Sheep, goats	1-5	Irrigation	3-6 l/m^2/day
Standpipe supply (in l/p/d) [68]		**Water losses in supply systems**	
Rural, village control	45	In a medium to large distribution system in reasonable condition: 15-25%.	
Rural, washing, laundry on site	65	In old system with mains in poor condition: 35-55% [68]	
Urban, no payment	70+	In a water trucking scheme: around 20% [21]	
Household connection (in l/p/d) [68]			
Low income, unreliable supply	50-55		
Low income, metered supply	70-90		
Low income, no payment	130+		
Middle income	180		
High income	240		

Water collection time and use

The collection time of water is a good indicator of water availability as it takes into account distance, waiting times, and to a certain extent the effort needed to obtain water. Studies have shown that people will not really restrict their water use if collection times are less than three minutes, or a distance of about 100m in easy terrain with no waiting times. Longer collection times will result in a restriction on the use of water.

Interestingly, the amount of water collected if the collection time is between three and 30 minutes remains constant. This means that if it takes eight minutes to fetch water, the amount of water used will be more or less the same as if it took 20 minutes to collect it. If collecting water takes more than 30 minutes (i.e. a distance of roughly 1km), the amount of water used decreases again [15]. Figure 5.2 plots water collection time against the quantity of water used.

The largest health benefit from an improved water supply will result if collection times are below three minutes. Although bringing the water collection time down from 25 minutes to six minutes will result in an important saving in time and energy (in itself a large benefit), but will probably not reduce water-washed infections.

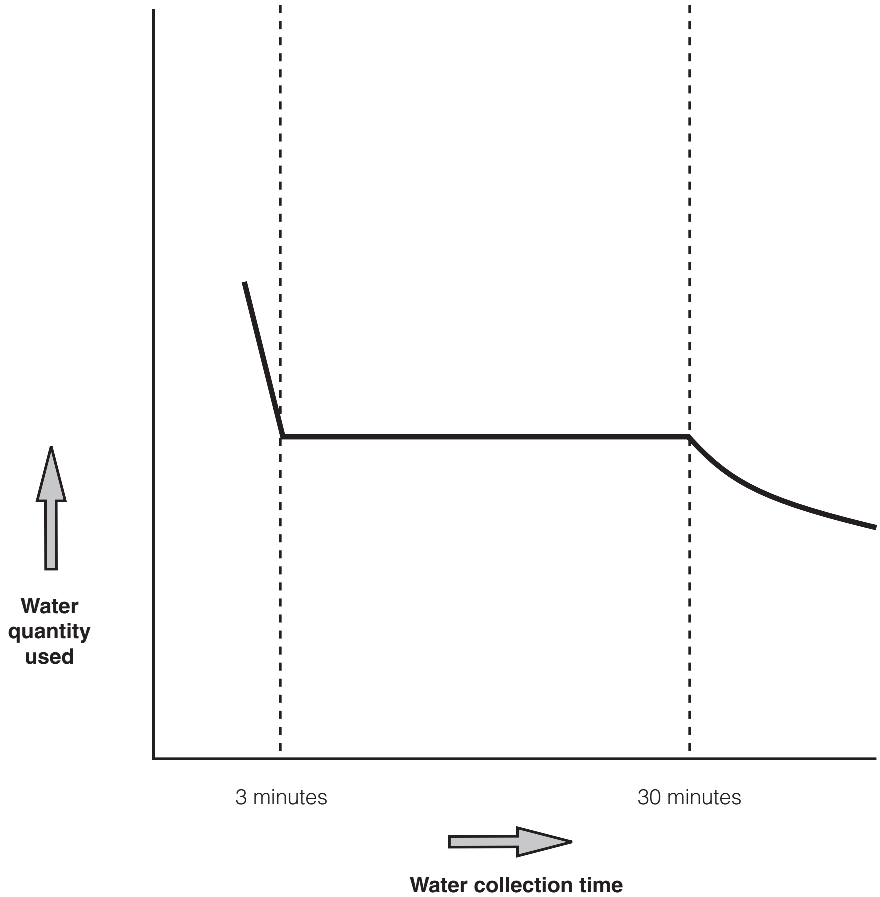

Figure 5.2. Water collection time versus water use [15]

To avoid long waiting times at the sources, their numbers and yield must be sufficient. There should be a maximum of 500 to 750 people using each functional handpump, and 200 to 250 people per tap. If tapstands with multiple taps are used, no more than six to eight taps per tapstand should be installed [47].

The minimum flow at a supply should be around 7.5 litres per minute [66]. During all seasons the sources' yield should be high enough, and seasonal changes in supply must be taken into account.

If a source has a low but constant yield it may be possible to collect the water in a reservoir (e.g. a spring box) then put a tap on the reservoir.

Storing water

Water is only available if it is at hand when needed. Unless the source is on the household plot, access to water is limited. This problem can be overcome by storing water on the plot.

Where the water supply is unreliable (e.g. harvesting rainwater, piped water with intermittent supply) storage improves availability when water is not accessible.

An additional advantage of storing water is that the water quality improves over time. If water is stored for one day over 50 per cent of the bacteria will die. Suspended solids, which can contain pathogens, will often settle out during storage. By pouring the clear water out carefully, the settled solids can be separated from the water [(64)].

Vessels that can be used to store water include local traditional clay pots, mortar jars, ferrocement tanks, and plastic or fibreglass vessels or tanks.

To avoid contamination vessels or reservoirs used for drinking-water should have a small opening or tap to prevent people from dipping the water out. The vessel should be covered with a clean, tight lid to keep animals, insects, and contaminated material out. If the water is not used for drinking, the way it is extracted is less important, but as *Aedes* mosquitoes – vector of yellow fever, dengue fever, and several other arboviruses and filariasis – can breed in household reservoirs no matter what their size, all water reservoirs should be covered properly.

How much water should be stored will depend on the situation. In general the less reliable the supply, the more effort needed to obtain the water, and the higher the water need, the larger the storage capacity should be. If there is a reliable, continuous piped water supply with a house connection then storage will not usually be necessary; but if people rely on rainwater storage needs may be large. Where there is a reliable source throughout the year, a storage capacity equivalent to the amount of water used in one to two days is probably adequate.

In addition to water storage vessels, households usually need vessels to transport water. These should be made so that carrying the water is as easy and comfortable as possible. The vessels should be covered with a clean cover or lid, and the water should be poured instead of dipped out.

In emergency situations it is often necessary to distribute water vessels so that people can collect and store water. The minimum for each household is two water containers of 10-20 litres for collecting water, and an additional 20 litres for household storage [(66)].

5.2 Water quality

Water quality includes the physical quality (e.g. turbidity), the chemical quality (e.g. content in salt), and the microbiological quality (whether it contains pathogens). Here we will only look at the microbiological quality of the water.

Water quality issues other than health

The presence of pathogens in water will not usually cause any problems other than health.

If the water is treated, polluting sludge (e.g. the sludge produced during coagulation) may be produced.

5.2.1 Water quality and disease transmission

Water can transmit pathogens directly to people in two ways. The pathogens may be water-borne and the disease is transmitted through drinking-water, or the water may contain pathogens which can penetrate the skin.

Faecally polluted drinking-water can transmit faecal-oral infections. The transmission route is direct from person (or animal) to person. These pathogens may contaminate the water at the source, but contamination may also occur during the transport, distribution, or handling of the water.

Transmission of the Guinea-worm is more complex. People infected with Guinea-worm will have a blister on their skin. If the blister comes in contact with water, it bursts and discharges the worm's larvae. These larvae can infect *Cyclops* (a water flea), inside which they develop. People become infected when they ingest *Cyclops* through drinking-water. Guinea-worm infection cannot be transmitted directly from person to person. The water will be contaminated at the source, and if the water at the source is safe, contamination at a later stage is not very likely.

If water containing a particular species of snail is contaminated with urine or faeces from infected people, schistosomiasis can be transmitted. This pathogen can penetrate the skin of people who are in direct contact with the contaminated surface water.

If water is contaminated with the urine of animals infected with leptospirosis, the pathogen can be transmitted through direct skin contact with the water. Rats are the main reservoir of leptospirosis.

Table 5.4 presents the different disease-groups linked to water of poor quality.

Table 5.4. Infections associated with poor water quality

Risk-factors related to poor water quality i Drinking-water ii Skin contact with surface water	Faecal-oral infections	Schistosomiasis	Water-based with two intermediate hosts	Soil-transmitted helminths	Beef and pork tapeworm	Leptospirosis	Guinea-worm infection	Spread by direct contact	Vector-borne infections
i Contaminated with excreta	H/A								
Contaminated by Guinea- worm							H		
ii Contaminated with excreta		H/A				A			

H: human host
A: animal host

5.2.2 The health impact of improved water quality

Contaminated drinking-water is just one of the potential transmission routes of faecal-oral infections, which can also be transmitted by food or hand-to-mouth contact. Where faecal-oral infections are endemic, and sanitation, handwashing practise, and food hygiene are poor, the majority of cases will probably not have resulted from drinking contaminated water. In contrast, where faecal-oral infections are common, and sanitation, handwashing practise and food hygiene are adequate, the role of drinking-water in the transmission of faecal-oral infections is probably important (15).

As Table 5.5 shows, improving water quality in unsanitary neighbourhoods will probably not really affect levels of (infant) diarrhoea, while improving the water quality in 'clean' neighbourhoods probably will reduce it (70). Water quality is

Table 5.5. Reduction in infections associated with improved drinking-water quality

Disease (group)	*Reduction in occurrence*	*Remarks*
Diarrhoea	15% (26)	
Infant diarrhoea	negligible (70)	if neighbourhood sanitation is poor (open defecation in neighbourhood)
	40% (70)	if neighbourhood sanitation is good (no open defecation in neighbourhood)
Guinea-worm infection	78% (26)	

especially important in an urban or peri-urban environment, where water supplies are often at risk of pollution, and the risk of large outbreaks is higher than in a rural environment[(15)]. As Guinea-worm will normally only be transmitted through drinking-water, improving the drinking-water quality at the source is very effective in controlling the infection.

The quality of the water used for washing hands, body, and clothes is not really important as long as it is not heavily polluted. The risk of transmitting pathogens other than schistosomiasis [(15)] and leptospirosis during bathing in surface water is limited.

Animals do not need water of very high quality, but most domestic animals can be infected with faecal-oral infections, and cattle and pigs can be infected with beef and pork tapeworm, so their water quality should be as high as possible.

5.2.3 Practical issues concerning water quality

This section looks at some general points on water sources, storage and distribution, treatment, and water quality assessment in the field.

Water sources

One of the priorities in selecting a water source is quality. The quality and protection of the source is important regardless of whether the water will be treated or not. Good quality water needs less, or no, treatment; and if treatment fails there will be fewer health risks. Sources must be protected from pollution by installing adequate structures for protecting, collecting, and distributing the water. Health and hygiene promotion will probably be needed to make people aware of the importance of protecting the water source.

Water can be obtained from several different types of source.

Springs: An adequately protected spring will normally produce good quality water. Building a proper headwall, access structures, and drainage system will prevent degradation. Latrines should not be sited above the spring, and a hedge or fence should keep animals at least 10 metres away from the area above the spring. A ditch should be dug close to the fence to divert runoff. Figure 5.3 shows an example of a protected spring.

If a spring has a low yield, a spring box might be constructed to collect and store water that can then be withdrawn through a tap. The spring box should be well constructed, and all openings (e.g. man-holes, overflow pipes) should be closed securely or covered with fly screen.

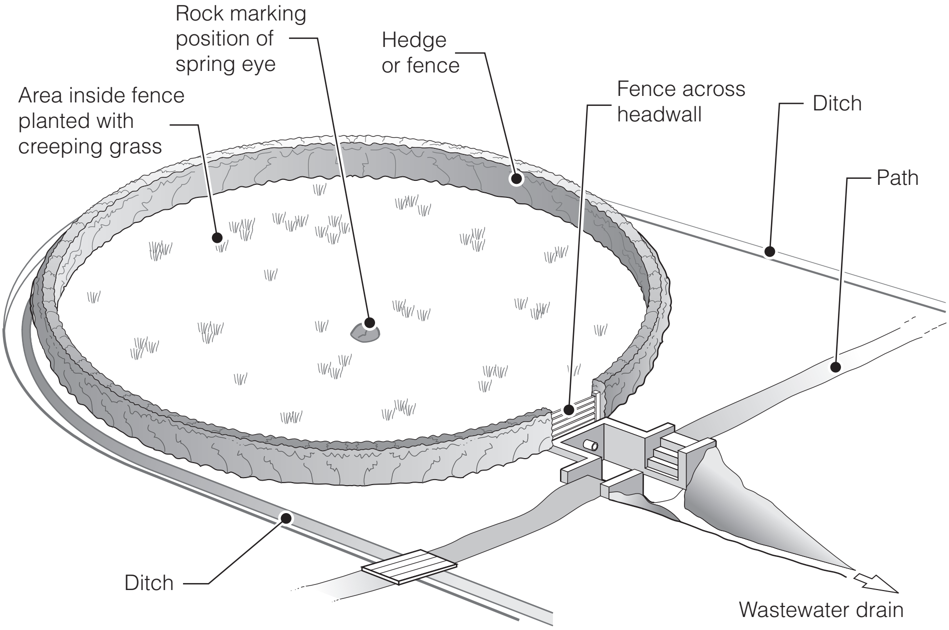

Figure 5.3. A protected spring (adapted from 64)

Rainwater harvesting: If rainwater is properly collected and stored it will usually be of good quality. The catchment area (e.g. roof, rock) and guttering or channels should be kept as clean as possible. The first minutes of rainfall are best discarded to avoid collecting unwanted material like dust, debris, or bird droppings. Alternatively, a silt trap can be installed. The storage tank must be built to prevent contamination by animals, insects, or polluted material [56]. The water should be withdrawn from the storage tank by a tap or pump to avoid contamination during collection. Rainwater is seasonal and large storage capacity is needed to bridge dry periods, so rainwater harvesting is not usually appropriate as the only source of water.

Borehole or tube-well: A properly constructed borehole with handpump usually produces good quality water. The tube-well should be sited a safe distance from sanitary structures. To avoid the seepage of contaminated surface water or shallow groundwater into the tube-well, install a good grout seal. A watertight apron sloping away from the pump must extend for at least 1 metre around the tube-well. The borehole casing must be intact or else polluted water could enter. If water must be added to prime a suction pump, be careful to use clean water to avoid contaminating the water in the tube-well (43). The apron must drain into a drainage channel that leads spilt water at least 4 metres away from the tube-well before disposing of it in a garden or soakaway. If possible, a fence or hedge should be installed around the borehole to keep animals at distance (82).

It is very difficult to assess whether the underground structures of existing tube-wells are adequate, and it is therefore best to assume that they are not. The apron and drainage channel should be intact and not have any cracks. There should be no ponding of water within 2 metres of the borehole, and no excreta (human or animal), refuse, or surface water should be within 10 metres of the tube-well (82). A sanitary survey would identify any of these as risk factors that might contaminate the water in the tube-well.

Hand-dug wells: Water abstracted from a hand-dug well is usually of intermediate quality. Sanitary structures should be sited at sufficient distance from the well. The top three metres of the well lining must be watertight to prevent polluted surface water or shallow groundwater from seeping into the well. A space is often created during construction between the original soil and the lining. This must be properly sealed to prevent surface water from entering the well. There should be a watertight apron at least one metre wide around the well (82), and a drainage channel at least four metres long must lead spilt water away before discharging it properly (64).

If possible, water should be withdrawn using a system that prevents the vessel and rope from being contaminated (e.g. by being left on the ground). A headwall must be installed to prevent surface water or other contamination from entering the well. The headwall should discourage people from standing on it, as this could result in soil or spilt water contaminating the well. Children must be prevented from throwing material in the well (15). Where possible, a fence or hedge should be installed to keep animals at distance. Figure 5.4 shows an appropriate hand-dug well.

If a hand-dug well is covered with a lid and a handpump is installed, several risk factors are eliminated or reduced. A raised manhole should be installed to ease maintenance, and to allow people to get to the water without demolishing the structure if the pump breaks down.

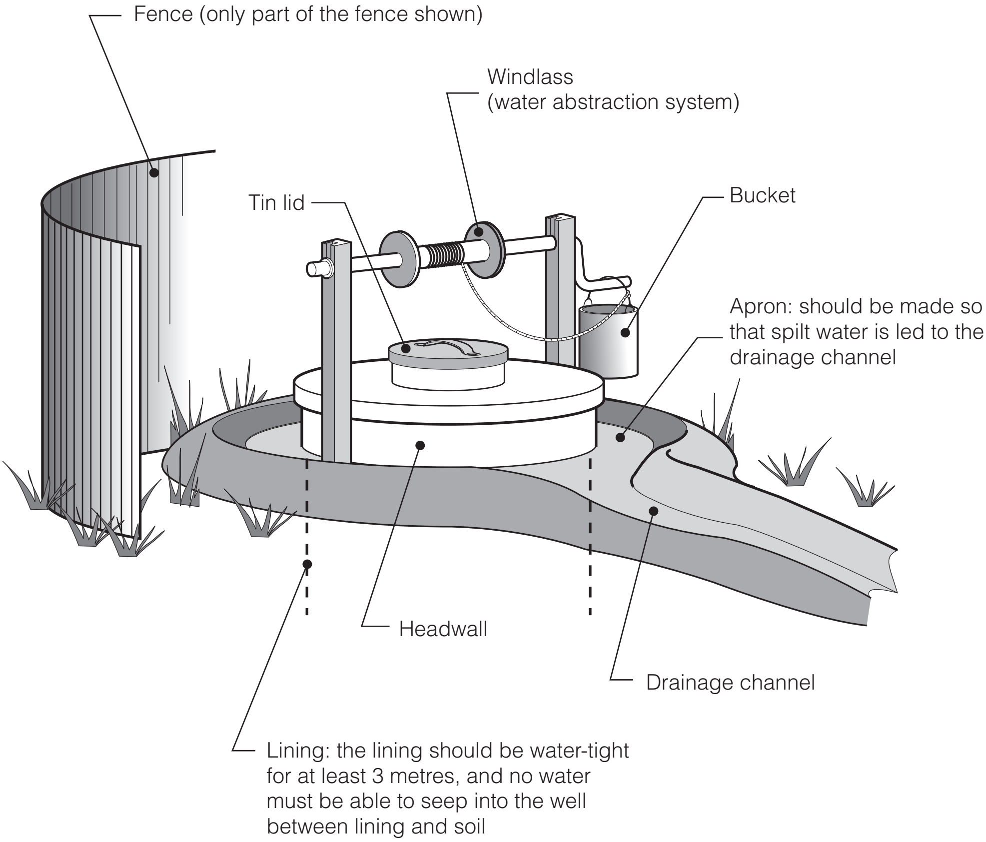

Figure 5.4. Hand-dug well (adapted from 64)

If existing wells are assessed in a sanitary survey, it is best to assume that the underground structures are not adequate. Risk factors to look for include broken or cracked apron and drainage channel, ponding of water within two metres of the well, and the presence of human or animal excreta, refuse, or surface water within 10 metres of the well [82].

Surface water: Any type of surface water must be assumed to be polluted or at risk of pollution. If surface water has to be used for drinking-water, the water should be abstracted as far upstream as possible. The river water will be less contaminated upstream of where people bathe, wash, or play in a stream, and animals come for watering. The quality of surface water can be improved by installing infiltration galleries in the riverbed or by digging riverside wells or infiltration wells [21].

When selecting a water source, seasonal fluctuations in water availability have to be considered. Surface water, water from shallow wells, and rainwater are all usually influenced by the seasons, and water may be in short supply at the end of the dry season.

Water quality beyond the source

Installing a water supply system that provides water of very good quality is of little use if the water is going to be contaminated at a later point. It is very common for water to be contaminated with faecal-oral pathogens during distribution, transport, collection, storage, or handling [48].

Distribution points, vessels, and reservoirs must be designed so that the risk of contamination during filling is minimal. Transport and storage vessels should have a small neck so that water cannot be dipped out. (Be practical, however, as the difficulty of filling a vessel with a small neck at a handpump must be considered.) The vessels should be properly covered to keep animals, insects, dust and other contaminants out. The water should be taken from the vessel either by pouring, or by using a tap. Vessels used for transporting and storing drinking-water should only be used for this purpose. If they have been used for something else, or have been empty for some time, they must be properly cleaned and possibly disinfected before being used for drinking-water. Vessels can be cleaned with boiling water or a chlorinated solution. Health and hygiene promotion will probably be needed to improve behaviour concerning water handling and storage.

A piped water system with intermittent supply is also at risk of pollution. Intermittent supply means that the pressure in the pipes will occasionally be lower than the pressure in the surrounding soil, which means that contaminated water can seep back into the pipes. Installing an electric pump to draw water from a piped water supply with a low water pressure, as often happens in cities in developing countries, can draw polluted water into the system.

Water treatment

The term water treatment is used here to mean manipulating the water to remove water-borne pathogens (e.g. those that cause diarrhoeal diseases). This will often be accomplished by chlorinating the water.

It is not always obvious whether water needs to be treated or not. It is more important to treat the water when many people are supplied by the same source, the water is contaminated, there is a risk of an outbreak of water-borne disease, and polluted water is playing a role in the occurrence of water-borne infections. In addition the local technical, financial, institutional, and logistical capabilities will have to be assessed to determine whether the capability exists to treat the water adequately. This assessment must look into both the current and future situation.

Water treatment at communal level requires funds and adequate support, while treatment at household level will rarely be reliable. The priority should therefore be to find a source that provides water of an adequate quality, and to maintain this quality by protecting the source.

Water from safe sources used by small communities does not usually need to be treated. The priority should be on health and hygiene promotion to both protect the source and handle and store the water properly.

A piped water supply to (peri-)urban areas should normally be chlorinated to reduce the risks of water-borne outbreaks of faecal-oral infections. In an emergency situation, water should be chlorinated if it is piped to more than 10,000 people. Water should also be chlorinated if an outbreak of faecal-oral infections is occurring, or if there is a risk of an outbreak [(66)]. Other than in emergencies or during a significant threat of an outbreak of faecal-oral disease, there is little use in introducing a water treatment system that could not be maintained when external support is withdrawn [(15)].

Although it is not possible to go into much detail on water treatment here, there are some important points concerning chlorination and boiling of water.

Chlorine added to water will work in three ways:

- Part of the chlorine will oxidise contamination, including pathogens. The more contamination there is, the more chlorine will be used up. This is ‘consumed chlorine’.
- Part of the chlorine will combine with matter in the water, and form ‘combined residual chlorine’. Combined residual chlorine functions as a disinfectant, but is less effective than ‘free residual chlorine’ [(15)].
- Part of the chlorine will form free residual chlorine. The free residual chlorine has a remaining or residual effect in water. If pathogens contaminate the water during distribution, handling, or storage, the free residual chlorine in the water will normally kill them.

Proper chlorination therefore has two effects: it kills pathogens present in the water at the time of treatment, and it will, to some degree, protect water from future contamination.

Normal chlorination of drinking-water is not effective against the cysts of faecal-oral protozoa (amoebiasis, giardiasis, cryptosporidiosis, and balantidiasis) [3].

In chlorinating drinking-water enough chlorine must be added to leave sufficient free residual chlorine without giving the water a bad taste or wasting the product. Normally a free residual chlorine content of 0.2-0.5mg/l at the point of distribution is adequate [22]. Annexe 4 shows how to determine the amount of chlorine that must be added to water.

After the chlorine is added, it needs time to react with the contamination and turn into combined residual chlorine. A contact time of at least 30 minutes should therefore be allowed before the water is safe to drink, or before the free residual chlorine can be measured. In a cold climate chlorine acts more slowly, and the contact time will have to be longer [15]. If the pH of the water is high, chlorine is less effective in killing pathogens. At a pH of over 8, the free residual chlorine content of the water should be between 0.4 and 1.0mg/l [22].

Sometimes the boiling of water is promoted to make it safe. To be certain that all pathogens are dead, water has to be boiled for 5-10 minutes, although bringing water above 75°C will normally kill the vast majority of the pathogens [28]. Unlike chlorination, boiling water is effective on water of high turbidity, and against protozoa. Boiling water has several disadvantages though, which often makes it less useful than chlorination. Around 1kg of firewood is needed to boil one litre of water, which will often make it environmentally and financially unsustainable. And unlike chlorinated water, boiled water has no residual effect against pathogens [21].

Assessing water quality

In the field there are two ways to assess water quality: conduct a sanitary survey in which all threats to the quality of water are evaluated, or test the water for specific bacteria (usually faecal coliforms and total coliforms) to check whether the water is contaminated. Testing for bacteria is relatively costly and complex, and some skill is needed to obtain reliable results. It also only indicates water quality at the time of the test. Although a sanitary survey does not give a measurable level of pollution, it is often more appropriate than bacterial testing as it does not need specialised material, is instant, and gives a more holistic view of the water quality and its threats.

Treated water should be free of any coliforms when it enters the distribution system. At the distribution point treated water should contain no faecal coliforms. The presence of (faecal) coliforms in treated drinking-water is an indication that treatment is not working properly, or that the water is being contaminated during distribution. Instead of determining which coliforms are present, it is often enough to verify that the water has a sufficient level of free residual chlorine, and that there has been enough contact time between the chlorine and water.

Unlike treated water, any source of untreated water can be expected to contain faecal coliforms, and it will be virtually impossible to obtain water free of faecal coliforms without treatment (15). In rural areas it will often be difficult to reach WHO or national guidelines even with appropriate structures.

5.3 Additional health issues concerning water supply

A water supply can be a health threat because of its structure or because of poor design or maintenance. The main health risks will be a result of creating an environment in which vectors or intermediate hosts can breed or live.

5.3.1 Large water reservoirs

Artificial reservoirs used for water storage can create two major health problems. The reservoirs are potential breeding sites for *Anopheles* mosquitoes that transmit malaria and filariasis (36), and if people come in direct contact with contaminated water schistosomiasis can also be transmitted. An additional health risk could be created if the spillway of the reservoir creates shallow, turbulent, 'white water' in which the blackfly, the vector of river blindness, can breed (232,240).

5.3.2 Water distribution and storage

All water reservoirs used in the distribution or storage of water (e.g. service reservoirs, overhead tanks, small domestic water containers) should be adequately covered and maintained to prevent them from becoming breeding sites for *Anopheles* mosquitoes and *Aedes* mosquitoes (80).

5.3.3 Sullage

Chapter 7 goes into more detail on drainage, so here we will only briefly point out the health risks associated with the disposal of sullage (or domestic waste water).

All water supply systems will produce waste water in the form of used water, water spilled at the distribution point, and water leaking from pipes or taps. Although sullage normally contains fewer pathogens than sewage, it will often contain faecal pathogens, and could potentially transmit excreta-related infections to either people or animals.

If the casings or linings of boreholes or hand-dug wells are not properly sealed, waste water could seep back in, contaminating the water.

Where waste water keeps soil moist, a favourable environment for soil-transmitted helminths (e.g. hookworm and roundworm) or sandflies could be created [(80)].

Accumulated polluted waste water can become a breeding site for domestic flies, which transmit several faecal-oral infections and diseases spread by direct contact. *Culex* mosquitoes, which transmit filariasis and several arboviral infections, breed in polluted waste water too [(21)]. *Anopheles* mosquitoes can breed in ponds or puddles formed by unpolluted waste water.