2.1 General considerations (WHO 1982)

The provision of water supplies to small communities must be considered within the context of regional plans and take into account cost, geography, technical expertise and, where appropriate, cultural preferences. Water quality is nevertheless the major consideration in designing a system and preference ought to be given to using the best quality water available. Often this will be groundwater.

Plans for new or improved rural water supply systems must always be made in conjunction with plans for adequate sewage disposal systems. This is essential to avoid, or at least minimise, the danger of contamination of water sources or resources with sewage.

With new schemes the possibility should always be considered of integration into existing supplies (following their expansion), provided the quality, quantity and reliability of these existing supplies has been proven. A second possibility that should be considered is grouping a number of villages into one system supplied from one common source. Both these approaches have the advantage of supplying water from a single large source that can be more effectively controlled and more regularly monitored. In general, the proliferation of a series of small sources must be discouraged since this will fragment monitoring and supervision.

Although no mention was made in the general discussions of self-help schemes, they are often essential in developing countries and it might be appropriate for them to be considered in some European situations as well.

2.2 Source selection (WHO 1982)

The best quality source of water available should always be reserved for potable water supplies, to avoid or to minimize the need for treatment. The prime objective must be to provide safe drinking-water, but if other needs can be met by the same source, then provision to do so may be made. Possible sources of drinking-water are listed in Table 2.1 with an indication of their suitability for supplying communities of various sizes. The sources are listed in order of probable purity, the sources of better quality water appearing first.

Groundwater: These are the preferred source of water, provided the topography is suitable. Protection of the aquifer from pollution is necessary (especially in fissured rock aquifers and karstic soils). Groundwater comes from springs, wells or boreholes, and infiltration galleries. Springs avoid the need for pumping; the year-round adequacy of their flow must be ensured; they are vulnerable to pollution so they require protection; their quality depends on the geology of the area (e.g. sandy or karstic soil) and the time of year, so expert advice must be sought; and galleries may improve the protection of the source, the yield and the reliability.

Wells and boreholes require pumping but the provision of power for pumping will ease the problems of treatment, especially disinfection; they tend to be less vulnerable to pollution since they are more protected, but expert advice should be sought; and their quality
will depend on the geology, so treatment may be necessary to remove iron, manganese, sulphur, methane and ammonia, as salinity and high amounts of dissolved solids may impair the quality. Infiltration galleries (also bank infiltration) are primarily a treatment process that can be used, depending on the water quality, as the main treatment step; they are subject to clogging and vulnerable to pollution; and the quality of water is related to the quality of the adjoining river.

Table 2.1: Applicability of sources to rural or dispersed communities (WHO 1982)

<table>
<thead>
<tr>
<th>type of source</th>
<th>Applicable to small communities (yield &lt; 2l/s)</th>
<th>Applicable to larger communities (yield &gt;2l/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring water (sandy aquifers)</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Galleries</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Deep groundwater</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Shallow groundwater</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Infiltration galleries</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>surface water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Streams and rivers</td>
<td>yes (a)</td>
<td>yes</td>
</tr>
<tr>
<td>Lakes</td>
<td>yes (a)</td>
<td>yes</td>
</tr>
<tr>
<td>Reservoirs</td>
<td>yes (a)</td>
<td>yes</td>
</tr>
<tr>
<td>direct catchment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rainwater (cisterns)</td>
<td>yes (b)</td>
<td>no</td>
</tr>
</tbody>
</table>

a) It is necessary to take into account that these types of source need the kind of treatment that may not be easily available for the smallest supplies.

b) Due to the limitations set by seasonal variation in quantity and quality, and by the storage required, the use of rainwater is not advised unless no other source is practicable.

**Surface waters**: These include streams, rivers and lakes. Surface waters are the most important source of freshwater for human use. They are more vulnerable to pollution than groundwaters; intakes should be sited upstream of known sources of pollution; the water quality can be very variable depending on seasonal factors and man’s activities in the catchment serving the source; the storage of surface water will diminish the effects of pollution, even out seasonal differences and help maintain supplies in times of drought, but may be subject to eutrophication; and treatment, especially disinfection, is considered essential to ensure drinking water quality at all times.

**Rainwater**: Its use is advised only where no better source is available; it may be vulnerable to the effects of air pollution; storage facilities must be provided; catchments and storage tanks must be protected from pollution; and it may require mineralization.

Coordination of policy is necessary between those responsible for drinking-water supply and those responsible for water resource management, so that other uses (e.g. irrigation) do not interfere with exploitation for potable water supply. This is particularly so with regard to the use of groundwaters and the effects of pollution in general. The final selection of the source is made on the basis of an evaluation of the local situation. Figure 2.1 is a flow chart of source selection.
Figure 2.1: source selection (WHO 1982)

2.3 Protecting water sources (WHO 1997)

If water supplies are to remain potable, both the source and the catchment need protection. A watershed that is used to supply untreated surface water should be sparsely inhabited (only extensive agriculture use, no grazing of cattle) and should consistently yield clean, clear water. Every effort should be made to site the abstraction point upstream sources of pollution; if this is not possible, appropriate forms of treatment must be applied.
2.3.1 Catchment protection

A survey of the catchment area should reveal potential sources of contamination. Surface waters and groundwaters are both vulnerable. Whereas raw-water reservoirs may be protected from large-scale human activity, rivers may pass through heavily populated areas and be contaminated by both domestic and industrial discharges. Groundwaters may be contaminated by the seepage of industrial wastes buried in the ground or in abandoned wells, and by chemicals discharged accidentally onto the land.

Both surface waters and groundwaters are at risk from agricultural pollution in rural areas. Where possible, protection zones should be clearly demarcated, and activities that may affect water quality should be restricted or prohibited within their boundaries. Such activities may include the dumping of toxic waste, the discharge of undesirable effluents, drilling, mining, quarrying, and the use of agricultural fertilizers and pesticides.

In some parts of the world, risk assessment of water sources and catchment areas is based on systems that take into consideration the hydrogeology, and the hydraulic loading of contaminants at and below the surface. Some governments are beginning to introduce legislation on groundwater protection zones under which housing, industrial and certain agricultural activities will be excluded from specified parts of catchment areas.

Water suppliers are beginning to recognize three protection zones for groundwater, as follows:

1. The area surrounding the source mostly at risk from contamination by pathogens. This is often the 50-day isochron (the area within which pathogens would reach the source in 50 days or less).
2. The area surrounding the source most at risk from chemical contamination. This will vary greatly and will depend on aquifer type and abstraction rate as well as on industrial and agricultural activity in the area.
3. The total catchment area.

The establishment of protection zones requires intersectoral agreements involving various authorities and ministries such as those concerned with health (surveillance), agriculture, forestry, housing, and environmental protection, as well as the water suppliers.

2.3.2 Groundwater protection

The most significant risk to human health related to drinking-water quality is from microbiological – particularly faecal – contamination. Health protection thus demands that sources of microbiological contamination are located sufficiently far from drinking-water sources as to minimize or eliminate the health risk.

When abstraction from a water source for human consumption is being considered, the minimum safe distance (MSD) for all potentially polluting activities should be fixed during the planning stage. Both surface and groundwater sources for drinking-water require protection. However, groundwater in its natural state is generally of good quality, and because subsurface water movement is relatively slow, it is usually easier to control sources of contamination of groundwater than it is for surface-water sources. For community
environmental techniques in rural areas

supplies, the most common sources of microbiological contamination are on-site sanitation and sewage-treatment facilities, open wells and other open surface sources of water, and concentrated animal husbandry.

The MSD should be determined from the time taken by contaminants to travel from their source to the source of drinking-water. This will depend on local conditions, the most important of which are the geological and hydrogeological conditions of the area, the quantity of faecal matter likely to be discharged, and the number of existing and planned sources of contamination. It is therefore very difficult to specify a universally applicable minimum distance between the location of, for instance, pit latrines and a water source. In an area where the aquifer is highly permeable and the overlying unsaturated zone thin and permeable, the MSD for a latrine will be far greater than in an area where a relatively thick and impermeable unsaturated zone overlies an aquifer of relatively low permeability.

In areas of fissured rock aquifers (where water is held in cracks and joints in the rock), the velocity of groundwater movement, and therefore of contaminants, will be high and must be taken into consideration when MSDs are set. This is particularly important for planning on-site sanitation where a thin, unsaturated zone of relatively low permeability overlies a fissured rock aquifer, e.g. in a karstic (weathered limestone) area. As the unsaturated zone is where the majority of microbial removal takes place, no direct source of contamination should come into contact with the water-table at its highest level.

The direction of flow of groundwater in an area will also influence the MSD. As a general rule, shallow groundwater movement reflects surface topography; sources of contamination should therefore be located downhill of drinking-water sources wherever possible.

The concentration of contaminating activities in the area concerned also affects the MSD and is particularly important where on-site sanitation or nonconventional sewage treatment is used. In areas where there are very large numbers of sources of microbiological contamination, such as low-income urban areas using on-site sanitation, there may be a build-up of nutrients in the unsaturated zone and, possibly, the aquifer. This may increase the survival time of microbes and so extend the MSD.

It is often difficult to obtain hydrogeological data in rural areas, and in community-based programmes it may not be possible to conduct thorough surveys in each area. An MSD can still be determined, however, although it may be less accurate than in other areas.

2.4 Wells

2.4.1 Dug wells (WHO 1997)

Open or poorly covered well heads pose the most common risk to well-water quality, since the water may then be contaminated by the use of inappropriate water-lifting devices by consumers. The most serious source of pollution is contamination by human and animal waste from latrines, septic tanks, and farm manure, resulting in increased levels of microorganisms, including pathogens. Contamination of drinking-water by agrochemicals such as pesticides and nitrates is an additional and increasing problem for small-community
Dug wells are generally the worst groundwater sources in terms of faecal contamination, and bacteriological analysis serves primarily to demonstrate the intensity of contamination and hence the level of the risk to the consumer. An on-site inspection can effectively reveal the most obvious sources of contamination, and can be used to promote well-head protection.

Various types of hand-dug wells are shown in Figure 2.2, ranging from poorly protected to well protected; all types should be included by the surveillance agency in the inventory. The upgrading of unprotected wells and the construction of protected wells for community use should be strongly promoted.

Many tens of millions of families world-wide still depend on private and public dug wells; technical assessment and improvement of these wells is therefore very important. The most common physical defects leading to faecal contamination of dug wells are associated with damage to, or lack of, a concrete plinth, and with breaks in the parapet wall and in the drainage channel. However, the most hazardous gross faecal contamination is most commonly associated with latrines sited too close to the well. Emergency relocation of either the latrines or the water source is essential when such serious problems are encountered.
Figure 2.2: different types of wells (WHO 1997)

The majority of open dug wells are contaminated, with levels of at least 100 faecal coliforms per 100ml, unless very strict measures are taken to ensure that contamination is not introduced by the bucket. A community dug well with a windlass whereby one bucket is suspended over the well in a narrow opening is an improvement on each individual using his or her own bucket. Figure 3.3 shows a sanitary concept for an open dug well.
environmental techniques in rural areas

Water quality should be greatly improved by the installation of a hand-pump and the fitting of a sanitary cover to an open dug well, access being restricted by a lockable sanitary lid, which prevents any contamination of the well by buckets. However, even this relatively costly improvement may fail to reduce contamination significantly unless the well lining is made...
watertight down to the dry-season water-table.

A dug well is usually constructed with a diameter from 90 to 300 cm. It can be dug to depths of about 60 to 80 m. A diameter of about 90 to 100 cm is necessary for one man to work in and 120 to 130 cm for two men. It has also been found that the efficiency of two diggers working together is more than twice that of a single man. (SKAT and Technology 1985)

2.4.2 Hand-pumped and mechanically pumped wells (WHO 1997)

In about 85% of cases, shallow or deep tubewells with hand-pumps and proper sanitary protection will supply water that contains few, if any, faecal indicator bacteria. Where indicator bacteria are identified, the source of faecal contamination can usually be detected by an on-site sanitary survey at and around the well-head (except where the aquifer itself is contaminated).

To ensure that the sanitary protection of a tubewell is adequate, a reinforced concrete plinth should be built on to the well-head; its diameter should be greater than that of the riser. The plinth should be sound and drained, and the hand-pump should be located and sealed in it in a sanitary manner above the surrounding plinth and ground level. A concrete apron should be laid around the well-head and plinth, at least 2 metres in diameter and sloped towards the drainage channel, which should run to a soakaway located away from the tubewell. Additional sanitary protection should be provided by fencing the well site to keep animals out.

The area immediately surrounding the tubewell should be managed in such a manner as to reduce the risk of contamination. Latrines should be located downhill from the well and a minimum of 10 metres away from it, sources of pollution, such as open dug wells, within 15 – 20 metres of the tubewell should be filled in, and animals should be kept at least 10 metres away. It is difficult to define protection zones for individual tubewells as the resources are rarely available for a full study of the properties of the aquifer or for comprehensive pumping tests.

Tubewells sometimes show evidence of persistent contamination, even though sanitary inspection has revealed few local hazards. This may be the result of aquifer contamination, which is a particular problem where fissured geological strata are combined with thin top soil, and is on the increase, notably in urban and periurban areas. Under these conditions, it will be necessary either to disinfect the water supply continuously, or to locate a deeper aquifer, sink a deep borehole, and use mechanical pumping.

Mechanical pumping from a deep borehole is a conventional technology more usually associated with urban settlements and developed countries because of the operation and maintenance requirements. The same principles of sanitary protection apply, and it is generally appropriate to define protection zones for the borehole because the output is much higher than that of a hand-pumped tubewell and can serve a greater population, the area of the aquifer exploited is correspondingly larger, and adequate resources are more likely to be available.

Drilling a borehole makes it possible to reach deep aquifers that are less likely to be affected by pollutants originating from the land or surface waters. Water from deep boreholes
environmental techniques in rural areas

is normally free from microbiological contamination and may be used by small communities without further treatment. However, certain structural precautions are essential when wells and the associated pumps are installed. The pump casing should extend approximately 30cm above ground and downwards to the parent rock. Concrete aprons and platforms should be constructed as for shallow wells, and the concrete sanitary seal should extend down into the space (annulus) between the casing and the excavation.

2.5 Springs

If a spring is to be used as a source of domestic water:

- it should be of adequate capacity to provide the required quantity and quality of water for its intended use throughout the year;
- it should be protected to preserve its quality.
Quality-Quantity
The following relationship can be taken as a criterion for the quality and quantity which is available: (SKAT and Technology 1985)

\[
\frac{\text{spring capacity in the rainy season}}{\text{spring capacity in the dry season}} = 3-5 \text{ for good spring}
\]

There is a time interval between maximum/ minimum rainfall and maximum/minimum yield of a spring. This means that the lowest yield should not be expected at the end of the dry season but 2 or 4 month later. The water temperature may also give some information about the quality of the spring: E.g. in the grass land zone of Cameroon an underground source of good quality shows a temperature of 18°C. Especially the way the water-temperature changes during a day informs about the quality of the spring. (constant temperature means good quality)

locations of springs
Geological springs normally appear
- where a low permeable stratum reaches the surface
- where two different kinds of subsoil meet
- where topsoil meets rock.

In grass-lands, springs are mainly found in valleys and along streams inside raffia bushes.
In forest areas, springs usually appear at the bottom of valleys, but it is difficult to locate them because rich vegetation covers everything.
In volcanic areas, springs can suddenly appear and disappear almost anywhere, especially during and after eruption or earthquakes.

A spring catchment (Figure 2.5) consists of the following features: (WHO 1997)
- spring box (watertight tank), which intercepts the source and extends downwards to an impermeable layer, or a system of collection pipes and a storage tank;
- a cover that prevents the entrance of surface drainage or debris into the storage tank;
- a protected overflow outlet;
- a connection to the distribution system or auxiliary supply;
- an impermeable layer (e.g. of concrete or puddled clay) behind the box and above the eye of the spring to prevent the infiltration of contaminants.

Provision must be made for the cleaning of the tank and the emptying of the contents.
Exposed springs are vulnerable to contamination from human and animal activities (WHO 1997). The usual method of protecting springs is to collect the water where it rises by enclosing the eye of the spring in a covered chamber or box with an outlet near the bottom to allow water to flow away from the original site of the spring; in this way the natural spring is disturbed as little as possible. The exact procedure will depend on the type and site of the spring. The hillside must be excavated to a sufficient depth to tap the aquifer even when the water level is low and, for a protected gravity spring, to ensure that the collected water does not exert a back-pressure on the eye of the spring. The intake structure should be designed, and the excavated area backfilled with graded gravel, to prevent the inflow of sand and silt with the water into the spring box; this will form the back wall of a gravity spring and the floor
of an artesian spring. The intake and gravel backfill should be covered by an impermeable cap (of concrete or puddled clay for example) to prevent surface-water infiltration. To ensure that the collected water is not contaminated, an adequate pipeline and storage tank, if required, should be provided.

The spring box should have a lockable inspection cover. Air vents, drains, and overflows should be fitted with mesh screens, and the whole structure surrounded by a ditch to divert surface water. Springs usually become contaminated when barnyards, sewers, septic tanks, cesspools, or other sources of pollution are located on higher adjacent land. In limestone formations, however, contaminated material frequently enters the water-bearing channels through sink holes or other large openings and may be carried along with groundwater for long distances. The following precautionary measures will help to ensure that spring water is of a consistently high quality:

- Providing for removal of surface drainage from the site. A surface drainage ditch should be located uphill from the source so as to intercept surface-water runoff and carry it away from the source. The location of the ditch and the points at which the water should be discharged are a matter of judgement, based on factors such as topography, subsurface geology, land ownership, and land use.
- Constructing a fence to prevent the entry of livestock. The location of the fence should be selected in the light of the considerations mentioned above. The fence should exclude livestock from the surface-water drainage system at all points uphill of the source.
- Providing for access to the tank for maintenance; unauthorised removal of the cover should be prevented by fitting a suitable locking device.
- Designing the cover in such a way as to prevent contamination from entering the storage tank.
- Monitoring the quality of the spring water by means of periodic checks for contamination. A marked increase in turbidity or flow immediately after a rainstorm is a strong indication that surface runoff is reaching the spring.

Artesian springs should be protected by a box with walls extending above the maximum static head; a strong sanitary cover should also be provided. To conserve water and increase the productivity of an artesian well, the casing must be sealed into the confining stratum, otherwise water may be lost through leakage into lower-pressure permeable strata at higher elevations. A flowing artesian well should be designed so that the movement of water from the aquifer can be controlled; water can be conserved if the well is equipped with a valve or shut-off device. When the recharge area and aquifer are large, and only a small number of wells penetrate the aquifer, the flowing artesian well produces a fairly steady flow of water throughout the year.
2.6 River and stream intakes (Brassington 1983)

There are significant drawbacks in using a direct intake from a river or stream as your sole water supply.

First, supply can work only if there is water in the stream. A simple way to make sure that stream water levels are always high enough is to install a low weir. This needs not to be very sophisticated at all. A length of steel pipe about 75 mm or 100 mm in diameter will control the water level.

Secondly, the supply will be vulnerable to pollution problems. Animals may drown in the stream and become wedged near your intake or there may be animal droppings which contaminate the supply. Septic tank overflows to the streams and accidental spillages are other frequent problems.

An Intake can be constructed following the principles set out in Figure 2.6.

![Figure 2.6: construction of a stream intake (Brassington 1983)](image)

Small intakes can be made extremely simple. They may consist only of a piece of pipe fitted with a strainer, which is buried in the stones in the bed of a stream. A more sophisticated alternative is to connect the pipe to a small tank buried in the stream bed like the example shown in Figure 2.8.
Figure 2.7: Sanitary inspection form for surface source (WHO 1997)

**I. Type of facility**  
SURFACE SOURCE AND ABSTRACTION

1. General information:  
   Health centre:  
   Village:  

2. Code no.—Address:  

3. Water authority/community representative signature:  

4. Date of visit:  

5. Water source taken:  
   Sample no.:  
   Thermonotolerant coliform grade:  

**II. Specific diagnostic information for assessment**

<table>
<thead>
<tr>
<th>Risk</th>
<th>Y/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Is there any human habitation upstream, polluting the source?</td>
<td>Y/N</td>
</tr>
<tr>
<td>2. Are there any farm animals upstream, polluting the source?</td>
<td>Y/N</td>
</tr>
<tr>
<td>3. Is there any crop production or industrial pollution upstream?</td>
<td>Y/N</td>
</tr>
<tr>
<td>4. Is there a risk of landslide or mudflow (causing deforestation) in the catchment area?</td>
<td>Y/N</td>
</tr>
<tr>
<td>5. Is the intake installation fenced?</td>
<td>Y/N</td>
</tr>
<tr>
<td>6. Is the intake unscreened?</td>
<td>Y/N</td>
</tr>
<tr>
<td>7. Does the abstraction point lack a minimum-head device (weir or dam to ensure minimum head of water)?</td>
<td>Y/N</td>
</tr>
<tr>
<td>8. Does the system require a sand or gravel filter?</td>
<td>Y/N</td>
</tr>
<tr>
<td>9. If there is a filter, is it functioning badly?</td>
<td>Y/N</td>
</tr>
<tr>
<td>10. Is the flow uncontrolled?</td>
<td>Y/N</td>
</tr>
</tbody>
</table>

Total score of risks:  

Contamination risk score:  
- 9-10 = very high  
- 6-8 = high  
- 3-5 = intermediate  
- 0-2 = low  

**III. Results and recommendations**

The following important points of risk were noted:  
(list nos. 1-10) and the authority advised on remedial action.

Signature of sanitarian:  

---
2.7 Rainwater catchment (Hasse 1989)

Rainwater collected from clean house roofs can be of better microbiological quality than water collected from untreated household wells. When rain falls after a long dry period, however, any rainwater collected may carry with it significant amount of contamination and debris which have accumulated on the roof and in the gutters. It is therefore recommended that the water running off the roof after the first storms of the season, and preferably for the first 5 – 10 minutes afterwards or until it runs clear, should be discarded or used for purposes other than drinking. Various devices are available for diverting this initial flow to discharge or secondary uses.

The quality of the collected rainwater can also be improved by proper maintenance of the roof and gutters, and careful cleaning at the beginning of every wet season. Some form of mesh should be placed between the guttering and the downpipe to prevent the entry of coarse debris; it then becomes important to clean the screen regularly to prevent blockage (Even a small cleanable sandfilter is advisable). The worst fouling of roofs occurs when they are situated under trees in which birds roost. In areas where malaria is endemic, care should be taken to avoid creating pools of water that could become breeding sites for mosquitos.

A rainwater storage tank should be completely covered and well maintained. If the cover is inadequate, lizards and geckos will enter and produce raised thermostolerant (faecal) coliform counts. A fine mesh fitted to all openings to the tank will prevent the entry of organic debris. Water should be drawn off by a tap located a little above the base of the tank.
The following general indicators for decision making can be given.

1. The value of rain water rises with increased distance to or inaccessibility of other water sources.
2. If rainwater remains the only source of water, rainfall patterns must be studied carefully. If the pattern shows a more equal distribution over a long observation period, it is possible to choose the size of a reservoir according to the precipitation, even on a semi-annual basis. Where the rainfall is extremely unevenly distributed with frequent drought periods, a reservoir should be as large as possible, based on the maximum rainfall. This is expensive but still economic after taking all other factors into account.
3. The purpose of water use and the amount of consumption should be analysed in advance.
4. Access to construction materials is another factor to be considered. The availability of the materials differs from region to region.
5. Life expectancy and maintenance demands are also to be considered. Table 2.2 shows different types of rainwater reservoirs.

Table 2.2: different types of reservoirs (Hasse 1989)

<table>
<thead>
<tr>
<th>Type of tank</th>
<th>construction cost (US $ per m³)</th>
<th>estimated life expectancy (years)</th>
<th>Maintenance</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>corrugated iron tank</td>
<td>About 43 decreasing to 34 with increased capacity</td>
<td>8-15</td>
<td>If used for rainwater only repainting every 5 years. Mixed use depending on the aggressiveness of pipeborn water</td>
<td>Sensitive to external damage, not to be used at public places</td>
</tr>
<tr>
<td>Ferro-cement structures</td>
<td>About 31 decreasing slightly with increased capacity</td>
<td>15-20</td>
<td>Relatively easy repair of damage, replastering after ten years exponential</td>
<td>Structure must be kept moist</td>
</tr>
<tr>
<td>reinforced brick tank</td>
<td>About 62 and above 100 m³ decreasing to 53</td>
<td>30-40</td>
<td>Minimum, replastering after 15 years can become necessary</td>
<td>Plaster must remain moist otherwise leaks occur and replastering is required</td>
</tr>
</tbody>
</table>

2.8 Water distribution

Water supply services for scattered rural populations will continue for the foreseeable future to rely on hand-pumps and hence will not normally include piped distribution. The provision of piped water supplies to rural areas through regional schemes and/or the extension of urban systems to rural areas would be appropriate, wherever feasible. However, extension of urban systems to low-income areas should not undermine the existing level of services in the urban areas already served.

Household storage of water, made necessary because of intermittent supplies, raises some problems related to health and others of a more social nature.

The need to allow for upgrading of the original designs in such cases is
environmental techniques in rural areas

acknowledged. There is general agreement that the provision of intermittent water supply systems should be discouraged on health grounds, and that those systems now operating intermittently should be upgraded to allow continuous operation as soon as possible. However, since such upgrading will take a considerable time in many developing countries, it is necessary to study the health and economic implications of existing intermittent supplies.

In-house plumbing costs should be considered when deciding on the level of water service at the planning stage. There is a need to develop low cost and easy-to-repair taps, which can be locally manufactured, for households and public standposts. Although standpost systems are well developed, there are problems with the organization and management of such systems.

There is room for the development of simple, inexpensive, and reliable water meters. Metering is considered highly desirable as a means of controlling consumption and waste, of collecting data for planning and evaluation, and of providing an equitable basis for tariff charges.

Galvanized iron, polyvinyl chloride (PVC) and polyethylene are the main pipe materials in use although asbestos-cement pipes are still used despite health concerns. Pipe cost is a primary constraint in water supplies. In European countries 60 to 80% of the costs are related to the pipes.

Contamination of the water in pipes is a problem, particularly with intermittent supplies. To minimise this problem more attention should be given to jointing and bedding techniques. There is also a need to evaluate the accessories associated with pipelines, such as pipe joints, etc. Pipe-laying in urban areas is a critical operation in view of the exposure to heavy traffic loadings, difficulty of repair, importance of leakage control, and the possibility of illegal connections. Training of qualified supervisors is essential.

In areas where piped water supplies may not be feasible in the foreseeable future there may be a need to study alternative systems for the carriage of water (for example, transport and vending of containerised water). Some attention should be given to the form of containers used for hand-carried water in order to ensure the maintenance of water quality.

Use of alternative energy sources affects the requirements for communal storage capacity. There is a need to assess alternative construction techniques and materials for storage reservoirs and elevated tanks. Standardisation of small tanks or containers for household storage is desirable on a national basis.

Literature


