A fieldworkers guide

Urban Water Supply Surveillance

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Introduction

This manual is designed for field workers who undertake routine surveillance of drinking-water supplies in developing countries. It was developed as an output of an urban surveillance programme in Uganda and therefore is focused primarily on urban areas. However, it is hoped that the information included will also be of use in rural drinking water surveillance programmes.

Drinking water surveillance programmes usually collect a wide range of information on water supplies, including the quality of the water and associated sanitary risks, the continuity of the supply, the quantities of water used, the costs of water and the coverage of the population. However, these different types of information require data collection at different frequencies and using different methods. Of these, the quality and continuity of supply require most frequent monitoring and collection of relevant data of these service indicators makes up the bulk of routine field activities. Thus the focus of this manual is on the routine surveillance of water quality and continuity by analysing water and conducting sanitary inspections.

The manual is geared towards low-cost programmes that utilise on-site testing kits and is focused on microbiological testing as this is of the greatest importance to health. However, it also briefly addresses specific concerns about arsenic, fluoride and nitrate, as these may be particular concerns in some countries. The manual is also geared towards the implementation of drinking water surveillance programmes that target the urban poor and thus cover a wide range of sources of water as well as water stored within the home.

The purpose of the guide is helping field workers undertake their activities efficiently and effectively and therefore focuses on the fieldwork element of surveillance. The success of any surveillance programme is largely determined by the performance of the field staff and thus it is critical that they receive adequate training and support to be able to perform surveillance activities well.

This guide is part of a series and has companion volumes, which are a training and co-ordination guide, a comprehensive manual on urban drinking water surveillance and a manual for the use of computer software for sanitary risk and water quality information management. For more in-depth information such as the design of sampling networks, the planning and implementing of training and information management, please consult the companion volumes.

The manual is designed to cover all the major issues in surveillance relevant to the field worker. It provides a brief overview of the impacts of water on health, which then leads into a discussion on the indicators we use in surveillance programmes and how often we collect this data. The manual then discusses water quality and the processes to follow when taking and analysing water samples, carrying out a sanitary inspection and the reporting of your information to various stakeholders. The final sections of the manual are concerned with the use of the surveillance data in promoting improvements in water quality and supply.

Section 1: Water and health

Water is essential for human existence. Without a basic amount of water to consume people rapidly deteriorate and die. Most people have access to some form of water supply in order to survive and these are the water supplies that we are interested in a drinking water surveillance programme.

Whilst water is a basic necessity for life, water has many impacts on health. These are related to the:

- Water quality – the consumption of water which is contaminated by disease-causing agents (or pathogens) or toxic chemicals. The impacts of water quality may be mild or severe (including fatal), short-term (acute) or long-term (chronic) and may affect very few or very many people.
- Water quantity – the use of insufficient amounts of water for personal and domestic hygiene. Poor hygiene caused by use of inadequate volumes of water may lead to skin and eye diseases as well as promote the transmission of many infectious diseases.

Table 1 below illustrates the types of disease that are related to water and sanitation. This does not include vector-related diseases such as malaria as these are not specifically related to water supply.

Group	Examples of diseases
Diseases which are often water-borne (caused by consumption of contaminated drinking water	Cholera Typhoid Infectious hepatitis Giardiasis Amoebiasis Dracunculiasis (guinea worm)
Diseases often associated with poor hygiene	Bacillary dysentery Enteroviral diarrhoea Paratyphoid fever Pinworm Amoebiasis Scabies Skin sepsis Lice-borne typhus Trachoma
Diseases often associated with inadequate sanitation	Ascariasis Trichuriasis Hookworm
Diseases with part of life cycle of parasite in water	Schistosomiasis

Table 1: Diseases related to water and sanitation, adapted from Bradley, DJ, London School of Hygiene and Tropical Medicine, various

Very often, the risks that individuals or communities are exposed to through poor water quality or inadequate quantity of water is influenced by other factors related to water supply. In particular three other factors may influence the risk of disease - the **accessibility of water** (usually in terms of distance or time to the water source), **cost of water** and the **reliability of the supply**. Where water is far from the home, the cost of water is high or the supply is very unreliable, insufficient amounts of water may be collected or other sources of water (such as ponds) may be used which are more contaminated. Where water is not located at the home or where water supplies are unreliable, water will have to be stored in the home and this may increase the risk of contaminating the water through poor handling or storage practices.

In terms of water quality surveillance programmes based on the protection of public health, we are particularly interested in the infectious diseases that may be transmitted by pathogens. These diseases are primarily spread by pathogens that are found in faeces, principally human faeces, and are transmitted by the faecal-oral route that is summarised below.

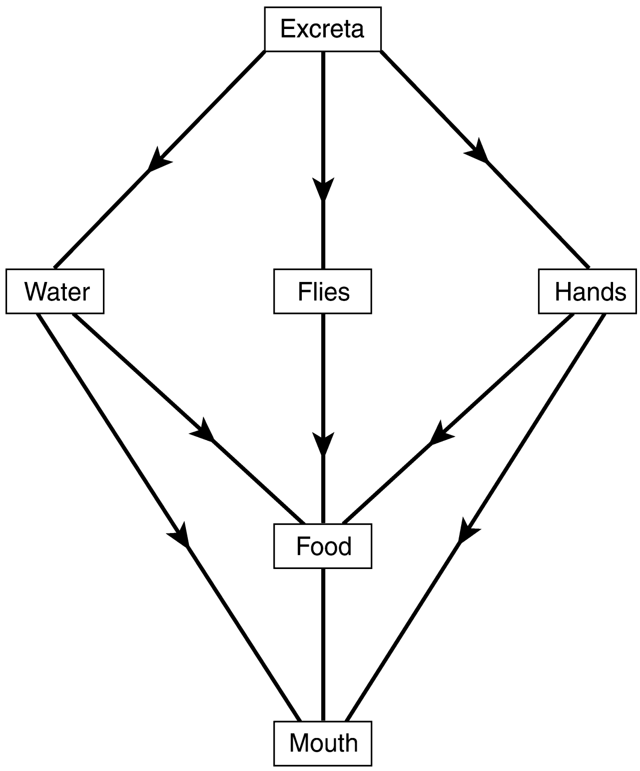

Figure 1: Principal elements of faecal - oral disease transmission

Surveillance can help break these barriers by:
1. Identifying whether faecal contamination of water sources and drinking water stored in the home has occurred
2. Providing communities and households with information about their water source and drinking water and supporting them to make improvements
3. Identifying the ways in which faeces contaminate drinking water supplies and preventing these through source improvement and protection
4. Identifying safe sources for drinking and cooking/food preparation and promoting the use of these sources in the community
5. Preventing transmission of pathogens into drinking water by ensuring that clean and covered collection containers are used
6. Preventing the transmission of pathogens into drinking water by ensuring that the storage containers used are covered and kept clean
7. Preventing the transmission of pathogens into drinking water by ensuring that people wash their hands after defecation and promoting the use of containers where water is poured and not directly scooped out
8. Ensuring that raw fruit and vegetables are washed in clean drinking water

9. Ensuring that water sold by vendors is of good quality

When we carry out surveillance we are therefore trying to raise awareness amongst communities about risks to their health and to identify ways to improve the water sources and the safe water chain. Thus we will use surveillance data in technical interventions and health education as discussed later. However, a critical element in this process is to ensure that communities and other stakeholders have the information that can be used by them to initiate improvements.

1.1 Service quality indicators used in surveillance

The direct influence of water on health relates to the quality of the water that is consumed and the quantity of water that is used for hygiene purposes and this may in turn be related to cost, distance, time and reliability. Using all these influence we can define a set of measurable service indicators that we can use to monitor and assess the water supply. These are:

1. Quality of water – we usually emphasise the microbiological quality as this represents the greatest risk to health
2. Quantity – the average amount of water used each day
3. Continuity – how much of the time water is available in the supply
4. Cost – how much people pay to obtain water services
5. Coverage – the percentage of the population that has access to a recognisable water supply (this usually is taken to mean a supply with source protection and/or treatment)

Whilst all these indicators are important, different indicators require different types of assessment and frequency of data collection. The ways in which we collect this information and how often we assess them is summarised in Box 1 below.

Box 1: Collecting information on the different indicators

Quality – this will vary significantly in a short time and over short distances. We need to consider the quality of water within the whole water chain and not simply at sources. This information is collected frequently either using on-site equipment or laboratories and is a routine field activity.

Quantity – this will vary depending on whether water is available within the house, from a single tap in the yard or from a communal source. Reliability may also affect quantities used. This data is collected infrequently through a water usage study

Continuity – this may also vary significantly in a short time and over a short distance in piped water supply. Point sources continuity may not vary significantly or may be due to specific breakdowns. This data will be collected frequently as a routine field activity for piped water through sanitary inspection and less frequently for point sources (e.g. boreholes, protected springs and dug wells) through inventories and water usage studies.

Cost – this may vary between sources and sometimes may change over time and in different areas. This is usually collected infrequently as part of inventories and water usage studies.

Coverage – this is often measured in terms of the numbers of people who have water supplies at different service levels (e.g. within the home, in the yard, public) and types of source. This requires large data collection exercises and is usually done infrequently. If we want to measure access to a 'safe' water supply, we need to include water quality and continuity data as well as data from water usage studies.

This box illustrates that in general, we will collect data on water quality and continuity on a regular, routine basis and this forms the bulk of routine surveillance activities. The other factors are often only assessed relatively infrequently when inventories and water usage studies are carried out, or in the case of coverage large-scale assessments of source use, service level and compliance with accepted quality and continuity standards. In this manual we focus on water quality and sanitary inspection. If you want to know more about the other indicators, please consult the reference manual.

1.2 Surveillance programme development

When we develop surveillance programmes, we usually go through a number of steps. The first step will be to carry out an inventory of sources available to the population that lacks a direct household connection at a yard level or within their home. To do this, you should fill out an inventory form for each water source you find. An example form is shown in Annex 1. In some cases, you may already know many of the details about the source, such as the name, location and when it was constructed from records in your office. However, in most cases, you will have to visit each area and record the sources that are available. This will be particularly important in urban areas where a large number of the sources may be from people with their own tap who sell water to their neighbours. Make sure that you find all the sources available and record their details. This information is essential to develop assessment and routine monitoring programmes.

Following the inventory, a training course in surveillance techniques will be held where the fieldworkers will become familiar with the equipment to be used, sanitary inspection and using surveillance data. The next step will be an assessment of the water in each area. This will include all the point sources that are functional, a sample of taps and a sample of households. Once this data has been collected and analysed, routine monitoring will be undertaken each month. You will need to take a sample for water quality analysis and carry out a sanitary inspection of each source you visit. Make sure you record data accurately and in a legible form as this will be put into a database. Field workers may put in data or this may be done by someone else, so make sure you data are easily understood.

Usually, refresher training will be undertaken. This may be short participatory events where staff from a number of areas come together to discuss surveillance activities and share experiences. Some times it may involve training in specific issues, such as construction techniques or health education. In some places, water usage studies may be undertaken and fieldworkers will receive training in the techniques and undertake the study. This often provides useful information for you to implement improvements in water sources and in-house water.

Section 2: Water quality

Our primary concern with health problems caused by water supply are the infectious diseases and in particular the faecal-oral route diseases. These are all caused by disease-causing micro-organisms, or pathogens, thus our principal concern is always the microbiological quality of the water that is being consumed. We know there is a link between consumption of water contaminated with pathogens and disease. Therefore we try and ensure that water is free of pathogens. Microbiological quality may change very rapidly over time and short distances and therefore requires frequent testing. We are also concerned with parameters of water quality such as colour, odour or taste that may cause people to reject a water supply of little microbiological risk and consume water from a more contaminated supply. These are usually called aesthetic parameters.

The chemical quality of water is of lower priority as in general the effects on health are long-term (i.e. chronic). There are some exceptions to this, for instance arsenic, nitrate and fluoride may all provide short-term health effects and in some cases we need to include these in our surveillance programme. It is essential that before new supplies are commissioned, a full chemical analysis is carried out to identify any significant toxic chemicals that may be present at levels that represent a risk to health. Certain chemicals may then be periodically tested on an ongoing basis. However, it is usually better to ensure that routine testing of microbiological quality and aesthetic parameters is being routinely conducted before embarking on a routine chemical-testing programme.

Pathogens found in water come in different forms. They may be bacteria, viruses, and protozoa. All the principal pathogens that may be transmitted by water come from human faeces and in few cases animal faeces. Different microorganisms survive for different amounts of time in water, have variable susceptibility to chlorine and may cause mild or severe effects. Many pathogens are readily inactivated by the action of chlorine and piped water supplies that have been treated and disinfected should have few pathogens in the final water. However, microorganisms may enter the piped water supply due to failures in the distribution network or local failures as discussed later.

Most point sources use groundwater, which in its natural state is usually of good microbiological quality. Microorganisms are removed from water by a number of processes that are grouped together under the term **attenuation**. These processes may lead to the permanent or temporary removal of microorganisms. Attenuation includes:
(i) predation by other bacteria within the soil and in biologically active layers around pit latrines.
(ii) adsorption onto particles in the soil and sub-surface, thus removing the organism from the water
(iii) natural die-off of the microorganisms due to the time taken for surface water carrying microorganisms to reach the water table.

However, contamination of point sources may occur because of poor sanitary protection measures due to poor design, siting, construction or operation and maintenance. These sources also often show a seasonal variation in quality and quantity that is important for our monitoring programmes.

Water may also become contaminated as people collect it from a source and take it home. This may result from many factors, such as poor cleanliness of the container, poor personal hygiene and poor storage practices. We therefore need to test this water and use the information to inform health education programmes.

2.1 Microbiological quality

Given that we know that many pathogens may be transmitted through water used for drinking or food preparation, we need to determine what is an acceptable level of microbiological quality that represents only limited risk to health. We could try and test for the pathogens directly themselves, but this is not a good way to monitor microbiological quality. There are very many different pathogens that may be found in water, however, they will not be found in all waters. For many of the pathogens, analytical techniques either do not exist or are expensive and time-consuming and thus actions cannot usually be taken as quickly as is required.

As we know that most pathogens are derived from faeces, the approach adopted by most surveillance bodies world-wide to analyse the water for bacteria that show faecal contamination has occurred. These are called *indicator bacteria*. By using indicator bacteria, we can reduce the number of micro-organisms that we need to test for, which reduces costs, whilst retaining good means to assess whether water represents a risk to health of the users. The characteristics of an ideal indicator bacterium are summarised in Box 2 below.

Box 2: Basic characteristics of the ideal indicator

a) Present whenever pathogens are present.
b) Present in the same or higher numbers than pathogens.
c) Specific for faecal or sewage pollution.
d) At least as resistant as pathogens to conditions in natural water environments, and water purification and disinfection processes.
e) Non-pathogenic.
f) Detectable by simple, rapid and inexpensive methods.

The indicator that most surveillance bodies use in routine assessment of the risk of faecal contamination is *Escherichia coli* (*E.coli*) or as an alternative, thermotolerant (faecal) coliforms. Other indicators are also sometimes used and most common of these are the total coliforms. This is the group of bacteria that include *E.coli*, but also other bacteria that come from environmental sources and so their presence may not represent a risk to health. Total coliforms are useful when disinfected piped water supplies are provided, as their presence indicates that either the treatment processes at the water treatment plant have failed or that the integrity of the piped network has been compromised. However, in point water supplies they have little value as they can be expected to occur. There are other indicators, such as faecal streptococci and bacteriophages that may be used by some water suppliers and surveillance agencies, but are not discussed here as their use is not widespread.

Whilst *E.coli* provides the closest match to the criteria for an ideal indicator, it is not a perfect indicator and it is possible to find pathogens in drinking-water supplies when we do not find any *E.coli*. In particular, *E.coli* or thermotolerant (faecal) coliforms may not provide a good indication of the presence of protozoa or viruses. However, in general, these indicator bacteria at present provide a reasonably reliable indication of the risk of disease from the water supply. However, given the weaknesses in these indicators, water that has no *E.coli* should be seen as *low risk*, rather than as *safe*.

As we know that relying on E.coli or thermotolerant (faecal) coliforms alone is inadvisable, we need other measures of the water quality that indicates whether there is a risk of faecal contamination. Some of these involve other analytical parameters that provide a good indication of the likelihood of microbiological quality. When combined with analysis of *E.coli* or thermotolerant (faecal) coliform, these are called the 'critical parameters'. The other critical parameters are:

- Turbidity – this is a measure of the suspended solids in the water. Turbidity is important because bacteria are often found attached to suspended particles in the water. In chlorinated supplies, raised turbidity may reduce the effectiveness of disinfection.
- Disinfectant residual – this is only relevant in supplies that have been disinfected before the water is supplied to consumers. In most water supplies this will be chlorine. When chlorine is added to drinking water, some is used to inactivate micro-organisms or react with substances in the water. In most cases, a small amount of unreacted chlorine is left in the water to act as a safeguard against contamination entering the supply during distribution. This is called the free chlorine residual that should be routinely monitored. Another chlorine residual that may be monitored is the total chlorine level, this is the concentration of chlorine that was dosed.
- The pH of the water – this is critical for effective chlorination as where the pH is too high, chlorine will be consumed in reactions to restore the pH back to neutral. In general, the optimum range of pH is 6.5-8.5.

All the critical parameters require frequent and routine monitoring.

In addition to the critical parameters, other tools are required in order to ensure that the risk of microbiological quality is kept as low as possible. This includes:

1. Sanitary inspection – an assessment of the hazards and contaminant pathways into the source that may cause microbiological contamination to occur. These focus on the source and the immediate surroundings. Sanitary inspections are discussed later in this manual.
2. Source protection – the measures that are put in place to protect the source of water from becoming contaminated. These cover both groundwater and surface water and may include a range of measures from those in the immediate area of the source to much broader protection measures.
3. Minimum treatment requirements – these will generally only cover surface water and groundwater that supplies a piped distribution network. All surface waters should be treated and this should be through a number of stages – this is called the multiple barrier principal. Where groundwater is used to supply piped distribution networks, disinfection is required.

2.2 Routine field data collection

The routine activities that are undertaken in water supply surveillance focus on water quality and the risks at the supply. This means that we need to undertake water quality analysis and sanitary inspection at the water sources and within homes on a regular basis. Sanitary inspections provide us with both a useful way of identifying what the likely cause of contamination when it is found without the need for re-testing. However, sanitary inspection has many other, possibly more useful, applications.

Sanitary inspection data can act as a predictive tool. This means that it allows us to be able to assess whether contamination may occur in the future even when contamination is not found in the sample taken. This then allows us to take preventative action to prevent contamination by improving the water source. Sanitary inspection also acts as a good measure of operation and maintenance of the water source or supply and allows us to identify weaknesses that should be addressed through improved operation and maintenance, health education, training and support to communities managing water supplies.

Therefore, every time a sample is taken for the analysis of water quality, it is essential that a sanitary inspection be carried out. By doing a sanitary inspection we will be able to identify immediate actions required to stop contamination and to put in preventative measures to prevent future problems.

2.2.1 Water quality analysis

In this section we discuss how the water quality testing should be undertaken. In the surveillance programmes covered by this manual, it is expected that field staff are mainly carrying out tests for the critical parameters using portable equipment and the manual for the equipment should also be read. However, where samples are taken and analysed at a laboratory, the guidance provided below would still be relevant.

2.2.1.1 Before you start

Preparation is the key to field work. Unless you are properly prepared, ensuring that you have all the items needed to do your field work and have prepared the kits properly, the field work will become difficult and less effective. Therefore take time to plan you activities.

Before you leave for the field, you should ensure that you have done the following:

1. Sterilised the equipment
2. Made sure you have sufficient dishes, pads, filters, tablets and methanol in order to be able analyse samples and sterilise the equipment in the field
3. Made sure that you have the daily report sheet and sanitary inspection forms ready for use in the field
4. Made sure that you have set yourself a programme of sampling, so you know where you are going and which sources you will test
5. Made sure that you analysed the sample from the last source within 3 hours of completing the test at the first source. You will need to note the time you took the first sample and then time yourself to make sure you do not exceed 3 hours of sampling.

Remember that the last sample must be taken no more than three **(3)** hours after the first sample was taken. Most kits will also have a maximum number of samples that can be incubated – for instance 16 in the Oxfam-DelAgua kit. Bear in mind, that it may be difficult to take 16 samples within 3 hours, as this is equal to 5 samples per hour (including travel between sites). Do not try and rush the sampling in order to collect many samples within the available time, as this may lead you to make mistakes. It is better to take fewer samples whose results are reliable than many that are not.

It is often a good idea to prepare the plates that you will use for incubating the samples before you leave the office, as this will be time-consuming in the field. It also means that you do not have to take the pads with you. If you prepare the plates before you leave, you should make sure that you prepare one or two plates more than the number of samples you plan to take. This will allow for any mishaps in the field.

Make sure the plates are sterile before you put in the adsorbent pad. Plates can be sterilised by either putting them into a steam steriliser for 15 minutes or by flaming them with the **blue** flame from a lighter. If you use a steam steriliser, you will need to let the plates dry before putting in the pads.

When you add the media to the pads, you need to make sure that the media is still good. If the media looks orange or yellow or if it has yellow strands or lumps in the bottle, then the media has become contaminated and **should not be used**. If the media is cold (for instance because it has been stored in a fridge), you may find some media has clear crystals at the bottom of the bottle – this is not contamination, but merely the precipitation of the media. These crystals can be re-dissolved by holding the bottle in you hand for some minutes and gently shaking the bottle. The media should be stored in a cool, dark place and preferably within a fridge. If the media is stored in a fridge, it should last for up to one year. However, if it is not stored in a fridge, do not use media that is more than 6 months old.

If the media is good, then add this to the plates holding the adsorbent pads. The pad should become fully saturated with the media and there should be slight excess media in the plate (this will be liquid in the plate). This excess prevents the pad from drying out whilst you are sampling and during incubation.

2.2.1.2 Sterilising the equipment before you leave for the field

The filtration apparatus should be sterile before you leave for field work ready to take the first sample. The key components to sterilise are:

1. The filtration apparatus, including the funnel and the bronze disk
2. The sample cup (for an Oxfam-DelAgua kit, this is the cup which has a hole at the top)

To sterilise this equipment, follow the procedure outlined in the kit manual. Before adding the methanol, make sure the filtration apparatus is in position 2 – where the filter funnel is attached loosely to the filtration base.

DO NOT LEAVE THE FILTER FUNNEL UNATTACHED TO THE BASE AS THIS WILL FALL INTO THE SAMPLING CUP DURING STERILISATION AND MAY BE DAMAGED. ALSO DO NOT LEAVE THE FILTER FUNNEL IN A TIGHTLY ATTACHED POSITION AS THIS WILL PREVENT STERILISATION.

Once the funnel is ready, add up to 16 drops of methanol into the bottom of sampling cup. Tilt the cup towards you and let the methanol slowly run down the side of the cup. Light the methanol and place the cup on a firm surface. Once about half the methanol has burnt away, place the filtration apparatus into the sampling cup upside down and allow the equipment five (**5**) minutes to sterilise. This can be done as you move to the first site. Some key points to remember are:

1. THE FILTRATION APPARATUS MUST REMAIN IN THE SAMPLING CUP UNTIL IT IS TO BE USED. **DO NOT PUT THE FILTRATION APPARATUS INTO THE FILTER CUP, AS THIS WILL MAKE IT UNSTERILE.**

2. **DO NOT PLACE THE HOT SAMPLE CUP ON THE INCUBATOR LID AS THIS MAY CAUSE DAMAGE.**

3. REMEMBER YOU NEED TO STERLISE THE EQUIPMENT **BEFORE** EACH SAMPLE AND NOT SIMPLY BEFORE YOU LEAVE FOR THE FIELD.

The filter cup – this is the cup on which the filtration apparatus sits – does not need to be sterile, although it should be clean.

2.2.1.3 Sampling and analysis in the field

At each sample point you go to, make sure you go through the following steps to do a microbiological analysis:

1. Place the kit on a firm surface where it is easy for you to work.

2. Sterilise the forceps by flaming them in the **blue** flame of the lighter. You must make sure the forceps cannot get contaminated whilst you will use them. Place the forceps into the kit lid catch with the two prongs facing upwards. If you or anyone else touches the forceps, or you place them on any surface, you **MUST** re-sterilise them before picking up the filter paper.

3. Take the filtration apparatus out of the sampling cup and put it carefully onto the filter cup. Make sure you do not put any part of your hands or fingers inside the filter funnel as you do this. Press the filtration apparatus down firmly onto the filter cup until the 'O' ring seal is within the vacuum cup.

4. Leave the assembled filtration unit on a firm surface. DO NOT place the filtration unit on top of the incubator lid as this may cause it to become stuck. If you have to use the kit as a work surface, use the small shelf to the side of the incubator, but take care not to spill water on the kit. It is better to use another surface for filtration.

5. Take the sample cup to the source. First swill the sample cup 3 times with the water you wish to test. This is important as it removes any methanol traces that may been left in the sample cup and which may prevent the bacteria from growing. Once you have swilled the cup three times, take the sample to be analysed.

6. Put the sample on firm surface away from potential contamination and close to the filtration unit. Take a filter paper and open the packaging. Take the funnel of the filtration unit and HOLD IT IN YOUR HAND. **DO NOT PLACE THE FUNNEL ON ANY SURFACE AS THIS WILL MAKE IT UNSTERILE.**

7. Take the filter paper and place it gently on the bronze disk, making sure that it completely covers the disk and is evenly placed.

8. Replace the funnel and tighten it into the filtration position.

9. Pour the sample water into the funnel. The funnel has three graduations – 100ml, 50ml and 10ml. Make sure that the bottom of the meniscus is level with the graduation for the sample volume you are taking.

10. Place the vacuum pump into the small hole on the side of the filtration unit. Gently press the pump a few times to start the water flowing. You may need to press the pump several

times to ensure all the sample has gone through. Try not to press the pump too hard as this may make it difficult to pump again.

11. Once the sample has passed through the filter paper, disconnect the vacuum pump and loosen the filtration funnel. Take a plate from the stack and open it, leaving the top resting on the base.

12. Take the filter from the base of the filtration unit carefully with the forceps and lay the filter paper on top of the pad evenly. Make sure the paper completely covers the pad and make sure no air bubbles are present under the paper, as this will prevent the bacteria from growing.

13. Place the lid on top of the plate and put the plate back into the stack. Make sure you either mark the plate with a sample number so that you remember which plate was taken from which source.

14. Throw away the remaining sample and dry the filtration unit and sample cup. RE-STERILISE THE FILTRATION UNIT AND CUP READY FOR THE NEXT SAMPLE.

The other tests that you will carry out are simple. For turbidity, pour water into the tubes slowly until you cannot see the black circle at the base of the tubes. If you can still see the circle when the tube is full, record this as being less than 5TU (<5TU).

Chlorine and pH will only be tested for piped water supplies or household water where chlorine has been added. First of all, swill both sides of the comparator out with water that you will test. Fill each chamber up to the top.

Add a **DPD1 tablet** to the left hand side (marked DPD) and a **phenol red** tablet to the right-hand side (marked pH). DPD1 tests for **free** chlorine residual and phenol red for pH. Shake the comparator well until the tablets are fully dissolved. Hold the comparator up in the light. Choose which standard colours on the side of each chamber the water with tablet matches most closely and read off the value that this colour is equivalent to. To test for **total** chlorine, add a **DPD3** tablet into the chamber marked DPD where you put the **DPD1** tablet. Make sure the DPD1 tablet has been previously dissolved in the water as otherwise you test for **combined** chlorine.

At each site carry out a sanitary inspection and note the score as discussed below.

Record your results on the daily report sheet like that shown in Annex 2 at the back of this manual. On the top of the form fill in:

- The town where you work
- The area where have done the sampling
- The date when you took the samples
- Your name

For each site, mark:

- The sample number (1,2,3 etc)
- The source name
- The code number of the source (if one has been allocated)
- Whether you have done a sanitary inspection

- The sanitary risk score
- The time you took the sample
- The colour of the sample (this is just a visual assessment, clear etc)
- The turbidity
- The free chlorine
- The total chlorine
- The volume of water filtered

At this point leave the faecal coliform data as this cannot be filled in until you have incubated the samples.

2.2.1.4 Incubating the samples

Once you have finished you sampling, the plates must be left for at least **one (1) hour before switching on the incubator**. This is to allow the bacteria time to resuscitate and this is essential as otherwise false readings may be obtained. However, no sample should be left for more than four (**4**) hours, thus you only have three (**3**) hours for sample taking and processing. Once the last sample has been left for one hour, the incubator can be switched on.

The samples should incubate for a minimum of 14 hours. If the kit is being run from an electricity supply, you can incubate the samples for up to 24 hours. If the battery is being used, never incubate a sample for more than **18** hours. Incubation is usually best done overnight. Thus if the incubator is switched on at 3.00pm, you should switch off the incubator the following morning around 9.00 am the following day.

2.2.2 Reading the membrane filtration test results

When you switch off the incubator, you should read the results immediately. The bacteria we are interested in (the faecal coliforms) form yellow colonies on the MLSB media used in the Oxfam-DelAgua and many other kits. You should only count the yellow colonies that are at least 2mm in diameter. DO NOT count any colonies that are clear, red or any other colour, as these are not faecal coliforms. If you use a different media, for instance Maconkey broth, make sure you are clear what faecal coliform colonies look like.

The filter papers have a grid on them to allow you to count the colonies more easily. Count the colonies systematically, counting all colonies in one column of the grid before moving to the next column. Note down the number of colonies you have found on the daily report sheet. Where there are so many colonies that it is impossible to see individual colonies clearly, mark the result as too numerous to count (**TNC or TNTC**).

Using the volume you have used, calculate the number of colonies per 100ml as this is the standard volume for reporting microbiological results. We usually record results in terms of colony-forming units (cfu). If you used a 100ml sample, this is the same as the number of colonies you have counted. If you have used less than 100ml, you will need to multiply the number of colonies found by the proportion of 100ml that was used in analysis. Thus if have 50 colonies on a plate that came from a 50ml sample, you need to multiply by 2 to get a figure for 100ml (this would be 100cfu/100ml). If you had used a 10ml sample, you would have to multiply by 10 (in this case you would have 500cfu/100ml). Note these on the daily report sheet and keep this safe ready for data entry.

It may be necessary to take smaller volumes for analysis for a number of reasons. Once the number of colonies on a plate exceeds 200, the validity of results may be compromised as the competition for limited nutrients from the media may have caused some bacteria to fail to form colonies or for their size to be small. Where heavy contamination is found, the colonies may start to coalesce, making identification difficult. Thus we would prefer a smaller sample so that we can develop the colonies more effectively. In other cases, the water may be very turbid and thus we have to use a smaller volume to prevent the filter becoming clogged.

2.3 Sanitary inspection

Sanitary inspections are a form of risk assessment. When we carry out a sanitary inspection, we are evaluating the water supply to see whether there is a likelihood of contamination occurring. In many ways, sanitary inspection is more powerful than water quality analysis as when we test water, the degree to which we draw conclusions about the supply are often quite limited. In a sanitary inspection, we can often draw very strong conclusions about the ongoing status of the supply and the potential risks of contamination in the longer-term. Sanitary inspection data will also tell us what interventions are required It is also a tool that can be used by community members to be able to monitor their water supply.

In a sanitary inspection, we try to identify all the major risks that could be present that may cause contamination and establish a system that allows us to quantify the risks. This is useful, as we may need to prioritise certain sources or certain risks. As we are trying to develop an integrated risk assessment of the source, there are different types of risks that should be incorporated into a sanitary inspection. These in general terms are:

Hazards factors: these are factors from which contamination may be derived and are a measure of sources of faeces in the environment. Examples will include pit latrines, sewers, solid waste dumps and animal husbandry.

Pathway factors: these are factors that allow microbiological contamination to enter the water supply, but do not provide the faecal matter directly. Pathways are often critical to whether contamination occurs as the presence of hazard may not directly correlate with contamination if no pathway exists for the contamination to reach the water supply. Examples of pathway factors include leaking pipes, eroded catchment areas and damaged protection works.

Indirect factors: these are factors that enhance the development of pathway factors, but do not either directly allow water into the source nor are a source of faeces Examples include lack of fencing or faulty surface water diversion drainage.

These factors can be incorporated into the sanitary inspection forms that are provided in Annex 3 at the end of this manual.

The sanitary inspection forms in Annex 3 have a series of questions that all have a YES/NO answer. For every question that has a yes answer we give one point and for every no answer we give zero points. We can then count up all the yes scores to get a final sanitary risk score. This provides the overall assessment of the source.

2.3.1 Filling in the form

It is crucial that you fully understand what each question is asking you when completing a sanitary inspection form for a water supply. Bear in mind that the questions are phrased so that a YES answer means that a risk is present and therefore study the forms carefully. The forms are usually reasonably simple to use and you should receive training in conducting a sanitary inspection before starting surveillance activities. Two examples of how to fill in a sanitary inspection form are given below.

Type of facility: PROTECTED SPRING

There are 10 questions of the sanitary inspection form and these are summarised below with explanatory notes.

Qu. 1 Is the spring unprotected?
This question asks whether the source is **NOT** protected. Thus if the spring is an unprotected spring, the answer will be ***Yes*** and if it is a protected spring, the answer will be ***No***. Look for any protection works present at the site.

Qu. 2 Is the masonry protecting the spring faulty?
Look for faults such as holes in the structure, or the top breaking up.

Qu. 3 Is the backfill area behind the retaining wall or spring box eroded?
Look for channels developing in the area immediately behind the retaining wall, a loss of vegetation in the backfill areas leaving bare earth, pits or holes in the backfill area or the development of footpaths within the backfill area.

Qu. 4 Does spilt water flood the collection area?
Is there significant amounts of wastewater close to the outlets, causing people to wade. Pay attention in particular at whether flooded wastewater level approaches the outlet pipes.

Qu. 5 Is the fence absent or faulty?
If the fence is damaged in any way (no longer reaches full way around spring), then this represents a risk

Qu. 6 Can animals have access within 10m of the spring?
This is independent of the previous question as a fence may exist but does not prevent animals from coming close to the spring and possibly enter the backfill area.

Qu. 7 Is there a latrine within 30 and uphill of the spring?
Latrines that are downhill of the spring will be unlikely to affect the spring

Qu. 8 Does surface water collect uphill of the spring?
Look for pools of surface water uphill of the spring within at least a 50m radius

Qu. 9 Is the diversion ditch absent or non-functional?
Above each spring, a purpose-built ditch should be constructed to divert surface water away from the protection works. This helps to prevent inundation of the spring. If there is no ditch, it has filled up or it no longer reaches around the full extent of the spring, then this creates a direct route for contaminated surface water to enter the backfill area and cause contamination or erode the backfill

Qu. 10 Are there any other source of pollution uphill of the spring (e.g. solid waste)
Where sanitation facilities are poorly developed, many people may dispose of faeces into garbage or drains and this creates a serious hazard to the water source, particularly when surface water diversion ditches are not present.

Total risk score = the sum of all the questions with a ***Yes*** answer. This can be converted into a percentage by dividing the total number of yes answer by the total number of questions and then multiplying by 100. Thus 7 yes answers out of 10 questions = 7/10 or 70%.

Type of facility PIPED WATER

This again has 10 questions with a YES or NO answer. However, the format of this inspection is somewhat different because it is designed to cover a whole area rather than a specific sampling point. The form also includes six questions that relate specifically to the immediate areas around the sampling points in each area and 4 questions regarding broader supply problems. At the side of each question, there is an additional line to allow you to identify at which sample point(s) the problem was found. For the questions relating to immediate sampling points, if any tap within the area has this problem, it should be answered as YES and the sample number noted. For the supply problems this is also useful, but less important.

Qu. 1 Do any taps leak?
If any tap visited in the area leaks, then this question should be answered as ***Yes***
Qu. 2 Does surface water collect around any tapstand?
If this is found at any tap visited, it should be answered ***Yes***
Qu. 3 Is the area around any tapstand eroded?
Look for signs of water channels close to the tap. If this is found at any tap visited, it should be answered ***Yes***
Qu. 4 Are pipes exposed close to any tapstands?
Look in particular at the pipe from the supply leading directly to the tap. Do not count the riser pipe for the tap. If this is found at any tap visited, it should be answered ***Yes***
Qu. 5 Is human excreta on the ground within 10m of any tapstand?
If this is found at any tap visited, it should be answered ***Yes***
Qu. 6 Is there a sewer within 30m of any tapstand?
Check with the household. If this is found at any tap visited, it should be answered ***Yes***
Qu. 7 Has there been discontinuity in the last 10 days at any tapstand?
You will need to ask households within the area whether this has occurred. If this is found at any tap visited, it should be answered ***Yes***
Qu. 8 Are there signs of leaks in the mains pipes in the Parish?
As you move through the area, look for any obvious signs of leaks. These may include the sudden appearance of water along roadsides or strips of lush vegetation. Also ask households in the are if they know of any leaks in their area.
Qu. 9 Do the community report any pipe breaks in the last week?
Ask households within the are whether this has occurred.
Qu. 10 Is the main pipe exposed anywhere in the Parish?
As you move through the area, look for mains pipes that have become exposed. In particular, check along roads as this is often where mains pipes are located. Bear in mind some pipes are designed to be above ground and these would not be included as a risk. If in doubt clarify with the water supplier.

Total risk score = the sum of all the questions with a ***Yes*** answer. This can be converted into a percentage by dividing the total number of yes answer by the total number of questions and then multiplying by 100. Thus 7 yes answers out of 10 questions = 7/10 or 70%.

2.4 Sampling site selection and sample approaches

Selecting where we take samples from and how often samples should be taken is often critical to how useful the results from surveillance are. In order to develop effective monitoring programmes we need to take into account what may cause variations in water quality, when these variations may be seen and how many people use each type of source.

2.4.1 Point sources

For point sources, sample site selection is simple, as there is usually one well-defined outlet that is used by the population. In the case of a borehole, this will be the handpump and in the case of a protected spring this will be the outlet pipe. In other point sources, such as dug wells, samples could be taken from the handpump or windlass or directly from the well itself.

The frequency of sampling of point sources will be determined by the likelihood of variation in water quality, the quality determined during the assessment and the numbers of people using different sources.

As a minimum, we want to test point sources when the quality is likely to be worst in order to assess the actual risk to public health. This would usually be during periods of rainfall (the wet season) and sometimes immediately after a heavy rainstorm as some shallow groundwater, such as springs, may show very rapid response to rainfall. In order to evaluate overall performance of these sources, it is also useful to test them during periods when the quality will be likely to be better – i.e. during extended dry periods. We can then use this data to assess whether the sources are subject to significant year-round pollution, which may indicate that contamination is more widespread within the groundwater and therefore, improvement may be more difficult. Alternatively, we may find that contamination is purely seasonal and therefore we could conclude that contamination is primarily localised and control of pathways may be most important to reduce the risks to health. Such findings will also help us target health education programmes so that they concentrate on the times of greatest risk to health.

In general, you should always try and visit each point source within your area once per year and if possible two or three times per year. Shallow groundwater sources like protected springs and dug wells will be likely to be more vulnerable to contamination than deeper groundwater sources such as boreholes. In deeper groundwater, the potential to remove or retard pollutants is usually increased due to the time taken for surface water to infiltrate down the water table, although in some areas, groundwater is found in fractures and these often have high flows and less capacity for pollutant removal.

In both shallow and deeper groundwater sources, direct contamination may occur because the sanitary protection measures around the source have not been well maintained. Thus many of the direct pathway risks may be more important in causing contamination. This is likely to be particularly the case when excreta are found on the ground surface in solid waste dumps or drains and can be directly washed into the source because it lacks diversion ditches. Other critical problems will be found where the backfill area of a spring has been allowed to become eroded and this allows water to enter the source very close to the outlet. For boreholes, the lack of a seal between the top of the riser pipe and the apron will provide a direct route of entry for contaminated surface water if it is allowed to inundate the borehole headworks. Similar problems will be noted for a dug well that lacks a cover or headwall.

Therefore, it is important to look at each point source when developing your sampling programme. If particular individual sources or types of sources show major defects in sanitary protection measures, more frequent sampling may be advisable. As discussed later in this manual, this type of data is very useful also in planning improvements.

The frequency of sampling may also be increased where the point sources are located in high-density areas, as there is likely to be a greater number of hazards in the environment that may cause contamination. Clearly, the number of people likely to be using point sources should also guide you and this forms part of a zoning process that is described in an accompanying volume. Where water usage studies have shown that many people use point source and that relatively few people use piped water, a greater frequency of point source sampling is recommended.

When sampling a source, you should also consider whether the outlet should be flamed before the sample is taken. This depends on what exactly you wish to test:

- the quality of water in the source, or
- the quality of water actually being collected by the users.

Flaming is usually carried out when we want to directly test the quality of the water in the source. We flame the sample point to eliminate any bacteria that may be on the outlet itself which have been introduced by the users themselves through poor hygiene. However, it is often more useful to know exactly what quality of water is being collected by the users and therefore we take an unflamed sample. If we wish to check whether the contamination has come from poor hygiene around the outlet or from the source itself, we would take both a flamed and an unflamed sample. This may help us direct our health education programmes. Obviously at some source we cannot flame the outlet – for instance protected springs – as water flows continuously.

2.4.2 Piped water sampling and choosing sample sites

Piped water supplies may vary significantly within a short period of time and over a short distance. This variation is not usually caused by a defined external event – for instance the season – but due to poor treatment or re-contamination within the distribution network. As the variation is often less easy to predict than for point sources and as many people are likely to use taps, we need to take regular samples from the piped network. The numbers of samples to be taken is usually based on the population that is served by piped water. In the case of urban piped water supplies, we may need to use the data from water usage studies to decide how many people are likely to use piped water. The table below gives the WHO recommended minimum number of samples to be taken from piped water supplies.

Population	**Number of samples per month**
Below 5,000	1 sample per month
5,000 – 100,000	1 sample per 5,000 population
Above 100,000	1 sample per 10,000 population plus 10 samples

Table 2: Sample numbers by population (WHO, 1993)

In urban areas, we will usually sub-divide the town or city into smaller areas. These may be administrative or based on the piped system characteristics such as service reservoir, age of pipes etc. Thus, rather than base our numbers of samples on the total population of the town that uses piped water, we would look at the population in each area and use it to calculate the number of samples for that area.

There are some points in the piped water supply where we should always take samples. These are the final water leaving a treatment plant or the nearest point that is accessible to surveillance staff and from service reservoirs/storage tanks or the nearest tap where access is difficult. In addition, we need to take samples from the distribution network itself. When sampling from the distribution network, there are two approaches we can be adopted in the selection of sampling points. We can select fixed sample points, from which samples are always taken whenever monitoring visits are made to the area. Sometimes we select fixed sample points because they are easy to gain access to or are located in key areas such as markets or densely populated settlements. By using a fixed sample point, we can also monitor trends within the supply to look for any changes over time.

However, the problem with using a fixed sample point approach is that many of the problems in piped water supply may be very localised and thus by always selecting the same sample point we may miss many cases of water quality failure that occur in other parts of the system. As a result we often prefer to develop a random sampling approach within the area being sampled. This gives us a better chance of identifying water quality problems when they occur. When we use a random approach to sample site location, this means that each time an area is visited, the sample is taken from a different tap within the area. Thus, the same number of samples are taken from each area on each visit, but the actual location of the sample point changes. This approach is often called stratified random sampling, as we are dividing the city or town into smaller units.

Sometimes, it is most effective to mix both fixed sampling points at critical points such as markets and random samples. However, in a routine surveillance programme, the fixed sample points should not make up more than one-third of all the samples taken. Therefore, when carrying out your routine sampling programme, try and vary most of the locations that you a sample from month to month. For instance, in a Parish with several zones or cells, you may want to take a sample of different zones in different months.

Flaming will again be a major issue in piped water supplies. Again, flaming is of greatest use when the actual water in the system is being tested. We may want to know this when we are using data to regulate the water supply and we are in a position to enforce the water supplier to meet national standards. However, in many cases we are more interested in the actual quality of water that is being collected in order to focus health education and operation and maintenance training on maintaining a safe source.

It is not uncommon to find that communities or households attached a length of hosepipe to their tap. They usually do this because the tap itself causes water to spray and thus there is a lot of wastage. The operator cannot get money for this water and thus they use local materials to ensure the water can be directed into container with little wastage of water as possible. However, these attachments often causes the water quality to deteriorate and is likely to be a source of contamination when this is found. If we want to use surveillance to protect public health, it is important to know the quality of water that people actually collect and if we find contamination, to identify what was the likely causes of this deterioration. Thus it is a good idea to take both flamed and unflamed samples for analysis.

2.4.3 Household water sampling and selecting sampling sites

Testing the water stored in households is a key a routine surveillance activity. Water may be good at the source, but once it reaches the home, it may have become very contaminated due to poor handling and storage. We therefore need to carry routine testing of household water to ensure that it is of reasonable quality and where it is not, to use the surveillance information in health education to promote safe water handling.

The number of households and their location is likely to vary depending on exactly what the purpose of the testing is. If a routine programme of household water quality testing is undertaken, the number of samples taken each month will usually be defined based on the number of people likely to store drinking water in the home and the resources available for surveillance. Usually, we would want to ensure that a reasonable number of tests are taken.

In this kind of programme, the households selected for water quality testing should be varied from month to month, although like the piped water sampling we may define areas from which we always want to take a sample. This random approach is adopted as we are not trying to pilot a particular activity but are trying to encourage improved water handling through an ongoing process of dialogue with the community and households.

In other cases, the testing may be part of a specific study that is related to a health education or other intervention. In these cases, we would usually define a particular group that will receive the intervention and group that will not. In this kind of study, we may be trying to assess the impact of our intervention by comparing the water quality in the study group and the water quality in a control group that receives no additional intervention. We may want to do this so that we can generate data from which to perform statistical tests. Another reason why we would do such an experiment is that if we only took the group receiving the intervention and saw that water quality improved, we cannot be sure that this was primarily due to the intervention, whether is was a random effect and would be seen in all household water or whether the full interventions was required.

2.5 Chemical tests

In some areas we may need to carry out chemical tests apart from chlorine and pH. Usually, these will be on point sources and the three chemicals of particular importance are arsenic, fluoride and nitrate.

These three chemicals all have acute toxic effects and are persistent in water supplies – i.e. they represent an ongoing risk as opposed to occasional poisoning events. Other chemicals should be tested during source selection or periodic evaluation, unless their presence leads to rejection of water supply, for instance iron and manganese, when more frequent analysis will be carried out. Surveillance agencies usually only undertake very limited chemical testing, given the costs and the often stable nature of chemicals in water. However, water suppliers are likely to undertake more frequent chemical analysis and may be required to be the water law.

Nitrate

Nitrate is usually derived from human activity and may come pit latrines, organic solid waste and inorganic fertilisers. Nitrate is of concern to health because it causes methaemoglobinaemia ('blue-baby syndrome'). Once nitrate enters groundwater, it is un-reactive and concentrations will only be reduced through dilution. Therefore nitrate represents a long-term hazard to the resource. If you test for nitrate, then bear in mind that in shallow groundwater nitrate may show seasonal peaks and often nitrate may increase through the wet season as organic nitrogen breaks down to form nitrate. If you find raised nitrate, you should think carefully about whether the source is viable in the long-term and look for alternatives such as taps. Analysis of nitrate is best done at a laboratory, although there are some accurate field spectrophotometers that provide reliable results. If you use photometers or probes, the results are only semi-quantitative and are probably only useful in trend monitoring.

Arsenic and fluoride

Arsenic and fluoride are often derived from natural sources where minerals bearing these substances are found in bedrock. Excess fluoride causes dental and skeletal flouorsis which an extremely painful and debilitating illness. Arsenic is related to cancers and is of increasing concern in many countries where high levels are found in groundwater and large numbers of people are affected. Both chemicals should be tested when a source is being developed, particularly in areas where there is a suspicion that they may exist because of the underlying geology or in the case of arsenic where mining or industrial processes are known to release it into the environment.

Arsenic may require more frequent testing as it appears that concentrations may increase when abstraction of groundwater leads to changes in the sub-surface water chemistry. At present, accurate results for both chemicals can only be obtained from laboratory analyses, although researchers are trying to develop a field kit for arsenic. When these chemicals are found in water, an alternative source should be found or if this is impossible, the water will need to be blended with water with low concentrations.

Section 3: Reporting your findings

Reporting on your findings is an essential step in routine surveillance. There is little point in collecting a lot of useful information unless this is shared with other people to be able to make improvements in the water supply. The people you report the information to should always include the communities where you took the sample. People have a right to know the quality of their drinking water and the steps that they can take to prevent diseases. In many cases, the actions required to improve the source will be the responsibility of the community themselves. For household water quality, improvements in handling and storage will clearly need to be done by the households themselves.

Other people may also need your results and conclusions. Water suppliers will need to be made aware of problems within their water supplies so that action can be taken. The urban authority may also need the information for planning interventions to improve water supply, to focus health education programmes and to be able to promote improvements in water supply.

The different groups of information users have different needs and the way in which you present your findings and how often you provide reports may be crucial in making sure actions are taken. In the following sections, the process of information sharing is described, but please be aware that what is most important is that you find out who wants the information, how often and in what format.

3.1 Community feedback

One of the most important groups of people who need access to your results are the communities where you have taken samples and done sanitary inspections. Obviously, these people will want to know whether their water is safe, what risks are involved in drinking the water and what they can do to improve their water quality.

However, whilst communities need the information that you have generated, it would be impossible to go each member of the community and discuss the results with them. It is also important to remember that most people will have only a very limited understanding of what the information means and therefore you should try and make sure the information you provide the community is in a format that they can understand. You should also recognise that people will want more than just information about the risks – they will also want advice about what to do with the information.

The first stage in planning a feedback mechanism to a community is to decide how you will get the information to them. As it is not possible to visit every individual household, we have to consider the best way of reaching most people at one time. There are several ways in which this can be done:

1. Provide a report to a local community organisation. This could be a local council (e.g. LC1 in Uganda) or to a local development committee, NGO or community-based organisation (CBO) or perhaps a local clinic or health centre. It is important to select an organisation that has regular meetings with all the community and which is able to disseminate the findings on water quality and sanitary risk to the majority of the community.
2. Put results up in a central or commonly visited place within the community (e.g. a community centre, health centre, school, church or mosque). If you do this, you must

make sure that people are aware that this is the place that they can information and you must also make sure that you provide the information in a simple format that requires little explanation.

3. Community meetings. This is often a very good ways of sharing the information with the community and has an added advantage in that you can initiate a wider discussion of what the findings mean and what the community can do to improve their water supply and household water quality. However, although such meetings are useful, you should also bear in mind that these meetings may fall outside normal working hours and you may therefore need to set aside extra time for attending them. A further point to keep in mind is that whilst community meetings are important, the community themselves will usually have many other things to discuss and may not respond well to over-frequent meetings.

Often the best way to plan feedback to the communities is to combine two of the above approaches or even all three. Thus you may provide regular feedback to a community organisation, for instance each month, and then attend community meetings on an occasional basis (for instance twice a year).

When you hold a community meeting, you must be well prepared beforehand as otherwise it is likely that the meeting will not be useful in promoting improvements in water quality. It is essential therefore to think about what your objectives are for the meeting and what kind of information are you providing and the sort of questions this may generate. In particular, you should be aware that many people might look to you or your urban authority to make the improvements, rather than taking responsibility themselves to improve their water supply. You must be clear what exactly you can offer in terms of support to the community – whether technical, financial or advocacy – and be sure that this is understood. Otherwise, people may blame you for failing to improve their water supply. Key points to remember are:

1. Do not make promises you cannot keep – explain what you do and what you cannot do
2. Be positive about the things that you and the community can do to improve the water supply

It is not a good idea to plan a community meeting solely to provide information. The community members will almost certainly want advice and possibly seek direct support. If you are holding a meeting, therefore, the objective should be to discuss your findings with the community in the light of initiating local action to improve the water supply.

The types of questions you are likely to face will be things like ‘will we get diarrhoea from our water?’, ‘what can we do to improve our water supply?’, ‘what can you do to help us?’. Be sure you can answer these questions and try to develop a discussion about what the community can do themselves and how important they view improvement of their water supply. Use health education materials with the community – for instance use some of the PHAST tools to generate a debate about what can be done by the community to improve the water supply. One good method of doing this is to take a sample with community members the day before the meeting and read the results with the community at the meeting. You can show them the plates that you incubated and explain what the colonies mean. You will often find that people react positively to such direct ways of reporting results and they often do not need to understand germ theory to be aware that contamination is bad for their health.

3.1.1 How to relay the information

The way in which the information presented to the community will be important in determining how well it is received and whether communities will use the information to improve their water supply. There is no point in providing communities with information such as the number of faecal coliforms per 100ml or the total risk score as people may not understand these and you will have to spend a significant amount of time in explaining what these results mean.

To provide a simple report to the community, you can use one of the forms at the end of this manual. These provide basic information about the water quality and risks and identifies what the major problems are. Make sure you note the major problems that are within the power of the community to address. Where other risks are found that the community may not be able to directly address – for instance interruption in supply or latrine proximity to the source – try to provide other advice such as recommendations to use tap water for drinking, or to report faults to the water supplier.

The example reports shown in Annex 4 at the end of the manual provide a simple format that can be used and given each month to the representative of the community organisation. The organisation must be encouraged to share these results with the community and to try and develop a plan of action. Make sure they know where to contact you if they need further information of advice.

Where communities are not literate, you can modify these forms to show the degree of contamination and the risk score in terms of colour, but be aware that this will require more explanation to be sure that people understand what the different colours mean and what they should do about their water supply.

3.2 Informing the urban authority

The urban authority should be provided with reports on your findings every month. This is partly to ensure that appropriate action is taken where necessary and also as a way of reporting on the activities you have undertaken. The urban authority needs different information from that required by communities and the information can be more technical and detailed.

The information provided should still be in a summary form – there is little point in providing all your daily report sheets and sanitary inspections forms. The information that should be included should cover:

- The sources and areas visited each month
- How many samples and sanitary inspections have been carried out
- What were the results of the analysis and sanitary inspections
- What actions have you already taken or planned with the communities concerned
- Recommendations on other actions required
- Plan for the next period

Much of this information about the sources and results can be printed using the 'Sanman' database, so relatively little additional work is required. Examples of 'Sanman' reports are show at the end of the manual. However, you should always include a discussion of what actions you have already taken or planned and your recommendations for further actions.

Make sure that the report is concise and relevant and reaches the key decision-makers within your urban authority.

3.3 Water suppliers

It is important to share you findings with the water supplier in the area. This is important not only when problems are found, but also when water quality is good. The process of information sharing is often a key element in developing a better co-ordinated response to poor water supply.

When reporting information to water suppliers, you must make sure that they receive information which is relevant to them. The information that should be provided should relate to the samples you have taken from their water supplies and the sanitary inspections carried out. Water suppliers are not responsible for household water and unlikely to be responsible for point sources. Therefore there is little point in providing this information unless it is specifically requested.

You can use the reports generated by 'Sanman' to give to water suppliers, as this will tell them where each sample was taken, what the results were and what the risk score was. You should also attach a brief report on any recommendations you have to improve the quality of the water supply.

Section 4: Using the surveillance data

There is little point in collecting surveillance data unless you plan to use it to make improvements. Sometimes, the use of the data may require other people to make decisions and therefore your surveillance data becomes a very useful tool to influence the decision-makers. The key part of this process is to make sure that your data is reliable and comprehensive. Trying to influence decision-makers who may have very limited budgets is difficult when the data you give them is scanty or unreliable. As decisions made to improve water supply usually involve the commitment of substantial sums of money, it is essential that this is based on sound data. In many cases, interventions are required at a community level, possibly to improve operation and maintenance of communal supplies or to promote safe water chains. Again, these interventions should be based on sound data and the surveillance programme should be a key component in designing and implementing community-based interventions.

4.1 How do we use the surveillance data?

Surveillance data can be used to direct the improvement the water supply and water quality through a number of ways and at various levels. There are policy issues that can be influenced by surveillance data by indicating where water supplies should be prioritised, what types of improvement should be implemented and what additional needs are required to support sustainability, for instance training of community caretakers and supporting water source committees.

4.1.1 Assessing your data

The first step in planning interventions is to be sure what your information is actually indicating. There are some very simple ways that you can assess your data. For instance, you can look to see which type(s) of water source(s) are most contaminated and whether the contamination is related to particular seasons. If one source type is generally more contaminated than others, you could use this information to:

1. Inform health education to emphasise the use of safe sources in the community
2. Lobby for extension of the safe water supply to more people
3. Where the contaminated sources are heavily used, raise funds to improve these sources.

In the last case, you should look at the sanitary inspection data and decide whether this indicates that there is likely to be widespread contamination of the whole water body or whether contamination is likely to be localised. Localised contamination will often be seen where there is a large variation in quality between wet and dry seasons and where there are significant recording of pathway and indirect risk factors. In these cases, it may be worth trying to look at how often different risk factors were reported under different water quality result categories – for instance 1-10FC/100ml, 11-50 FC/100ml. 51-200FC/100ml. This can be gained from a report in the 'Sanman' programme called 'Survey by Category'. This can then help you plan your intervention.

Your should also look closely at the household water quality results. For instance, source waters may be of good quality but household water highly contaminated. In this case, the focus of any intervention should be on health education around the safe water chain. In other cases, water quality in houses may be very variable and it may be worth following up to see whether the source type influences this in any way.

4.2 Engineering interventions at water sources

Engineering interventions may be needed on all kinds of water sources. These need to be considered carefully and planned to reflect the ability of the communities to maintain improvements in water supply and what is most cost-effective. The technical improvement in water should be based on the sanitary inspection and water quality data. Of particular importance is to look at the sanitary risk data and to assess what this tells us about improvements we should make.

4.2.1 Protected springs

For protected springs, it is important to look at the state of the protection works – including the backfill area – to see whether these show any deterioration. In many cases, the deterioration in the immediate sanitary protection works is more important in causing contamination than the hazards such as pit latrines and this was seen in Uganda. However, the deterioration in the sanitary protection measures are important to improve irrespective of what the quality of water is like from any samples taken.

The deterioration in the basic sanitary protection measures shows us that the water source has not be well-maintained and that the community has not been able to sustain the source. We therefore need to try and make sure that the community can be helped to improve the sanitary protection. We should also bear in mind that the improvement of sanitary protection measures such as the quality of masonry and the protection of the backfill area will be dependent on other factors such as the presence of a fence and an uphill diversion ditch will be critical. If we try and resolve one issue without addressing the underlying causes, it will simply delay the onset of water quality problems and not resolve them.

For instance, we may see that the catchment area has become eroded and lost its vegetation cover, at the same time there is no fence and the uphill diversion ditch is either absent or faulty. The erosion of the catchment areas results from two major factors. The lack of a fence means that both people and animals can get access directly onto the catchment area and may cause erosion by creating footpaths or by making holes in the ground. The lack of a diversion ditch allows surface water to run directly onto the backfill area that not only causes erosion but also may allow water to directly enter the water source. So if we only improve the backfill area without putting in place the fence and diversion ditch, we will not reduce the risk of contamination.

In this case, the technical intervention will require three stages:

1. Improve the catchment area by laying murram and laying new grass
2. Build a fence - in many cases it is better to use either a brick wall or a hedge, since if you use fencing wire this may get stolen or damaged.
3. Build a diversion ditch – one way to do this is to use large flagstones (hard core) with a mortar mix or by casting concrete.

Other technical interventions may require the rehabilitation of a source because the whole structure has deteriorated so badly or because the design is known to be inadequate to provide good quality water. However, rehabilitation is only worthwhile where there is a significant expressed demand by the community for the improvement of their water supply and that measures are put in place to improve sustainability.

Rehabilitation will require the complete dismantling of the existing structures before starting new works. Care must be taken at this point that the flow patterns are not disturbed. The rehabilitation should, wherever possible, utilise the most appropriate design and you may therefore need to bear in mind that the designs used in rural areas may require alterations when being translated into an urban environment. In urban areas, there is likely to be more intense pollution and a greater number of pollution sources. This may mean that more attention must be paid to the type of media that is used in the backfill and that greater care must be taken to protect the backfill area from contaminated surface water.

Designs should be used that enclose the area for where backfill media will be placed, which enables both flow to be directed towards the outlet pipes and to ensure that filtration is maximised during flow through the backfill media. The backfill media should be gravel with a nominal diameter of less than 25mm. This provides filtration potential than larger aggregates that are often used, thus increasing the possibility of removing contaminants that may enter the structure. The gravel pack should be overlain by layers of clay and sand to provide additional protection against the entry of contaminated surface water with a top layer of soil, which is essential to be able to support an adequate vegetation cover.

Spring protection works should always be protected by ensuring that an uphill diversion ditch is provided with a concrete lining, stone pitching or well-compacted clay and a brick fence is provided that allows for growth of a live fence inside the fence. The number and size of outlets of the spring should be carefully considered. In many cases, there is a problem of congestion at the source and this may lead to significant problems. This may be overcome by ensuring that more outlets are provided either through constructing a spring box with outlets on several sides, or where a retaining wall is provided, then outlets can be provided with a ‘T’-junction that allows two outlets to come from a single delivery pipe. In many cases, it is also better to use smaller diameter pipes for the outlets as where large pipes are used, a large proportion of the water may be lost during collection and this may increase problems with congestion. By using a smaller pipe diameter, not only can the water be directed more effectively into the collection vessel, but may also allow more pipes to be used.

The critical element of rehabilitation is to ensure that community commitments are obtained for the sustained improvement of the water supply as otherwise the funds spent on rehabilitating the supply may have been wasted. One way to achieve this is to make sure that the community itself contributes to the capital investment costs, by financial contribution or donation of labour.

In many cases, the technical improvements may not require external resources, but will focus on ensuring that communities undertake the basic operation and maintenance tasks. Many of the basic technical improvements require communities to carry out simple tasks, such as clearing wastewater drains or pools of water close to the source, cleaning and repairing the surface water diversion measures, as well as repairing the concrete works such as aprons, retaining walls and covers on wells.

The surveillance programme should also promote improved environmental hygiene around the source, including the removal of solid wastes that are uphill and/or close to the source and the draining of stagnant surface water within the immediate area of the source. It is also important to work closely with the community to try and control the construction of pit latrines and animal enclosures close to the source.

4.2.2 Boreholes

We often find that boreholes have a better water quality than other point sources because they are sunk deeper into the ground and often have greater protection against contamination. However, you should use your sanitary inspection data to identify whether any problems are noted in the protection works. This may include poor drainage of wastewater that allows stagnant water to form pools close to the borehole, the deterioration in the apron leading to undercutting of the borehole or a handpump being loose at the base where it is attached to the apron. These all require attention to prevent future problems and the community should be encouraged to make minor repairs and clean the environment close to the borehole to prevent contamination. Again, where fences are lacking and there is no means of ensuring surface water cannot flood the apron area, the risks of contamination will increase and you should work with the community to address these problems.

For boreholes, it is often important to prevent latrines and animal enclosures from being constructed close to the borehole as these may allow direct contamination of the groundwater. You should always try to ensure that such hazards are at least 10m away from the borehole and if there are latrines uphill, you should increase this to 30m. Boreholes where the top of the rising main (the pipe that comes out of the ground) cannot be sealed represent a particular hazard as this means that surface water may be able to directly enter the borehole. In this case, try to create a concrete ring around the top of the pipe and if possible seal this by making a small plinth for the handpump to rest on and extend the rising main into the base of the handpump. Where possible, try and avoid using drilling techniques that make it difficult to close off the top of the rising main.

4.2.3 Dug wells

Dug wells are often more vulnerable to contamination than other point sources because it is difficult to make the lining of the well impermeable and often the means of withdrawing water is insanitary. In some cases, dug wells are constructed to reduce the specific risk of guinea worm transmission and therefore only have an headwall to prevent people from entering the well. However, such wells may still be contaminated and it is therefore preferred that dug wells should be covered and either a handpump or windlass installed to withdraw the water. Where water is collected by a bucket, this may contaminate the well, particularly if each person uses their own bucket and the area is not well fenced to prevent animals from having access to the well.

It is generally better to use alternative sources such as a tap or borehole if you wish to improve the water supply in an urban area and the use of dug wells is not encouraged in urban areas. If dug wells exist and are used, there are designs where the intake of water can be protected by installing a filter box at the base of the well. Where wells are used, you should ensure that these are covered, have a headwall of at least 30cm above the apron and a handpump or windlass is used.

4.2.4 Rainwater collection

In urban areas, rainwater collection may be practised by some people and you may consider promoting rainwater collection as a means to improve water supplies in low-income areas. However, before trying to promote rainwater collection, you should try and see how many people already collect rainwater and how many do this in a systematic way using guttering and a tank or drum. This is the kind of information that you can collect in a water usage study. You also need to consider the climate and in particular rainfall patterns. If rain is infrequent or of overall limited amount, then rainwater collection may not be appropriate.

Where very few people collect rainwater by any means, then promoting rainwater collection may be difficult. It is common that where rainfall is such as to make its collection feasible, people will already do this even if it is only by placing a bucket under their roof. Where people do not do this, it suggests that either the rainfall is not conducive to collection because it is not frequent or of only short duration or because people prefer other types of water. You could still try to promote rainwater collection, for instance by setting up some demonstration collection tanks, but this may not be the most cost-effective way of improving access to water in urban areas. It could be that people will respond more positively to setting up tapstands or rehabilitating point sources.

Where people do collect rainwater by any means, we have a much better chance of promoting rainwater collection. If there is significant collection of rainwater, try to evaluate how many people do this in a systematic way as these people may be able to act as promoters of rainwater collection to the rest of their communities. However, always be careful with promoting rainwater collection as in many low-income communities there may be a lack of space and the air quality may be poor. Always consult professionals who have data on air quality and if there is significant pollution from industry or traffic, it is better to look at alternative methods of water supply improvement. The main places that rainwater collection is most likely to be appropriate are lower-density areas on the edge of towns where the air quality is likely to be better and there is greater space. However, you should only promote rainwater collection where people use roofs made of iron sheets or tiles, do not promote rainwater collection where grass or reeds are used for roofing material as this is likely to cause contamination and colour problems.

If people do collect rainwater, you should test this and carry out a sanitary inspection. Some of the major problems that you are likely to find are that the roof is dirty and the tank is not cleaned regularly. The roof should be cleaned at the start of every wet season by sweeping the roof and removing any solid material from the gutters. It is also preferred that the collection system has some way of diverting the first flow of water from the roof as this may have picked up excreta from birds and rodents. The household should make sure that the roof is not overhung by trees or close to food stores as this may encourage rodents and lead to excreta on the roof being found.

The tanks should be cleaned at the start of every wet season and the tank should have a drainpipe to allow all the water to be flushed out. If possible, the household should clean the tank by using a dilute chlorine solution such as bleach in water. The water from the tank should be drawn from a tap, rather than dipping a bucket into the water as this may cause contamination.

4.2.5 Piped water

Technical interventions for piped water will be undertaken at local (i.e. individual taps or groups of taps) or at larger levels such as supply mains repair. The degree to which field workers will get directly involved in these interventions will depend on how the supply is managed. Where the pipe water is a community-managed supply, you are likely to be actively involved in the planning and implementation of technical improvements in the same way as for point sources. Where the supply is operated by a separate arm of your local authority or there is a separate water supplier (for instance a parastatal), then you may be actively involved in identification of the problem, making recommendations on actions required and monitoring whether the action has been carried out rather than directly implementing the works yourself. Again, always look at your sanitary inspection data to help decide what the principal problems are and whether they relate to local problems or larger supply problems

Major supply faults often require major investments that you may not directly have access to. Where the community manage the supply, you will need to work with them to identify the major supply fault and develop strategies for improvement. In the case of utility supplies, you will need to work with the water supplier to reduce these risks. When you see local problems you should make sure that you incorporate working with communities to protect their piped water supply by reducing the risk of contamination.

4.2.6 Piped water supply faults

The resolution of supply faults may require either simple improvement of basic operation and maintenance procedures or significant investment in infrastructure. Below we discuss how you can use the data both in community-managed water supplies and in utility supplies.

4.2.6.1 Community-managed supplies

The process of making improvements community-managed piped supplies will be similar to those for point sources. Thus, a process of dialogue with the community, the identification of problems and solutions and development of action plans will all be critical steps in the process. In many community supplies, the supply faults may relate to deterioration in the source protection measures, similar to those discussed under point sources. These are important to rectify in a community-managed piped water supply.

Other major problems that typically occur relate to the condition of the storage tank(s) and whether the system leaks or often runs below pressure – this could either be daily (related to excess demand) or seasonal due to low flow at the source. By using the sanitary inspection data, you can identify where there are major shortcomings in the current supply system and where improvements are required. In some cases, this will be minor – for instance ensuring that the inspection cover on a storage tank is kept in place or locked. In other cases, more major problems will involve repair of leaks (including possibly replacing broken pipes) or making repairs to the storage tank. In these cases, your surveillance data will identify the problem and allow you to enter a process of dialogue with the community about how to improve the supply. You may also need to lobby for funds from your local council to support basic repairs, but this should not be used to cover the full cost of such repairs unless the council is making a long-term commitment to taking over the operation and maintenance of the supply.

In most cases, it will be expected that the community will have access to available tools and trained staff to undertake simple pipe repairs and repairs to the storage facility. Where these are lacking, a key intervention will be to identify training needs and appropriate people to train from the community. The purchase of tools should, by preference be covered by the community, although you may be able to support this either through cost-sharing or by paying for the tools and allowing the community to re-pay over some periods of time. It would also be expected that some tariff would be levied on these supplies and this would be used to fund operation and maintenance. If these things are not in place, it may be very difficult to sustain community-management

4.2.6.2 Utility supplies

Where piped water supplies are provided by a utility, you still need to use your data to make improvements, although this may demand less of your time than would often happen with a community-managed supply as it is expected that the utility will have the staff, skills and materials to make essential repairs as part of their operation and maintenance programme. This does of course depend on the type of utility and the roles of surveillance data and bodies when the supply is provided by the local council may be somewhat different than a situation when the supply is provided by a parastatal or private sector operator. However, critical in both cases, is that the surveillance data should be used to make improvements in supply when needed.

Where water supply services are managed by the local urban authority, the surveillance arm is likely to take a more active role in the resolution of problems. This will include the development of a programme of action to address the problems noted and may include direct participation in some of these activities, such as cleaning of service reservoirs. In utility supplies, the actions of the surveillance agency will be more focused on identification and timely reporting of faults and discussion about the implementation of a programme of action.

In both cases, there are basic O&M activities that should be carried out on a regular basis, that surveillance bodies should monitor. This includes flushing and cleaning of distribution lines and service reservoirs. Where flushing or cleaning are not regularly carried out, this may become noticeable as colour or odour problems increase or an increased chlorine loss. You should ensure that you are provided with information from operations staff about the frequency of these activities.

4.2.7 Local level actions in piped water supplies

In addition to supply faults, we commonly also come across risks within the local environment around the tap. These are problems like the exposure of a pipe close the tap, finding stagnant water close to the tap or the erosion of the area around the tap. In many cases, we find that contamination has come from the immediate area around the tap rather than as a result of poor supply management. In this case, we need to focus our attention on ensuring that the area around the tap and the customer main is kept clean and that the pipe remains buried.

This is similar in many ways to the issues regarding point sources and also includes some of the health education interventions that we discuss briefly later on. In general, providing advice for the managers of public taps is easier than trying to advise every single household that may have a connection. In any case, the numbers of people using a public tap are likely to be far higher than users of direct household connections.

In many cases, the pipe that connects the tap riser to the supply main is buried at a very shallow depth and therefore is easily exposed and damaged. The damage may result from vehicles or from areas that are prone to flooding. The particularly weak points are the joints – both at the connection to the supply main (where pressure may be highest) and the joint between the supply pipe and the riser pipe at the tap itself. In the latter case, this is often damaged when many people use the tap and the riser pipe for the tap has no support, this leading to damage when people are rough with the pipe. In this case, you should encourage the users of the tap to put in a support for the riser pipe. In the case of existing taps, this may have to be a metal support, but for new taps, encourage the users to provide a concrete plinth to support the pipe. When you are undertaking the construction of a new tap, make sure you always provide support to the riser pipe.

Other critical problems that we may find at a local level will include where people have put a length of rubber or plastic pipe on the end of the tap. This is usually done because the tap does not direct the water directly into the collection container and water sprays. This is water that cannot be charged for, thus many operators want to make sure that only the water for which money can be collected is provided. It is also often irritating for the user to have water spraying around. However, whilst providing convenience for the user, the addition of such lengths of rubber pipe may cause the water to become contaminated.

The main reason often for water spraying from a tap is because the design of the tap is poor. Taps that have an insert often provide water that comes out in a single stream even at high pressure, thus when selecting taps look for those that provide the best means of directing the flow. Alternatively, there are two other ways in which you can reduce the need for attaching rubber hose. You can reduce the height of the riser pipe to a level that is just above he height of the usual container. Riser pipes do not need to be 0.5m high if the usual container is only 0.3m high. The other approach, which may be appropriate when the tap is already in place, is to construct a small plinth to rest the container on that will raise the container up to close to the height of the tap. This will also help to support the tap against damage.

4.3 Ensuring good community management

Many interventions will be based on trying to improve community management of water supplies. This may apply to both point sources and public taps. In many cases, water quality failures may have resulted from poor community management and improving capacity at a local level to operate, maintain and manage a water supply is often a major component in water supply improvements. Your surveillance data should help to identify major weaknesses in current community-management and allow you to focus on working with communities to strengthen this.

In order to improve capacity at a local level, it is important to ensure that the community recognises and understands the health risks related to poor water quality and the causes of the failure. Therefore, as a first step, initiate discussion with the community about the quality of their water, the problem with sanitary protection measures. Through discussion, try to work towards a consensus about what problems exist and how these can be overcome – what can the community do and what support do they need (technical, training, and financial).

Identify with the community why the source may have deteriorated - does a committee still exist? If so, who is on the committee? How often do they meet? Do they have any means of collecting funds from the community or donation of labour? If no committee exists or is weak, then you will need to work with the community to identify a new committee or ways in which the existing committee can be strengthened. This may include replacement of members who no longer have time to be an active committee member or training of a committee in basic management skills, such as accounting or setting tariffs.

Identify whether there is a caretaker for the source. If there is, what work do they currently do? Is this effective? If the basic work is not carried out, what are the major problems? Does the caretaker require some payment? In many urban areas, it is less easy to rely on people donating their labour to carry out work and people have limited time. In many cases, it may be easier for community members to provide money to help support operation and maintenance. If this is the case, you will need to spend time with the community to identify how funds can be raised to support a salary for the caretaker and what the relationship of the caretaker should be to the committee.

Often a priority is to set up or re-activate a water source committee, with a chairperson, secretary, treasurer and about 3 other members. You should carefully consider whether this committee should be independent of other local administrations or a part of the local administration. If the committee is to be independent of local administration, make sure you are clear how these will interact. This committee should agree a tariff that will be set for water and how this will be collected. A tariff should be set for both taps and point sources, although in the latter cases, this may be simply a monthly flat rate contribution from each household.

Each public tap or water source should have a caretaker from the local community who has clearly defined roles and responsibilities. Usually, one caretaker will deal with a single source, but this could be extended to a number of sources in some circumstances. At the back of the manual, are simple checklists for monitoring and operation and maintenance for sources that the caretaker and committee can use to make sure the work required is being carried out. What is important is that the tasks to be completed are reasonable in relation to the remuneration that the caretaker will receive. It should also be stressed, that the community as a whole and the committee in particular also have a responsibility to ensure the water supply remains in good working order and they must ensure that the caretaker has access to the tools and resources needed to maintain the water supply.

Community members can also undertake simple assessment and monitoring of their own water supplies. The checklist in Annex 5 provides a simple system for water source communities and operators to both monitor and maintain sources. If you use these forms, or develop similar forms for other water supplies, make sure that you provide training to the communities that will use them and make sure that are clear about what information they can collect and how often it is suggested that they collect this information.

4.4 Household water and the safe water chain

Water in the household is often not of the same quality as the water at the source. Recontamination of water during collection and storage often happens because the containers used are not kept clean or because they are not covered and people can put their hands into the water. To address these issues, you need to have a good idea about how people collect and store their water and what treatment of water they practice within the home.

Encouraging good handling and storage practices is an important role for health workers and the surveillance data can be very useful in supporting this as you can use the results of tests to demonstrate to people the level of contamination in their drinking water. However, always think carefully about what it is you want to say and whether the actions you would like people to take at the household level are achievable and realistic.

Of particular importance is to consider whether you should always tell people to boil their drinking water or whether this should be used in particular times of increased risk, such as a disease outbreak or heavy rains. One of the problems with always telling people to boil their water is that the impact may decrease with time and people may stop boiling water because of the cost, taste or because it is perceived as unnecessary. Boiling water is expensive – it requires a significant amount of fuel and often takes a considerable time. Once water is boiled, the household will have to wait for it to cool before it is drunk and very often the water has an unpleasant ‘flat’ taste as the oxygen has been lost. In some families, water may be boiled and then contaminated again as they pour the water between different containers to re-aerate the water to improve the taste. This may then lead to increased risks in times of greater urgency for boiling as they feel that the message is not relevant to them. Therefore, if you plan to use message about boiling water, make sure you base this on discussions with communities and households so that they understand why it is important for them to continue to boil water even when there is no epidemic.

There are some other ways in which water may be effectively treated in the home. Where water is clear, chlorine can be added either in the form of tablets in a dilute form of bleach. You should check the free chlorine content of available bleach before suggested it is used. There are now some specific household treatment units that have been developed which include both a disinfectant and a container with a tap which are often very effective in improving water quality.

In some areas, households may filter the water either through cloth or by using some form of candle filter. These methods are effective at removing pathogens such as guinea worm but may not reduce contamination from bacteria or viruses. Where candle filters are used, remember that the only types of candle filter that disinfect water are those containing halide resins (for instance iodine). Silver is not a particularly effective disinfectant. Where water is filtered and boiled, you should advise households to filter the water first and then boil it as the candles may support micro-organisms that can enter the water as it passes through the filter. Other local filters may be used, such as a three-pot sand filter which may help reduce the contamination of water but may not remove all the contamination.

Where you promote boiling, you should also consider a number of other issues that will be important in promoting a safe water chain. The first step is to advise communities on using sources that are known to be safe. By making sure that you report your surveillance findings to the community in an appropriate way, you can provide them with the information they need to make an informed choice about the source they select. This should be done both through regular reporting of findings through a local organisation as discussed earlier, and by holding follow-up meetings with the community. This approach often helps to reduce contamination of drinking water in the home as the water collected at the source is good. For instance, in one town in Uganda (Soroti), an emphasis was placed on the use of borehole water for drinking as this was the best quality at source found in the town. However, you will need to make sure that you focus on how households can keep good quality water free from contamination once they have collected it and stored it within their home.

The sanitary inspection form for household water quality helps you to assess what the major problems are. Of critical importance is to ensure that the inside of the container is kept clean as otherwise this may encourage the growth of bacteria. However, the way in which the containers are cleaned is very important. Households should be discouraged from using silt from the area around the source for cleaning as this often contains contaminated material. Where containers have a wide opening, they should be scrubbed using soap at least once per week and preferably every day. Soap is a good disinfectant and should remove most of the bacteria that may be found in the container. Where soap is not available, then ash can be used.

Where the container has a narrow opening (for instance a Jerrycan) then cleaning may be more difficult. Again, discourage practices such as using wastewater and silt from a source to clean the Jerrycan as this may actually increase the contamination. The most effective way to clean Jerrycans is to fill it with water and then add some bleach and allow it to stand for at least 30 minutes. This is likely to inactivate most of the bacteria that may be in the Jerrycan. Households should rinse the container thoroughly with clean water if this method is followed. The storage container should be cleaned in the same way at least once per week or more often if possible.

Both the container used for collecting water and the one used to store the water in the home, should be covered and the cover only removed when pouring water from the container. It is best for the household to use a container with a tap fitted as this reduces the potential for contamination as dirty hands cannot enter into the container. If such containers are not available, you should encourage households to pour water rather than scoop it from the container using a cup as this often leads to contamination when the user has dirty hands.

4.5 Health and environmental education in communities

The improvements in water sources and water stored within the home that have been described require health and environmental education programmes to be initiated within the community. Even where your organisation is undertaking rehabilitation or will fund directly the technical improvements required, it is important that this is supported by education programmes to help communities sustain source and good hygiene behaviours.

There are many approaches to health education and many methods have been developed and may be appropriate under different circumstances. However, in most cases, people are more likely to make changes in their behaviour and invest time and resources and maintaining a water supply if they have been able to discuss the issues and draw their own conclusions about the need to change or maintenance. Participatory methods of education are often the most effective in promoting behaviour change and this may cover a wide variety of aspects including household hygiene practice as well as paying tariffs for water in order to sustain the water supply.

Participatory health and sanitation transformation (PHAST) tools have been used in several countries to promote improvements in water quality. The PHAST approach emphasises the community role in decision-making and health staff act as facilitators rather than ‘teachers’ in helping communities understand and discuss problems and identify solutions. It is beyond the scope of this short manual to describe the PHAST methodology in detail ad there are other manuals that can be used to help develop these approaches. Usually training should be give to health staff when they undertake PHAST techniques as it is important to understand the purpose and methodology of the approach before trying to use them in the community.

However, the basis of PHAST is that communities and households can and will develop their own solutions to problems. Whilst the PHAST techniques are one particular way of providing the support to this process, participatory methods can be employed without using the specific PHAST tools. At a simple level, the use of community meetings for discussion and problem-solving can be effective in initiating a process of change. If this is supported by water surveillance data then this can be very effective in encouraging community-based solutions to local problems. One method of achieving this is to go with community members when you take samples and then read the plates the following morning together. This often provides a good way of illustrating the problems of water contamination in different water sources and different homes to a community and can be used as the starting point for dialogue. Whilst this process may be enhanced by using the PHAST tools, particularly when dealing with household water, you can still achieve a significant amount participatory education and decision-making.

Other methods of health education include mass media (such as radio, television and newspapers), drama, song and storytelling as well as delivery of particular messages through meetings and posters. All these methods may have advantages in promoting messages to a large audience, which is obviously not as easy when participatory methods are used.

It is important to be clear as to what you are trying to achieve and what type of message you wish to relay when using these techniques. Avoid making health messages confusing and in particular make sure the way in which you present your message can not be interpreted in more than one way. It is often useful to show people both good and bad examples as this often makes the health message clearer. For instance, if you are trying to promote the use of covered pots for drinking water, make sure it is clear that a good practice is a pot with a lid and that bad practice is a pot without a lid.

Make sure that the way in which you have presented your health education message is relevant to the target audience. For instance, there may be little point in developing a poster of the benefits of covering a clay storage pot, if everyone uses a Jerrycan to store their water. You should always try to pre-test any materials that you use to make sure that your target audience can understand the message that is being presented.

It often helps to present the same message through a variety of different media as this often reinforces an idea in the community. It is also crucial to make the messages interesting and dynamic and so you may need to update the message you are sending after some time. When a single type of message is always relayed in the same way, people may start to ignore the message as it is no longer new or interesting.

In all methods of health education, it is often a good idea to focus on the benefits to the community which go beyond health gains. Thus, when trying to promote treatment of water within the home, bringing ideas of better health providing greater opportunities to generate income or enhancing social status is often better than simply emphasising a lack of diarrhoea as a result. Don’t forget, many people may not perceive diarrhoea as being more than an inconvenience unless it is severe and life-threatening.

The content of the messages you will need to deliver will depend on the circumstances in your areas and therefore you should always think carefully about the issues and needs of communities in your area rather than just adopting materials from elsewhere. Also bear in mind that health education should not just focus on household hygiene and water handling, but also the broader environment. You may therefore, need to emphasise the benefits of a clean environment, the safe disposal of faeces and solid waste and good source maintenance practices as well as safe water handling in the home. For piped water, it may be important to emphasise the need to pay water bills to avoid disconnection and the need to report major failures in the supply (discontinuity, leaks etc) to the water supplier. The table below provides some ideas about messages you can send using surveillance data.

Focus of activity	Types of message	Surveillance data
Operation and maintenance of a water source	Point sources: maintain protection works; maintain and clear diversion ditches; clear wastewater drains; drain stagnant water; maintain fences. Taps: paying water bills; keeping area around	Sanitary inspections Water quality results Costs of water and reconnection

	tap clean; reporting faults to the water supplier	
Environmental hygiene	Clearing environment of rubbish and faeces; keeping pit latrines away from sources; keeping environment around taps clean	Sanitary inspection data
Promoting safe sources	Use of sources know to be safe for drinking and food preparation	Water quality data
Promoting safe water handling	Using clean containers; using containers with lids	Sanitary inspection data Water quality data
Promoting safe water storage and treatment	Using clean containers; using containers with lids, pouring or using a tap to get water; treatment of water	Sanitary inspection data Water quality data

Table 3: Health education message using surveillance data

It is also a good idea to build capacity within the community to monitor their water source and water handling practices. This can help the community develop their own mechanisms for ongoing sustained good operation and maintenance of the source and good hygiene practices within the home. The simple checklists at the end of manual provide one way of helping communities to monitor their own water sources. However, bear in mind that communities may have their own priorities concerning water and you may need to adapt the checklists to ensure that the approach is relevant to the needs of the community. When encouraging communities to monitor their water supply, it is important that the information generated by the community can be linked to the information generated through surveillance. Otherwise, a situation will result where one set of information is disregarded and this may limit the effectiveness of interventions.

Identifying people within the community who can acts as local health promoters is often a good way for encouraging ongoing efforts to improve health within communities. This may take time to establish and there should be a commitment from the community to support such activities, this may include paying the caretaker a small salary and providing local volunteers with support to make home visits and to address community meetings. These people can act as the main conduits for information regarding water quality and supply that you have collected through your routine activities and will become a focal point for improved environmental health within their community.